T.C.
YEDİTEPE UNIVERSITY
GRADUATE INSTITUTE OF SOCIAL SCIENCES

THE FUTURE OF MODELLING AND SIMULATION FOR CONTEMPORARY ARMED FORCES JOINT TRAINING

by

Tuğrul OĞUZHAN

Submitted to the Graduate Institute of Social Sciences
In partial fulfillment of the requirements for degree of
Master of
Business Administration
İSTANBUL, 2002

T.C.
YEDİTEPE UNIVERSITY
GRADUATE INSTITUTE OF SOCIAL SCIENCES

THE FUTURE OF MODELLING AND SIMULATION FOR CONTEMPORARY ARMED FORCES JOINT TRAINING

by

Tuğrul OĞUZHAN

Supervisor

Asst Prof. Dr. Mesut Hakkı CAŞIN

**Submitted to the Graduate Institute of Social Sciences
In partial fulfillment of the requirements for degree of
Master of
Business Administration
İSTANBUL, 2002**

THE FUTURE OF MODELLING & SIMULATION FOR CONTEMPORARY ARMED FORCES JOINT TRAINING

by

Tuğrul OĞUZHAN

Approved by:

Asst. Prof. Dr. Mesut Hakkı CAŞIN --
(Supervisor)

Asst. Prof. Dr. Çetin KAYA --

Asst. Prof. Dr. Baransel ATÇI --

Date of Approval by the Administrative Council of the Institute **09/03/2002**

TABLE OF CONTENTS

Chapter 6- EFFECTIVE TRAINING WITH SIMULATIONS

LIST OF ABBREVIATONS

ACTD	Advanced Concept Technology Demonstration
ADS	Authoritative Data Sources
ADSIM	Air Defense Simulation
AFSAA	Air Force Studies and Analyses Agency
AH	Avalon Hill Company
AIS	Aggregate Level Simulation Protocol Infrastructure Software
ALSP	Aggregate Level Simulation Protocol
AP	Agile Provider
API	Application Programming Interface
AO	Area of Operation
ARTEP	Army Training and Evaluation Program
ATD	Advanced Technology Demonstration
AWSIM	Air Warfare Simulation
BBS	Brigade/Battalion Battle Simulation
BGTT	Battle Group Tactical Training
CAX	Computer Assisted Exercises
CBS	Corps Battle Simulation
CCTIs	Chairman's Commended Training Issues
CCTT	Close Combat Tactical Trainer
CINC	Commander in Chief
CJCS	Chairman Joint Chiefs of Staff
CMMS	Conceptual Model of the Mission Space
COA	Course-of-action
COFT	Conduct of Fire Trainer
CPX	Command Post Exercises
CSA	Combat Support Agency
CSS	Common Semantics and Syntax
CSSTSS	Combat Service Support Training Simulation System
C [sup 3]	Command, Control, and Communication

C4I	Command, Control, Communications, Computers, and Intelligence
C4ISR	Command, Control, Communication, Computer, Information, Reconnaissance
DARPA	Defense Advanced Research Projects Agency
DDM	Data Distribution Management
DEPTEMPO	Deployability Tempo
DIF	Data Interchange Formats
DIS	Distributed Interactive Simulation
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
DQ	Data Quality
DS	Data Security
DTO	Defence Technology Objectives
EDOK	Eğitim Doktrin Komutanlığı
EADSIM	Army's Space and Strategic Defense Command's Extended Air Defense Simulation (also called the C3ISIM)
ENWGS	Enhanced Naval Warfare Gaming System
Fedex	Federation executive
FM	Field Manual
FOC	Full operational capability
FOM	Federation Object Model
FTX	Field Training Exercises
GAO	General Accounting Office
GIE	Global information environment
GRWSIM	Grand Warfare Simulation
HLA	High Level Architecture
IDA	Institute for Defense Analyses
INFOSYS	Information Systems
IOC	Initial Operational Capability
IPC	Inter-Process Communication
IPT	Integrated Product Team
ISMT	Indoor Simulated Marksmanship Trainer

IT	Information Technologies
JAAR	Joint After Action Report
JAOC	Joint Air Operations Center
JANUS	A Series of Land Combat Models With Limited Air and Naval Operations
JECEWSI	Joint Electronic Combat Electronic Warfare Simulation
JCATS	Joint Conflict and Tactical Simulation
JCM	Joint Conflict Model
JELC	Joint Exercise Life Cycle
JEMP	Joint Exercise Management Plan
JESS	Joint Exercise Support System
JFACC	Joint Force Air Component Commander
JFC	Joint Force Commander
JFLCC	Joint Force Land Component Commander
JFMCC	Joint Force Marine Corps Commander
JMET	Joint Mission Essential Task
JMETL	Joint Mission Essential Task List
JMRR	Joint Monthly Readiness Report
JOA	Joint Operations Area
JSB	Joint Synthetic Battlespace
JSCP	Joint Strategic Capabilities Plan
JSIMS	Joint Simulation System
JTC	Joint Training Confederation
JTF	Joint Task Force
JTLS	Joint Theater Level Simulation
JTP	Joint Training Plan
JTTP	Joint Tactics Techniques and Procedures
JULLS	Joint Universal Lessons Learned System
JWARS	Joint Warfare System
JWCA	Joint Warfighting Capabilities Assessment
K.K.K	Kara Kuvvetleri Komutanlığı
MACS	Multipurpose Arcade Combat Simulator

MARFOR	Marine Corps Forces
MEF	Minimum Marine Expeditionary Force
MEU SOC	Marine Expeditionary Unit (special operations capable)
MIE	Military Information Environment
MILES	Multiple Integrated Laser Engagement System
MOOTW	Military Operations Other Than War
MOM	Management Object Model
M&S	Modelling and Simulation
MSIAC	Modeling and Simulation Information Analysis Center
MSM	Mission Space Models
M&SRR	Modeling and Simulation Resource Repository
MTGs	Master Training Guides
MTM	Model-Test-Model
MTP	Mission Training Plan
MTW	Major Theater War
MTWS	Marine Corps Tactical Warfare System
NASM	National Air& Space Warfare Model
NATSIM	National Simulation
NBC	Nuclear-biological-chemical
NCA	National Command Authority
NESS	Naval Simulation System
NGO	Non- Governmental Organizations
NMS	National Military Strategy
NWARS	National Wargaming System
NWGS	Naval Warfare Gaming System
O&M	Operations and Maintenance
OMT	Object Model Template
OPFOR	Opposition Force
OpSims	Operationally focused simulations
OPTEMPO	Operational Tempo
PDU	Protocol Data Units
PERSTEMPO	Personnel Tempo

PGTS	Precision Gunnery Training System
PVO	Private Voluntary Organizations
R&D	Research and Development
REFORGER	Return of Forces to Germany
RESA	Research, Evaluation and Systems Analysis
RTI	Run Time Infrastructure
Rtiexec	RTI Executive
SBA	Simulation-based acquisition
SETS	Squad Engagement Training System
SIMNET	Simulation Network
Sim Engine	Simulation Engine
SMART	Simulation and Modeling Anchored by Real Testing
SNE	Synthetic Natural Environment
SOM	Simulation Object Model
SSC	Small-scale contingency
STAFFEX	Staff Exercises
TACSIM	Tactical Simulation
TD	Technology demonstration
TECOM	Test and Evaluation Command
TES	Tactical Engagement Simulation
TILV	Target Interaction, Lethality and Vulnerability
TRM	Technical Reference Model
TRMWG	Technical Reference Model Working Group
TWSEAS	Tactical Warfare Simulation, Evaluation and Analysis System
UCP	Unified Command Plan
UCCATS	Urban Combat Computer Assisted Training System
UCOFT	Unit Conduct of Fire Trainer
UJTL	Universal Joint task List
VPG	Virtual Proving Ground
VR	Virtual reality
VV&A	Verification, validation, and accreditation
WARSIM	Warfighter's Simulation

WFS	Weapon Fire Simulator
TWSEAS	Tactical Warfare Simulation, Evaluation and Analysis System
WIM	WARSIM Intelligence Module

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

I would like to express my gratitude to my thesis advisor Asst Prof. Dr. Mesut Hakkı CAŞIN for his invaluable comments, his advices and help throughout my study. It was a great honor for me to study with him.

I would like to express my best regards to Prof. Dr. Doğan ALTUNER , the Director of Yeditepe University Graduate School of Social Sciences, for his support throughout the master of business administration program.

I would like to thank to Turkish War Academy Command for their support by giving the chance to use their library.

I also would like to express my best regards to Turkish Land Forces Command for providing this chance to attend the master of business administration program and improve myself.

ABSTRACT

The fast changing trends of the new century and information superiority makes the contemporary Armed Forces improve its characteristics through a vision approach. Because of that reason contemporary Armed Forces apply the joint structures and joint training system to fulfill the needs of future concepts of battlefield environment. On a battlefield environment which the battlefield tempo, decisive, initiative commanders, soldiers and technology will be the dominant players to win the victory, modeling &simulation has a lot of benefits especially for preparing the commanders and soldiers to the battlefield environment as if in real conditions; for using information most effectively and for leading the national studies by the way of testing, evaluating and following the state of art technologies within the application areas of training, analysis and acquisition.

This thesis involves the triggers of contemporary Armed Forces training needs, new battlefield concepts, the new characteristics of Armed Forces to keep up with future battlefield environment and the Joint Training System to improve Armed Forces' capabilities in the course of the above viewpoint. The application areas and benefits of modeling &simulation were analyzed thorough the findings of the researches and studies; High Level Architecture which is the last technical frame that modeling &simulation intent to apply, Interoperability concepts and Joint Simulation System, which is a single, distributed, seamlessly integrated simulation environment to conduct training in virtual environment by integrating all of the units Armed Forces, were involved in thesis.

As last, the requirements, expectations and priorities about how to apply an effective learning with simulation based training were analyzed through the viewpoint of Turkish Armed Forces' trainers and conclusions and recommendations for a further study were given according to the research model.

ÖZET

Yeni yüzyılın hızla değişen koşulları ve bilginin üstünlüğünün her alanda artması çağdaş orduların da sahip olması gereken kabiliyetleri bir vizyon yaklaşımı ile geliştirmesini gerektirmektedir. Bu sebeple, çağdaş ordular gelecek yüzyılın muharebe sahası konseptlerinin gereksinimlerini en iyi şekilde karşılayacak müşterek kuvvet yapılarını ve müşterek eğitim sistemlerini kullanmaktadırlar. Muharebe temposunun, karar verme kabiliyeti , inisiyatifi yüksek komutanların ve askerlerin ve teknolojinin muharebenin sonucunu belirleyeceği bir ortamda modelleme & simülasyonun özellikle eğitim, analiz ve tedarik alanlarında komutan ve askerleri gerçek koşullardaki gibi muharebeye hazırlama, bilginin en etkin şekilde kullanımı, ileri teknolojileri takip edip değerlendirerek milli çalışmaları yönlendirme açısından büyük faydaları vardır.

Bu tezde yukarıdaki bakış açısı altında çağdaş orduların eğitimini yönlendirecek faktörler, yeni muharebe sahası konseptleri ile çağdaş orduların kazanması gereken kabiliyetler ve bunların daha da geliştirilebilmesi için gerekli olan Müşterek Eğitim Sistemi anlatılmıştır. Modelleme & simülasyonun kullanım alanları ve faydaları daha önce yapılmış çalışmalardaki sayısal bulgularla ifade edilmiş ; teknik çerçevede ulaştığı Yüksek Seviye Mimarisi ve Geçişlilik konseptleri ile bir ordunun tüm birimlerini irtibatlayarak eğitimin sanal ortamda gerçekleştirilebildiği Müşterek Simülasyon Sistemi konsept bazında anlatılmıştır.

Son olarak simülasyon tabanlı eğitimlerde etkin bir öğrenimi gerçekleştirmek için gerekli olan ihtiyaçlar, beklentiler ve öncelikler Türk Silahlı Kuvvetleri eğiticilerinin bakış açısıyla incelenerek bir model oluşturulmuş ve bu modele göre sonuç ve öneriler ifade edilmiştir.

1- INTRODUCTION

The Armed forces exists to deter war or, if deterrence fails, to establish peace through victory in combat wherever national interests are challenged. To accomplish this, the Armed forces must be able to accomplish their assigned strategic roles. Moreover, for deterrence to be effective, potential enemies must perceive that the Armed forces has the capability to mobilize, deploy, fight, and sustain combat operations in unified action with its services and allies. Training, therefore, is the process that melds human and material resources into these required capabilities.

The forces of the future must be trained to face a wider range of threats, emerging unpredictably anywhere in the world, employing varying combinations of technology, and challenging us at varying levels of intensity. These forces must be more lethal and flexible, and joint organizations performing at all levels of war will be more autonomous, smaller, and organized at lower echelons than today's forces.

Military field training has some challenges as a result of changing world trends and their effects to military environment, the reductions in defense budgets of nations, high technology and new battlefield concepts which are a result of information superiority of new age. Modeling & simulation is an alternative method to field training especially for supporting improved capabilities of forces and decision making through applications in five main areas:

First is concept development, capability and force structure analysis, including preparedness and resourcing; second is acquisition including systems design, development, prototyping, testing and procurement; third is training including individual training and collective single service, joint and combined training; fourth is the conduct of operations, including courses of action analysis, linking strategic, operational and tactical levels of command, mission planning and rehearsal; fifth is the support to the force in being including development and testing of doctrine and tactics and systems evaluation and improvement.

1.1- GENERAL PROBLEM DEFINITION

There are a lot of reasons to use modeling and simulation. Generally, modeling & simulation is preferable especially for four reasons in training. The reasons for using simulation in training can be summarized as cost effectiveness, safety, reducing environmental effects, training effectiveness. The cost effectiveness, safety, environmental protection, which is the results of using simulation, is acceptable through the science communities.

When it is about measuring the effectiveness of training with modeling &simulation, it is easy to determine the metrics of technical areas in simulation based training. Cost savings, cost avoidance or risk reduction can be quantitative metrics for measuring the effectiveness. On the other hand functional training area effectiveness of using simulation is directly related with learning. The metrics can be defined as readiness and unique training for measuring the effectiveness of modeling &simulation in functional areas of training. Readiness is enhanced because the lower cost of training with modeling and simulation (M&S) tools increases the quantity and quality of training opportunities. Unique Training is possible with M&S because only electrons are in danger of getting killed.

The problem is about effective learning with simulations. There are a lot of large-scale simulations that are used to train the joint forces of nations currently and this number will increase for providing the future needs of battlefield environment. The simulations run in a distributed environment with high level architecture system and integrate all units of Armed Forces of nations. So that, they are more complex and costly than the training devices, simulators, and simulations of previous generations. On the other hand, priorities tend to be weighted toward engineering rather than effective learning. As a result of the ignorance about effective training environment in simulations gaps occur while trying to construct well designed simulations by engineering efforts.

1.2- OBJECTIVE AND SCOPE OF THE STUDY

As it mentioned in problem definition, to measure the learning effectiveness is not so easy with metrics. There is no single universally accepted theory of how people learn and learning can vary in different situations.

This study aims to define the expectations and priorities about how to apply simulation based training for effective learning from the viewpoint of trainers in Turkish Armed Forces and make some recommendations for effective learning with simulations. So that with further studies it may be possible to measure the learning effectiveness of simulations. To determine these priorities a questionnaire was prepared and the ideas of the randomly selected trainers in Turkish Armed Forces were asked. To prepare the questionnaire the study of Joint Simulation System Learning Methodology Working Group (JSIMS LMWG) were used as reference document. This study is given in Appendix C to familiarize Turkish modeling &simulation designers and developers with learning methodologies of JSIMS. Chapter 6 includes the analysis results of the research.

As sub- objectives of the study the followings can be found in chapters. Sub-objectives of the study were collected as literature survey from books, articles, magazines and a large internet survey.

In the study, Chapter 1 began with training needs analysis. The triggers of the training needs were defined and the effects of changing world trends and information superiority to military training were told briefly. Vision approach for providing the future characteristics of contemporary armed forces and the new concepts, which will shape the training environment of Armed forces, were told as a next step. At the end, the chapter implies that training will be more important in future for the contemporary Armed Forces and training will be more jointly in future.

Chapter 2 is about the jointness concept and Joint training system. In the Chapter the history of jointness concept was told since World War I. The vision, goals and principles of the Joint Training System were also included in the chapter. The Phases of the Joint training system was depicted as a summary with figures. The chapter implies that Joint Training System provides the commander with a process to look at all of his missions and determine which tasks are most important to those missions and Modeling & Simulation is an important way to increase the effectiveness of Joint Training System.

In Chapter 3, definitions of modeling& simulation were given at the beginning. The history of wargaming was told to define the importance of modeling &simulation coming from early ages. The technology overview of the military modeling &simulation –also called interoperability concepts- were included in the chapter to show how simulations had been improved. It can be easily understand from the chapter that the future of modeling &simulation will be designed according to High Level Architecture system and modeling &simulation will be used to train not only individual soldiers but all of the units of contemporary Armed Forces also including the allied forces of multinational operations and non- governmental, voluntary organizations through the operations other than war.

Chapter 4 aimed to tell the application areas and benefits of modeling &simulation. There are certain benefits of simulation according to the application areas. In the chapter this benefits were told through the literature survey and the outputs of the study about modeling and simulation effectiveness which was prepared by Institute of Defense Analysis (IDA) were included to show the statistical results according to the defined metrics of their methodology. This methodology was also given in Appendix A.

Chapter 5 was put into the study to introduce a new simulation system to Turkish modeling &simulation community. The Joint Simulation System (JSIMS) will have the full operational capability at 2003. In the chapter the operational requirements, general capabilities of Joint Simulation System (JSIMS) were included. The shortcomings of existing simulation systems were also told briefly. The technical architecture of the Joint Simulation System (JSIMS) is not a sub-objective of the study but a brief overview was put into the thesis. An example Joint Simulation System development scenario was given in Appendix B.

The conclusions, the recommendations, limitations and implications were included in Chapter 7.

1.3- METHODOLOGY

It is clear that defense strategies of nations are the most important part of national security strategies. As an addition, there are five factors to achieve the objectives of defense strategies: concepts, training, leadership, operations and man/material. On the other hand the idea of preparing concepts according to the produced defense technologies and weapon systems is not applicable today as a result of fast changing trends of the world and information superiority. Today, concepts of future battlefield lead the production and acquisition of new weapon systems and defense technologies.

In this study, through the above approach the triggers of training needs and new characteristics of contemporary Armed Forces were analyzed and new concepts of future battlefield were defined. The joint training system that the modern nations applied to keep up with the changing battlefield environment were included also in the study. Especially, the articles, which were published by Turkish Training and Doctrine Command and the Joint Publications, which was published by United States Joint Chiefs Of Staff, were the reference documents to analyze the training cycle of contemporary Armed Forces.

Of course, training is the best facilitation to prepare the soldiers to battlefield environment. Although training has alternative methods to apply, the most important point is achieving the objectives with limited resources and time. So that, through this viewpoint modeling and simulation was analyzed as an alternative method to increase the effectiveness of training. The studies of Defense Modeling and Simulation Office (DMSO), the articles, reports, thesis in Defense Modeling and Resource Repository, the Simulation and Interoperability Workshop documents, EBSCO articles, NATO Modeling and Simulation Group documents, Interservice/Industry Training and Simulation and Education Conference (I-ITSEC) documents, John Surdu's studies about the operational uses of simulations, the studies of Institute of Defense Analysis of about measuring the effectiveness of modeling and simulation, theses in Turkish Universities and the studies of United Sates Joint Warfighting Center about Joint Simulation System were the important documents to construct the frame of modeling& and simulation part.

As a problem, effective learning in simulation based training were determined through the study and a questionnaire was prepared to determine the expectations and priorities about how to apply simulation based training from the viewpoint of trainers in Turkish Armed Forces. According to outcomes a model was constructed and conclusions were given according to this model. The study of Joint Simulation System Learning Methodology Working Group (JSIMS LMWG) was the sole source to construct the main frame the research about the determined problem.

1.4- ANALYSING THE TRAINING NEEDS

Training facility is the best application to follow the changing trends of the world conditions and the changes in battlefield environment. These fast changes both in world trends and in battlefield environment, which are results of information superiority, creates the new concepts of contemporary armed forces. And the most important result of these concepts is applying the joint structure for armed forces to provide the overall needs of a vision approach. Vision approach is the key to define the characteristics and transformation of contemporary armed force to joint structure. And it is sure that joint training must be the strategy of contemporary armed forces to transform the whole army into an objective force structure which will provide the versatility, agility, lethality, survivability and sustainability for both inside operations and international operations and small- scale contingencies.

Whether one is an experienced or inexperienced training professional or the person responsible for 'people' issues, making her training counts is the influence of the future success of her organization and people in it. In order to do this she must be able to match all training directly to the needs of the organization and the people in it.[1] Training can be a useful tool in helping to resolve significant organizational or management problems. Management often recognizes that training in technical skills delivers real benefits, but will blanch at the thought that training in non-technical areas can also be of great value. If it could be proved that the results of training in high-level inter-personal skills or problem-solving skills could be measured, the trainers would be taken more seriously by their potential customers.[2]

If training is to be valued within a company, then it must be possible to demonstrate a link between training provision and the performance of the company balance sheet.[3]It is obvious that the real benefit of training can be explained as having the ability of preparing any organization for future and leading to apply the best methods and applications for

---

[1] Bartram, S. and Gibson, B., 1997, Training Needs Analysis: A Resource for Identifying Training Needs, Selecting Training Strategies, and Developing Training Plans 2nd ed, Introduction Part, Anthony Rowe Ltd., Chippenham, Wiltshire, pp 1

[2] Bedingham, K., 1997 "Proving The Effectiveness of Training", Industrial and Commercial Training, MCB University Press, pp 88-91

[3] Hedges, P. and Moss, D., 1996, "Costing the Effectiveness of Training: Improving Driver Performance", Industrial and Commercial Training, MCB University Press, pp 14-18

catching the real success and performance at anytime. In a short summary, the benefits of training can be listed as below:

- Reduction in Cycle Time
- Improved Quality
- Increased Performance
- Reduced Errors
- Cost Effectiveness

Training needs can be obvious or can be obtained from analyzing the performance. Especially acquiring the knowledge and skills of the job to beginners with little or no experience is the obvious form of training. But when it is about the people who are doing their job for a long time and are component what they do, training is derived from analyzing their performance to identify the aspects that could be improved or to find the potential that is not being used properly. Even when training needs to be appearing obvious, it is still necessary to analyze the specific knowledge and skill requirements in order to choose appropriate methods that will meet them. Because training and development is an investment, it is important to treat it as investment made in machinery, new technology or premises.[4] So that the triggers must be defined in a wide spectrum for training needs. Barbara and Gibson define these triggers as in Table 1.1 [5]

The triggers are directly related with happenings in the organization, external influences to the organization and negative indicators that causes serious problems for the organizations. It is almost same for all organizations and implies that there may need to make some changes in organizations environment. If the triggers can be determined very well, preparing the training content will be easier and the training investment will be more meaningful and effective.

---

[4] Bartram and Gibson, 1997 Training Needs Analysis: A Resource for Identifying Training Needs, Selecting Training Strategies, and Developing Training Plans 2nd ed, Part I, Anthony Rowe Ltd., Chippenham, Wiltshire, pp 1-5

[5] Ibid, Part I- 8

Table 1.1- The Triggers of Training Needs Analysis

QUESTIONS	*NOTES*
•. What is happening in your organization that might be a trigger for training needs analysis? - Taking on new people - Internal promotions or transfers - New procedures and systems - New standards - New structures and relationships - New products - New customers - New equipment - Appraisals - Requests from: your manager, senior managers, individuals - Review of previous training plans - Involvements in initiatives such as Investors in People - Downsizing - Commitment to training for specific employees, e.g. graduates - Succession planning activities - Feedback from training events •Are there any negative indicators in your organization that might be additional triggers? Negative indicators include: - Customer complaints - Increasing numbers of grievance and/ or disciplinary situations - High turnover of new recruits - Loss of customers - Increasing turnover of experienced employees - Disputes - Standards of work not being achieved - Increase in waste/rejects/errors - Higher incidence of sickness or absence - Decreases in productivity /output - Low response rates to internal job vacancies • What external influences are there on your organization that might be further triggers? External indicators include: - New legislation - Changes to legislation - Customer requirements - Competitor activity - Supplier activity - Professional body - Regulations/requirements	*Look out for links between the triggers. For example, could the increase in turnover of experienced employees be having an effect on loss of customers? Add to this the new recruits and it is likely there is increasing pressure on managers. Perhaps this is affecting how they manage? Look at the disciplinary matters and check appraisals for comments about this.*

Source: Bartram and Gibson, 1997 Training Needs Analysis: A Resource for Identifying Training Needs, Selecting Training Strategies, and Developing Training Plans 2nd ed, Part I, Anthony Rowe Ltd., Chippenham, Wiltshire.

The most important role of Armed Forces is the deterrence. Armed Forces must establish peace in the battlefields if national interests are challenged. To accomplish this, the Armed forces must be able to accomplish their assigned strategic roles, which are defined according to the National Security Strategies. Moreover, for deterrence to be effective, potential enemies must perceive that the Armed forces has the capability to mobilize, deploy, fight, and sustain combat operations in unified action with its services and allies. Training, therefore, is the process that melds human and material resources into these required capabilities. Training will be stone of combat as the Army’s top priority because it is the corner stone of combat readiness So that the Armed forces training needs must also be developed and analyzed through these triggers.

According to Tınaz, when the armed forces training needs are analyzed, the triggers that will be important for defining the army’s future training are[6]:

- The ratio of military budget in national budget
- The few probability of a war among the overseas nations.
- The limitations for applying the field training exercises and lethality training because of the increases in the population which creates urban and environmental problems and affects the sensitivity of people.
- The idea of composing multinational joint forces among the democratic and peacekeeping countries, the importance of command and control of these forces by applying the joint and multinational training.
- The probability of using space in a higher ratio than past.
- The budget, which will be used for research & development to follow the technological developments about the training methodologies, systems, tools and services.
- The probability of using the same training tools both in wartime and peacetime.

---

[6] Tınaz, E., 2000, “Eğitim-Öğretim Konsepti-2020”, Hedef 2020 ve Ötesi, Özel sayı, T.C. K.K.K Eğitim ve Doktrin Komutanlığı, Ankara, Sahife35-38

The triggers for the army training needs must include the above items but generally to define the army training needs, the future trends of changing world conditions and the key elements, which will influence the army training as a trigger, must be examined together. After these analyses the goals, the methods, the policies, and the tools must be clarified.

1.5- THE FUTURE TRENDS OF CHANGING WORLD

To evaluate the future trends of changing world the key drivers must be identified. Some of the greatest changes in the nature of war have not been the result of a technological innovation at all. They have been the result of massive political, economic, and the social developments in the structure of society as a whole.[7]

Technology is a term that can be difficult to come to grips with. Technology infers research and development with practical aims and objectives. Political and military aims, at least strategic and operational levels, ought not to be dictated by technology. More appropriately, technologies should be pursued to meet, and therefore subordinate to political and military objectives. Still, it must be noted that, strategy without suitable tactical instruments is simply a set of ideas.[8] The key drivers, which will shape the world of future, can be listed as:

Demographics: The fast growth of population and urbanization are the most important factors for this key driver. The growth of population must be also thought for defining the training needs of army. The increase of lifespan and growth will result in two ways: Firstly in developed countries, declining birth-rates and aging will combine to increase health care and pension costs while reducing the relative size of the working population, straining the social contract, and leaving significant shortfalls in the size and capacity of the work force. Second result in developing and undeveloped countries, these same trends will combine to expand the size of the working population and reduce the youth bulge—increasing the potential for economic growth and political stability.[9] The lack of adequate numbers of jobs in countries with burgeoning youthful populations is creating widespread social

---

[7] Howard, M., 1973, "Military Science in Age of Peace", War Theory and Campaign Study Department, U.S. Government Printing Office, Alabama, 1996

[8] Alley, Anthony D., 1994," Forecasting Military Technological needs", edits in Challenge and Response by Dr. Karl P.Magyar, Air University Press, pp209-219

[9] National Intelligence Council 2000, Global Trends 2015: A Dialogue About the Future With Nongovernment Experts, Available on site http://www.cia.gov/cia/publications/globaltrends2015

discontent. Worldwide, an estimated sixty million people between the ages of fifteen and twenty-four already cannot find work. The pressure on labor markets is bound to intensify with strong population growth. The phenomenon of legions of young adults and adolescents with uncertain and often poor prospects for establishing a livelihood may be one of the greatest threats to political stability anywhere-triggering criminal behavior, feeding discontent that can burst open in street rioting, or fomenting political extremism.[10]

On the other hand the growth of population means the urbanization. The army applies its field training in large areas and the urbanization will create a great reduction in these areas. So that it will be very important for applying the field training facilities in future. Live training will be more difficult than past and because of that reason modern techniques such as modeling and simulation will be used to prevent the lack of live training exercises.

Natural resources and environment: Food, energy, water scarcities and allocation of these sources can be listed in this key driver. The purpose of warfare is to cause a change in the behavior of an opponent. The mechanism of warfare throughout time has ranged from rocks to spears to muskets, to armored divisions, to chemical weapons, to airborne platforms. Warfare, also taken the form of economic sanctions, blockades, and the freezing of the assets of foreign governments held in another nation state. There is a next step –an intensity of economic warfare over artillery or tank warfare, aggressiveness in economic warfare without large losses of human resources. [11] So that disrupting an opponent's economy will affect the ability of its infrastructure system to support its military forces and to provide the nation with organic essentials (energy, food, water and other natural resources or imported ones) and infrastructure (highways, ports, and railroads. Such disruptions will lead the military forces to more training facilities to win the warfare as if an economic sanction will happen in future.

Science and technology: The continuing diffusion of information technology, new applications of biotechnology, and the development of weapon technologies; on the other hand the high probability of use of these technologies by Disaffected states, terrorists, proliferators, narcotraffickers, and organized criminals are the important subjects while

[10] Renner, M., 2000, "Alternative Futures In War and Conflict", Naval Warfare College Review, Vol. LIII No.3

[11] Arnold, David H., 1994, "Economic Warfare -Targeting Financial System As centers of Gravity", edits in Challenge and Response by Dr. Karl P.Magyar, Air University Press, Alabama, pp345-362

thinking this key driver. Technology diffusion to those few states with a motivation to arm and the economic resources to do so will accelerate as weapons and militarily relevant technologies are moved rapidly and routinely across national borders in response to increasingly commercial rather than security calculations. For such militarily related technologies as the Global Positioning System, satellite imagery, and communications, technological superiority will be difficult to maintain for very long. In an environment of broad technological diffusion, nonmaterial elements of military power—strategy, doctrine, and training—will increase in importance over the next 15 years in deciding combat outcomes. [12]

While the weapon systems are developing at the same time the anti-weapon systems like non-lethal weapons, antimissile, antitank systems are also developing and as a result of the development of anti-weapon systems the human factor and the capabilities of soldiers which are gained from training will be effective for most of the operations.

The global economy and globalization: The networked global economy will be driven by rapid and largely unrestricted flows of information, ideas, cultural values, capital, goods and services, and people. The globalization, national and international governance will also create the needs for new structures, material, and new training methods, tools for the army. The economy will be the real driver for adopting the new structures, material and tools into army so that cost effectiveness will play a great role for the transformation of army in future. Especially while defining training methodologies the cost effective systems like simulation and modeling will replace the live training facilities.

National and international governance: Governments will have less and less control over flows of information, technology, diseases, migrants, arms, and financial transactions, whether licit or illicit, across their borders. Nonstate actors ranging from business firms to non-profit organizations will play increasingly larger roles in both national and international affairs. The quality of governance, both nationally and internationally, will substantially determine how well states and societies cope with these global forces.

[12] National Intelligence Council 2000, Global Trends 2015: A Dialogue About the Future With Nongovernment Experts, Available on site http://www.cia.gov/cia/publications/globaltrends2015

Prolonged wars/conflicts (both domestic and international) inflict heavy material, social political, and psychological damage, and take heavy toll on human life but rarely accomplish the intended goals of participants. Frequently, there are no victors or vanquished in the traditional meaning of these terms. In some cases, a participant may realize its goals and objectives not sorting a decisive military defeat over its opponent but through the other party's decision to cut its losses and to withdraw from the conflict, rather than risk additional loss of life or further economic and social damage.[13]

As it mentioned above the probability of conflicts and wars among the developed countries will be law and the factor of having dynamic relationship with allies to defeat the war probability will create being in the standards of allies and that will be possible mostly by training applications.

Future conflicts: The risk of war among developed countries will be low. The international community will continue, however, to face conflicts around the world, ranging from relatively frequent small-scale internal upheavals to less frequent regional interstate wars. Internal conflicts stemming from religious, ethnic, economic or political disputes will remain at current levels or even increase in number. Asymmetric threats like terrorism in which state and non-state adversaries avoid direct engagements with the military but devise strategies, tactics, and weapons to minimize strengths and exploit perceived weaknesses will play a great role in future. Strategic weapons of mass destruction which includes also nuclear missile threats will be important for defining the balance of power and the countries will go on spending to keep up with this balance.

Like the most of the periods of past during the information age the wishes and intends of human will lead the warfare activities. Whatever the high rate of technological diffusion in information age increases, the fact that these technologies will be used by the soldiers of the army must not be forgotten. So that in future the Discipline, Morale and Training must be the most important factor for the success of leaders and soldiers in war.[14]

---

[13] Magyar, Karl P. and Danapoulos, Constantine P., 1994,Prolonged Wars-A Post Nuclear War Challenge, Tentative Observations and Conclusions, U.S. Government Printing Office, pp 449

[14], Kurul, S., "Eğitim-Öğretim Konsepti-2020", Hedef 2020 ve Ötesi, Özel sayı, T.C. K.K.K Eğitim ve Doktrin Komutanlığı, Ankara, Sahife 15-21

The future trends are the beginning point of expressing the training needs for a contemporary army. These trends will shape the main frame of defining ideas for the future years. To understand the effects of the future trends in changing world, the key elements, which will construct the main body for a contemporary army approach, must also be analyzed. Shaping the training environment for the army according to these key elements will have the great role to have the success on battlefield for the future years. These key elements are mostly important for composing the military strategy but the fact that military strategy is a sub- part of national interests is enough to explain the combination of ideas to show a whole picture of a country's future approaches.

1.6- INFORMATION SUPERIORITY

Sun Tzu reminds us, "Know the enemy and know yourself; in a hundred battles you will never be in peril." His timeless wisdom is about information superiority.[15]

Information environment is the aggregate of individuals, organizations, and systems that collect, process, or disseminate information, including the information itself. [16]

Information superiority is the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same. Information superiority is achieved in a noncombat situation or one in which there are no clearly defined adversaries when friendly forces have the information necessary to achieve operational objectives.[17]

Throughout history, possessing a relative information advantage has been integral to success in combat. Leaders have always struggled with the need for accurate and timely information about the nature of the operations area, their own force, and the enemy. Likewise, leaders have actively sought to deny the enemy accurate or timely information or deceive him through misinformation to seize and sustain a relative information advantage. From Sun Tzu's parables of ancient Chinese battles in The Art of War through the use of a relatively complex and sophisticated network of sensors and processors employed during

---

[15] Joint Chief of Staff, 1997, Concept For Future Operations- Expanding Joint Vision 2010, Chapter 5, May 1997, pp 35

[16] Joint Chiefs of Staff, 2000, Joint Vision 2020, US Government Printing Office, Washington DC, June 2000, pp 7

[17] Ibid, 7

the Persian Gulf Conflict, history is rich with examples of victories enabled by having an information advantage. Today, however, information-specific technologies are providing an unprecedented capability to know oneself and the enemy and to establish information superiority as the primary enabler of a new era in warfare. However, it must be borne in mind that war itself is a human enterprise—a complex struggle of independent wills. Despite the revolution in information technologies, uncertainty will remain a fundamental characteristic of warfare.

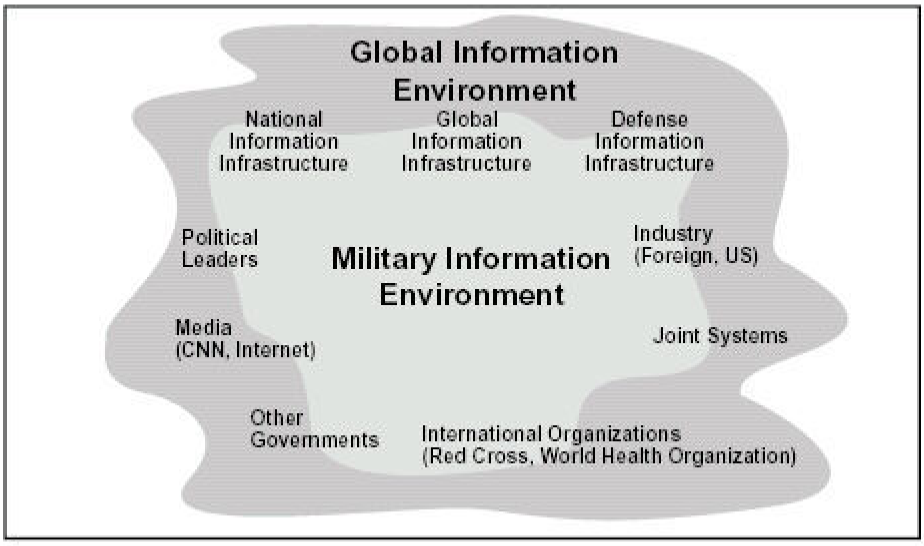

Figure 1.1 - Information Environments (GIE and MIE)
Source: Field Manual 100-6 Information Operations, Headquarters, Department of The Army, Washington DC, 1996

The global information environment includes (GIE) all individuals, organizations, or systems, most of which are outside the control of the military or National Command Authorities, that collect, process, and disseminate information to national and international audiences. All military operations take place within the GIE, which is both interactive and pervasive in its presence and influence. Current and emerging electronic technologies permit any aspect of a military operation to be made known to a global audience in near-real time and without the benefit of filters. With easy access to the global or national information network, suppression, control, censorship, or limitations on the spread of information may be neither feasible nor desirable (see Figure 1.1).[18]

[18] Department of the Army Headquarters, 1996, Field Manual 100-6 Information Operations, Washington DC, pp 1-4

The sphere of information activity called the military information environment is defined as[19] the environment contained within the GIE, consisting of information systems (INFOSYS) and organizations—friendly and adversary, military and nonmilitary, that support, enable, or significantly influence a specific military operation.

The Military Information Environment (MIE), at a minimum:

- Reaches into space from the home station to the area of operation (AO).
- Reaches into time, from the alert phase through the redeployment phase.
- Reaches across purposes, from tactical missions to economic or social end states.
- Includes people, from deployed soldiers and families at home to local or regional populations and global audiences.

The pressures to downsize the military after cold war sparked an increased demand for information technology as a way to leverage the efficiencies of computers, computer networks and information systems against the need for people. As a result, there is not functional area-operations, intelligence, weather, communications, engineering, logistics, services, security etc. that doesn't rely extensively on information systems to get their day-to day jobs in past now uses the information technology as a real need. While information systems have made process more efficient, one unintended consequence is that there are no longer enough people to get the job if these information systems fail. But because of today's complex and austere resource environment, it appears there is no going back. So that information systems must be placed to strategic and operational centers of gravity because of the reliance on technology. The most important effect of information superiority is the transformation of battlespace functions- maneuver, strike, and protection, logistics- in to new operational concepts.

The technological innovations as seen in figure can be overlaid skillfully over the current concepts of battlespace to achieve improved and more powerful warfighting capability. But as shown in Figure 1.2 (see next page), the information environment of today is very

[19]Department of the Army Headquarters, 1996, Field Manual 100-6 Information Operations, Washington DC, pp 1-4

complex and each partner in the environment has a relation with each other. So that trying to improve the current concepts with only technological innovations is not enough. The concepts must be composed at operational and strategic levels by the help of information superiority

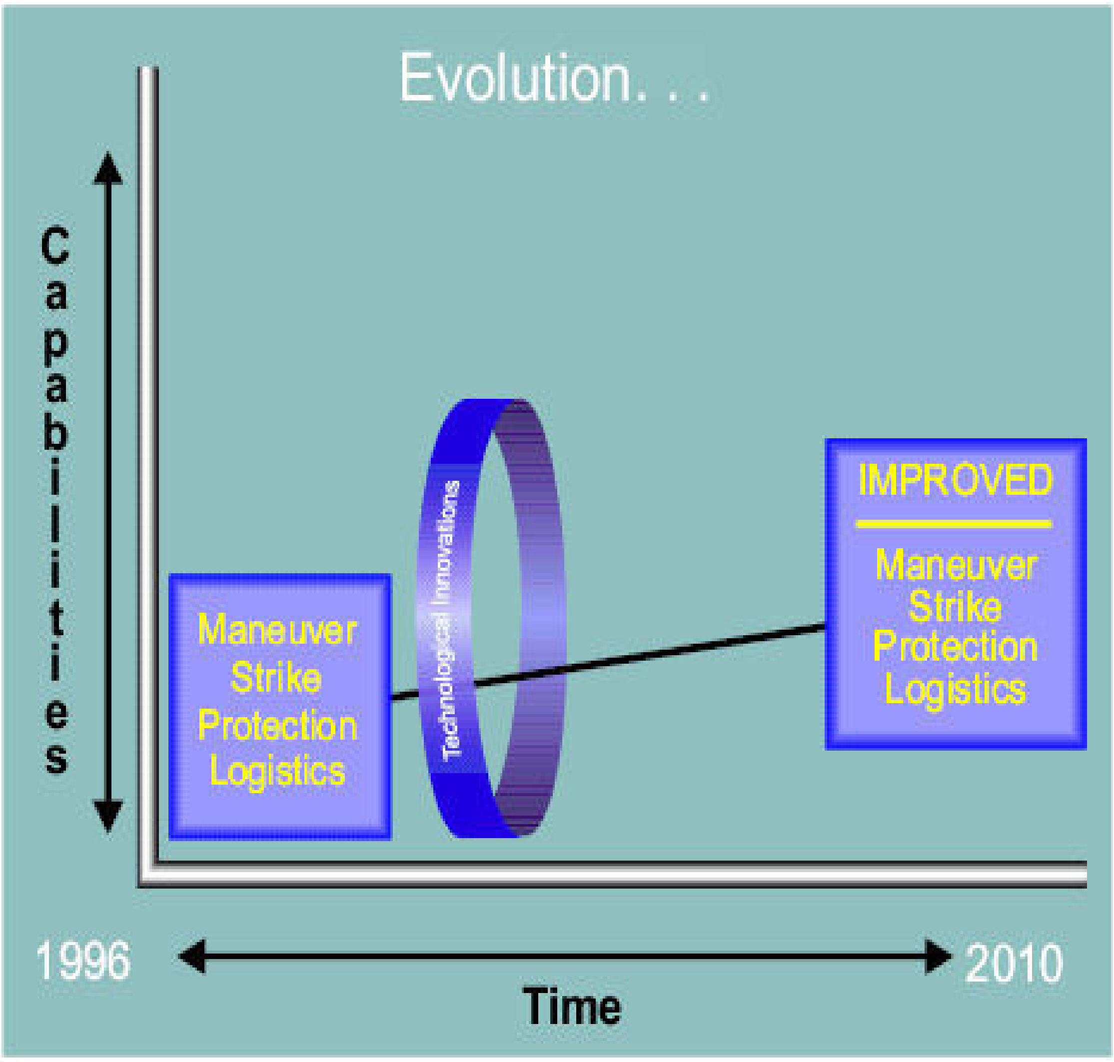

Figure 1.2- Evolutionary Trend

Source: Joint Chief of Staff, Concept For Future Operations, May 1997

By using the information superiority as shown in Figure 1.3 (see next page), the army will have the chance of projecting all in GIE and MIE so that as a new approach, the current concepts will not try to be improved by only technological innovations but also by all of the information environment effects. As a result new concepts – Dominant maneuver, precision engagement, full dimensional protection, focused logistics- will occur and with these full integrated concepts the army will have more powerful capabilities than past. As lastly to apply these integrated concepts the joint force structure and joint training must be adapted to contemporary armed forces.

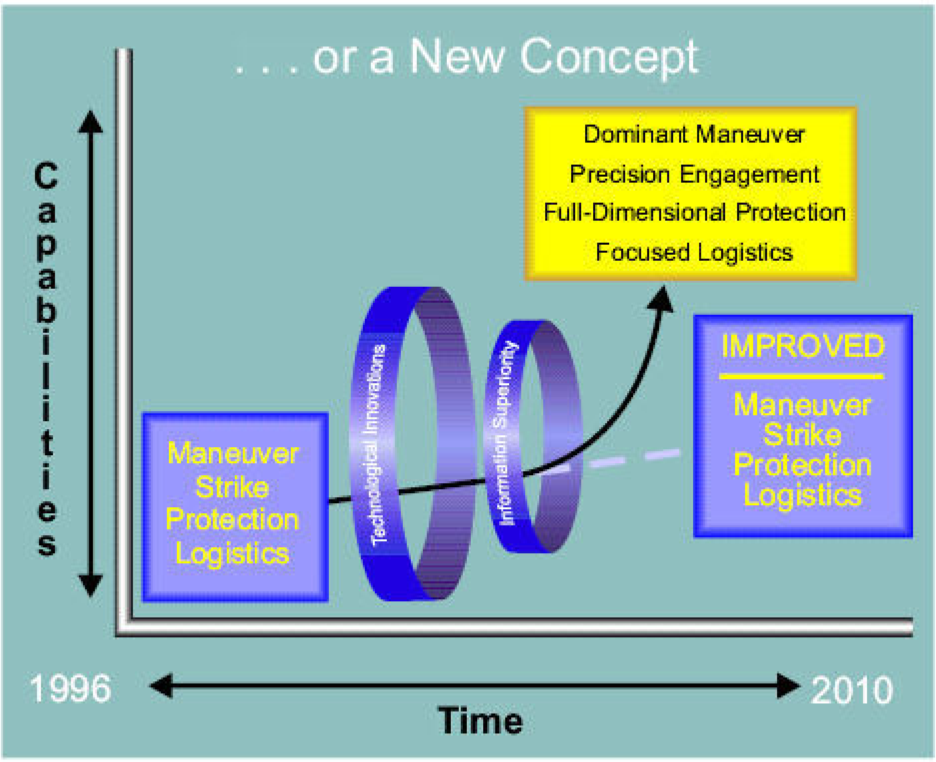

Figure 1.3 - A New Conceptual Framework

Source: Joint Chief of Staff, Concept For Future Operations, May 1997

1.7- A VISION APPROACH TO CONTEMPORARY ARMED FORCES TRAINING

In future, the modern nations will face a wide range of interests, opportunities, and challenges and will require a military that can both win wars and contribute to peace. The global interests and responsibilities of these nations will endure, and there is no indication that threats to those interests and responsibilities, or to the allies, will disappear. The strategic concepts of decisive force, power projection, overseas presence, and strategic agility will continue to govern the efforts to fulfill those responsibilities and meet the challenges of the future. The vision approach builds upon guiding the continuing transformation of contemporary Armed Forces. The primary purpose of those forces has been and will be to fight and win the Nation's wars. So that, Armed Forces must be faster, more lethal, and more precise in future than they are today and as a result modern countries must continue to invest in and develop new military capabilities. So that vision describes the ongoing transformation to those new capabilities. This new capabilities can be defined dependent upon realizing the potential of the information revolution, today's capabilities for maneuver, strike, logistics, and protection.

To implement the Vision, the Armed forces must transform itself as rapidly as possible, while maintaining focus on warfighting readiness and taking care of its people. The challenge is about maintaining a trained and ready force capable of decisively executing the National Military Strategies and winging the Nation's wars while, at the same time, pushing ahead with the transformation process.[20]

The development of asymmetric and differential strategy is required by the change in the range of potential military operations facing the armed forces in the emerging international security environment and the constraints consequent of both downsizing and the ever increasing costs of traditional platforms.[21] The security environment can be described more expansively as a range of high or low end global competitors, high or low end regional competitors,[22] counter-insurgency, peace or humanitarian operations, dangerous industrial activities, weapons of mass destruction proliferation, collapsing or disintegrating states, and nonstate terrorism.[23]

After analyzing the three ideas in above paragraph the, joint force, because of its flexibility and responsiveness, will remain the key to operational success in the future. "We should not expect opponents in 2020 to fight with strictly 'industrial age' tools, Our advantage must ... come from leaders, people, doctrine, organizations and training that enable us to

---

[20] The 2001 US Army Modernization Plan, Military Technology Volume XXV Issue 10-2001,pp10-25
[21] Hitches, T., 1996, "Lawmakers Call '97 Clinton Plan Unrealistic," *Defense News*, 11-17 March 1996, pp 14.
[22] Glashow, J., 1996, "Regional Powers May Gain Clout," *Defense News*, 11-17 March 1996, pp 36.
[23] Board of Directors, USAF Long Range Planning, 1996, "Future Operating Environments," Briefing Slides 29 February 1996, Slide 33.

take advantage of technology to achieve superior warfighting effectiveness."[24] So that the vision approach must describe in broad terms the human talent – the professional, well-trained, and ready force – and operational capabilities that will be required for the joint force to succeed across the full range of military operations and accomplish its mission in future.

The forces of the future must be trained to face a wider range of threats, emerging unpredictably anywhere in the world, employing varying combinations of technology, and challenging us at varying levels of intensity. These forces must be more lethal and flexible, and joint organizations performing at all levels of war will be more autonomous, smaller, and organized at lower echelons than today's forces.[25]In describing those capabilities, the vision must provide a vector for the wide-ranging program of exercises and experimentation being conducted by the Services and combatant commands and the continuing evolution of the joint force.

" The main reason for being unsuccessful during the war and peace time operations in military arena is the uncalculated changes of future, and being indifferent to these changes."[26](Cohen and Goach, Military Misfortunes)

It is important that the difference between battle development and force development must be understood clearly. Force development is the way of forming the appropriate structure and systems for Armed forces according to the threats and national resources. On the other hand battle development includes the modernization of doctrine, training, leader, organization and soldier development to build up a better and more effective force structure in future years. So that, a vision approach is the best source to create contemporary Armed Forces according to the national and military strategies in future years.

The Vision's goal is to ensure that the Armed Forces fulfill its responsibilities in continuously meeting the National Military Strategy. To do this Armed Forces must

---

[24] Joint Chiefs of Staff, 2000, Joint Vision 2020, US Government Printing Office, Washington DC, June 2000, pp 5

[25] Joint Staff, 1999, Joint Training Policy For The Armed Forces Of United States, CJCSI 3500.01B, 31 December 1999, Washington D.C., pp A-2

[26] Bütün, M.O., 2000, "2020 için Muharebe Geliştirme", Hedef 2020 ve Ötesi, T.C. K.K.K EDOK Özel sayı, Sahife 24

transform itself into a full spectrum force more capable of dominating at every point on the spectrum of operations. The Objective Force approach by applying a vision approach can meet the challenges of the future by providing the Nation with an contemporary Armed Forces that is more responsive, deployable, agile, versatile, lethal, survivable, and sustainable. This force must be capable of reversing the conditions of human suffering rapidly and resolving conflicts decisively.

These characteristics of the Objective Force are complementary features that together produce an overall capability greater than the individual capabilities they describe. The characteristics arise from the Vision's goal and the likely shape of the future international security environment. In turn, they provide the analytical foundation for developing the concepts, doctrine, and systems that will constitute the Objective Force. Figure 1.4 describes the Objective Force characteristics and aims to achieve full spectrum dominance:

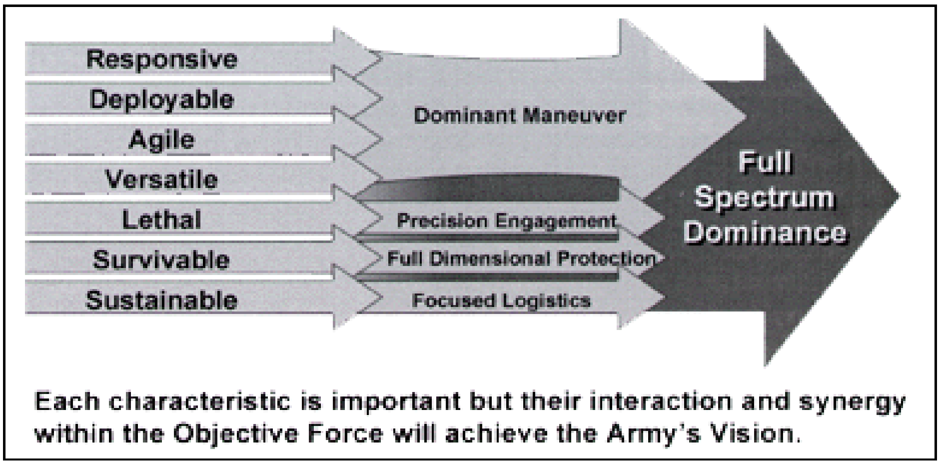

Figure 1.4 - Full Spectrum Dominance

Source: United States Army Posture Statement FY01, Chapter 2, The Army Vision, Available at http://www.army.mil/aps/aps_ch2.htm)

The Objective Force must be responsive to allow the Armed forces to meet frequent contingency requirements with any element of the force. To be responsive requires the ability to put forces where needed on the ground, supported by air and naval forces, to directly affect the outcome of the situation or crisis at hand within hours of a decision. The forces deployed must be prepared to accomplish their mission regardless of the environment, the nature or scope of the proposed operation, or other commitments. They should have a demonstrated capability to deter the prudent adversary, as well as to influence and shape the outcome of the crisis. If required, they should have the ability to employ force from low to high-intensity. Responsiveness applies to more than just operational forces; the entire mobilization process must be responsive in order to ensure the availability of the entire force in a timely manner.

To achieve this responsiveness, Objective Force units must be deployable. These units must be capable of rapid strategic movement to create the opportunity to avert conflict through deterrence and confront potential adversaries before they can achieve their goals. The Objective Force requirement is to have a combat brigade on the ground within 96 hours after lift-off, a division within 120 hours, and five divisions within 30 days. Within a theatre of operations, Army forces must be able to reposition rapidly to create and exploit advantage. The Army must reduce the size of its systems to attain the desired level of strategic and intra-theatre deployability.

Responsiveness and deployability can be achieved in part through the lighter formations, reductions in deployment tonnages, improved military and civilian force projection platforms, advanced en-route planning/rehearsal tools, and simplification and reduction of reception, staging, onward movement, and integration requirements. Responsiveness is also improved through force design and organizational principles that permit commander to rapidly tailor and deploy the appropriate force for each contingency and transition to other forms of operations when battlefield conditions change.[27]

Because of the broad range of missions that will be assigned to armed forces, often in highly volatile situations, Armed forces must be able to shift intensity of operations without augmentation, a break in contact, or additional training. Today's forces possess the agility to shift seamlessly from offensive to defensive to offensive operations on the battlefield. Agility is the ability to move and adjust quickly and easily. It springs from trained and disciplined forces. Agility requires that subordinates act to achieve the commander’s intent and fight through any obstacle to accomplish the mission.[28] The

[27] The 2001 US Army Modernization Plan, Military Technology Volume XXV Issue 10-2001,pp 10-25
[28] Department of Army Headquarters, Field Manual 3-0, Chapter 4 –Fundamentals of Full Spectrum Operations, Available on site http://www.adtdl.army.mil/cgi-bin/atdl.dll/fm/3-0/ch4.htm

Objective Force must replicate that same agility in a much broader, full spectrum context within entire theatres of operation. These forces will frequently be called upon to transition from non-combat disaster relief to low-intensity contingencies to high-intensity warfighting with little or no time to change mindset or organizational design. The agility to make these transitions without losing momentum is a function of army's people. The Armed forces must develop it through leadership and training.

Versatility is closely related to agility, but it is a function of force organization and equipment. The elements of the Objective Force must be adaptive to changing situations and must have utility across the spectrum. This will allow the Armed forces to respond when needed and rotate forces in and out to relieve operational tempo (OPTEMPO) and personnel tempo (PERSTEMPO). The frequency and duration of small-scale contingency (SSC) operations leave neither the time nor the forces for overly specialized units or extensive reorganization and preparation for specific missions. The Armed forces cannot sustain the operational and personnel tempo of the broad range of crisis response, SSC operations, and sustained commitments with only part of its force.

Versatility is the ability of Armed forces to meet the global, diverse mission requirements of full spectrum operations. Competence in a variety of missions and skills allows Armed forces to quickly transition from one type of operation to another with minimal changes to the deployed force structure. Versatility depends on adaptive leaders, competent and dedicated soldiers, and well-equipped units. Effective training, high standards, and detailed planning also contribute. Time and resources limit the number of tasks any unit can perform well. Within these constraints, commanders maximize versatility by developing the multiple capabilities of units and soldiers. Versatility contributes to the agility of Army units.[29]

Therefore, the Armed forces must have the ability to commit all of the force in its turn, regardless of component, to meet operational demands, even if those demands are for distinct operations in different areas of the world. All Armed forces must have the built-in organizational flexibility to respond.

---

[29] Department of Army Headquarters, Field Manual 3-0, Chapter 4 –Fundamentals of Full Spectrum Operations, Available on site http://www.adtdl.army.mil/cgi-bin/atdl.dll/fm/3-0/ch4.htm

An overwhelming ability to win through application of lethal force can frequently preclude conflict by making the adversary's potential losses disproportionate to his objectives. Lethality must be embedded in every force and unit. They must all have the ability to transition from peace to war and access joint capabilities easily without a break in momentum. Even in a seemingly benign environment, armed forces cannot ignore the possibility of a chance encounter with hostile elements, whether because of a sudden, unforeseen change in the situation or from radical factions determined to undermine the peace. The consequences of the inability to apply appropriate lethal effects are not just unnecessary loss of life, but could include significant political and operational changes in the environment. Furthermore, lethality signals to adversaries the potential consequences to them of their willingness to escalate the conflict.

As armed forces continue to operate in harm's way, it is crucial to their confidence that we take all possible measures to protect the force and ensure its survival. Survivability also affects the perceptions of adversaries about their ability to fight and win against armed forces. But the survivability of the Objective Force must extend beyond combat operations across the full spectrum of operations, and it must address current and emerging asymmetric capabilities. To meet these challenges, the Armed forces must have modern equipment that incorporates new technologies to meet mission requirements, counter emerging threat capabilities, and reduce the risks of fratricide.

Armed forces must retain the capability to continue operations longer than any adversary we confront. This is a critical aspect of equipment superiority. Sustainability is directly linked to responsiveness and deployability. Careful planning and discipline is essential to deploy only those forces and systems needed to ensure dominance at every point on the spectrum of operations. Sustainment requirements will be reduced, where possible, by minimizing forces deployed into the area of operations through split basing and the use of technology to provide reach-back capability. Host nation and allied support for armed forces can also reduce sustainment requirements, but the Armed forces must be able to operate unilaterally if necessary.

Objective Force operations are characterized by reduced sustainment demands and therefore a reduced theatre logistics footprint; however, they are also characterized by increases in velocity and tempo as well as increased operational distances that must be supported. Therefore, Armed forces and joint sustainment capabilities, from the strategic to the tactical levels, must be transformed to the Objective Force characteristics in order to realize the warfighting potential of the force as a whole [30]

Consequently, armed forces must continue to find ways to exploit advanced technologies and reduce the logistics footprint and related costs of army support structure and aerial sustainment is a critical enabler of Objective Force agility, versatility, and sustainability.

As it transforms itself into the Objective Force with the characteristics described above, the Armed forces can remain a values-based force that derives its greatness from its people. Armed forces can continue to attract, train, motivate, and retain the most competent and dedicated people in the Nation to fuel his ability to be persuasive in peace and invincible in war. Armed forces must invest in training, educating, and equipping our soldiers while providing them and their families with the well being necessary to make the Armed forces a rewarding and fulfilling profession. Providing the soldiers and leaders with a strong physical, mental, and moral foundation can enable them to act decisively while conducting full spectrum operations in the complex environments they will surely face.

In sum, the Vision points to a synergy that will revolutionize the effectiveness of the Armed forces in order to match its capabilities with the Nation's strategic requirements. If technology permits, the armed forces intend to reduce or even eliminate the current distinctions between light and heavy units. Anticipated technological improvements can enable new organizational and operational concepts that optimize the employment of Armed forces and joint capabilities across the full spectrum of operations. The versatility inherent in these organizations can be magnified through the training and leadership of high quality men and women, who will be prepared to transition from disaster relief to low-intensity contingencies to high-intensity warfighting without pause. Applying the Objective Force design across the Armed forces can improve overall capability, helping alleviate OPTEMPO and PERSTEMPO challenges and enhance the Nation's capacity to sustain long-term commitments while responding to frequent contingencies.

---

[30]Army War College, Amy Transformation War game 2001,2001, “Vigilant Warriors”, Carlisse Barracks, PA, 22-27 April 2001, Available on site http://www.tradoc.army.mil/tpubs/misc/ArmyTransformationBooklet.pdf

1.8- THE FOUR OPERATIONAL CONCEPT WHICH WILL SHAPE THE TRAINING ENVIRONMENT OF CONTEMPORARY ARMED FORCES-OBJECTIVE FORCE-

While full-spectrum dominance is the goal, the way to get there is to "invest in and develop new military capabilities." The four capabilities at the heart of full-spectrum dominance are dominant maneuver, precision engagement, focused logistics and full-dimensional protection. These four capabilities need the full capabilities of the total force.[31]New equipment and technological innovation are important, but more important is having trained people who understand and can exploit these new technologies.[32]

1.8.1- Dominant Maneuver

Dominant Maneuver is the ability of joint forces to gain positional advantage with decisive speed and overwhelming operational tempo in the achievement of assigned military tasks. Widely dispersed joint air, land, sea, amphibious, special operations and space forces, capable of scaling and massing force or forces and the effects of fires as required for either combat or noncombat operations, will secure advantage across the range of military operations through the application of information, deception, engagement, mobility and counter-mobility capabilities.[33]

Dominant Maneuver will be the multidimensional application of information, engagement, and mobility capabilities to position and employ widely dispersed joint air, land, sea, and space forces to accomplish assigned operational tasks. [34]

Maneuver and fires have always been primary elements of combat power. In dominant maneuver these qualities are inextricably linked. This allows forces to move into positional

[31] Garamone, J., 2000, "Joint Vision 2020 Emphasizes Full-Spectrum Dominance", Available on site http://www.defenselink.mil/news/Jun2000/n06022000_20006025.html
[32] Army War College, Amy Transformation War game 2001,2001, "Vigilant Warriors", Carlisse Barracks, PA, 22-27 April 2001, Available on site http://www.tradoc.army.mil/tpubs/misc/ArmyTransformationBooklet.pdf
[33]Joint Chiefs Of Staff, 2000, Joint Vision 2020, US Government Printing Office, Washington DC, June 2000, pp 24
[34] Army Vision 2010, Dominant Maneuver, Available on site http://www.army.mil/2010/dominate_maneuver.htm

advantage to deliver direct or indirect fires to control or destroy an enemy's will to fight. Fires provide the destructive force and facilitate maneuver.[35]

One of the most important factors to improve dominant maneuver is using the technology for all weapon systems, command, control, computer, intelligence and logistic systems. Table-1.2 defines some of the defense technology objectives of dominant maneuver:

Table 1.2 - Dominant Maneuver DTOs

DTO No.	Title	Completion
A.02	Robust Tactical/Mobile Networking	FY01
A.03	Joint Power Projection/Real-Time Support (Navy) / Rapid Force Projection Initiative Command and Control TD (Army)	FY03
A.05	Integrated Collection Management ACTD	FY99
A.06	Rapid Battlefield Visualization ACTD	FY00
A.07	Battlefield Awareness and Data Dissemination ACTD	FY00
A.09	Semiautomated Imagery Processing ACTD	FY99
A.11	Counter-Camouflage Concealment and Deception ATD	FY01
A.13	Satellite C3I/Navigation Signals Propagation Technology	FY03
A.16	Navigation Warfare ACTD	FY99
A.17	Joint Task Force ATD	FY01
A.19	Extending the Littoral Battlespace (Sea Dragon) ACTD	FY01
E.01	Small Unit Operations TD	FY02
F.01	Synthetic Theater of War ACTD	FY99
G.04	Joint Countermine ACTD	FY00
G.05	Rapid Battlefield Mine Reconnaissance	FY00
G.06	Rapid Sea Mine Neutralization	FY00
G.08	In-Stride Amphibious Breaching	FY98
AP.01.00	Advanced Aerodynamic Concepts for Increased Flight Efficiency	FY01
GV.06.02	Surface Ship Integrated Topside Concepts	FY03
GV.10.01	Submarine Signature Control	FY03

Source: Joint Chief of Staff, Concept For Future Operations, May 1997

There are two effects of the dominant maneuver: First is the physical presence of the armed forces and second is the impact in the minds of opponents and others in the operational area. The joint force structure is the best way to work in cooperation with interagency and multinational partners with varying levels of commitment and capability for applying dominant maneuver concept.

[35] Reimer, Dennis. J., "Dominant Maneuver and Precision Engagement", JFQ Forum, Winter 1996-1997, pp13-16 Available on site http://www.dtic.mil/doctrine/jel/jfq_pubs/domin.pdf

So that deterrence can be achieved successfully by the presence effect of dominant maneuver. Like the physical presence, the impact of dominant maneuver is effective to provide for good-faith negotiations or prevent the instigation of civil disturbances.

1.8.2- Precision Engagement

Precision Engagement is the ability of joint forces to locate, surveil, discern, and track objectives or targets; select, organize, and use the correct systems; generate desired effects; assess results; and reengage with decisive speed and overwhelming operational tempo as required, throughout the full range of military operations.[36]

Table -1.3 defines some of the defense technology objectives of precision engagement:

Table 1.3 – Precision Engagement DTOs

DTO No.	Title	Completion
A.05	Integrated Collection Management ACTD	FY99
A.11	Counter-Camouflage Concealment and Deception ATD	FY01
B.01	Precision Rapid Multiple Rocket Launcher ACTD	FY98
B.03	Precision Signals Intelligence Targeting System ACTD	FY99
B.05	Target Acquisition ACTD	FY98
B.06	Air/Land Enhanced Reconnaissance and Targeting ATD	FY00
B.07	Joint Continuous-Strike Environment (Proposed ACTD)	FY01
B.08	Arsenal Ship	FY01
B.11	Guided Multiple Launch Rocket System ATD	FY98
B.12	Enhanced Fiber Optic Guided Missile ATD	FY01
B.15	Antimateriel Warhead Flight Test ADT	FY00
B.19	Cruise Missile Real-Time Retargeting ATD	FY00
B.21	Miniaturized Munitions Technology Guided Flight Tests	FY02
C.01	Battlefield Combat Identification ATD	FY03
E.03	Objective Individual Combat Weapon ATD	FY99
E.04	Non-Lethal Weapons Technical Demonstration	FY01
H.09	Sensor Fusion/Integrated Situation Assessment TD	FY02
J.03	Counterproliferation I ACTD	FY00
J.04	Counterproliferation/Counterforce II (Proposed ACTD)	FY03
J.05	Wide-Area Tracking System (Proposed ACTD)	FY00

Source: Joint Chief of Staff, Concept For Future Operations, May 1997

Technological improvements and innovations that provide increased lethality and accuracy enable precision engagement. Many of these capabilities have application across the range of military operations. Likewise, information superiority enables precision engagement,

[36] Joint Chiefs Of Staff, 2000, Joint Vision 2020, US Government Printing Office, Washington DC, June 2000, pp 18

linking intelligence, surveillance, reconnaissance, and target acquisition with effective command and control. It provides the means to rapidly and accurately identify and assess targets or objectives and to select and apply the precise force to achieve the desired effects. Precision engagement emphasizes responsiveness and accuracy to achieve operational objectives. This new concept will result in less risk, less collateral damage, higher probability of success, and overall economy of force across the full range of military operations.

Precision engagement depends on a system of systems that permits Armed forces to locate the target, provide responsive command and control, have the desired effect, assess the effect, and reengage if required. That is, Armed forces can shape the battlespace and conduct a dominant maneuver.[37]

Space-based surveillance assets can provide near real time threat detection, targeting data, and damage assessment, closing the loop between the sensor and shooter. Satellite navigation systems can allow for greater positional and timing precision in a new generation of "fire and forget" weapon systems, while denying this advantage to our adversaries. Global military satellite communications provide the backbone of responsive command and control.[38]

Precision engagement enables joint force commanders to develop revolutionary strategies, operational ideas, and schemes of maneuver.[39] This is the first result of precision engagement .By trying to organize the most correct systems is a way of training the leaders and commanders in a fast decisive way. As a result, regardless of its application in combat or noncombat operations, the capability of using precision engagement correctly allows the commander to shape the situation or battlespace in order to achieve the desired effects while minimizing risk to friendly forces and contributing to the most effective use of resources.

[37] Stein George J., Information Attack: Information Warfare In 2025, Chapter 3 Confused visions, Available on site http://www.au.af.mil/au/2025/volume3/chap03/v3c3-3.htm

[38] USSSPACECOM, 1998, USSPACECOM Vision 2020, Available on site http://www.spacecom.af.mil/usspace/LRP/ch02.htm

[39] Cohen William S., 1999, Annual Report to the President and Congress, Chapter 10 Revolution in Military Affairs and Joint Vision 2010, Available on site http://www.fas.org/man/docs/adr_00/chap10.htm

1.8.3- Focused Logistics

Focused Logistics is the ability to provide the joint force the right personnel, equipment, and supplies in the right place, at the right time, and in the right quantity, across the full range of military operations. This can be made possible through a real-time, web-based information system providing total asset visibility as part of a common relevant operational picture, effectively linking the operator and logistician across Services and support agencies. Through transformational innovations to organizations and processes, focused logistics can provide the joint warfighter with support for all functions.[40]

The most often quoted reasons for developing focused logistics are downsizing, changing threat environment, technology, and political and fiscal realities.[41]

Focused logistics, the final new operational concept, again illustrates the thinking that the ability to project power with the most capable forces is the central problem. The ability to fuse information, logistics, and transportation technologies; provide rapid crisis response; track and shift assets even while enroute; and deliver the logistics and sustainment to the level of operations" assumes that getting stuff there for the forces is the essence of projecting power. In many cases, especially against traditional adversary's armed forces or other military operations like peace enforcement and humanitarian relief, this may be true.[42]

Space-based satellite communications, navigation, surveillance, weather and earth resource monitoring data provide the required battlespace awareness to deliver responsive and tailored logistical packages directly to the point of need. Deployment and replenishment of space-based assets on orbit can become more cost-effective, and responsive to a theatre commander's needs, as future launch systems and satellite operations capabilities are deployed. [43]

---

[40]Joint Chiefs Of Staff, 2000, Joint Vision 2020, US Government Printing Office, Washington DC, June 2000, pp 27

[41] Cusick, John P. and Pipp, Donald C., 1997, “In search of Focused Logistics”, JFQ Forum, pp 125-127

[42] Stein George J., Information Attack: Information Warfare In 2025, Chapter 3 Confused visions, Available on site http://www.au.af.mil/au/2025/volume3/chap03/v3c3-3.htm

[43] USSSPACECOM 1998, USSPACECOM Vision 2020, Available on site http://www.spacecom.af.mil/usspace/LRP/ch02.htm

The setting up of a 'Focused Logistics' system could have several advantages[44]:

- The availability of global real-time logistic information for all those who need it (as in the United States discount chain 'Wal-Mart' model). Automatic Identification Technology (bar codes, optical memory cards, radio frequency tags etc.) will enhance worldwide asset tracking.

- Electronic commerce systems would allow on-line ordering and payment.

- Logistics will be centered around speed, instead of mass, relying on rapid transportation systems on both land and sea, as well as in the air.

- Integrated distribution systems (supply chain integration) should improve response times, accurate delivery scheduling and forward delivery.

- The enhancement of civil-military integration should mean that the military capitalize on best business practice. Commercial lift can be used and brought onto the battlefield as a part of the force, as happened in the Gulf War. The contracting of civilian firms to provide a broad range of logistic services can be viewed as a potential force multiplier, especially in peacekeeping or humanitarian situations in countries that have little infrastructure.

- The accurate identification of future logistic requirements should allow industrial base planning, allow the Ministry of Defense to target investment in critical material which in times of war the supply of which is too uncertain or lead times too great.

- Logistic supply planning tools would allow real-time awareness of unit and weapon system readiness, enabling the logistician to be 'proactive' and using a 'pull' supply chain. The redesign of unit organization should allow it to have a smaller logistics 'footprint' and act as a broker of information and integrator of supplies and services.

- Personnel should receive additional training in the use of IT and acquisition.

---

[44] Rickard, J., Focused Logistics, Military History Encyclopedia on the Web, Available on site http://www.rickard.karoo.net/conceptslong3.html

- It would enhance overall acquisition reform, such as the move to the paperless contracting procedure, electronic commerce, the growth of civil-military integration and the use of life-cycle management.

Table-1.4 (see next page) defines some of the defense technology objectives of precision engagement. The real aim of the focused logistics is to reduce response times and costs, produce a more agile infrastructure, and improve quality and readiness. The capability for focused logistics will effectively support the joint force in combat and provide the primary operational element in the delivery of humanitarian or disaster relief, or other activities across the range of military operations.

Table 1.4 - Focused Logistics DTOs

DTO No.	Title	Completion
A.07	Battlefield Awareness and Data Dissemination ACTD	FY00
A.12	Information Security ATD	FY01
F.02	Advanced Joint Planning ACTD	FY99
F.14	Joint Decision Support Tools (Joint Logistics ACTD, Phase II)	FY98
F.15	Real-Time Focused Logistics (Joint Logistics ACTD, Phase III)	FY01
F.16	Logistics Tech. For Flexible Contingency Deployments & Operations	FY99
F.17	Adv. Amphibious Log. & Seabasing for Expeditionary Force Ops. ATD	FY01
F.18	Joint Advanced Health and Usage Monitoring ACTD	FY00
I.03	Airbase/Port Biological Detection ACTD	FY00
I.05	Chemical Add-On for the Airbase/Port Bio. Detection (prop. ACTD)	FY01
IS.02.01	Forecasting, Planning, and Resource Allocation	FY03
IS.03.01	Integrated Force and Execution Management	FY02
IS.10.01	Simulation Interconnection	FY03
IS.20.01	Universal Transaction Communications	FY03
IS.21.01	Assured Communications	FY01
MP.07.06	Affordable Sustainment of Aging Aircraft Systems	FY01
MP.14.11	Wartime Contingencies and Bare Airbase Operations	FY03
MP.16.06	Firefighting Capabilities for the Protection of Weapon Systems	FY03
MP.17.11	Airfields and Pavements to Support Force Projection	FY02
MP.23.06	Affordable, Short-Lead-Time Parts Production and Repair	FY97

Source: Joint Chief of Staff, Concept For Future Operations, May 1997

1.8.4- Full Dimensional Protection

Full Dimensional Protection is the ability of the joint force to protect its personnel and other assets required to decisively execute assigned tasks. Full dimensional protection is achieved through the tailored selection and application of multilayered active and passive measures, within the domains of air, land, sea, space, and information across the range of military operations with an acceptable level of risk.[45]

Full dimensional protection, the Joint Vision's third operational concept, requires control of the area of operations to ensure friendly forces maintain freedom of action during deployment, maneuver, and engagement. The Objective Force supports full dimensional protection by greatly reducing the vulnerability associated with deployment and maneuver. Objective Force survivability, a product of integrated information technology, increased weapons systems' effectiveness, and the increased dispersion of Army systems, can also contribute to full dimensional protection.[46]

The ultimate goal of the commander is to accomplish the mission to provide for the maximum protection of the force. This is best carried out with a versatile force that maintains the initiative and conducts synchronized operations in depth. In a Support and Stability Operation environment, proactive action that enforces the peace accords aggressively is the best force protection a commander can provide.[47]

A wide range of offensive and defensive actions to control all dimensions of the battlespace, including both active and passive protection measures, is a characteristic of full dimensional protection. Even at the low end of operations, a level of offensive capability may be necessary to preclude having to react after the fact to a threat. Operating at the low end does not mean we must allow a threat to act first before we respond. In addition, full-dimensional protection is characterized by the ability to:[48]

- Identify and track friendly vulnerabilities—potential targets for an adversary.
- Discriminate precisely between friendly and enemy elements at all levels in order to prevent fratricide. This same level of discrimination is necessary to enhance low-end operations like humanitarian assistance to precisely differentiate NGOs, PVOs, friendly factions, unfriendly factions, and coalition members.

[45] Joint Chiefs Of Staff, 2000, Joint Vision 2020, US Government Printing Office, Washington DC, June 2000, pp 29
[46] United States Army Posture Statement FY01, Chapter 2, The Army Vision, Available at http://www.army.mil/aps/aps_ch2_3.htm
[47] Quillin Tim W., 1999, Force Protection in Support and Stability Operations, School of Advanced Military Studies, United States Army and General Staff College, Fort Leavenworth, Kansas, 1999
[48] Joint Chief of Staff, 1997, Concept For Future Operations- Expanding Joint Vision 2010, May 1997, pp 53

- Reduce risk and limit non-battle casualties through a wide range of other inherent measures, such as sophisticated safety and health initiatives.

In battlespace environment the success can be gained only by applying the right methods at the right time. So that full dimensional protection provides this right method by including theatre missile defenses and possibly limited missile defense, offensive countermeasures; security procedures; antiterrorism measures; enhanced intelligence collection and assessments; emergency preparedness; heightened security awareness; and proactive engagement strategies. Consequently it can be said that all friendly forces can achieve freedom of action in battlespace environment and can have better protection in every echelon which are mentioned above, by applying full dimensional protection concept.

Joint Warfighting Capability Objectives	***JV 2010* Operational Concepts**			
	Dominant Maneuver	Precision Engagement	Full-Dimensional Protection	Focused Logistics
1. Information Superiority	●	●	●	●
2. Precision Force	o	●	o	
3. Combat Identification	o	●	●	
4. Joint Theater Missile Defense		●	●	
5. Military Operations in Urban Terrain	●	o	●	
6. Joint Readiness and Logistics	●	o	o	●
7. Joint Countermine	●		●	o
8. Electronic Combat	●	●	o	
9. Chem/Bio Warfare Defense and Protection	●	o	●	o
10. Counter Weapons of Mass Destruction		●	●	

● Strong Support o Moderate Support

Figure 1.5- Joint Warfighting Capability Objectives in Joint Vision 2010

Source: Joint Chief of Staff, 1997, Concept For Future Operations- Expanding Joint Vision 2010, May 1997

The Figure 1.5 depicts the Joint Warfighting Capability Objectives within the new concepts. Rapid advances in several key areas are creating warfighting and support capabilities far exceeding those of today. However, Armed Forces must not lose sight of the fact that potential adversaries will likely have access too much of this same technology. Recognizing the opportunities presented by these sophisticated innovations is a challenge in itself. All must remember that technology enhances the potential capabilities of the force. Only through improved doctrine, tailored training and education, innovative leadership, agile, and adaptable organizational structures will our force of quality people be able to use these innovations to achieve the new operational concepts.

The first chapter took a brief look at the training needs and transformation of contemporary armed forces to keep up with the future changes through a vision approach. Joint force and joint training is the best way to eliminate the future challenges. In second chapter the joint training system, which modern Armed Forces applied, will be talked about.

Chapter 2

JOINT TRAINING SYSTEM

2.1- MILITARY TRAINING DEFINITIONS

A broad spectrum of training and exercise events are sponsored at various command levels. Military training spans those events that fall within the following categories[49]:

Category 1: Service Training: Military training based on Service policy and doctrine to prepare individuals and interoperable units. Service training includes basic, technical, operational, and component-sponsored interoperability training in response to operational requirements deemed necessary by the combatant commands to execute assigned missions.

Category 2: Component Interoperability Training: Operational training based on joint doctrine or joint tactics techniques and procedures (JTTP) in which more than one Service component participates. This training normally includes CINC or Service initiatives to improve responsiveness of assigned forces to combatant commanders. Conducted under the auspices of a component commander, the purpose is to ensure interoperability of combat, combat support services, and military equipment between two or more Service components.

Category 3: Joint Training: Military training based on joint doctrine to prepare joint forces and/or joint staffs to respond to operational requirements deemed necessary by combatant commanders to execute their assigned missions.

Category 4: Multinational Interoperability Training: Military training based on allied, joint, and/or Service doctrine, as applicable, to prepare units in response to National Command Authority (NCA)-approved mandates. The purpose is to ensure interoperability of combat and combat support forces, and military equipment between US Service component(s) and other nation(s) forces.

[49] Joint Chiefs of Staff, 1996, Joint Training Manual for the Armed Forces of United States, CJCSM 3500.03, 1 June 1996, pp II-3

Category 5: Joint/Multinational Training: Military training based on multinational, joint, and/or Service doctrine, as applicable, to prepare units in response to NCA-approved mandates. The purpose is to prepare joint forces under a multinational command arrangement.

Category 6: Interagency/Intergovernmental Training: Military training based on NCA-derived standard operating procedures, as applicable, to prepare interagency and/or international decision makers and staffs in response to NCA-approved mandates.

2.2- CONCEPT OF JOINTNESS

"The conduct of war resembles the working of an intricate machine with tremendous friction, so that combinations which are easily planned on paper can be executed only with great effort. Consequently, the commander's free will and intelligence find themselves hampered at every turn, and remarkable strength of mind and spirit are needed to overcome this resistance." As Carl von Clausewitz's saying in quote friction, chance, and uncertainty still characterize battle. Their cumulative effect comprises "the fog of war.[50] With decreasing budgets and uncertain future, the military must find innovative ways to handle challenges that will span the spectrum of unlimited warfare to military operations other than war (MOOTW). Handling these future conflicts requires a proactive, joint effort from all of the services.[51]

Joining as a force in ad hoc manner cannot be the normal mode of operations for the future. The necessity of acting quickly and decisively will required the armed forces to be proactively joint. Centralizing the flag/general officer promotion process and enhancing joint test and experimentation efforts will help eliminate service biases and create service involvement in joint concepts. This in turn will push the services closer to a more proactive joint environment.[52] This becomes important to military leaders to "shape the force" for the future. The military must continue to explore new ways to make jointness more effective and produce more cost savings due to the reduced defense budget projections in future.

[50] Joint Chiefs of Staff, 1995, Joint Pub 1 Joint Warfare of the Armed Forces of the United States, Chapter 1, 10 January 1995, pp 2
[51] Davila, Jeffrey D., The Hierarchy and Necessity Principles: A Critical Examination of Jointness, Unclassified Report submitted to Naval War College, Newport, RI, February 2001, pp 15
[52] Ibid, pp 15

Future operations will be joint; in fact most will be combined as coalition alliances continue to increase.[53]

Military history shows that there is a long lineage of joint operations and that jointness and opposition to it have been around for quite a long time. It also highlights that again and again, the lessons of jointness had to be re-learned in the midst of crisis and disasters. A short historical review of joint operations since World War I underscores the significance of joint doctrine.

The need to blend forces for best effect arose many times during World War I; however, innovations such as amphibious warfare, close air support and special operations were quickly pushed aside as the war ended. Parochial concerns of shrinking armies, navies and air forces once again took over in the competition for scare resources and public support. In spite of extensive training, thought and development between the world wars, jointness remained a peripheral concern in the shaping of military doctrine. It was also widely believed that joint activities would have little significance in future wars. [54] While western militaries were struggling among themselves to find methods that would promote effective joint operations, the Soviets found a solution. Soviet reorganizations in the early 1900s included the post of Commander-in-Chief. He was provided with a unified headquarters, or Stavka, to coordinate military operations of army and navy units in a theatre of operations.[55]

Britain and her allies entered the Second World War ill prepared for joint warfare and paid a very high price for their lack of vision in peacetime. The frustrations of the beginning of the war began a long series of efforts that eventually brought allied operations to the highest scale and quality of joint warfare ever seen. Time after time, the blending of air support, armor, artillery, and ground forces offset the high quality of German infantry and armor. The complexity of joint organization grew as the war progressed, and the list of refinements in joint techniques expanded as the pace and scale of joint operations

---

[53] Young, Don C., 1999, USAWC Strategy Research Project: Enhancing Engineer Jointness and Future Joint Engineer C2 for Global Engagement, US Army War College, Carlisle Barracks, Pennsylvania, pp 19

[54] Desjardins, B., 1999, "Joint Doctrine for the Canadian Forces: Vital Concern or Hindrance?", Canadian Forces College Papers and Publications: AMSC2 (1999) Papers

[55] Boomer, F.M., "Joint or Combined Doctrine? The Right Choice for Canada" Unpublished paper, Advanced Military Studies Course - AMSC 1, CFC, Toronto, Ont, Available on site http://wps.cfc.dnd.ca/irc/amsc/amsc1/index.html.

increased. However, as had been the case after World War I, the "vast apparatus of joint operations so carefully and painfully crafted during the war crumpled rapidly as nations quickly demobilized".[56]

During that same period, the United States military brought the operational art of jointness to an equally high level of practice. The Pacific war, for instance, saw assorted elements of sea, land and air forces constantly being repackaged to satisfy operational plans that hinged on a high level of service cooperation. But here again, the case for jointness was unable to survive calls for retrenchment in the face of successive rounds of budget cuts. Even though both General Eisenhower and President Truman voiced strong arguments for unification of commands, a single chief of defense staff, maximum inter-service assignment of officers and a common procurement system, the positive benefits of jointness faded.

But after World War II, the armed forces abandoned joint practices and retreated into their separate organizations. Jointness once again became based on inter-service goodwill, a rare commodity at the best of times. Although the merits of jointness were demonstrated on several occasions during the Korean War, most notably with MacArthur's forces landing at Inchon, that war was fought with far less jointness than World War II. Jointness was also notably absent during the Vietnam War. The practice of muddling through in an ad hoc fashion remained the mainstay of operational doctrine from the 1950s through the 1980s, with a resultant lack of synchronicity and low synergy in major operations. Mounting joint operations was viewed as a complex, chaotic process that was best avoided. Joint operation failures such as Operation Eagle Claw, the April 1980 operation to free American hostages in Teheran, and the Grenada invasion, Operation Urgent Fury, revealed the extent of the inter-services problems.[57]

The old familiar problems of meshing separate service doctrine, logistics, and command and control re-emerged during the Falklands War and, once again, many lessons had to be relearned, the "hard way". The British experiences in the South Atlantic created a new sense of the value of jointness and a joint doctrine renaissance in the British forces. Soon

---

[56] Beaumont, Roger A., 1993, Joint Military Operations: A Short Story, Westport, Connecticut: Greenwood Press, pp 187.
[57] Boomer, F.M., "Joint or Combined Doctrine? The Right Choice for Canada" Unpublished paper, Advanced Military Studies Course - AMSC 1, CFC, Toronto, Ont, Available on site http://wps.cfc.dnd.ca/irc/amsc/amsc1/index.html.

after the Falklands War, the Goldwater-Nichols United States Defense Reorganization Act of 1986, together with the Gulf War of 1990-1991, provided further impetus in the drive for jointness.[58]

It can be argued that the end of the Cold War and the events that immediately followed the fall of the Soviet Empire have created an unstable, stressful military world environment. Inter-state and intra-state conflicts seem more frequent than during the Cold War period, and there seems to be an unending requirement for the United Nations to call on the military for humanitarian assistance, peacekeeping, peacemaking, contingency intervention, and limited international wars in various sectors of the globe. The essence of national security, military strategy and the main rationale for armed forces has changed and reforms to accommodate the new strategic environments have been undertaken by most nations, particularly those in the NATO alliance. The lesser requirement for territorial defense and the increasing need for quick response also have contributed to modifying the operational environment substantially and, one could argue, for displacing the focus of defense planning from the strategic to the operational level. Given the reduction of the Soviet threat, nuclear deterrence and the threat of first use have, for all practical purposes, been subjugated to better conventional defense as a means of countering aggression and ensuring victory.

The operational concept of joint Airland battle where new technology and doctrines would blend air and ground operations and combined deep strikes with close battle also has come and gone. Linear forward defense and attrition war has evolved toward non-linear defense and maneuver war. Recently, the Gulf War of 1990-1991 validated the U.S. forces' emphasis on power projection, superior strike-and-strike forces, and total battlefield awareness and "underscored the importance of joint operations, even though it revealed stubborn problems in getting ground, air and naval elements to work in harmony. The latest military operations in Central Africa, Haiti and the Balkans have highlighted the need for flexibility, imagination and innovative approaches to joint and combined operations. [59]

---

[58] Beaumont, Roger A, 1993, Joint Military Operations: A Short Story, Westport, Connecticut: Greenwood Press, pp 187.
[59] Libicki, M. et al., 1999, Mind the Gap: Promoting a Transatlantic Revolution in Military Affairs, National Defense University Press, Washington, pp 18-19.

Jointness is not created by doctrine, joint or otherwise. It is brought by people, good and bad. Like most things in life, a higher proportion of good people well trained in their service capabilities and how to employ them creates it more successfully. Words printed on paper, no matter how attractive, are largely meaningless in the greater scheme of things. Common tactics, techniques, and procedures are vital to training.[60] Real joint vision that drives future programmatic requirements is new and signals the potential erosion of prerogatives of the separate military services to train, organize and equip their forces.[61]

The jointness idea has been a way of the armed forces' operational art for a long time but with the changes of the world environment and battlefield environment training for both services and joint forces became more important than past. So that the joint training system must be designed with its long term vision to prepare the contemporary armed forces of the future more flexible, interoperable, responsive, agile, sustainable and survivable.

2.3- THE INTENT OF JOINT TRAINING

The intent of joint training is to provide a focus and framework for integrating core Service training programs--both individual and collective--illustrated in Figure 2.1.

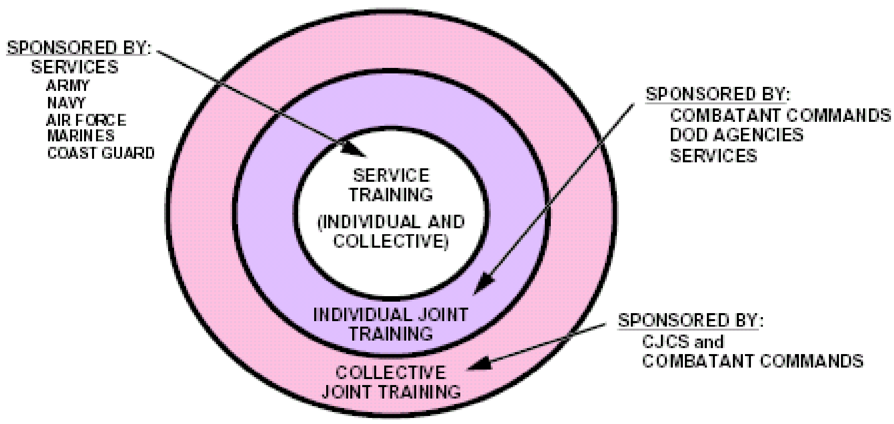

Figure 2.1- Joint Training Builds on Service Training

Source: Joint Chiefs of Staff, Joint Training Manual for the Armed Forces of United States, CJCSM 3500.03, 1 June 1996

---

[60] Wilkerson, Lawrence B., 1997, "What Exactly Is Jointness?", JFQ Publications, Summer 1997
[61] Young, Don C., 1999, USAWC Strategy Research Project: Enhancing Engineer Jointness and Future Joint Engineer C2 for Global Engagement, US Army War College, Carlisle Barracks, Pennsylvania, pp 19

Service training develops proficiency in the specific skills and capabilities the Army, Navy, Air Force, Marines, and Coast Guard bring to the joint arena. The Services also provide core interoperability capabilities, consistent with their defined roles and missions.

Joint training requirements may be met through both individual joint training and collective joint training programs. Joint organizations (e.g., Defense agencies) and Services will have varying responsibilities for individual joint training. Collective joint training, however, remains primarily a responsibility of joint commands, focusing on force integration issues.[62]

2.4- THE JOINT TRAINING VISION AND GOALS

The joint training vision is a start for a long range planning to achieve the short term goals. Vision must be a guidance to provide a properly designed working plan among the systems. And the most important goal of the joint vision is to prepare the trained contemporary armed forces. The Figure 2.2 describes the goals of joint vision shortly:

Figure 2.2- Join Training Vision

Source: Joint staff, The Joint Training System: A Primer for Senior Leaders, 1998

---

[62] Joint Chiefs of Staff, 1996, Joint Training Manual for the Armed Forces of United States, CJCSM 3500.03, 1 June 1996), Chapter 2, pp II-2

Firstly to enhance joint readiness the tasks, which the joint force will do to achieve its missions, must be determined very well. So that to define this tasks a joint task list must be developed. Developing a joint task list provides a common training language. The list institutionalizes requirements based "train-to-task" joint training system, incorporating strategic, operational, and tactical tasks. On the other hand developing a joint task list identifies standards to tasks for commander performance evaluations[63]. And by using joint task list the second goal of the joint vision can be achieved easily.

The objectives of a joint task list are depicted in Figure 2.3. These are the major task that will provide the joint readiness. These major tasks are beginning points of establishing the subordinate tasks, which the commanders will choose to establish their joint task lists. By applying this hierarchy of tasks, the common joint tasks are defined for the whole armed forces – individual joint training, collective joint training which are built on service training as depicted in Figure 2.1.

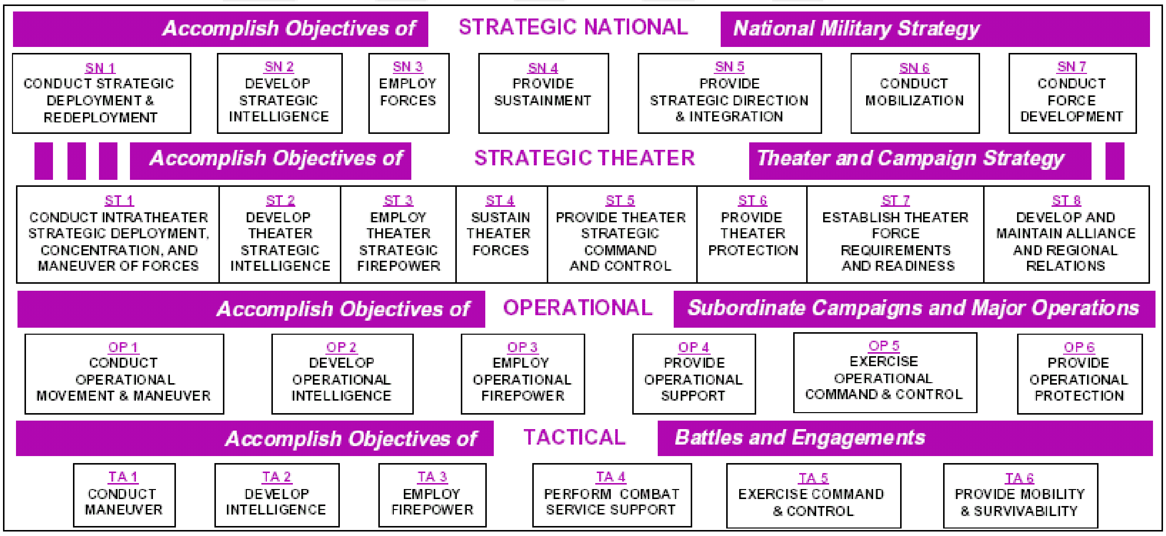

Figure 2.3- Universal Joint Task List

Source: Joint Chiefs of Staff, Joint Training Manual for the Armed Forces of United States, CJCSM 3500.03, 1 June 1996)

Composing a universal joint task list is also a tool for providing the interoperability as a third objective of joint vision. The interoperability can be defined as the ability to use the forces so exchanged to operate effectively together. In Joint Publication JP1-02

[63] Ibid, IV-3

interoperability is defined as the ability of systems, units, or forces to provide services and accept services from other systems, units or forces and use the services so exchanged to enable them to operate effectively together.

Although technical interoperability is essential, it is not sufficient to ensure effective operations. There must be a suitable focus on procedural and organizational elements, and decision makers at all levels must understand each other's capabilities and constraints. Training and education, experience and exercises, cooperative planning, and skilled liaison at all levels of the joint force will not only overcome the barriers of organizational culture and differing priorities, but will teach members of the joint team to appreciate the full range of Service capabilities available to them. The future joint force will have the embedded technologies and adaptive organizational structures that will allow trained and experienced people to develop compatible processes and procedures, engage in collaborative planning, and adapt as necessary to specific crisis situations. These features are not only vital to the joint force, but to multinational and interagency operations as well.[64] So that multinational operations and interagency operations must e among the long range goals of joint training vision.

Multinational operations, both those that include combat and those that do not, are conducted within the structure of an alliance or coalition. An alliance is a result of formal agreements between two or more nations for broad, long term objectives. A coalition is an ad hoc arrangement between two or more nations for common action.[65] "Multinational operations" is a collective term to describe military actions conducted by forces of two or more nations. Such operations are usually undertaken within the structure of a coalition or alliance, although other possible arrangements include supervision by an international organization (such as the United Nations (UN) or Organization for Security and Cooperation in Europe).[66] Figure 2.4 (see next page) depicts the operation and planning &execution considerations of multinational operations.

---

[64] Joint Chiefs of Staff, 2000, Joint Vision 2020,US Government Printing Office, Washington DC, June 2000,pp14

[65] Joint Chiefs of Staff, 1995, Joint Pub 3-0 Doctrine for Joint Operations, Executive Summary Part, 1 February 1995, pp xvi

[66] Joint Chiefs of Staff, 2000, Joint Doctrine for Multinational Operations, Chapter 1, 5 April 2000, pp 1

While describing the multinational considerations national goals are very important. Each nation in a coalition or alliance can have different national goals so that joint training must be built on understanding how the nation's goals can affect the conflict termination and achieve the desired operational capability. So that multinational objectives must be defined clearly and each member must support these objectives to provide the unity of effort through the capabilities of each member country. Cultural differences as the result of language, religion, and social outlooks must be assisted by employing linguists and area experts to have a successful joint multinational organization.

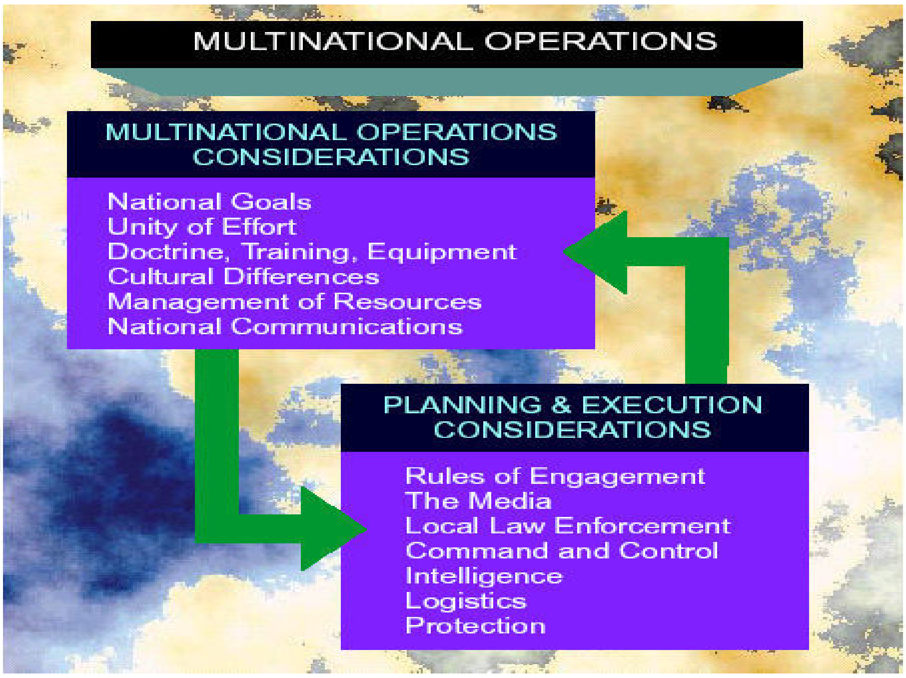

Figure 2.4 - Multinational Operations

Source: Joint Chiefs of Staff, Joint Pub 3-0 Doctrine for Joint Operations, 1995

Joint training through the joint multinational doctrine is a key for improving each member nation military forces' training and experience and to determine the types and quality of equipment. As a result of training each member must have the ability of performing their missions and must exploit its unique or special capabilities to each member. So that joint and multinational exercises must be key components of joint training and doctrine refinement. Types of exercises include command post exercises and field training exercises. Simulation can complement most exercises. Joint Simulation System and Distributed simulation is means to enhance training between remotely separated forces.

Interagency operations and coordination is a part of military operation other than war. Military operations other than war encompass a wide range of activities where the military instrument of national power is used for purposes other than the large-scale combat operations usually associated with war. Military operations other than war usually involve a combination of air, land, sea, space, and special operations forces as well as the efforts of governmental agencies and nongovernmental organizations, in a complementary fashion.

Figure 2.5 depicts principles, planning objectives and types of operations, which are included in military operations other than war. In these types of operations training plays a great role. For achieving these operations both military units and civilian organizations must be trained within the standards of a joint multinational and interagency operations doctrine. So that both government organizations and non- government organizations must apply their instruments according to the principles of military operations other than war in coordination with military efforts to achieve the national goals other than war. And for operations other than war the military instrument must also support the diplomatic, economic, and informational instruments.

Figure 2.5- Military Operations Other than War

Source: Joint Chiefs of Staff, Joint Pub 3-0 Doctrine for Joint Operations, 1995

In operations other than war, the threats may be subtle and indirect and threats are usually regional in nature. One of the most important about this probability is that they can develop quickly and the time period cannot be estimated. So that flexibility must be applied for all of the command control functions and especially the transition to post conflict operations-transition to civil operations, supporting truce negotiations, special forces operations to re-establish a civil government, public affair operations like using media support and international information campaigns and redeployment to meet new missions and crisis-must be planned in the early beginning of the conflicts. The "Provide Comfort" operation in 1991,which was applied for to provide humanitarian relief for the Kurds who are fleeing from Iraq because of the attacks of the Iraq forces; the "Eastern Exit" operation to rescue people from the bloody civil war on 1 January 1991 through the request of United States Ambassador

The conceptual construct of military operations other than war (MOOTW) requires that traditional command and control methods be modified. Subsequently, training for the commander and battle staff must also be modified to meet the requirements generated by these unique operations. With the successful advent of computerized battlefield simulations, war gaming has become the primary means of training the commander and battle staff in command and control war fighting techniques. These simulations are designed to support war fighting training not the complex environment of MOOTW. During MOOTW, commanders are expected to deploy and operate in an environment where combat operations are not the primary concern.

In fact, if combat occurs, it is an indicator that the commander may have failed the mission. Unlike conventional force against force operations, political objectives and cultural interaction have a far greater bearing on the operation and must be considered at the lowest levels of leadership. Rules of engagement and the application of traditional military power assume different perspectives. Damage and destruction inflicted as a result of traditional combat immediately and adversely affect the political aspects of military strategic, operational, and tactical objectives. Intelligence targeting and combat element employment requires surgical precision and must avoid collateral damage.

Functions that normally support direct combat power have greater importance in MOOTW. These support elements have the inherent capacity to deliver products and services and can positively promote political objectives. Focus is directed toward the psychological resolve of the population and their willingness to accept and support the host nation's government and US foreign policy objective exacerbate the situation, aggressive belligerent social groups or other threats also attempt to gain legitimacy through support of the population. [67]

According to the last goal of joint training vision joint training is a method of operating effectively with fewer resources. Armed forces will be much smaller in 2020 yet the world will be a dangerous place. In addition, space will be added to the land, sea, and air as a conflict medium as competition among nations in space increases. This environment, coupled with the information explosion, the changing characteristics of military personnel, fiscal constraints, and significant technological advances will require a much more educated and trained force.[68]

It is likely that the military of the future will be a joint warfighting team. Both manpower and resource constraints, coupled with limited types and numbers of weapons, not to mention congressional direction, have made a joint approach mandatory. We cannot afford duplication of effort, nor can we afford not to have enough capability to accomplish the mission. This means that complimentary systems, weapons, and munitions must be developed. The issue is not whether we will fight jointly, but whether we have doctrine to make joint warfare successful. Does joint doctrine support the synergism of capabilities that makes for success in combat?[69] So that the joint training principles must be determined clearly by Armed Forces and the Armed Forces must find the ways of increasing the effectiveness of the joint training. If the principles are well understood by every soldier and officer the synergism of joint training leads the soldiers to develop both doctrines, weapon systems and equipment.

In future this synergy can be created by using high fidelity modeling & simulation tools such as Joint Simulation System. (JSIMS). In a synthetic battle space environment the commanders and staffs will realize the requirement for achieving jointness and by using

---

[67] National Simulation Center's Spectrum Team, "This is Spectrum", Available on site http://www-leav.army.mil/nsc/famsim/spectrum/intro.htm

[68] Air University, "Professional Military Education (PME) in 2020", Available on site http://www.fas.org/spp/military/docops/usaf/2020/app-l.htm

[69] Ferriter, Edward C., 1995, "Which Way Joint Doctrine?", JFQ Forum Publications, pp 118-119

simulation & modeling tools easier than past and they will have the chance to use deterrence capability of powerful Armed Forces before the both small scale and overseas wars begin.

2.5- THE PRINCIPLES OF JOINT TRAINING

According to the Joint Chiefs of Staff of United States the principles of joint training is depicted in Figure 2.6: [70]

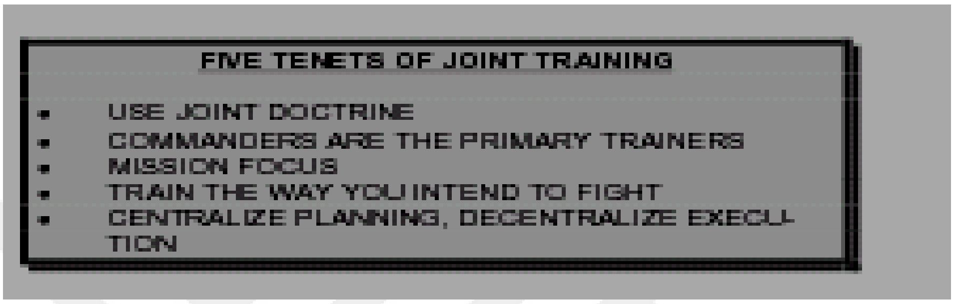

Figure 2.6-Five Tenets of Joint Training

Use Joint Doctrine: Joint training will be accomplished in accordance with approved joint doctrine. Joint doctrine establishes the fundamentals of joint operations and the guidance on how best to employ national military power to achieve strategic ends. Joint doctrine provides the common terms, concepts, and perspective, which fundamentally shape the way the contemporary Armed Forces plan and execute joint operations. Joint doctrinal publications describe common procedures and uniform operational methods from a common baseline. Effective joint training must be based on approved joint doctrine. Joint doctrine embodies the concepts likely to be employed throughout the range of military operations. When it is necessary to introduce experimentation events into joint training exercises, combatant commanders will use care to ensure that exercise participants understand that doctrinal deviations are for experimentation purposes, and may not change doctrine and procedures for future operations.

Commanders are the Primary Trainers: Commanders at all echelons are responsible for preparing their commands to accomplish assigned missions. Being trained and ready is

[70] Joint Chiefs of Staff, 1999, Joint Training Policy for the Armed Forces of United States, Enclosure A, Washington D.C., 31 December 1999, pp A-3

commanders' business. Joint commanders' training guidance forms the basis for planning, executing, and assessing all joint training programs. Commanders establish joint training objectives and plans, execute and evaluate joint training events, and assess training proficiency and program effectiveness. They ensure the programs are consistent with their assigned missions, priorities and intentions, and allocated resources. In developing the training programs, commanders must balance mission requirements with the potentially detrimental impact of a high Operational Tempo, Personnel Tempo, and Deployment Tempo on unit quality of life and overtaking of low density/high demand (LD/HD) assets. Senior commanders are the approving authorities for the training programs of assigned subordinates. Commanders determine how well their command is prepared to accomplish their assigned missions.

Mission Focus: The central theme of joint training is a requirement based focus on assigned missions. The intent is for each combatant commander and combat support agency (CSA) to develop training programs that focus on the requirements inherent in their organizations' primary warfighting missions. The Universal Joint Task List provides a common language and reference for combatant commands, Services, Combat Support Agencies, and the Joint Staff to communicate capability requirements. Mission focus provides a basis for rationalizing and prioritizing the allocation of scarce resources among numerous competing demands. A successful training program can be achieved when commanders consciously narrow the focus of their training efforts to a limited number of mission essential tasks.

Train the Way You Intend to Fight: Joint training must be based on realistic conditions and standards. Conditions are those variables in an operational environment or situation in which a unit, system, or individual is expected to operate that may significantly affect performance. Conditions are organized into three broad categories: physical, military, and civil, which are derived from the JFC's assessment of mission-related political, economic, social, cultural, and geographic implications, as well as threat, available forces, and time. Standards are established, as the minimum acceptable proficiency required in the performance of a particular task under a specified set of conditions. For mission essential tasks of joint forces, each task is defined by the JFC and consists of a measure and criterion. The measure provides the basis for describing varying levels of task performance. The criterion describes the minimum acceptable level of performance associated with a particular measure of task performance. The criteria are often expressed as hours, days, percentages, occurrences, minutes, miles, or some other command stated measure. Implications of “train the way you intend to fight” include: 1) Command, control, communications, computers, and intelligence (C4I), as well as logistic and transportation activities, should use (preferred) or emulate real capabilities.2) Training to achieve focused logistics should include information tasks that test and stress tailored transportation and logistic packages for deployment and sustainment. The goal is to be adaptive and support the warfighter. 3) Integration of the capabilities of the Reserve Components, other Federal departments, agencies, and the globalized private sector is essential for training the way you intend to fight. They should be integrated into the combatant commander’s joint training plans.

Centralize Planning, Decentralize Execution: In military operations, centralized planning and decentralized execution provides organizational flexibility. Decisions are made where and when necessary by subordinates, consistent with available resources and the senior commander’s intentions, priorities, and mission objectives. Training methods must mirror operational techniques. The intent is to apply available resources with enough flexibility to optimize training effectiveness and efficiency. This process requires an analysis of who needs training and the current level of training proficiency, then selecting the most effective and efficient method to accomplish the training objective. Decentralization promotes bottom-up communications, especially concerning mission-related strengths and weaknesses.

2.6- THE WAYS OF INCREASING THE EFFECTIVENESS OF JOINT TRAINING

According to the Joint Training Policy for the Armed Forces of the United States there are six steps to increase the effectiveness of joint training: Firstly this publication implicates using the joint training system and this approach can include the other steps except modeling and simulation. The other steps can be listed as: Using the Universal Joint Task List, Joint Exercises, Joint Training Course Management, Advanced Distributed Learning Network and Modeling &Simulation. So that five approaches will be talked about while defining the Join Training System, Modeling &Simulation approach to increase the effectiveness of joint training will be analyzed in next chapters.

2.7- JOINT TRAINING SYSTEM

Joint training system provides a requirement -based methodology for aligning training programs with assigned missions consistent with command priorities and available resources. This system emphasizes the direct linkage among the National Military Strategy, combatant command mission requirements, and training. The ultimate result is trained and ready personnel who are able to effectively execute joint and multinational operations. Figure 2.7 depicts the four phases of Joint Training System[71]:

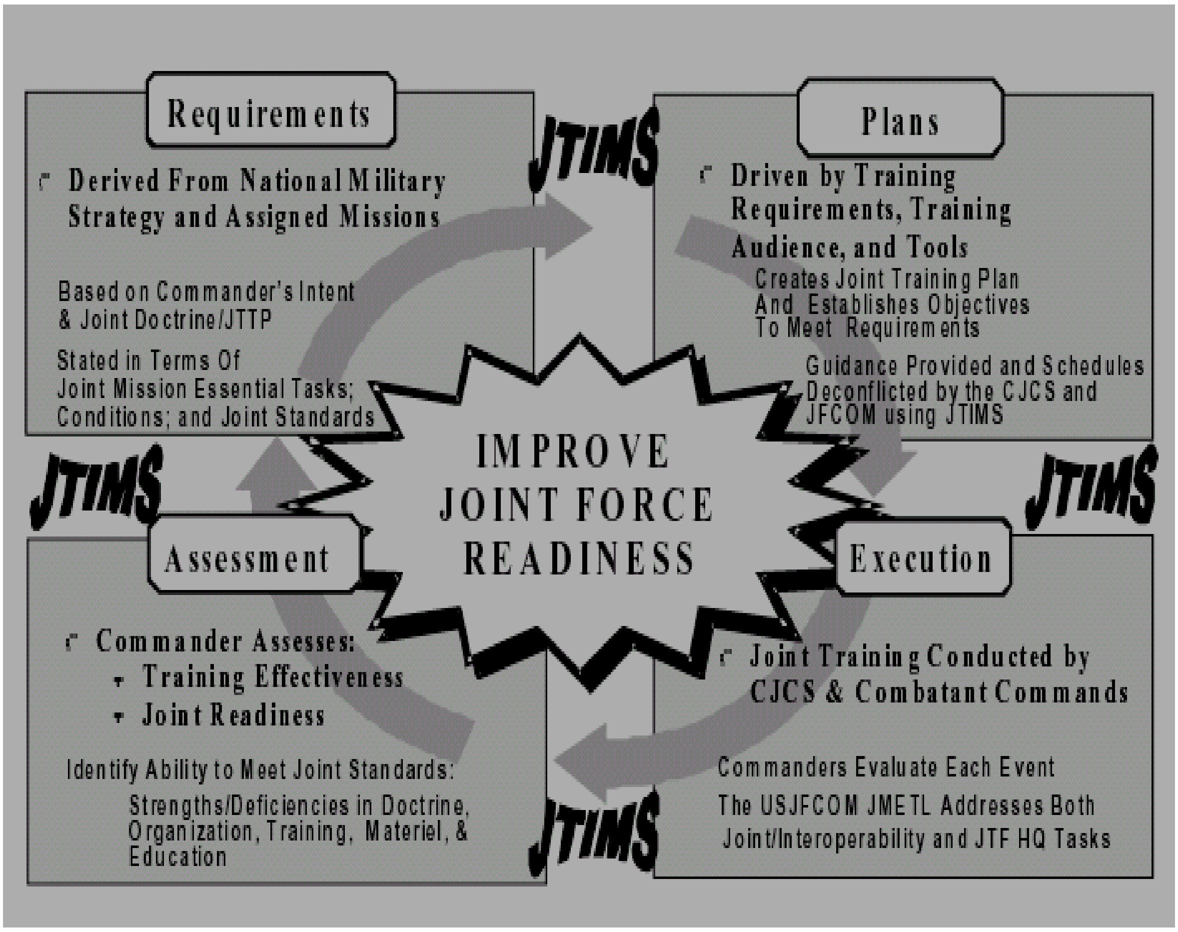

Figure 2.7- Joint Training System

Source: Joint Chiefs of Staff, 1999, Joint Training Policy for the Armed Forces of United States, Enclosure A, Washington D.C., 31

[71] Ibid, C-1

2.7.1- Requirement Phase

The requirement phase (Input/process/output) is depicted in Figure 2.8 [72]:

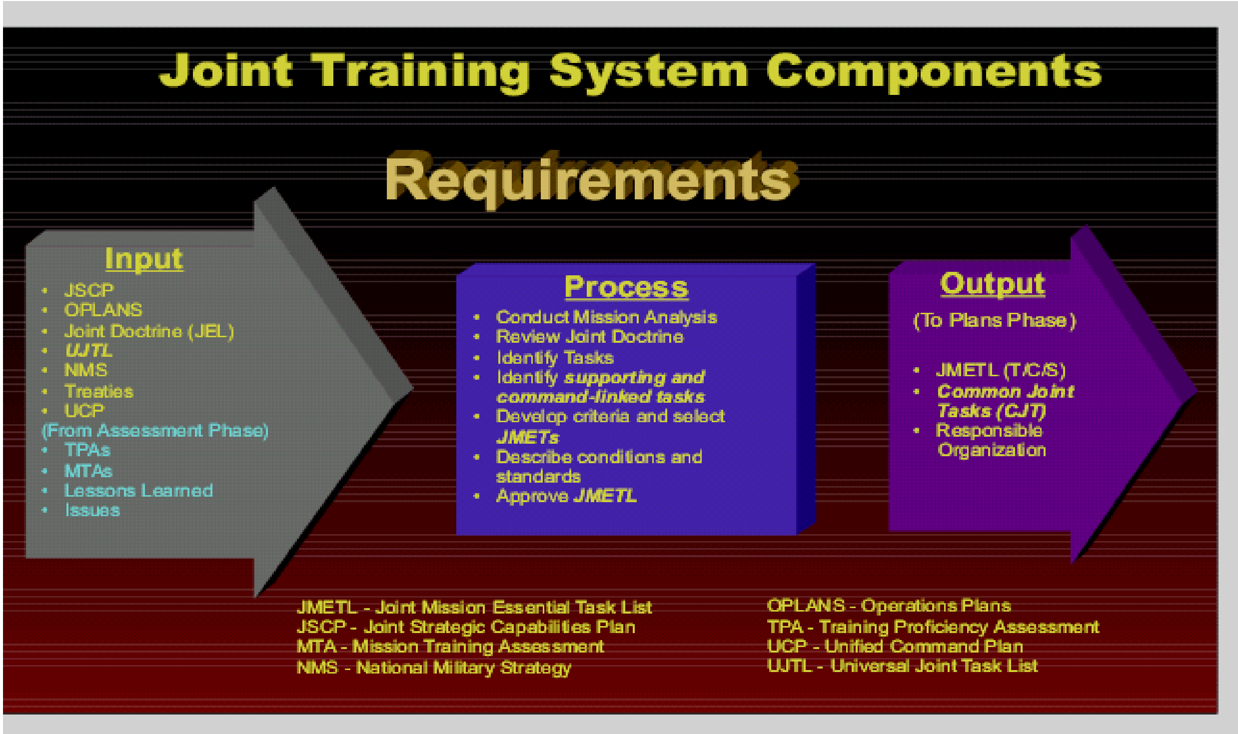

Figure 2.8 - Requirement Phase

Source: Joint staff, The Joint Training System: A Primer for Senior Leaders, 1998

Requirements Phase answers the question, "what must my command be able to do?" The purpose here is to define mission requirements in terms of tasks that must be performed and the responsible organizations at all levels throughout the force. Sources from which missions and ultimately tasks are derived include the Joint Strategic Capabilities Plan (JSCP), Unified Command Plan (UCP), and joint doctrine.

A Joint Mission Essential Task List (JMETL) outlines those tasks that are essential to a combatant's command's ability to perform assigned missions. This listing results from the mission analysis conducted during this phase, and provides the supporting documentation from which training requirements are derived. Resources available to assist combatant commanders in developing their specific tasks, in the format and language required, include the Universal Joint Task List (UJTL), JMETLs from other commands, Master

[72] Joint Chiefs of Staff, 1998, The Joint Training System: A Primer for Senior Leaders, pp 16

Training Guides (MTGs), and joint doctrine. Common joint tasks are mission essential tasks from two or more combatant command JMETLs and are found in the JTMP. Command-linked tasks (those that must be performed by another major command in order for a combatant command to perform its own mission) must also be identified. Supporting tasks (those that contribute to the accomplishment of a JMET) are performed by subordinate elements of a joint force, such as joint staff or functional components, etc.

2.7.2- Plans Phase

Plans Phase begins once a command's JMETL is developed and approved. Here, the commander asks the questions, "what training is needed?", " who must be trained?" and "what are my priorities?" In answering these questions, the commander provides essential guidance to his staff and begins the Plans Phase. Figure 2.9 summarizes the Plan phase[73]:

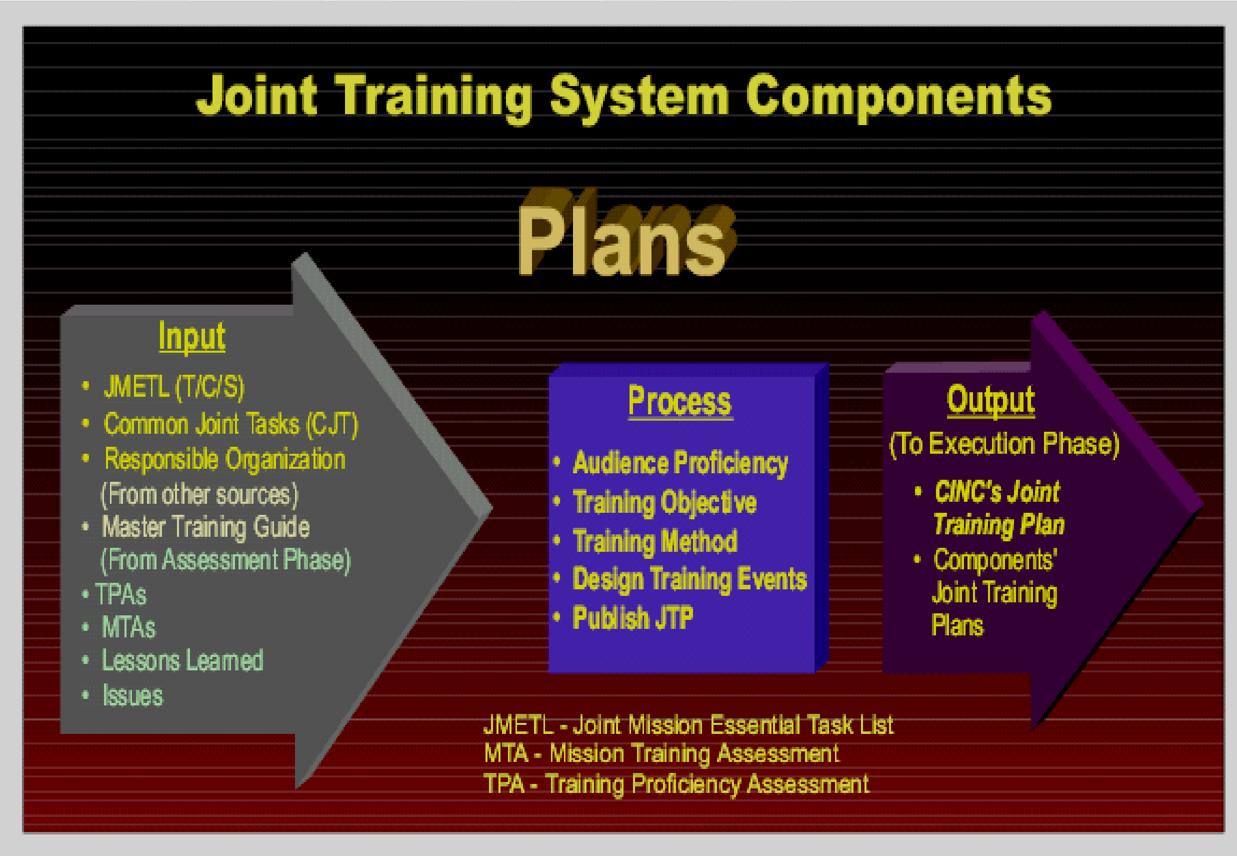

Figure 2.9- Plans Phase

Source: Joint staff, The Joint Training System: A Primer for Senior Leaders, 1998

[73] Ibid, 19

2.7.3- Execution Phase

In Execution Phase, the commander's focus is executing and evaluating the training event. He does this by using the product of the Plans Phase, the CINC's JTP, to develop discrete training events. Those training events may take the form of academic sessions (e.g., seminars, workshops, and facilitated conferences) or exercises to include Field Training Exercises (FTX), Command Post Exercises (CPX) or Computer Assisted Exercises (CAX). There are four stages within the Execution Phase. They are: Planning, Preparation, Execution, and Post exercise-evaluation. Each stage is conducted for each discrete event. These four stages comprise what is known as the Joint Exercise Life Cycle (JELC) Taken together, they help frame the exercise and assist in its proper completion. THA Post exercise-evaluation stage is particularly significant, because it provides input to guide development of the next training cycle. Figure 2.10 depicts the Joint Exercise Life Cycle[74]:

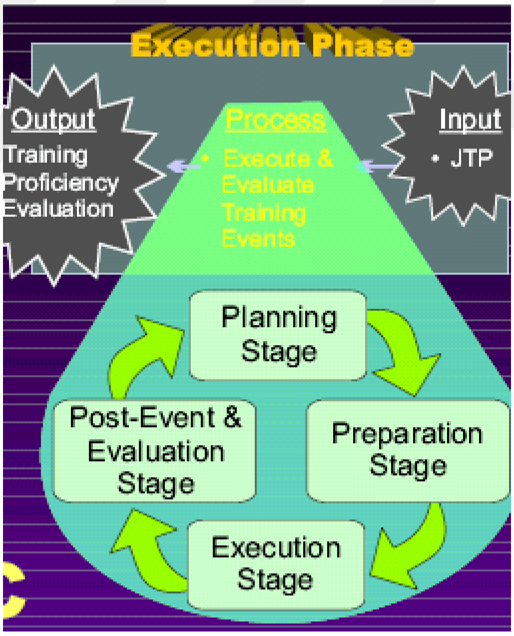

Figure 2.10- Joint Exercise Life Cycle

Source: Joint staff, The Joint Training System: A Primer for Senior Leaders, 1998

Evaluation of training is a command responsibility linked to assessments in Phase IV. Beyond a command's training proficiency, evaluation also supports development of issues (those issues that are beyond a command's ability to resolve) for resolution by the

[74] Ibid, 20

joint community. For example, these include input into the Joint Universal Lessons Learned System (JULLS), and task proficiency observations that must be included in the Joint After Action Report (JAAR).

Figure 2.11 summarizes the Execution phase[75]:

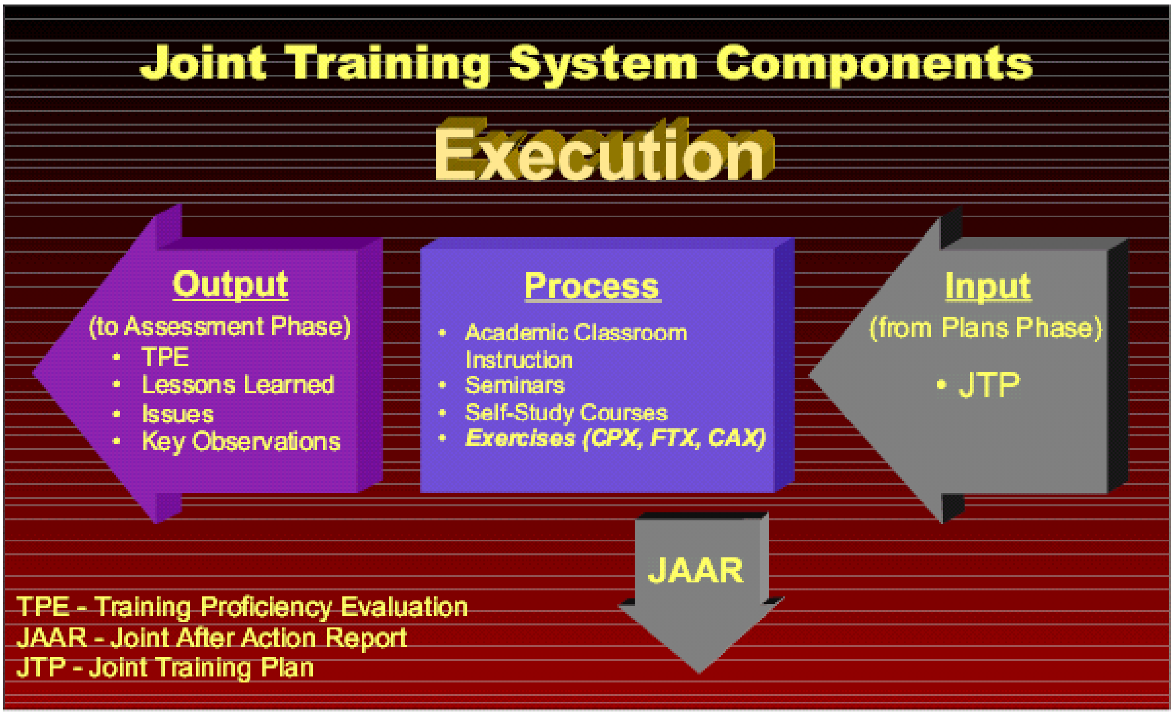

Figure 2.11- Execution Phase

Source: Joint staff, The Joint Training System: A Primer for Senior Leaders, 1998

2.7.4- Assessments Phase

In Assessments Phase, the commander seeks a determination of the command's mission capability from the training viewpoint. Although assessments complete the joint training cycle, they also begin the next cycle, because they drive future training plans. The products from the Execution Phase become the inputs of the Assessments Phase. The commander performs actual assessment; taking into account the results gathered using the assessment plan outlined in the command's Joint Training Plan.

The Assessments Phase serves three purposes: First, it provides the structure that allows the commander to view the level of training in his command and make judgments on his

[75] Ibid, 21

ability and confidence to accomplish assigned missions. Secondly, it provides the necessary feedback to adjust or improve training shortfalls (forces/staffs etc.) within his command. Finally, the Assessments Phase supports external processes related to readiness. Some of these include the Joint Monthly Readiness Report (JMRR), Joint Warfighting Capabilities Assessment (JWCA), Joint Center for Lessons Learned (JCLL), and the Chairman's Commended Training Issues (CCTIs). Figure 2.12 depicts the Assessments Phase[76]:

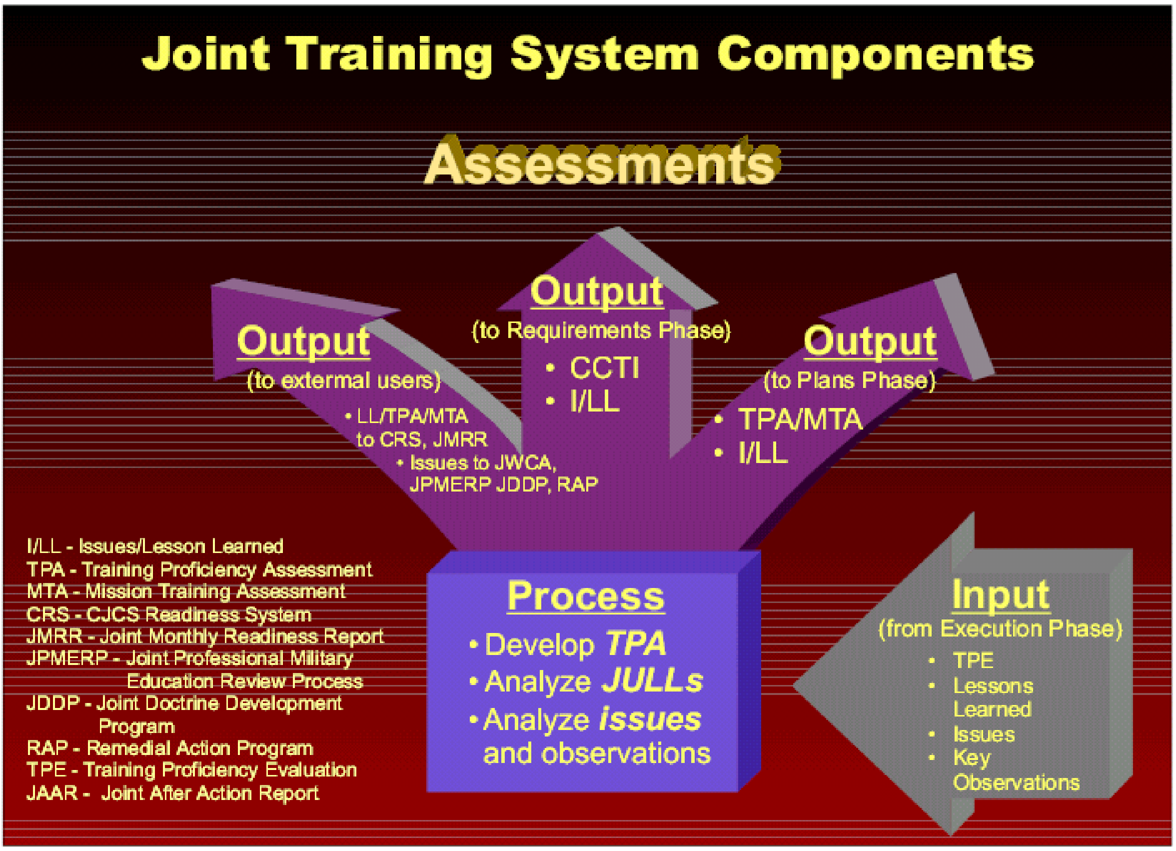

Figure 2.12 - Assessment Phase

Source: Joint staff, The Joint Training System: A Primer for Senior Leaders, 1998

In brief, Joint Training System provides the commander with a process to look at all of his missions and determine which tasks are most important to those missions. He then can focus his limited resources on those tasks. Having done that, he then develops a training plan that identifies who he'll train (training audience) and what will be the objective of his

[76] Ibid, 23

training. He then executes that plan and follows through with an assessment of how well the training was accomplished. As it is seen joint training system includes the steps for increasing the effectiveness of joint training except Modeling and simulation. Especially Execution phase is directly related with Joint Exercises and Joint Course management. The joint training system takes its objectives from National strategy and Joint doctrines in requirement phase so that the courses in execution phases are all designed according to the aims of Joint Course management and consequently one step of increasing the effectiveness of joint training is directly put into the joint training system at the beginning of the requirement phase. Although Advanced Distributed Learning Network can be defined as a tool of joint training system it is also included in execution phase by applying self study courses, Joint Universal Lessons Learned and Joint Action Report.

In Chapter 3, Modeling &Simulation will be analyzed as a method for increasing the effectiveness of the joint training. The definitions of Modeling &Simulation, the technological review to meet the needs of today's battlefield environment, the benefits of using simulation in training will be included in this chapter. At the end of chapter a new approach of military Modeling &Simulation-Joint Simulation System will be analyzed.

Chapter 3

MODELLING& SIMULATION

3.1- MODELLING& SIMULATION DEFINITIONS

The definitions were extracted from DoD M&S Glossary.[77]

Model: “A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process.”

“A mathematical model is a symbolic model whose properties are expressed in mathematical symbols and relationships.” (The representation is comprised of procedures (algorithms) and mathematical equations.

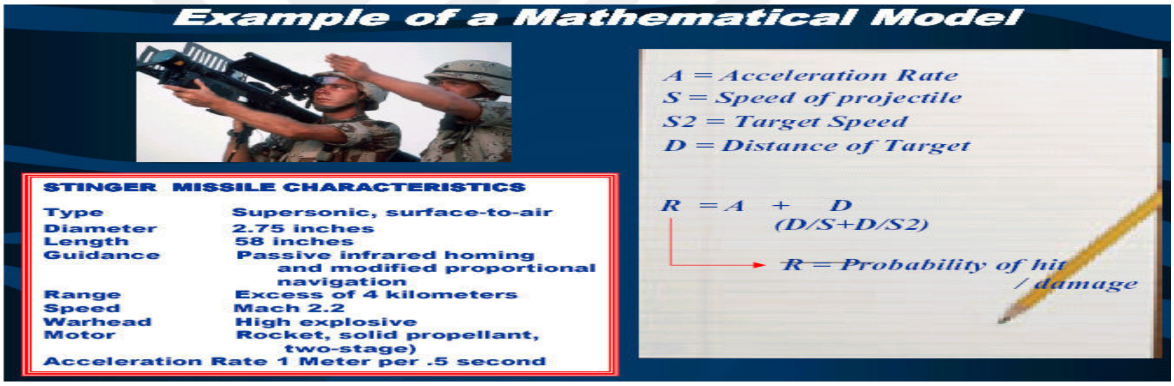

Figure 3.1- A Mathematical Model

Source: Stanford and Snead, MS 101 Introduction to Modeling and Simulation Presentation, Available on site http://www.dmso.mil

A physical model is a model whose physical characteristics resemble the physical characteristics of the system being modeled. Physical models are the symbolic forms utilized for simulators.

Process Model models the processes performed by a system. Process Models allow for the expression of dynamic relationships of a situation expressed by mathematical and logical processes.

---

[77] Defense Modeling and Simulation Office (DMSO), 1998, DoD Modeling and Simulation (M&S) Glossary DoD 5000.59-M, January 1998, Available on site URL http://www.dmso.mil/public/library/policy/p500059m

Simulation: A method for implementing a model over time.

Live Simulation: A simulation involving real people operating real systems. Live simulations involve individuals or groups, may use actual equipment, may provide a similar area of operations, and may not fully replicate actual activity. Live Simulations may result in large resource expenditure, safely hazards, and maneuver damage.

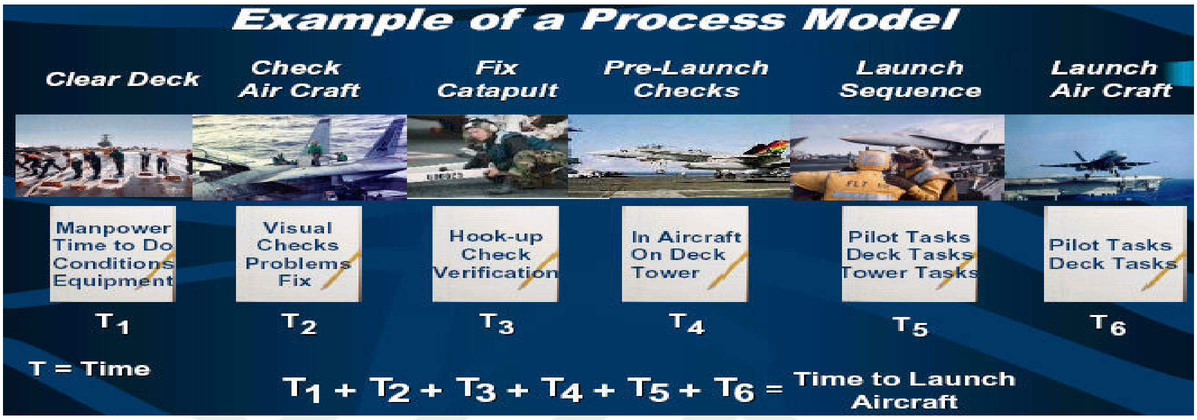

Figure 3.2- A Process Model

Source: Stanford and Snead, MS 101 Introduction to Modeling and Simulation Presentation, Available on site http://www.dmso.mil

Virtual Simulation: A simulation involving real people operating simulated systems. Virtual simulations inject human-in-the-loop in a central role by exercising motor control skills (e.g., flying an airplane), decision skills (e.g., committing fire control resources to action), or communication skills (e.g., as members of a C4I team).)

Constructive Simulation: Simulations that involve simulated people operating simulated systems. Real people stimulate (make inputs) to such simulations, but are not involved in determining the outcomes. Constructive simulations make measurements, generate statistics, and perform analysis. Constructive simulations offer the ability to analyze concepts, predict possible outcomes, and stress large organizations. Many constructive simulations use a large number of established legacy models and most constructive simulation provide a valuable service, but may not be designed to share information.

Distribute Simulation: Connected simulations, sharing information through state of- the-art communication systems.

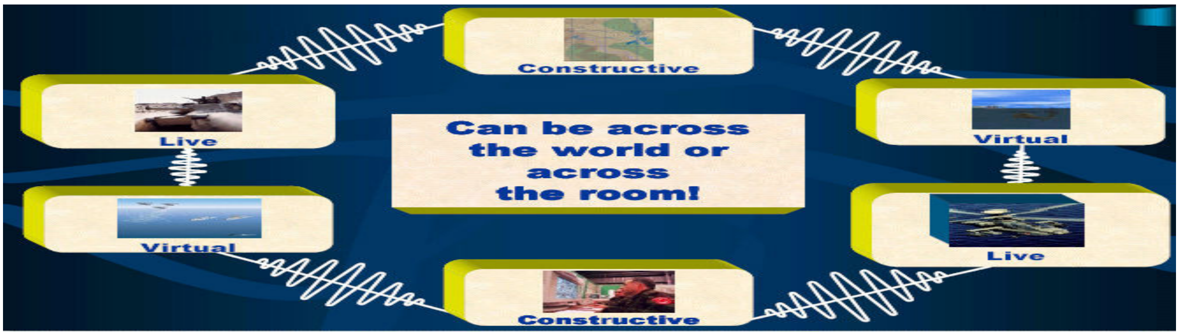

Figure 3.3- Distributed Simulation

Source: Stanford and Snead, MS 101 Introduction to Modeling and Simulation Presentation, Available on site http://www.dmso.mil

Fidelity: The accuracy of the representation when compared to the real world. A model or simulation is said to have fidelity if it accurately corresponds to or represents the item or experience it was created to emulate.

Resolution: The degree of detail and precision used in the representation of real world aspects in a model or simulation. Resolution means the fineness of detail that can be represented or distinguished in an image.

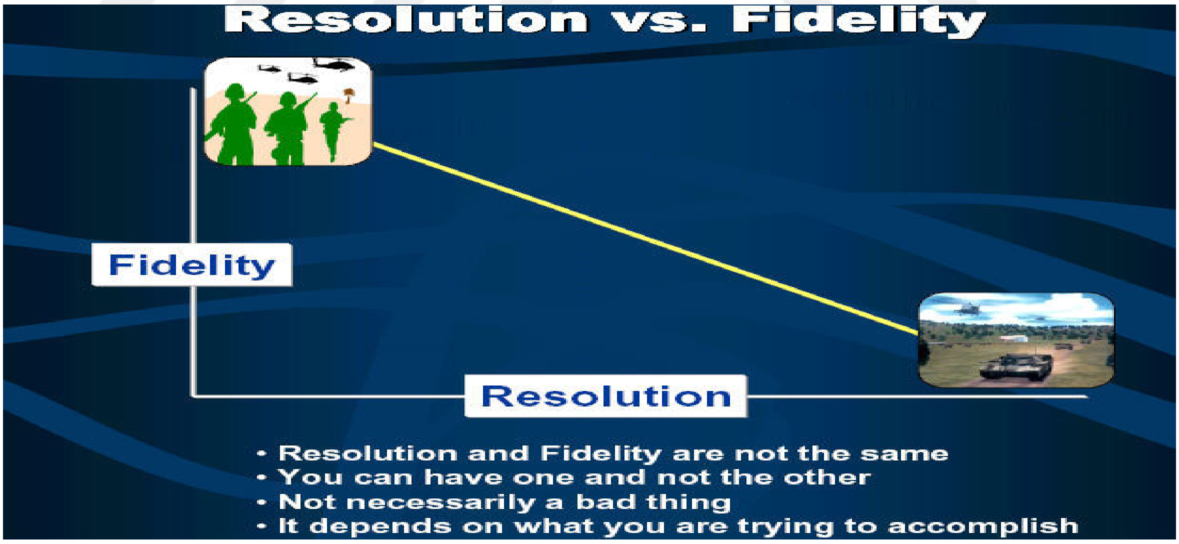

Figure 3.4- Resolution vs. Fidelity

Source: Stanford and Snead, MS 101 Introduction to Modeling and Simulation Presentation, Available on site http://www.dmso.mil

War Game: A simulation game in which participants seek to achieve a specified military objective given preestablished resources and constraints; for example, a simulation in which participants make battlefield decisions and a computer determines the results of those decisions.

3.2- HISTORY OF WARGAMING

Wargames are a bridge between the art and science of warfare studies, and offer military educators a proven tool for conveying knowledge of the operational art and for developing leaders' decision-making skills.[78] According to Culkin[79] the elements of a wargame are:

- Objectives
- A Scenario
- A Data Base
- Models
- Rules
- Players
- Analysis

Today, the proven effectiveness of educational wargames is enhanced by the incorporation of state-of-the-art computer models and simulations. The high-fidelity feedback provided at great speed by microprocessor systems makes possible a level of realism in wargaming not previously observed. When employed in conjunction with military and other government agency subject matter expertise, these new systems create learning environments that are the most challenging leadership opportunities available short of deploying operational forces in the field.

A historical simulation attempts to duplicate a past event, including duplicating the key elements of that past event that the original participants had to deal with. Most wargames, including chess, do this. What makes a simulation such a powerful form of communication is that it is, like most events, non-linear. A book or film is linear. The author leads you from point to point, with no deviation allowed. Simulations, games in general, and analytic history, are non-linear. That is, you can wander all over the place and still be somewhere.

---

[78] Perla, Peter P., 1994, "Future Directions for Wargaming" Joint Forces Quarterly 5, Sum 94, pp 83.
[79] Culkin, Rodger T., 1999, Post Cold Wargaming and The American Military Leadership Challenge, Air Command and Staff College Air University, pp 11

Flip through a book, and you pick up pieces out of context. Make different moves in a game, and you have a context, because the game allow, even encourages, deviating from the historical events. Linear media can be a drag at times, non-linear media keeps you on your toes. Analytic history is written with non-linear use in mind. You can wander around a piece of analytic history and still get a lot of useful information[80]

The first and foremost advantage of war games is that they make people think about war. Players can test their skills in the art of making decisions that affect thousands of people, despite the lack of information (Clauswitz's famous "fog of war").[81] One example of such thinking is the evolving strategy of the US Navy during the interwar years: the concepts of aircraft carrier-based fleet engagements and "island hopping" were developed from war games played at the Naval War College.[82] Adm Chester W. Nimitz acknowledged the usefulness of war games in a letter to that institution: "The war with Japan has been [enacted] in the game room here by so many people and in so many different ways that nothing that happened during the war was a surprise--absolutely nothing except the kamikaze tactics towards the end of the war; we had not visualized those."[83] Furthermore, Germany's tactical expertise on the battlefield during World War II was attributed to the use of war games in the education and training of its officers.[84]

Second, war games can be used to investigate new ideas without risking the lives of soldiers, sailors, and airmen. For example, the use of light aircraft carriers and battleships in coordinated landings was gamed at the Naval War College some 15 years [85]before the actual landings, and the Japanese--in their gaming of Pearl Harbor--developed tactics for delivering a torpedo attack in shallow harbor waters.

---

[80] Dunnigan, James F., 1997, The Complete Wargames Handbook, Chapter 5- History of Wargames, Available on site: http://www.hyw.com/Books/WargamesHandbook/5-4-anal.htm

[81] Defence Science Board, 1988, Report of the Defense Science Board Task Force on Computer Applications to Training and Wargaming, Government Printing Office, May 1988, Washington, D.C, pp 6.

[82] Vlahos, M., 1986, "Wargaming, the Enforcer of Strategic Realism: 1919-1942," Naval War College Review, Volume 39, No. 2, March-April 1986, pp19

[83] Wilson, A., 1968, The Bomb and the Computer, Delacorte Press, New York, pp 3 Cited in: Lee, David B. "Advantages of Wargames War Gaming Thinking For The Future", Available on site: http://www.airpower.maxwell.af.mil/airchronicles/apj/3sum90.html

[84] "War Games," 1961, Military Review Volume 41, No. 6, June 1961,pp 68 Cited in: Lee, David B. "Advantages of Wargames War Gaming Thinking For The Future", Available on site: http://www.airpower.maxwell.af.mil/airchronicles/apj/3sum90.html

[85] Vlahos, M., 1986, "Wargaming, the Enforcer of Strategic Realism: 1919-1942," Naval War College Review, Volume 39, No. 2, March-April 1986, pp15

Third, war games can provide a less expensive alternative to command-post and field exercises, which have casts of thousands and are used to check command and control procedures and unit employments.[86]Further, war games allow commanders to run a campaign plan repeatedly without actually extending resources and causing unit fatigue.[39] For example, the American crossing of the Roer River in World War II was gamed many times without subjecting troops to hostile fire. When the actual operation took place, virtually nothing came as a surprise.

Fourth, hours of boredom sprinkled with moments of terror are a reality of the battlefield, and critical decisions are often made during the moments of terror. But time can be compressed or expanded during war games to focus on campaign issues and discuss available options. The hours of boredom can be disposed of in a tick of the clock. Fifth, any location in the world can be the setting for a war game. Since battles are fought over maps rather than actual territory, they do not affect treaties, international relationships, peacetime safety restrictions, or the environment.

Wargaming has a long history and has throughout the ages, changed history's path, either directly or indirectly. Wargaming has had more of an effect on the course of human events than is realized by most people. It all started around 3000 B.C., in China, with a man named Sun Tzu. A general and the earliest known philosopher on the subject of warfare, Sun Tzu also created the first known war game.[87] The first of the military games is thought to have been Wei-Hai ("encirclement"), a Chinese game that is usually now called Go.[88]

Chess is one of the oldest surviving ancient wargames. Games similar to chess go back thousands of years. Chess is also one of the more accurate wargames for the period it covers (the pre-gunpowder period). Chess is a highly stylized game. It is always set up the same way; the playing pieces and the playing board are always the same. The board is quite simple. Each of the pieces has clearly defined capabilities and starting positions, much like soldiers in ancient warfare. Given that ancient armies were so unwieldy and communication so poor, it is easy to see why each player in chess is allowed to move only

[86] Davis, Lee J., 1951,"Map Maneuvers, Their Preparation & Conduct," Military Review 31, No. 8 November 1951, pp 19. Cited in: Lee, David B., "Advantages of Wargames War Gaming Thinking For The Future", Available on site: http://www.airpower.maxwell.af.mil/airchronicles/apj/3sum90.html
[87] History of Wargaming, Available on site http://www.aimonline.com/history.htm
[88] Gray, Wilbur, "What is Wargaming Part I- History of Wargaming", Available on site http://www.hmgs.org/history.htm

one piece per turn. Because the armies were so hard to control, the battles were generally fought on relatively flat, featureless ground. Then, as now, the organization of the army represented the contemporary social classes. Thus the similarity is between chess pieces and the composition of ancient armies.

As a minor point on the history of chess, the "queen" was, until quite recently, called not the "queen" but the "general," "prime minister," or other similar titles to represent the piece's true function, namely, the actual head of the army who had under his personal command the most powerful troops. This is why the "queen" piece is so powerful. Not only does it represent the single best body of troops, but also the very leadership of the army. The king, on the other hand, is indeed the king of the kingdom, without whose presence the army is lost. Thus, the king is not necessarily a soldier of any particular talent. During the battle his main function is to survive and to serve as a symbol, a rallying point for his army.[89]

The first game to break away from chess, however, was invented by Helwig, Master of Pages to the Duke of Brunswick in 1780. This game included 1666 squares, each coded for a different rate of movement depending on the terrain the square represented. Playing pieces now represented groups of men instead of a single soldier, and each unit was rated for different movement (infantry moved 8 spaces, heavy cavalry 12, for example). There were also special rules for such things as pontooneers and the like. In 1795, Georg Vinturinus, a military writer from Schleswig, produced a more complex version of Helwig's game. He modified it in 1798 by using a mapboard that depicted actual terrain on the border between France and Belgium.[90]

Modern wargames were ushered in by a Prussian named Baron von Reisswitz (Haustrah, 1971) [91] the Prussian war counselor at Breslau. In 1811, he invented an innovative wargame. First, he constructed a table model of actual terrain. He then used blocks to represent units. Each player would give orders to an umpire, who was required to update

[89] Dunnigan, James F., 1997, The Complete Wargames Handbook, Chapter 5- History of Wargames, Available on site http://www.hyw.com/Books/WargamesHandbook/5-histor.htm
[90] Gray, W., "What is Wargaming Part I- History of Wargaming", Available on site http://www.hmgs.org/history.htm
[91] Hausrath, Alfred H., 1971, Venture Simulation in War, Business, and Politics: McGraw-Hill Book Company, New York. Cited in: Caffrey Jr., Matthew, 2000,"Toward A History- Based Doctrine for Wargaming", Aerospace Power Journal, Volume 14 Issue 3, pp 33

the terrain table, resolve combat, and tell the players only what they would know at that point in an actual situation. To determine casualties, umpires first consulted complex tables that indicated likely attrition based on range, terrain, and other factors. The exact attrition was determined by a roll of the dice, which depicted the uncertainties of the battlefield!

Yet, many historians do not credit Reisswitz with initiating modern wargaming. Why not? Because for all its innovation, Prussia used Reisswitz's invention in the same old way--educating princes in war. But times were changing. To counter Napoleon's advantage in numbers, the crowned heads of Europe turned to nationalism. Even after defeating Napoleon, dynastic rivalries encouraged--and the industrial revolution permitted--armies to continue to grow. Prussia soon found it had too many soldiers for only the sons of officers to command. Faced with this officer shortage, even conservative Prussia began allowing the sons of mere bankers, industrialists, and government officials to become officers.

One of these new officers was Reisswitz's son, Lt George H. R.J. von Reisswitz, who soon realized that he and his fellow "outsiders" simply did not know as much about war as those who had been taught it at their father's knee. He believed his father's game could help. In 1824 he adapted his father's game so it could be played on topographical maps. At a stroke, he made wargaming cheaper, more convenient (unlike a sand table, a map could be rolled up), and more flexible. The younger Reisswitz soon demonstrated his innovation to the Prussian chief of staff, Gen Karl von Muffling. After initially being bored and skeptical, Muffling became increasingly excited. Finally, he exclaimed, "It's not a game at all, it's training for war. I shall recommend it enthusiastically to the whole army." Actually, he soon ordered all garrisons to conduct wargames. This was the beginning of the young lieutenant's problems. His fellow officers resented the time these cumbersome wargames required. Finding his isolation intolerable, he took his own life in 1827. [92]

Of course, not all officers hated wargaming. As early as 1828, Lt Helmuth von Moltke advocated the use of wargames. (Patrick, 1977)[93] He even founded the Magdeburg

[92] Caffrey Jr., M., 2000,“Toward A History- Based Doctrine for Wargaming”, Aerospace Power Journal, Volume 14 Issue 3, pp 33

[93]Patrick, Stephen B., Wargame Design: Simulations Publications, Inc., New York, 1977, pp 4. , Cited in: Caffrey Jr., Matthew, 2000,“Toward A History- Based Doctrine for Wargaming”, Aerospace Power Journal, Volume 14 Issue 3, pp 33

(Wargaming) Club (Young, 1957)[94] This kept interest in wargames alive and when von Moltke became Chief of Staff in 1837, he officially pushed wargaming from the top. His influence had the desired effect and by 1876 another set of German wargame rules was published, this time by Colonel Julius Adrian Friedrich Wilhelm von Verdy du Vernois. Vernois' system was a "free" Kriegsspiel as opposed to Reisswitz rigid variety. This meant that most calculations and die rolling was eliminated in favor of an umpire who would determine results based on the situation and his own combat experience. Whether "free" or "rigid," however, wargames had become a mainstay of German military training.[95]

Observing the Europeans’ use of wargames for pre-conflict military planning, and studying their successes and failures in subsequent combat operations, the U.S. Naval War College staff recognized the utility of wargaming for professional military education. Livermore, Mahan, McCarty Little, and others introduced and advanced wargaming into the college curriculum before the turn of the last century.[96] In the United States, Army Major William R. Livermore introduced his The American Kriegsspiel, A Game for Practicing the Art of War on a Topographical Map in 1882. The game was complex and similar to Reisswitz' system, but did attempt to cut down on the paperwork involved by the introduction of several training aid type devices. At the same time Lieutenant Charles A. L. Totten introduced a game entitled Strategos: A Series of American Games of War. Totten's game was as complex as Livermore's, but he appealed to the amateur through the inclusion of a simplified, basic set of rules.[97]

Arguably the most decisive wargames of all time were played in 1905. That was the only year Count Alfred von Schlieffen's plan for a wide-turning movement through neutral Belgium and Holland was wargamed before his retirement. Virtually all present were on the Kaiser’s (German) team, while two first lieutenants played on the side of the armies of

---

[94] Young, John P., 1957, History and Bibliography of War Gaming, Department of the Army, Washington, D.C, pp 2-6. Cited in: Caffrey Jr., Matthew, 2000,“Toward A History- Based Doctrine for Wargaming”, Aerospace Power Journal, Volume 14 Issue 3, pp 33
[95] Gray, W., “What is Wargaming Part I- History of Wargaming”, Available on site http://www.hmgs.org/history.htm
[96] Culkin, Rodger T., 1999, Post Cold Wargaming and The American Military Leadership Challenge, Air Command and Staff College Air University, pp 9
[97] Gray, Wilbur, “What is Wargaming Part I- History of Wargaming”, Available on site http://www.hmgs.org/history.htm

France, Britain, Belgium, and Holland. The wargame concluded with the destruction of the French army so quickly that the British did not have time to come to the aid of France[98]

Germany continued to use war games as a resource for training military officers on how to think about warfare. They were especially important tools in the aftermath of World War I, when ceilings on both, manpower and spending were placed on the German army. Germany went so far as to require each regimental officer to devote one evening a week to wargaming. Game play continued well into World War II and was used to think through many campaigns

Other countries began to try out war games in the late 1800s. The British started informal gaming that used German rules in 1872 and, acting on a directive issued by the Duke of Cambridge, formally adopted war games in 1883. Each military district in England had its own war games. These games used some large-scale campaign as a backdrop, with part of the action occurring in the players' own military districts. From there, individual garrisons confronted military problems of attack and defense. Games were also used to illustrate military history and geography. Unfortunately, the British adopted the most rigid of the war-game rules for training, and when the Boers did not abide by them during the second Boer War (1900-1902), the British dropped the whole concept of war gaming for some 50 years.[99]

Japan appears to have adopted war gaining during the same time as the Europeans, although no definite date can be established. Works from von Meckel were translated into Japanese and used throughout the Japanese army, and the Japanese war college. The victory that Japan enjoyed over Russia in 1904 was attributed, in part, to war games. The Japanese "gamed" the Midway campaign as well as the raid on Pearl Harbor--the latter in the presence of the actual carrier task force commander, Vice Adm Chuichi Nagumo[100]

The semi-rigid wargame thus became the standard for most military conflict simulations around the world through the First World War. The games proved quite successful and history abounds with examples of how commanders were defeated as a result of ignoring

---

[98] Caffrey Jr., Matthew, 2000,"Toward A History- Based Doctrine for Wargaming", Aerospace Power Journal, Volume 14 Issue 3, pp 33

[99] Lee, David B., "Advantages of Wargames War Gaming Thinking For The Future", Available on site: http://www.airpower.maxwell.af.mil/airchronicles/apj/3sum90.html

[100] Ibid,

the result of a wargame. As an example, a Russian wargame in 1914 predicted defeat if General Samsomov's 2d Army did not begin its advance three days ahead of General Rennenkampf's 1st Army, "an action not contained in the plans. This change, so clearly indicated in the war games, was never made in the plans or their execution." The result was the Russian debacle of Tannenburg the same year.[101]

Up until World War II, the majority of the wargames available involved battles. The planning for larger operations was not so much a game as it was a paper-shuffling exercise directed toward solving the puzzle of getting all the pieces moving at the right place and time, much like planning a railroad schedule. But during World War II, things began to change. Much of the gaming used in World War II was of the conventional sort. But equally, if not more important, was the introduction of more scientific techniques. Much of the "gaming" that took place at the behest of the military after World War II was more operations research (OR) and systems analysis than the study of history. The study of past military operations, and history in general, which had formed the basis of the earlier wargames, was very much neglected. This situation has only been rectified to any degree in the last ten years. Meanwhile, the primacy of OR in the military allowed civilian wargames to pull ahead of, and in many cases replace, functions previously performed by OR based wargames. The military only began to play catch-up and develop effective games for their own requirements during the late 1970s and through the 1980s.[102]

Civilian wargaming in the US began, in 1953, when a young gentleman from Baltimore named Charles S. Roberts, developed a game called "Tactics." It posited two hypothetical countries, with typical post-World War II armies, going to war with each other. The game was professionally produced and distributed through the Stackpole Company (which already had a reputation as a publisher of books on military affairs). This was the first of the modern commercial wargames (as we know them). Charles Roberts was then working in the advertising business and was indulging in the commercialization of his hobby as a sideline.

---

[101] Gray, W., “What is Wargaming Part I- History of Wargaming”, Available on site http://www.hmgs.org/history.htm

[102] Dunnigan, James F., 1997, The Complete Wargames Handbook, Chapter 5- History of Wargames, Available on site http://www.hyw.com/Books/WargamesHandbook/5-histor.htm

But by 1958, he realized that there were a lot of people who were interested in his type of game, and he founded the Avalon Hill Company. For the next five years, Avalon Hill experienced tremendous growth. But up until 1961, only six games were published. However, during 1961, an additional six games were published, and from 1962 to 1963 six more games were published. Of these 18, only nine were wargames. They included Gettysburg, Tactics II, U-Boat, Chancellorsville, D-Day, Civil War, Waterloo, Bismarck and Stalingrad. It was the wargames, however, that accounted for most of the sales, and by 1962, Avalon Hill was selling more than 200,000 games a year.[103] In 1960s, Joint wargaming was becoming a reality. In 1961, a wargaming operation was established at the Joint Chiefs of Staff (JCS) level to provide an unbiased, joint arena to conduct McNamara's wargames.

The next year, predictions of a wargame cost study helped convince McNamara to support the creation of an air-mobile division, while relatively low-cost-effectiveness predictions influenced him to cancel the Skybolt air-to-surface missile system. This caused a storm of protests from Britain, which had spent significant funds on the program. The United States was blindsided by this criticism because McNamara's attrition-per-dollar calculations did not even consider the possible diplomatic repercussions of program cancellation.[104]

There was a combination of problems. First of all, the distribution system for games was changing in the early 1960s. Many distributors were having a hard time and a number of them, who represented 25 percent of Avalon Hill's volume, went bankrupt. Avalon Hill had borrowed heavily to finance its expansion, and this really left it on the ropes. Charles Roberts turned the company over to his two largest creditors and went on to a career in the printing industry.

Tom Shaw, who had joined Charlie a few years earlier (they had been long-time friends), was the only member of the old Avalon Hill to stay on. Business was pretty bad through the end of `63 into early `64, but then Avalon Hill began publishing one or two games per year and also decided to publish a long-planned wargaming periodical called The General. This was a critical move, as it provided a forum for gamers to discuss subjects of common

---

[103] Ibid

[104] Allen, Thomas B., 1987, War Games, McGraw-Hill, New York, pp 28. Cited in: Caffrey Jr., Matthew, 2000,"Toward A History- Based Doctrine for Wargaming", Aerospace Power Journal, Volume 14 Issue 3, pp 33

interest, and more importantly, to be aware that they were all part of a large group.[105] AH's classic Gettysburg game had cardboard counters marked with each brigade's name and relative combat strength based upon manpower. The gameboard was a map of Gettysburg laid out in squares originally, then in hexes in later editions. For the first time, a gamer could at least play a mock-up of Gettysburg on a battlefield marked with actual terrain features.

AH produced a great number of similar board games covering other ACW battles (Chancellorsville for example) and other wars (Midway and D-Day were both popular sellers in the late 1960's). The popularity of board games waxed in the 1970's, and many competitors to Avalon Hill emerged, including the prolific game writers at Simulation Publications Incorporated, who published over 40 titles a year during the decade, covering all aspects of military history. Avalon Hill also stepped up the quality and detail of their board games and a host of smaller companies joined the production frenzy. Over 300 Civil War board games of various battles were produced in the 1970's, with over 40 different games being produced on Gettysburg alone. Some were tactical, some were strategic, and others were operational in nature. In the mid 1970's, the largest wargame ever produced at that time came out - SPI's Richard Berg published the massive Terrible Swift Sword game with over 2000 counters in play! This was the first attempt to simulate the entire battle in regimental scale. TSS remains to this day one of the finest examples of a board wargame ever produced. The battlefield is laid out on three large maps divided by hexagons. A player lays out his counters on the map in historical positions. Counters are marked for strength ratings, movement abilities, and morale ratings. Each player in turn moves his counters into new positions, and is fired upon by the enemy's counters that are in range. Dice are rolled and the die roll results are cross-referenced against a matrix of fire strength / die roll / combat results. Results could include casualties being taken by the unit, a retreat being ordered (or an advance), combat, or nothing happens. Victory points are awarded for possession of landmarks or terrain features, as well as for destroying enemy units and leaders.[106]

---

[105] Dunnigan, James F., 1997, The Complete Wargames Handbook, Chapter 5- History of Wargames, Available on site http://www.hyw.com/Books/WargamesHandbook/5-histor.htm

[106] Mingus, S., “Wargaming Miniatures”, Available on site http://www.militaryhistoryonline.com/wargaming/mingus/default.htm

By 1980's wargames began to differentiate into categories. Atari's game console gave rise to arcade wargame, which focused on hand-eye coordination to rapidly defeat the enemy forces. The birth of the personal computer (PC) gave rise to map based campaign wargames, such as Eastern Front 1941. The first flight simulator was also created in 1980.[107] The 1980s also saw innovations in joint wargaming. In 1982, the National Defense University finally initiated a wargaming center and the Warrior Preparation Center became operational in Germany. The latter was specifically designed to allow senior US leaders and NATO headquarters to try war plans without having to maneuver troops. Bills for exercising damage, environmental concerns, and concerns over Soviet capabilities to monitor live exercises all contributed to increasing support for the center. By the late 1980s, all area commanders in chief (CINC) were using wargames.

A 1989 study concluded that US Central Command (US-CENTCOM) was clearly ahead of the pack--a circumstance that turned out to be fortunate. The 1980s also saw the first unclassified reports on how the Soviets wargame. This was due in part to greater openness. Articles that wanted to appear frank but revealed little began to appear in the Soviet open press. However, the real meat came from defectors from the Afghan army. Trained in Soviet wargaming methods, these officers were only too happy to provide details.[108]

In 1990, the deputy secretary of defense created the Executive Council on Modeling and Simulation (EXCIMS) to take a comprehensive look at wargaming. They saw a maze of adjudication software, most looking at one regime, using different data, and producing different answers to the same questions. Ground and naval surface forces had clearly played an important role during the final days of the Desert Storm campaign, yet no wargame could fully depict such a joint operation.

As a first step to bring order to this chaos, a permanent DOD-level office was established. In 1991, the Defense Modeling and Simulation Office (DMSO) was established. [109]Next they established an information clearinghouse so that work was not duplicated out of ignorance. Established in 1993, in 1999 it became the Modeling and Simulation

[107] Maclyntyre, K., 1999, Analysis in the Utility of Commercial Wargaming Simulation Software for Army Leadership Organization Development, School of Advanced Military Studies United States Army Command and General Staff College, Fort Leavenworth, Kansas, pp 10
[108] Caffrey Jr., M., 2000,"Toward A History- Based Doctrine for Wargaming", Aerospace Power Journal, Volume 14 Issue 3, pp 33
[109] Ibid,

Information Analysis Center (MSIAC).[110] As an interim measure, software was developed to allow existing service wargames to talk to each other. Finally, they funded programs to replace many one-service adjudication engines with a few joint ones. The Joint Warfare System (JWARS) was to replace most analytical models, while the Joint Simulation System (JSIMS), using modules developed by each service, was to replace all the models used to train CINC staffs[111]

3.3- TECHNOLOGICAL OVERVIEW OF MILITARY MODELLING AND SIMULATION: CONCEPT OF INTEROPERABILITY

The nations used the technologies, which are also a symbol of economic power for the war through the history. The agricultural nations were very careful about making wars after the harvest. The people were kept ignorant by their statesman to keep them focused on farming and warfare. The soldiers were occupied for the most time of the year with working on the fields. Volunteer soldiers came mainly from farms that did allow them to be absent during the winter months. The harvest called back the soldiers so that only a month or two were left where these farmers could find time to fight.

The industrial Revolution changed the way wars were fought.[112] The element of mass production introduced weapons of mass destruction (nuclear and chemical). The mass armies were not loyal to the landowners but to modern nation states which were paying the soldiers. The change from one wave to the other did not happen in a short period but similar to the industry, took its time to change the warfare. During the transition period, a few wars were actually fought with both types of armies. The big change in warfare was indicated by the manufacture of standardized arms like muskets with bayonets and their accessories. The parts became interchangeable and the industry acted quickly to the needs on the battlefield. Standardization was not only used to produce weapons themselves, but was also applied to military training, organization and doctrine.

---

[110] Adams, R., 1996, "An M & S Primer," Defense News Marketing Supplement, pp9-10
[111]Scott, William B., 2 November 1998, "'Title-10' Games Shape Policies," Aviation Week & Space Technology, pp 61-62 Cited in: Caffrey Jr., Matthew, 2000,"Toward A History- Based Doctrine for Wargaming", Aerospace Power Journal, Volume 14 Issue 3, pp 33
[112] Toffler, Alvin and Heidi, 1993, War and Anti-War, Part II, 1st ed., Little, Brown & Company (Canada) Limited, Printed in U.S.A, pp 38

During the information wave, technologies and ideas began to change the industrial wave societies. The mass society became slowly a communication society. With this development the military doctrine began to change. The duality between the two waves was expressed in the Gulf War of 1990-91 where a dual war was fought by the allies.[113] On one hand, mass destruction was used like in World War II with large bomb carpets over the enemy troops but on the other hand, high tech weapons were used to aim the targets precisely. As a result of information superiority and high lethality of weapons the nations did not need armed forces of great sizes. The second result of the information wave was about using the time properly and it will be more important in future. That can be defined as using the fast information technologies for weapon systems such as satellites, networks and other communication and targeting systems. And that is the way to provide a very high speed information process for Command, Control, Communication, Computer, Information, and Reconnaissance abilities (C4ISR) of armed forces.

In 1980s, the developments in computer science and communication technologies has been effective for developing new models and simulations but because they were not standardized and were produced for special aims by special groups, combining them and using these simulations together was impossible.

In 1990s the limitations for the defense budget was an important factor for new investments. The complex and increasing needs of the battlefield and environmental ideas had caused a long term planning and investment for using modeling and simulation properly. Consequently the modeling and simulation development firstly started by using Simulation Network (SIMNET), and Distributed Interactive Simulation (DIS), Aggregate Level Simulation Protocol (ALSP), and as last High Level Architecture (HLA) systems followed each other.

3.3.1- Simulation Network (SIMNET)

SIMNET was an advanced research project sponsored by DARPA and the Army, awarded to BBN and Perceptronics in 1983 .It was an early step in developing a large-scale network of interactive combat simulators and applying them to tactical training. It integrates aspects of direct and indirect fire, mobility, and combat aviation in combat scenarios that allow

---

[113] Ibid, 64

manned units to fight force-on-force engagements against an appropriately scaled and realistic enemy and, in the context of a joint combined arms environment, provides command and control and combat service support elements. SIMNET offered the Army a low-cost solution to training large groups of individual crews in inexpensive devices that replicate combat vehicles (e.g., M-1 tanks, M2/3 fighting vehicles).[114] SIMNET links tank, helicopter, and airplane simulators into a realistic "cyberspace battlefield."[115] Soldiers are taught how to work as a team and how to work successfully with others through an elaborate, computer-based VR simulation that creates the illusion of operating a tank or a jet under battle conditions. Students are placed inside cubicles that have roughly the same inner dimensions of a cockpit or tank interior; their efforts are coordinated through a sophisticated array of computers that display the field conditions in the "windows." Participants input information into the simulation by operating the various controls within the tank or cockpit; these inputs directly and immediately affect the computer output.[116]

SIMNET's networking approach assumed the need to link a multitude of military training `interfaces' via a common communication format that would allow various land, sea, and aviation components to participate in large-scale exercises. Simulator networking represents a conceptually powerful tool for training. Not only can geographically dispersed personnel and training assets be linked, but also the participants can interact as a team to develop a better understanding and appreciation of one another's capabilities, execution strategies, etc. Typically, it is far too costly to bring actual equipment and personnel assets of geographically dispersed components together for training on a continuing basis. To contain costs and maintain high training levels, additional emphasis will probably be placed on the use of networked simulation in support of distributed training requirements.[117]

However, each simulator has its own unique differences based on various engineering designs and paradigms. The problem is to develop a "method of networking heterogeneous simulators together, which allows realistic, consistent simulations to occur despite

[114] Oswalt, I., 1993, “Current Applications, Trends, and Organizations in U.S....”, Simulation &Gaming Volume 24 Issue 2,pp 153
[115] About SIMNET, Available on site http://www.rtimeinc.com/rtime_web/netscape/rt_about_simnet.html
[116]Browns, 1999 “Simulated Classrooms and Artificial students: The Potential Effects of New Technologies on...”, Journal of Research on Computing in Education, Vol.32 Issue 2, pp 307
[117] Swezey, Robert W. and Owens, Jerry M., 1998, “Task and training requirements analysis methodology (TTRAM): An analytic methodology for...”, Ergonomics, Nov 98, Volume 41 Issue 11, pp 1678

differences in simulator hardware and software...to achieve 'interoperability' of networked simulators." The concept of networked simulations was realized in the DARPA SIMNET program, where all the simulators were manufactured by the same vendor.[118]

Consequently, SIMNET approach was a link for achieving single exercises with actual equipment as weapons, vehicles etc. for the trainees within the same geographic area and within the characteristics of same software and hardware. But because of the challenges of both changing world and new military doctrines today simulation network approach is not suitable for contemporary armed forces and joint operation exercises.

3.3.2- Distributed Interactive Simulation (DIS)

DIS had been started in 1989 when ARPA initiated a program to enhance the SIMNET (Simulation Network) program.[119]The concept that extends the SIMNET program to include simulators manufactured by different vendors and having different functions is called Distributed Interactive Simulations or DIS. [120] The first step toward this goal -- Distributed Interactive Simulation (DIS), which enables an extended network of simulation through standardized protocols -- was developed in the SIMNET program under the Defense Advanced Research Projects Agency in Arlington, Va. DIS was sharply focused on training applications evolved from SIMNET and the Army's Simulation, Training and Instrumentation Command. This system evolved to interface live, virtual, and constructive players in this common virtual environment.[121]

Distributed Interactive Simulation involves a distributed virtual environment in which players communicate with others. In order that the databases don’t lose accuracy, every agent in the virtual environment must be aware of every change in the environment. The primary mission of DIS is to define an infrastructure for linking simulations of various types at multiple locations to create realistic, complex, virtual worlds for the simulation of

---

[118] Hardt, J. and White, K., 1998, “Distributed Interactive Simulation”, EEL 4781 Computer Networks, University of Central Florida, Fall 1998

[119] Park, Heon G., The Development of A Scenario Translator for Distributed Simulations, Chapter 2, Department of The Air Force Air University, Air Force Institute of Technology, Ohio, December 1996, pp 2-1

[120] Smith, E., 1998, “Distributed Interactive Simulation”, IST, Orlando, FL, Available on site http://www.ist.ucf.edu/labsproj/projects/dis.htm

[121] J.R.W, 1998, “New Protocols Link Simulators Better Than Ever Before.”, Military &Aerospace Electronics, Nov 1997 Volume 8 Issue 11, pp 15

highly interactive activities. This infrastructure brings together systems built for separate purposes, technologies from different eras, products from various vendors, and platforms from various services and permits them to interoperate. DIS exercises are intended to support a mixture of virtual entities (man-in-the loop simulators), live entities (platforms and test and evaluation systems), and constructive entities (wargames and other automated simulations). The DIS infrastructure provides interface standards, communication architectures, management structures, fidelity indices, technical forums, and other elements necessary to transform heterogeneous simulations into unified seamless synthetic environments.[122]

In distributed interactive simulation, real people can take part, using real equipment, to do the things they have to do in a real war, fighting against or alongside other people and systems that are simulated by computer models. This allows armed forces personnel to be trained (or to develop tactics or to evaluate the utility of a particular system capability) while the influence and interactions of other people, units, and systems are simulated. With modern communications, the various simulators do not need to be in the same location, allowing participants to use the very same equipment in the simulation that they would use in war. This also makes the experience more realistic and directly transferable to wartime operations, which is particularly important for providing commanders the opportunity to develop and evaluate operation plans. Even during a war, alternative plans can be experimented through simulation before being implemented. These two ideas are expressed as train-as-you-fight and take-the-simulation-to-war. To make distributed simulation possible, the various models and communications must comply with a consistent set of protocol standards.[123]

The foundation of DIS is a standard set of messages and rules called Protocol Data Units (PDUs).[124] UDP has been the primary protocol used in DIS to realize this desired interoperability. Through the use of the DIS protocol standard, UDP, DIS integrates traditional simulator technologies with computer communication technologies to create a

---

[122] Topçu, O., 1999, Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-, Chapter 1,Middle East Technical university, Ankara, December 1999, pp 11

[123]Department of Defense, 1998, “ Science and Technology”, Chapter 17, Arlington, VA, Available on site http://www.dtic.mil/execsec/adr96/chapt_17.html

[124] Topçu, O., 1999, Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-, Chapter 1,Middle East Technical university, Ankara, December 1999, pp 12

system that provides a common battlefield on which the various simulators can interact in active, real-time situations. By creating an environment that allows various types of interactive simulators to communicate, effective training can be accomplished at a variety of levels, from operational team training to force-on-force combined arms training. In order for DIS to take advantage of currently installed simulators and simulators to be installed in the future, both produced by different manufacturers, a means must be found for assuring interoperability among dissimilar simulators. There must be a predetermined set of messages that will allow host computers to communicate the necessary information about the vehicles or entities that they represent in the simulated world, and allow the various vehicles/entities to interact. Because UDP provides the necessary and desired interoperability, it also allows an important feature of distributed interactive simulation.

This feature that drives the DIS network requirements is the ability to work with output to and input from humans across distributed simulators in real time. This feature places tight limits on latency between hosts and also means that any practical network will require multicasting to implement the required distribution of all data to all participating simulators. Large distributed simulation configurations are expected to group hosts on multicast groups based on sharing the same sensor inputs in the virtual environment. This can mean a need for hundreds of multicast groups where objects may move between groups in large numbers at high rates. The overall total data rate (the sum of all multicast groups) is bounded, but the required data rate in any particular group cannot be predicted, and may change quite rapidly during the simulation.[125]

Once the network is initialized, the data can be transferred among the multicast groups. The foundation of DIS data structure is a standard set of messages and rules, called Protocol Data Units (PDUs). An example of one of these data units is the Entity State PDU, one of the most common PDU's, which represents all of the state information about a simulated entity that all other simulators need to know. An Entity State PDU contains data about the position and velocity of an entity (any object in the real world). The Entity State PDU also makes the type, position, orientation and appearance of an entity available to all other players of the distributed simulation. Such objects can be airplanes, vehicles,

[125] Pullen, J.M., Myjack, M., and Bouwens, C., 1998," Limitations of Internet Protocol Suite for Distributed Interactive Simulation in the Large Multicast Environment", University of Kansas, Kansas, Available on site: http://hegel.ittc.ukans.edu/topics/internet/internet-drafts/draft-t/draft-ieft-lsma-limitations-02.txt

ammunition, humans, etc. To save network bandwidth, extrapolation, or dead reckoning, is used for the movement of the entity.[126]

By using the position, velocity, acceleration, and rotational velocity data, a receiver is able to dead reckon a vehicle's position before the arrival of the next PDU, thereby reducing consumption of network bandwidth. Using this technique, DIS is able to limit the amount of data an average simulator transmits to approximately 250 bytes per second. Optimizations, such as dead reckoning, permit very large virtual battles to take place. The largest DIS exercise, part of DARPA's Warbreaker program, had 5,400 simulated entities interacting in a single DIS virtual world.[127]

One of the more interesting facts concerning distributed interactive simulation is that there is no central server. Each simulation application maintains its own copy of a common virtual environment. Representations of this environment (e.g. terrain databases) are distributed by various means to all simulation applications prior to any real time operation. DIS is strictly a peer-to-peer architecture, in which all data is transmitted to all simulators where it can be rejected or accepted depending on the receivers' needs. By eliminating a central server through which all messages pass, DIS dramatically reduces the time lag needed for a simulator to send important information to another simulator. This time lag, known as latency (and mentioned briefly above), can seriously reduce the realism, and therefore the effectiveness, of a networked simulator. Effective distributed simulation depends on very low latency between the times a new state/event occurs for a simulated entity to the time that the state/event is perceived by another entity that must react to it. For example, it is vital that when one simulator fires at another simulator the target is made aware of the incoming ammunition as soon as possible to allow it to take the appropriate defensive action. Any delay introduced by the training device results in negative reinforcement to the trainee.[128]

When using the PDU protocol, the DIS real time flow consists of packets of length around 2000 bits, at rates from .2 per second per simulator to 15 per second per simulator. This

[126]Riede, C., 1998, "DIS Implementations", University of Karlsruhe, Germany, Available on site http://www.akaflieg.uni.karlsruhe.de/~chr/eec_vs_gats/eec_vs_gats.html
[127] Hardt, J. and White, K., 1998, "Distributed Interactive Simulation", EEL 4781 Computer Networks, University of Central Florida, Fall 1998
[128] Fullford, D. et al, 1998, "Transitioning Your DIS Simulator to HLA", Mak Technologies, Cambridge, MA, Available on site http:// www.mak.com/tech/dis_to_hla_article.htm

information is intentionally redundant and is normally transmitted with the PDU protocol, and in some cases is also compressed. Required accuracy both of latency and of physical simulation varies with the intended purpose but generally must be at least sufficient to satisfy human perception. For example, in tightly coupled simulations, such as high performance aircraft, maximum acceptable latency is 100 milliseconds between any two hosts. At relatively rare intervals, events (such as collisions) may occur, which require reliable transmission of some data on a unicast basis to any other host in the system. The U.S. DOD has a goal to build distributed simulation systems with up to 100,000 simulated objects, many of them computer-generated forces that run with minimal human intervention, acting as opposing force, or by simulating friendly forces that are not available to participate.[129]

The idea of U.S. DOD is a result of the complex battlefield environment of future and to achieve the joint operations training of all units carries very much importance. So that with limited capabilities of simulating a few simulation object DIS is not enough to provide the training of armed forces acting with allied force in a joint battlefield environment.

3.3.3- Aggregate Level Simulation Protocol (ALSP)

DARPA initiated the multiservice Aggregate Level Simulation Protocol (ALSP) program in 1990 to link both analytical and training simulations.[130] Aggregate Level Simulation Protocol (ALSP), both software and a protocol, is used to enable disparate simulations to communicate with one another. It is used extensively by the United States military to link analytic and training simulations to support training requirements for Corps and above. ALSP consists of three components: 1.) The ALSP Infrastructure Software (AIS) providing distributed runtime simulation support and management; 2.) A reusable ALSP Interface consisting of a set of generic data exchange message protocols (i.e., formal rules for information exchange) to enable interaction among objects represented in different simulations; 3.) Participating simulations adapted for use with ALSP. [131]

---

[129] Hardt, J.and White, K., 1998, “Distributed Interactive Simulation”, EEL 4781 Computer Networks, University of Central Florida, Fall 1998
[130] Wilson, Annette L. and Weatherly, Richard M., 1994, “New traffic reduction and management tools for ALSP confederations”. 1994 Elecsim Internet Conference, Available on site: http://alsp.ie.org/alsp.
[131] United States Joint Forces Command Joint Warfighting Center, “What is ALSP?”, Available on site: http://alsp.ie.org/alsp/questions/What%20is/index.html

ALSP defines a general architecture for data exchange that allows the simulation (confederation) designers to decide what data will be exchanged, rather than having it specified by the protocol. At runtime, a simulator can tag data it wishes to share with other simulators and forward the tagged data to the infrastructure. The infrastructure forwards this data to other simulators that have requested data with the same tags. This process is very flexible, but it has the potential to be no deterministic because the tags can be defined at runtime. For example, if one simulator tagged a data item with the name "velocity" and another asked for "Velocity," the infrastructure would not forward the data.[132]

Figure 3.5 depicts the simulations, which ALSP is used to provide interoperability. ALSP permits multiple warfare simulations representing distinct segments of a battlefield, to interact with each other through a common, message-based protocol interface. ALSP Infrastructure Software (AIS) provides the infrastructure that permits multiple simulations to interact AIS principles include the following concepts: no central mode, geographic distribution of simulations, object ownership at the attitude level, a message- based protocol for the exchange of information, a conservative time synchronization approach, a common data representation, and the ability for simulations to use their existing architecture.[133]

The AIS consist of several components. The common modules provide data and time management services to each simulation. The broadcast emulator distributes messages. The control terminal provides the means for an operator to monitor and control ALSP components. Finally the confederation management tool provides the means for an operator to monitor and control multiple AIS components.[134]

[132] Morse, Katherine L. and Dillencourt, M., 2000, "Interest Management in Large-Scale Virtual Environments", Presence: Teleoperators & Virtual Environments, February 2000, Volume 9 Issue 1, pp52
[133] Topçu, O., 1999, Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-, Chapter 1,Middle East Technical university, Ankara, December 1999, pp 13
[134] The Mitre Corporation, 1995, "ALSP Project 1994 Annual Report", Cited in: Topçu, Okan, Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-, Chapter 1,Middle East Technical University, December 1999, pp 13

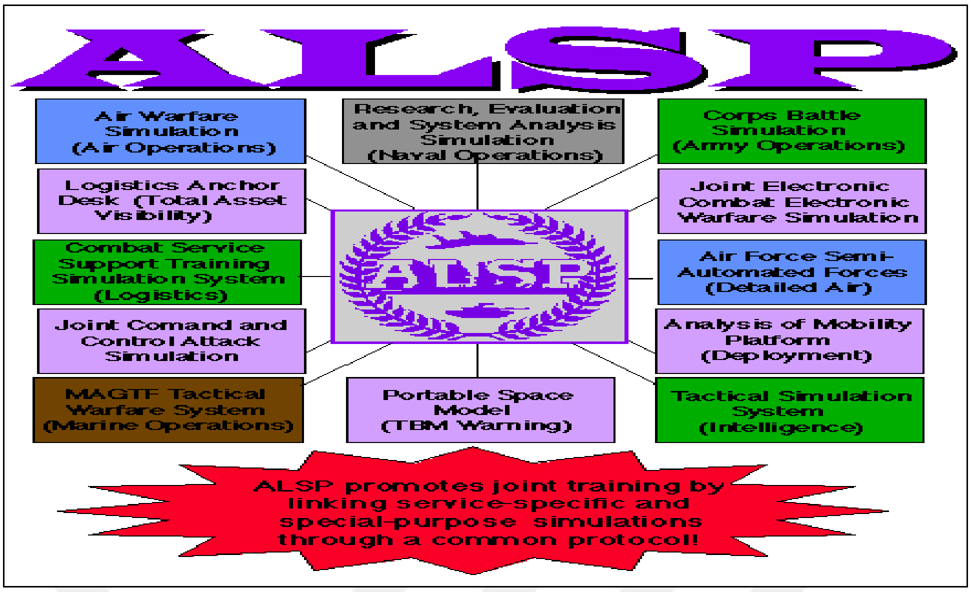

Figure 3.5 – ALSP

Source: United States Joint Forces Command Joint Warfighting Center, "What is ALSP?", Available on site: http://alsp.ie.org/alsp/questions/What%20is/index.html

- Simulation time management: Typically, simulation time is independent of wall-clock time. For the results of a distributed simulation to be ``correct,'' time must be consistent across all ``processes'' involved in the simulation.

- Data management: The schemes for internal state representation may differ widely among existing simulations. A common representational system and concomitant mapping and control mechanisms are needed.

- Architecture independence: The architectural characteristics, e.g. implementation language, user interface, and time flow mechanism, of existing simulations may differ widely. The architecture implied by ALSP should be unobtrusive to existing architectures.

Consequently ALSP was a technology development to provide the lack of DIS for linking more simulation objects in a simulation environment. The ALSP protocol is not a run time technology. However ALSP has the capability of for using the simulations with their existing characteristics it is not able to provide to link the simulations of today as a result of the very much software and hardware changes in the models and simulations which ALSP tries to link.

3.3.4- High Level Architecture (HLA)

The High Level Architecture (HLA) provides a common framework and approach for distributed simulations and virtual words to share information and capabilities, to expand interoperability, and to promote reuse and extensibility.[135] The HLA also provides a general architecture and services for data exchange, allowing simulation (federation) designers to specify the actual data to be exchanged between simulators (federates). Like ALSP, data is tagged by simulators and sent to the infrastructure for forwarding to other simulators. However, the possible tags and types for data are specified at simulation design time, allowing the infrastructure to perform error checking and to optimize how much matching it must do before forwarding the data to other interested simulators.

HLA is designed to support existing DIS and ALSP simulations through "wrappers" which convert between the DIS and ALSP protocols, and HLA service calls. For DIS, this entails breaking down PDUs into their constituent fields and tagging them individually before forwarding them to the infrastructure. For ALSP, this entails deciding before execution what tags will be used and performing error checking at runtime to preclude simulators from sending data with unknown tags. [136]HLA is not software. It is an architecture that provides standard methods of defining how distributed simulations will communicate. It is a set of specifications that define data objects. These standards are specified in HLA Interface Specification and the Object Model Template (OMT). HLA was developed by U.S. Department of Defense (DoD) Modeling and Simulation Office (DMSO). The HLA was approved as DoD’s technical architecture for modeling and simulation on 10 September 1996. [137]

The HLA defines a set of rules governing how simulations, now referred to as federates, interact with another. The federates communicate via a data distribution mechanism called Run Time Infrastructure (RTI) and use an Object Model Template (OMT) which describes the format of data. The HLA does not specify what constitutes an object (objects are the

---

[135] Dahman, J., 1998, “ High Level Architecture for Simulation”, Defense Modeling and Simulation Office, Cited in: Topçu, Okan, Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-, Chapter 1,Middle East Technical university, December 1999, pp 13

[136] Morse, Katherine L. and Dillencourt, M., 2000, “Interest Management in Large-Scale Virtual Environments”, Presence: Teleoperators &Virtual Environments, February 200, Volume 9, Issue 1, pp 52

[137] Topçu, O., 1999, Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-, Chapter 1,Middle East Technical university, Ankara, December 1999, pp 13

physical things that are going to be simulated, such as tanks and missiles), nor the rules of how objects interact. This is a key difference between DIS and HLA.[138]

The HLA is comprised of three elements:

- HLA Rules: A set of rules, which must be followed to achieve proper interaction of simulations (federates) in a federation. These describe the responsibilities of the runtime infrastructure in HLA federations.[139]

- Interface Specification: The HLA Interface Specification defines the interface between the simulation and the software that will provide the network and simulation management services. The Runtime Infrastructure (RTI) is the software that provides these services. There are currently RTI application programming interfaces in CORBA IDL, C++, Ada, and Java [140]

- Object Model Template: The OMT prescribes a common method for recording the information that will be produced and communicated by each simulation participating in the distributed exercise.[141]

The HLA object model template, HLA interface specification, and HLA rules are currently in the formal review and balloting process for acceptance to become IEEE standard 1516. This procedure encompasses two formal review periods and two formal ballots culminating in IEEE acceptance in year 2000.

3.3.4.1- Rationale for HLA:

Following reasons lead the M&S community to develop a new framework:

- No single, monolithic simulation can satisfy the needs of the users.

- All uses of simulations and useful ways of combining them cannot be anticipated in advance

[138] Fullford and et al., 1997, "From DIS to HLA", MS&T The International Training Journal 1/97, pp 4
[139] U.S. Department of Defense, 1998, "Draft Standard for Modeling & Simulation High Level Architecture-Rules version 1.3", IEEE P1516/D1, April 98
[140] U.S. Department of Defense, 1998, "Draft Standard for Modeling & Simulation High Level Architecture-Federate Interface Specification", IEEEP1516.1, February 98
[141] U.S. Department of Defense, 1998, "Draft Standard for Modeling & Simulation High Level Architecture-Object Model Template", IEEE P1516.2, February 98

- Future technological capabilities and a variety of operating environments must be accommodated.
- Specific simulation functionality should be separated from general purpose supporting runtime infrastructure.

Before going into detail, some frequently used terminology are explained:[142]

Federate: one simulation. A member of a federation (e.g. could represent one platform, like a ship, a cockpit simulator)

Federation: A named set of interacting simulations or federates (e.g. could represent an aggregate, like an entire national navigation simulation)

Federation Execution: A session of a federation executing together.

3.3.4.2- Object Model Template

The HLA is designed to facilitate interoperability. Hence, the OMT is designed to provide a means for open information sharing across the simulation community. The OMT does not constrain the content, but provides a streamlined format for communicating to the other users, who may reuse the—~ simulation, and the data inputs and outputs of the simulation. HLA object models are being documented using OMT components, which represent information about classes of objects, their attributes and their interactions in a tabular format using tables.

The Figure 3.6 summarizes the contents of OMT:[143]

---

[142] Defense Modeling and Simulation Office –DMSO, 1998 "HLA Glossary"
[143] Topçu, O., 1999, Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-, Chapter 1,Middle East Technical university, Ankara, December 1999, pp 15

OBJECT MODEL TEMPLATE

Provides a common framework for HLA object model documentation and fosters interoperability and reuse of simulations and simulation components.

TABLES:

- Object Model Identification Table
- Object Class Structure Table
- . Interaction Class Table
- Attribute/Parameter Table
- FOM/SOM Lexicon
- Routing Space Table

Figure 3.6 – Object Model Template

Source: Topçu, O., 1999, Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-, Chapter 1,Middle East Technical university, Ankara, December 1999

HLA separates data and architecture. It prescribes that OMT objects and interactions defined according to the OMT can be constructed and exchanged with no adjustments to HLA-compliant software.

The HLA specifies three types of object models: the HLA Federation Object Model (FOM), the HEN Simulation Object Model (SOM), and the HLA Management Object Model (MOM).

FOM: A description of all shared information (objects, attributes, interactions, and associations) between federates essential to a particular federation.

SOM: Describes the simulation (federate) in terms of the types of objects, attributes, and interactions it can offer to potential federations.

MOM: Identifies classes and interactions related to federation management.

3.3.4.3- Interface Specification

The interface specification identifies how federates will interact with the federation and, ultimately, with one another. The RTI provides services to federates in a way that is analogous to how a distributed operating system provides services to applications. Summary of interfaces:[144]

Federation Management coordinates federation-wide activities throughout the life of a federation execution. Interface functions include creation/destruction of a federation execution, joining and resigning a federate, coordination of federation save and restore, and coordination of federation synchronization points.

- Declaration Management: allow federates to specify the types of data they will send or receive by object class and attribute name and by interaction class from the FOM. Interface functions include specification of publishing and subscription interests.

- Object Management: supports life cycle activities of objects and interactions. The services enable the creation, modification and deletion of objects and interactions.

- Ownership Management allows federates to transfer ownership of object attributes to other participants in the simulation. The services offer both "push" and "pull" based transactions.

- Time Management: provides useful services for setting, synchronizing, and modifying simulation clocks.

- Data Distribution Management (DDM): allow federates to specify the distribution conditions for the specific data they send or ask to receive. RTI uses this information to route data from producers to consumers based on DDM declarations.

---

[144] Arguello, L. et al., "HLA- Based Distributed Simulation for International Space Station operations, Paper ID: 4c007, Gargarin Cosmonaut Training Center (GCTTC), 141100 Star City Russia, pp 2

3.3.4.4- HLA Rules

The HLA Rules describe the responsibilities of federates and their relationships with the RTI. There are ten rules. Five relate to the federation and five to the federate. Federation Rules:[145]

- Federation shall have an HLA Federation Object Model (FOM), documented in accordance with the HLA Object Model Template (OMT)
- In a federation, all representation of objects in the FOM shall be in the federates, not in the run-time infrastructure (RTI)
- During a federation execution, all exchange of FOM data among federates shall occur via the RTI
- During a federation execution, federates shall interact with the run time infrastructure (RTI) in accordance with the HLA interface specification.
- During a federation execution, an attribute of an instance of an object shall be owned by only one federate at any given time.

Federate Rules:

- Federates shall have an HLA Simulation Object Model (SOM), documented in accordance with the HLA Object Model Template (OMT).
- Federates shall be able to update and/or reflect any attributes of objects in their SOM and send and/or receive SOM object interactions externally, as specified in their SOM.
- Federates shall be able to transfer and/or accept ownership of attribute dynamically during a federation execution, as specified in their SOM.

[145] Topçu, O., 1999, Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-, Chapter 1,Middle East Technical university, Ankara, December 1999, pp 17

- Federates shall be able to vary the conditions (e.g. thresholds) under which they provide updates of attributes of objects, as specified in their SOM.

- Federates shall be able to manage local time in a way which will allow them to coordinate data exchange with other members of a federation.

3.3.4.5- Run Time Infrastructure (RTI)

At the heart of every HLA Federation is the RTI, which enables the various simulations to share information. Prior to the development of a commercial RTI, the DMSO asked MITRE to help develop a version of the software for public release. With this critical piece of the HLA in place, the M&S community could continue to evaluate and improve upon the system. Building upon experience gained through its work on the ALSP infrastructure software, MITRE helped to develop the RTI to provide common software services within the HLA. An Integrated Product Team (IPT) was assembled to produce the first publicly available RTI, the RTI familiarization version, or RTI F.0. Within a period of five months beginning with the DOD's acceptance of the HLA version 1.0 specification in August 1996, the IPT successfully developed, tested, and fielded the F.0 software. Members of the IPT were drawn from the DMSO, private industry (including the Virtual Technology Corporation and the Science Applications International Corporation), and MITRE. This work was undertaken to provide the HLA community with functional RTI software during the span of time between the approval of the HLA and the point at which commercial RTIs would be made available.

Based upon the work MITRE and MIT's Lincoln Laboratory had done on the 0.X series of RTI prototypes, with the guidance of the newly approved HLA RTI Interface Specification version 1.0, MITRE and its partners quickly produced a reliable and robust RTI in a single design, document, build, and test cycle. Following the success of the RTI F.0 design effort, work began on an improved and expanded RTI, version 1.0. Released in April 1997, it implemented more of the Interface Specification functionality, and incorporated performance improvements.

In January 1998, MITRE and MIT's Lincoln Laboratory released RTI 1.3, which provided the full set of HLA services specified in Interface Specification v1.3. The next version of the RTI will be 2.0, developed by private industry using an open competitive design process.[146]

The RTI is a set of software components that implement the services specified by the HLA Interface Specification. The RTI is the general purpose software that provides the common interface services for the execution of an HLA federation. The RTI provides these services to federates in a way that is analogous to how a distributed operating system provides services to applications.[147]

The RTI lets different types of systems interact. These systems can include simulations which run faster than real- time and simulate objects which are hierarchical aggregates of individual entities (platoons, companies, or battalions) all the way to high fidelity engineering models which run much slower than real time and simulate individual subsystems with very high accuracy. [148] While the HLA is architecture, not software, use of runtime infrastructure (RTI) software is required to support operations of a federation execution. The RTI software provides a set of services used by federates to coordinate their operations and data exchange during a runtime execution. Access to these services is defined by the HLA Interface Specification[149]

RTI is a distributed system comprised of two global processes, the RTI Executive (rtiexec) and the Federation Executive (fedex), and a library that is linked into each federate. The rtiexec is a well-known process that manages the creation and destruction of federation executions. The fedex is a global process per federation execution that manages the joining and resigning of federates in an execution. The linkable library provides the federate developer with the interface and implementation of a majority of the HLA services. The HLA services are performed via communication between the rtiexec, the fedex, and the federates utilizing socket-based reliable and best effort inter-process communication (IPC). The Figure 3.7 summarizes the run time infrastructure architecture:

---

[146] MITRE Corporation, 1999, "Development of the HLA Part-II", April 1999 Available on site http://www.mitre.org/pubs/showcase/hla/hla_n2.html

[147] U.S. Department of Defense, 1997, "High Level Architecture Run Time Infrastructure Programmer's Guide", Version 1.0, 15 May 1997

[148] Fullford, D. et al., 1997, "From DIS to HLA", MS&T The International Training Journal 1/97, pp 4

[149] Defense Modeling and Simulation Office, "Runtime Infrastructure", Available on site http://www.dmso.mil/index.php? page=70

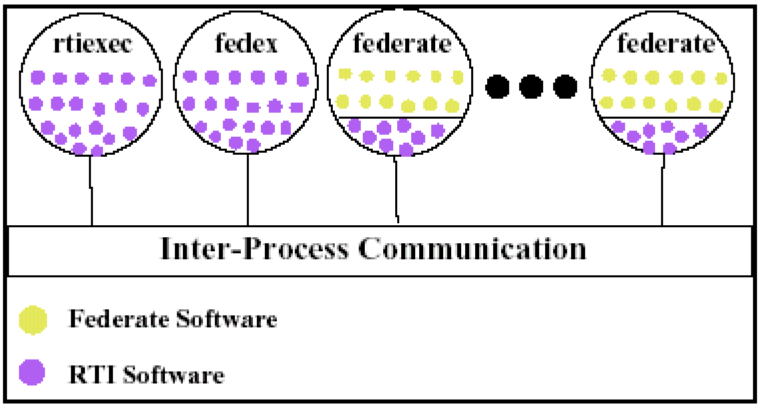

Figure 3.7 – RTI System Architecture

Source: U.S. Department of Defense, 1997, "High Level Architecture Run Time Infrastructure Programmer's Guide", Version 1.0, 15 May 1997

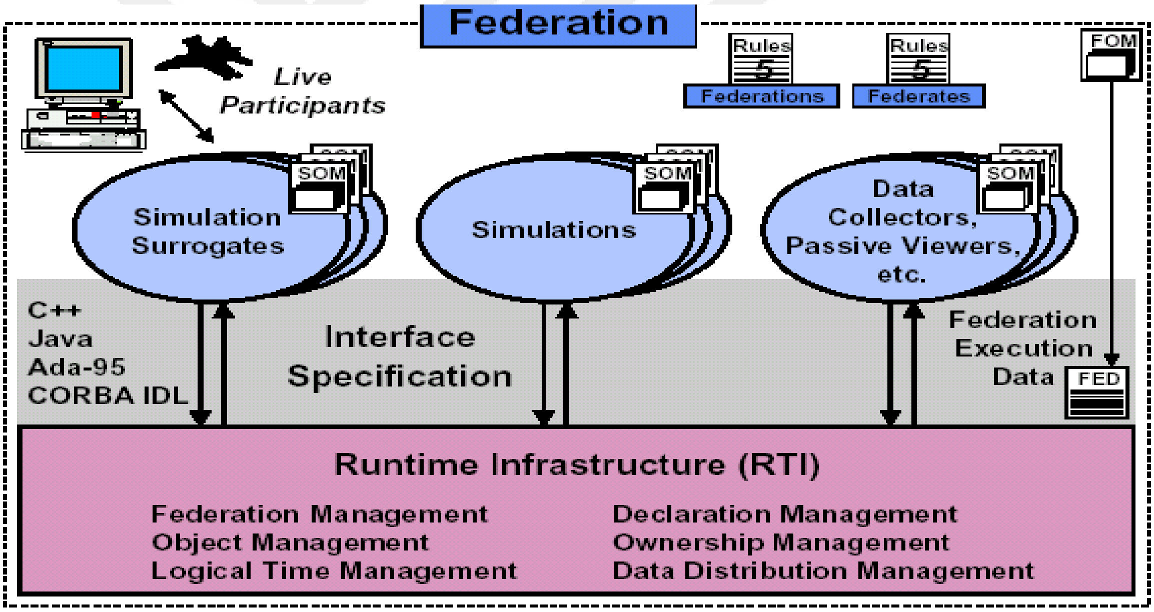

Figure 3.8 – HLA: A Functional View

Source: Zimmerman, P. and Turrel, C., 2001, "Why are you here?", High Level Architecture RTI and Tools User/Developer Forum, 25-26 July, 2001, Available on site http:// www.dmso.mil

RTI partitions the exchanges that take place between federate and Federation into six management areas of the FedExec life cycle, as shown in Figure 3.8. [150] Federation execution lifecycle starts with the federation creation and participation to it (Federation

[150] Zimmerman, P. and Turrel, C., 2001, "Why are you here?", High Level Architecture RTI and Tools User/Developer Forum, 25-26 July, 2001, Available on site http:// www.dmso.mil

Management) After joining, the federate declares its interests to federation (Declaration Management) and creates its objects and interactions (Object Management). Later, the federate updates its objects according to its specified data space (Data Distribution Management) and time management scheme (Time Management). Federate can pass the ownership of its created object to another federate (Ownership Management). After completion of its execution, the federate deletes the created object, erases its interests, resigns from federation, and tries to delete the federation execution; if it is the last federate, it succeeds, and lifecycle ends.[151]

Consequently, HLA can be summarized and it can be clearly seen the strength and flexibility of HLA from other protocols as Fullford defines:[152] The HLA both facilitates interoperability between simulations and provides the federates a flexible simulation framework. Unlike DIS where all simulations receive every price of data broadcast, the federates now have the ability to specify: What information they will be producing, what information they would like to receive, the data's transportation service, e.g., reliable, best effort, whether or not the federations timing mechanism is synchronous or asynchronous. The above points make it possible to have more simulations on a network at one time because the amount of data is being sent is reduced. The simulation software is also simplified because it does not need to process extraneous information.

3.4- CONCEPTUAL MODELS OF THE MISSION SPACE

A Conceptual Model of the Mission Space (CMMS) is a first abstraction of the real world, which serves as a common framework for knowledge acquisition with validated, relevant actions and interactions organized by specific task and entity/organization. It is a simulation independent hierarchical description of actions and interactions among the various entities associated with a particular mission area. [153]Conceptual Models of the Mission Space (CMMS) are simulation implementation-independent functional descriptions of the real world processes, entities, and environment associated with a particular set of missions. In particular, CMMS is:

---

[151] Topçu, O., 1999, Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-, Chapter 1,Middle East Technical University, Ankara, December 1999, pp 25
[152] Fullford, D. et al., 1997, "From DIS to HLA", MS&T The International Training Journal 1/97, pp 4
[153] U.S. Department of Defense, 1997, "High Level Architecture Run Time Infrastructure Programmer's Guide", Version 1.0, 15 May 1997

- A disciplined procedure by which the simulation developer is systematically informed about the real world problem to be synthesized.

- A set of information standards the simulation subject matter expert employs to communicate with and obtains feedback from the military operations subject matter expert.

- The real world, military operations basis for subsequent, simulation-specific analysis, design, and implementation, and eventually verification, validation, and accreditation/certification.

- A singular means for establishing re-use opportunities in the eventual simulation implementation by identifying commonality in the relevant real world activities. And

- A library of re-usable conceptual models for simulation development.[154] The Conceptual Models of the Mission Space (CMMS) intends to support a variety of modeling methods and to be compatible with a number of commercially available modeling tools. The CMMS concept is to permit mission space model developers to employ their preferred modeling methods and tools to instantiate the Entity-Action-Task-Interaction (EATI) representation.[155]

As shown in Figure 3.9 (see next page), CMMS is composed of three primary components[156]:

- Conceptual models: consistent REPRESENTATIONS of real world military operations,

- Technical framework: standards for knowledge creation and integration,

- Common repository: DBMS for registration, storage, management, and release.

---

[154] Defense Modeling and Simulation Office, 1998, "Conceptual Models of Mission Space", Information paper, June 11,1998 Available on site http://www.dmso.mil

[155] Dynamics Research Corporation, "CMMS Data Dictionary CMMS DD", Available on site http://www.dmso.mil

[156] Jack, S. et al, 1997, Conceptual Model of Mission Space (CMSS) Technical Framework, Document Number: USD/A&T-DMSO-CMMS-0002, Revision number:0. 2.1, Defense Modeling and Simulation Office, Alexandria, VA 22311, 13 February 1997,pp 6

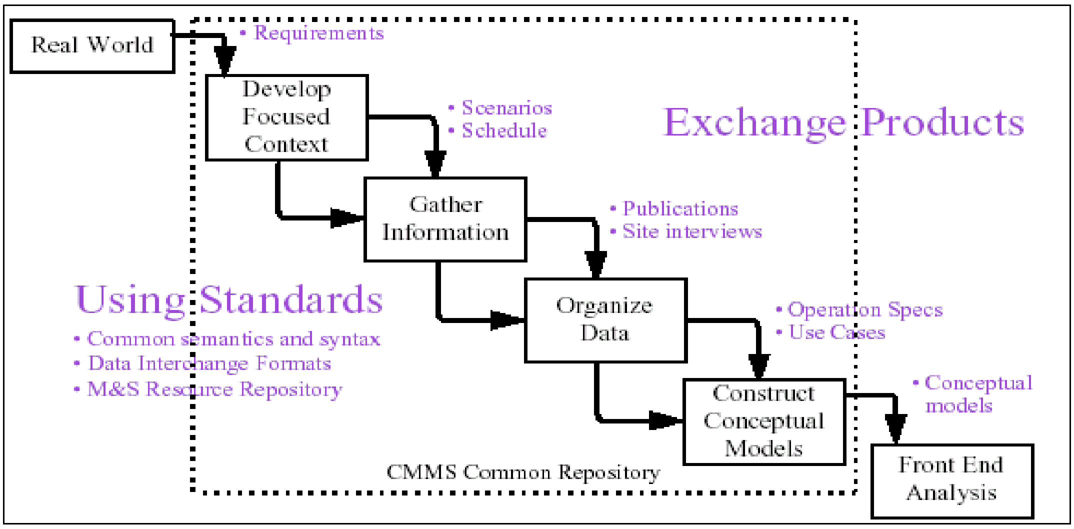

Figure 3.9 – CMMS Components and CMMS Development Process

Source: Jack, S. et al, 1997, Conceptual Model of Mission Space (CMSS) Technical Framework, Document Number: USD/A&T-DMSO-CMMS-0002, Revision number:0. 2.1, Defense Modeling and Simulation Office, Alexandria, VA 22311, 13 February 1997

The Defense Modeling and Simulation Office (DMSO) has developed a Data Engineering Strategy capturing the process of M&S development from knowledge collection to knowledge capture and the use of CSS and Data Interchange Formats (DIF) to produce models and simulations.[157] The Figure 3.10 summarizes the Data Engineering Strategy:

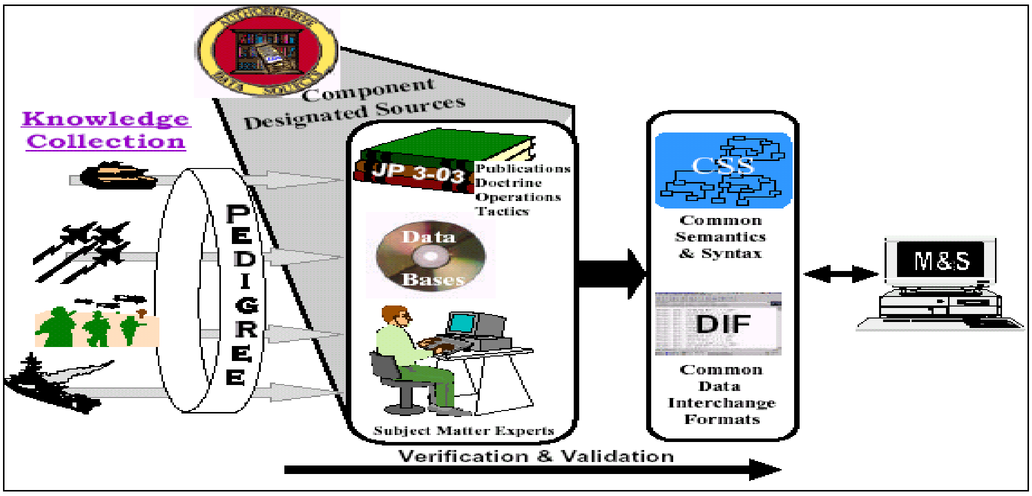

Figure 3.10 – Data Engineering Strategy

Source: Dynamics Research Corporation, 1998, "Technical Report: Data Dictionary Requirements Analyses Validation & Verification Plan", Defense Modeling and Simulation Office, Alexandria, VA 22311

[157] Dynamics Research Corporation, 1998, "Technical Report: Data Dictionary Requirements Analyses Validation & Verification Plan", Defense Modeling and Simulation Office, Alexandria, VA 22311, pp 2

DMSO also developed CMMS Toolset Architecture to ensure consistent effort across different M&S programs (CMMS, HLA, etc.). DMSO envisions mission space models (MSMs) being developed and submitted for inclusion in a model library. When a MSM is forwarded to the library, it will be stored in its native format (i.e., CASE tool product, MS Word document) and in a common format (produced by application of a Data Interchange Format). Also stored will be the CSS resources used in developing the model. Common Semantics and Syntax (CSS) resources provide a standard "grammar," methods, and language for describing military behaviors to be represented in models and simulation. CSS resources include[158]:

1. Lexicons (i.e., dictionaries of standard terminology) envisioned helping in knowledge discovery and the unambiguous definition of content.

2. Templates (common representation templates for Processes, Entities and Environmental Factors) that will ensure "completeness" and comparability of Knowledge Acquisition/Knowledge Engineering (KA/KE) products.

3. Style guides provide tool-specific usage procedures/constraints guidance to facilitate information integration and exchange via "parsing" (i.e., automated translation and storage).

Understanding the conceptual basis for the CSS requires a definition of semantics and syntax. DMSO defines semantics and syntax as follows[159]:

Semantics: the content or meaning embodied in the symbols and the symbol arrangements defined in the syntax.

Syntax: the symbols and structures that may be used in a representation and the ways that those symbols may be arranged with the allowed structures.

Figure 3.11 depicts the CMMS toolset architecture:

[158] Ibid, 3
[159] Ibid, 4

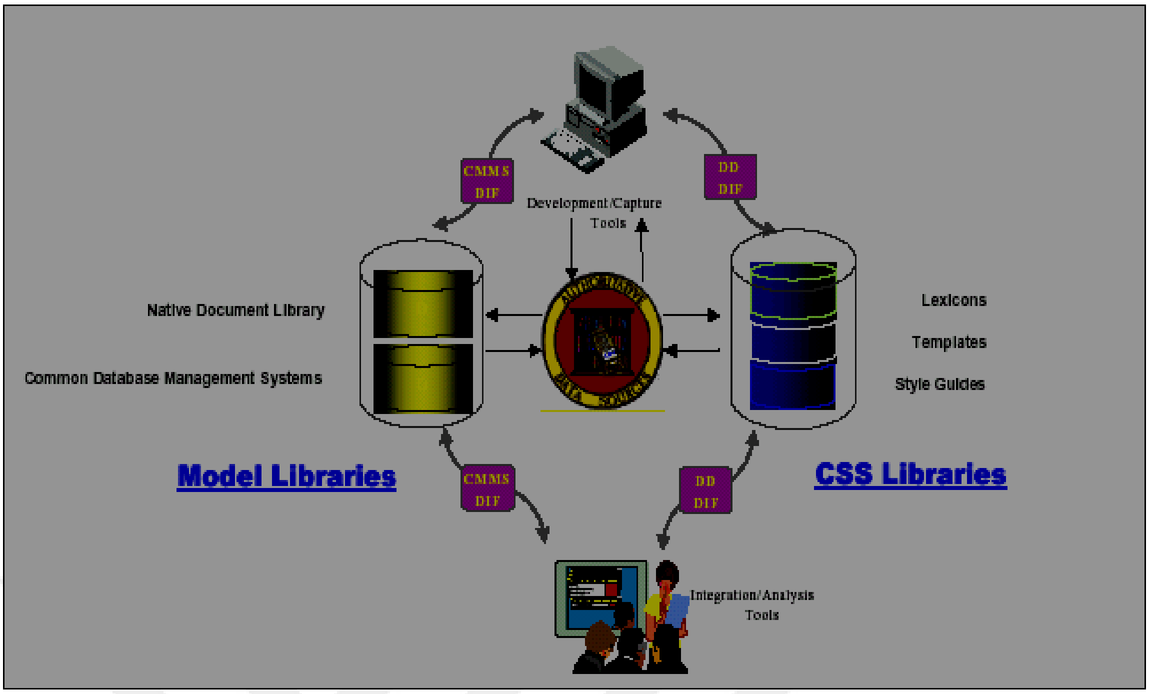

Figure 3.11 – CMMS Toolset Architecture

Source: Dynamics Research Corporation, 1998, "Technical Report: Data Dictionary Requirements Analyses Validation & Verification Plan", Defense Modeling and Simulation Office, Alexandria, VA 22311

The CMMS is to provide a common starting point for constructing consistent and authoritative M&S representations, and to facilitate interoperability and reuse of simulation components. The CMMS is envisioned as serving as a first abstraction of the real world and as a frame of reference for simulation development by capturing the features of the problem space or subject domain -- the Mission Space Model (MSM).

A MSM represents the specification of a Warfighter's view of a real world operation that military simulations must reproduce if it is to be credible. A MSM, therefore, represents the "stuff" of a simulation -- a logical by-product of a simulation's "front-end" analysis. Odds are that if a key entity, process, or dynamic is not represented in the MSM, it will not be represented (or improperly represented) in the developed simulation. While representing reusable representations of real world military operations, MSMs also inform the simulation developer about the real world problem or processes to be simulated and facilitates communication between the simulation developer and subject matter expert (SME). Being an abstraction, a MSM denotes the essential characteristics of a military mission and provides authoritatively defined conceptual boundaries relative to the perspective of the user. These features and subjects are the entities involved in any mission and their key actions, interactions, and conditions.

The CMMS represents a collection or library/repository of MSMs and is a simulation-neutral view of the real world. The CMMS acts as a bridging function between the warfighter, who owns the combat process and serves as the authoritative source for validating CMMS content, and simulation developers. Additionally, the CMMS provides a common viewpoint and serves as a vehicle for communications among warfighters, doctrine developers, trainers, C4I developers, analysts, and simulation developers. Such a foundation allows all concerned parties to be confident that DoD simulations are founded in operational realism.

A central feature of the CMMS is its ability to capture conceptual or mission space models produced by the major Partner Simulation programs including Joint Simulation System (JSIMS) and the Joint Warfare System (JWARS). Converters provide automated support for translating JSIMS and JWARS data from its "native format" to CMMS Library data structures. A CMMS Data Interchange Format (DIF) provides a standardized intermediate form between heterogeneous native formats and the CMMS Library. During the conversion and integration process tests for referential integrity, common semantics and syntax and the identification of redundant entities and processes are performed on the data.[160]

When fully defined and developed, the CMMS will provide an evolvable and accessible framework of tools and resources for conceptual or mission space analysis. The mission space structure, tools and resources will provide both an overarching framework and access to the necessary data and detail to permit development of consistent, interoperable, and authoritative representations of the environment, systems, and human behavior in simulation systems.

3.5- TECHNICAL REFERENCE MODELS

When two or more systems or components are required to interoperate or exchange information, a set of common and consistent service and interface definitions is needed to

---

[160] Defense Modeling and Simulation Office, 1998, “The Conceptual Model of Mission Space and Data Engineering Toolset”, Information Paper, June 11, 1998, Available on site http://www.dmso.mil

ensure the integrity of the information to be passed or exchanged. The set of definitions, integrated into a framework or abstraction, is known as a reference model.[161] The intent of the Technical Reference Model is to minimize continued proliferation of domain models in support of open systems and interoperability across domains, in joint operations, and across a wide range of applications.

In past three key models were Portable Operating System Interface (POSIX), Technical Architecture Framework for Information Management (TAFIM) TRM, and Generic Open Architecture (GOA)—that serve as the foundation for developing and enhancing the Department of Defense (DoD) Technical Reference Model (TRM).[162] Rapid changes in technology and the need to provide extensive user coordination and effect joint operations have further underscored the need for such a set of definitions associated around a model. In the absence of a common model, DoD Services and Agencies were left no choice but to develop their own domain reference models in an effort to satisfy their requirements and users. This domain is DoD Technical Reference Model.

The Department of Defense (DoD) Technical Reference Model (TRM) integrates the service view and interface view to meet the requirements of increasingly diverse and complex systems. The DoD TRM can be tailored to support a wide range of requirements, based in part on the following characteristics of the model:

- Ability of the model to support system architectures so that migration, enhancement, and technology insertion efforts can be supported.
- Degree(s) of freedom enabled by the model to select and or expand on services and interfaces.
- Ability of the model to support and allow new service and interface definitions, associations, and environment configurations (e.g.. network, distributed, platform-centric, multiplatform, and decentralized).

---

[161] Department of Defense, 2001, Technical Reference Model Version 2.0, 9 April 2001, Available on site: http:// www-trm.itsi.disa.mil

[162] More information can be found at DoD TRM web-site http:// www-trm.itsi.disa.mil

- Ability of the model to present or support different views (e.g., services only, interfaces only, services and interfaces, functional).
- Ease of mapping the model to other known reference models to facilitate establishment of relationships and links.

The model presented in Figure 3.12 depicts high- level view of DoD TRM:

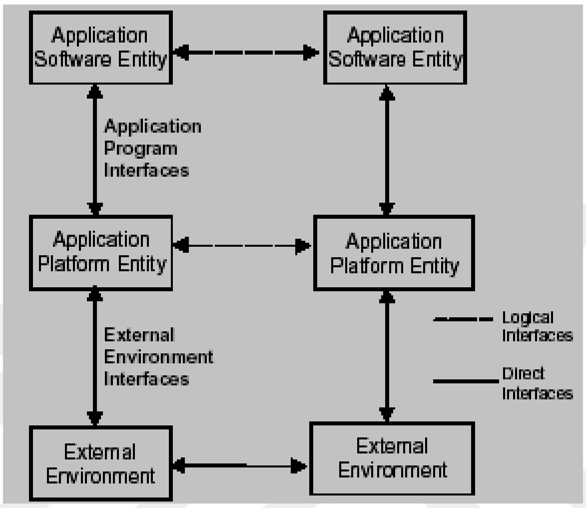

Figure 3.12- High Level Representation of the DoD TRM

Source: Department of Defense, 2001, Technical Reference Model Version 2.0, 9 April 2001, Available on site: http:// www-trm.itsi.disa.mil

The three major elements of the model are (1) the services, (2) the interfaces and (3) the entities that contain the services and interfaces. Entities have interfaces to other entities, and the specific interface nature is determined by the configuration established by the user. Apart from core services and interfaces, the contents and organization of an entity are left up to the user and tailoring requirements within the limits of the entity definition.

1) Entities: Entities are the elements of the model that contain the services and interfaces subsequently used to select and refine a set of standards. Entities contain the major service areas that may be common across several entities. The DoD TRM does not distinguish below the major service area since these service associations are unique to specific models. Lower-level services and interfaces form the basis for defining and tailoring multiple model views.

2) Services: The service is a key common element that establishes a link (i.e., common denominator) between requirements, standards, and the supporting environment (tools). Services support requirements via their functions and capabilities, while standards implement services. The service definitions contained in this document represent an extensive set derived from key reference model documents and coordinated via the Technical Reference Model Working Group (TRMWG) and the Services.

The service descriptions are intended to provide consistent definitions that can be applied across the different domains of application. They are intended to provide uniform means of establishing agreement and consensus between the different users on what a service is, and what is and is not included in its set of supporting functions and capabilities. The existence of an extensive set of core services does not mandate that a particular model or user include all or use all of those services identified in the core set. Users may select the set of core services applicable to them. It is also recognized that some services may be included in more than one major service area or may migrate from one major service area to another due to user requirements or technology drivers that necessitate such. Services may encompass both hardware and software capabilities.

As the list of services is expanded, additional guidance on their use will be included in this document. However, the existence of a core service with its accompanying definition should not be modified indiscriminately. Users must utilize that definition or justify why it should be modified before they are free to invent new service definitions for an existing one.

3) Interfaces: To support a broad range of system capabilities and performance requirements (inclusive of real-time needs) an extensive set of interfaces is required within the model. Interfaces represent the “pipes” through which all services are provided. The interface provides the “connective tissue” between the entities in Figure 3.12 These “pipes” are represented by a set of horizontal and vertical interfaces that fall into two major categories: logical and direct. Logical interfaces define what information is exchanged, i.e., they represent establishment of a data interchange between a source of data and its destination. Logical interfaces define peer-to-peer relationships between similar entities (at the same level of abstraction). Direct interfaces define relationships between adjacent entities and are those “directly” involved with the transmission, receipt, and routing of data between the entities. Direct interfaces allow the identification of operating system to extended-operating-system interfaces essential in weapon systems. The identification and type of interface is determined by user requirements and the operational domain in which a system is to be deployed.

The Figure 3.12 configuration thus allows for a robust and complete description of services and interfaces needed to effectively and adequately describe (tailor) a user's needs across a broad range of systems, applications, or platform configurations. The figure also identifies various configurations that a system may require in supporting its operational mission in both the classified and unclassified mode.

Figure 3.13 is the same basic model shown in Figure 3.12 with additional entity decomposition to illustrate that either a service or interface view, or both, can be graphically represented at the user's discretion. The figure also shows the tailorable nature of the model. This elaboration enables coexistence of a service view with an interface view. This depiction can provide accurate service relationships and present specific logical and direct interfaces where required for any domain. Figure 3.14 shows the DoD TRM services view of Figure 3.13, identifying examples of service areas. The representation also allows for future addition of other services or interfaces, should they be required, without changing the intent or semantics of the model. Consequently, application of the DoD TRM will assist organizations in achieving more effective levels of portability and interoperability in the following ways:

- Interoperability requirements are described in a consistent and common manner.
- Consistent specification of system architecture.
- Support for commonality across systems.
- Consistent use of standards.
- Comprehensive identification of interfaces.

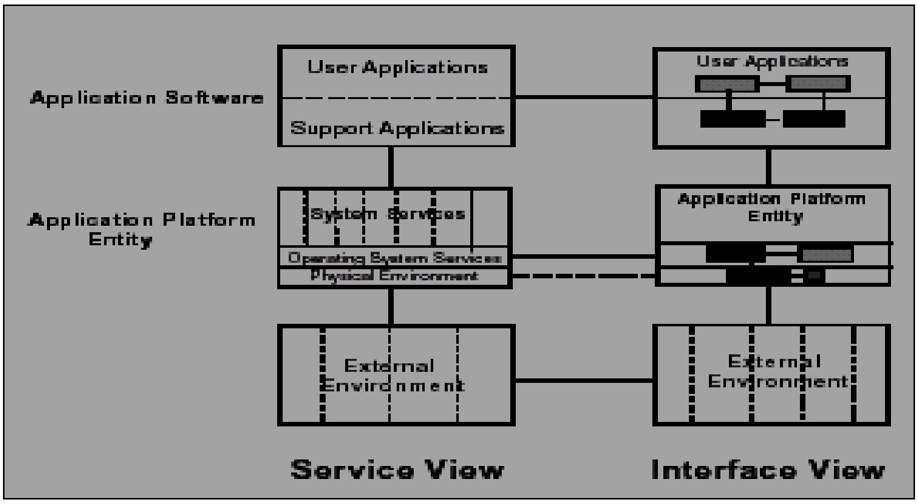

Figure 3.13 - DoD TRM Multi-platform View Showing Both Services and Interfaces

Source: Department of Defense, 2001, Technical Reference Model Version 2.0, 9 April 2001, Available on site: http:// www-trm.itsi.disa.mil

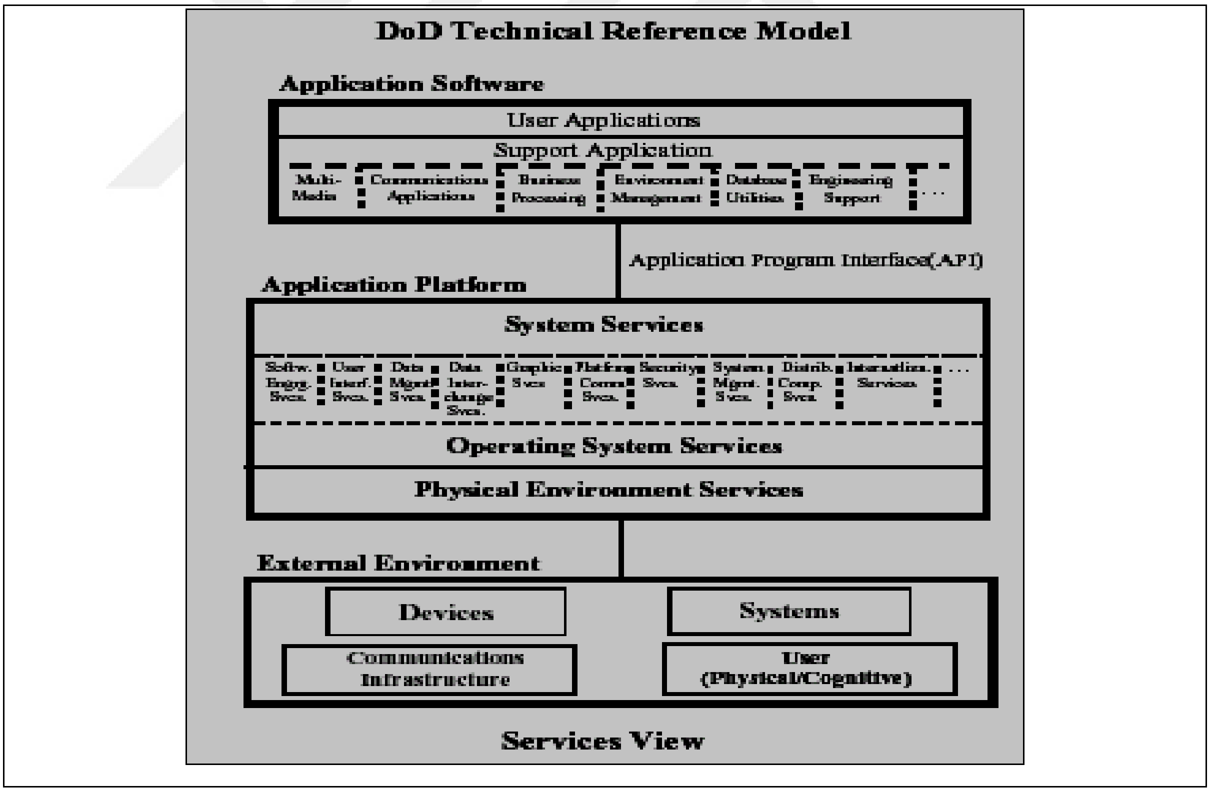

Figure 3.14 - DoD TRM Services View

Source: Department of Defense, 2001, Technical Reference Model Version 2.0, 9 April 2001, Available on site: http:// www-trm.itsi.disa.mil

3.6- DATA STANDARDIZATION

Data Standardization is the process of documenting, reviewing, and approving unique names, definitions, characteristics and representations of data according to established procedures and conventions.[163] Data standardization is achieved by logically identifying, grouping, and classifying data. The DoD Data Model is a logical representation of DoD data and how it is categorized based upon information requirements. Prime words and data elements are derived from the logical grouping of data in either the DoD Data Model, or the Functional Area or Component Data Models. The purpose of this logical grouping is to define, name, and identify characteristics of data to eliminate redundancy and facilitate common use and understanding. Once data requirements are identified, they are classified according to like structures and domains. Another purpose of this logical grouping is to identify standard rules for creating, sharing, maintaining, manipulating, and representing like data. Class words and generic elements facilitate this physical grouping of data.[164]

The goals of the data standardization can be listed as: Finding the data most important to the Department, modeling and standardizing the data, using standard data in information systems and shared databases, improving data quality, shareability, and interoperability and, reducing number of data elements, information systems and data translators.

The data standardization program seeks to facilitate reuse, interoperability, and data sharing among models, simulations, and C4I systems by establishing policies, procedures, and methodologies for data requirements, standards, sources, security, and verification, validation, and certification. The primary products of the data standardization program are: (1) Common Semantics and Syntax (CSS), which define common lexicons, dictionaries, taxonomies, and tools for data elements; and (2) Data Interchange Formats (DIF), the physical structures (BNF, SQL) used by programmers to actually interchange data. Other supporting data standardization products are: (1) Authoritative Data Sources (ADS), the primary means for identifying data for reuse; (2) Data Quality (DQ) practices, a body of

---

[163] Department of Defense, "DoD 8320.1-M-1, DoD Data Element Standardization Procedures," January 1993, authorized by DoD Directive 8320.1, September 26, 1991

[164] Command, Control, Communications and Intelligence Assistant Secretary of Defense, 1994, DoD 8320.1-M Data Administration Procedures", Appendix E- Data Standardization, Washington D.C. 20301-3040, 29 March 1994

VV&A/C guidelines; and (3) Data Security (DS) practices, the policies pertaining to data protection and release.[165]

The Data Standardization activities is depicted in Figure 3.15:

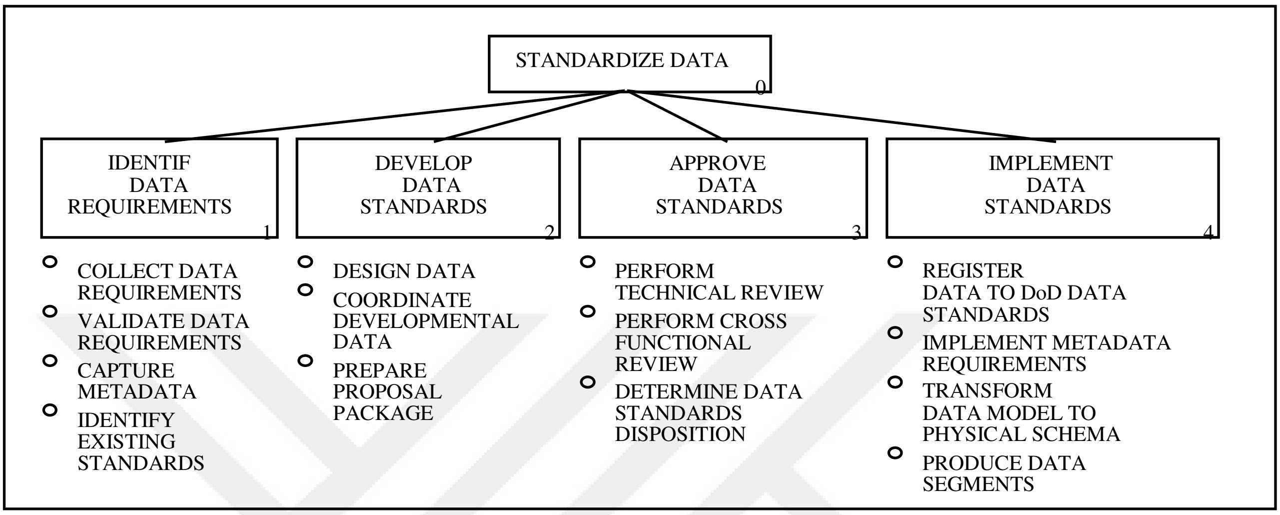

Figure 3.15- Data Standardization Activities

Source: IDR JH&EL, 1998, "Overview and Data Standardization", Section 4- Data Standardization Process, Presentation Slide Number 3, available on site http://www.w3.org/TR/REC-html40

Here is the four data standardization activities presented in an IDEF Node Tree.[166] Identifying data requirements includes the development of a logical data model and the capture of associated metadata. Once data requirements have been captured they need to be assessed to determine if data standard exist that can support the requirements. If data standards do not exist, then the requirements need to be documented in a proposal package and submitted for approval. Before the package is submitted, the requirements should be coordinated with all appropriate organizations to ensure that they are not duplicates of other standards and that they support all requirements.

After submittal, proposal packages are assessed for technical compliance with 8320 and distributed across DOD for cross functional review. After evaluation of comments, the

[165] U.S. Department of Defense, 1997, "High Level Architecture Run Time Infrastructure Programmer's Guide", Version 1.0, 15 May 1997

[166] IDR JH&EL, 1998, "Overview and Data Standardization", Section 4- Data Standardization Process, Presentation Slide Number 3, available on site http://www.w3.org/TR/REC-html40

data steward makes the approval disposition for the proposed standards. Only the data steward has the functional approval authority. After approval, the standards are transformed into physical schemas and distributed as reference data sets or database segments for reuse in automated solutions. The use of data standards should be registered in the Defense Data Dictionary.

Consequently, information is probably the most important resource available for the warfighter to accomplish the mission. We must ensure that the warfighter can access the required data, when it is needed, with some assurance that the data is accurate and universally understood. Data administration, through data modeling and data standards, is a force builder in making an interoperable, data sharing environment a reality. And it must be always remembered that sharing information across the Department is critical to success on the battlefield, and in the supporting functional areas.

This chapter includes history of wargaming and interoperability concepts of future modeling& simulation systems. The technological overview of military modeling &simulation was also tried to be depicted in this chapter. The benefits and applications of simulations will be talked about in next chapter.

Chapter 4

APPLICATION AREAS and BENEFITS OF USING SIMULATION IN CONTEMPORARY ARMED FORCES TRAINING

4.1- REASONS FOR SIMULATION

Carl yon Clausewitz discusses the "feel of the battlefield" and how great commanders deal with friction and see through the fog of war. He also notes that this feel only comes with experience. Unfortunately, this experience costs human lives.[167] According to Banks and Carson some common uses of simulation[168] are described in Table 4.1:

Table 4.1-Some Common Uses of Simulation

1	Simulation enables the study of, and experimentation with, the internal interactions of a complex system, or of a subsystem within a complex system.
2	Informational, organizational and environmental changes can be simulated and the effect of these alterations on the model's behavior can be observed.
3	The knowledge gained in designing a simulation model may be of great value toward suggesting improvement in the system under investigation.
4	By changing simulation inputs and observing the resulting outputs, valuable insight may be obtained into which variables are most important and how variables interact.
5	Simulation can be used as a pedagogical device to reinforce analytic solution methodologies.
6	Simulation can be used to experiment with new designs or policies prior to implementation, so as to prepare for what may happen.
7	Simulation can be used to verify analytic solutions.

Source: Banks, J. and Carson, J.S., 1984, Discrete-Event System Simulation, Englewood Cliffs, NJ: Prentice-Hall, Inc

[167] Surdu, J.R. and Pooch, U.W., 2001, "Simulations During Operations.", Military Review March/April 2001Volume 81 Issue 2, pp 38
[168] Banks, J. and Carson, J.S., 1984, Discrete-Event System Simulation, Englewood Cliffs, NJ: Prentice-Hall, Inc., Cited in: Surdu, R.J., 2000, Connecting Simulation to the Mission Operational Environment, A Dissertation for degree of Doctor of Philosophy, Texas & AM University, May 2000, pp 8

Modeling and Simulation (M&S) supports improved capabilities and decision making through applications in five main areas[169]: 1) concept development, capability and force structure analysis, including preparedness and resourcing; 2) acquisition including systems design, development, prototyping, testing and procurement; 3) individual training and collective single service, joint and combined training; 4) the conduct of operations, including courses of action analysis, linking strategic, operational and tactical levels of command, mission planning and rehearsal; and 5)support to the force in being including development and testing of doctrine and tactics and systems evaluation and improvement.

According to Maclyntyre, the criteria for evaluation of simulation are as follows[170]: 1) The simulation taught organizational leaders to process information. 2) The simulation taught organizational leaders to identify the problem to be resolved. 3) The simulation taught organizational leaders to understand the interrelationships of systems. 4) The simulation taught organizational leaders to identify the solution.

Simulation Technologies can simplify commander and staff responsibilities during operations. Traditionally, the Department of Defense (DoD) has focused on analysis and training simulations, and no operationally focused simulations (OpSims) specifically support operations. Simulations designed for course-of-action (COA) development and analysis, rehearsals and operations monitoring will make staffs and commanders more effective.[171] Simulations assist officer training by requiring students to implement their plans in models that include some of the difficulties of actual execution. Training with simulations is not only practical and economical but allows trainers to examine the working of student plans and to use simulations outcomes as a basis for further discussion and corrective training. Student exercises cannot capture all field operation dimensions but they can certainly reinforce instruction and provide useful links between the institution's

---

[169] National Defense Headquarters, 2000, Modeling and Simulation: Enabling the Creation of Affordable, Effective 2020 Canadian Forces, A Discussion Paper Produced by The Symposium Working Group/ A Sub-Committee of Strategic Capability Planning, April 2000, Ottawa, Ontario, pp 6

[170] Maclyntyre, K., 1999, Analysis in the Utility of Commercial Wargaming Simulation Software for Army Leadership Organization Development, School of Advanced Military Studies United States Army Command and General Staff College, Fort Leavenworth, Kansas, pp 19

[171] Surdu, J.R. and Pooch, U.W., 2001, “Simulations During Operations.”, Military Review March/April 2001Volume 81 Issue 2, pp 38

pure academics and the field training that graduates undertake when they return to Army units.[172]

Modern weapon systems, such as aircraft, artillery, missiles, tanks and naval command, control and fire systems, are expensive to procure, maintain and to use. They are complex and sophisticated in their operation and can effect the environment. The general trend in training, therefore is to have resource to simulation taking into account some or all of the following factors[173]

Certainly, computer simulation is no panacea. Realistic simulations may require long computer programs of some complexity. There are special purpose simulation languages and packaged systems available to ease this task, but it is still rarely simple. Consequently, producing useful results from a simulation can turn out to be surprisingly time- consuming process. In one way therefore, computer simulation should be regarded as a last resort- to be used if all else fails. However, there are certain advantages in employing a simulation approach in management science and it may be the only way of tackling some problems.[174]

On the other hand modern combat is so fast-paced, involves such a variety of threats, and requires information from so many different sources at such different timing intervals that battle management training is essential. Several trends have increased the effectiveness of simulating command, control, and communications (C [sup 3]) processes for training. They include the development of flexible networks, hardware, software, the use of evolutionary acquisition to allow training to be integrated into developing systems, and progress in the modeling and understanding of C [sup 3] activities. So that the education of military personnel in strategic planning, warfighting, and budgeting is another common application of modeling& simulation. [175]

[172] Holder, L.A. and Dessert, R.A., 1996, "Prairie Warrior A Joint and Combined Exercise.", Military Review, July/Aug 96 Volume 76 Issue 4, pp 5
[173] The NATO Training Group Working no Individual Training and Education Developments, 1998, "Simulation in Training" Available on site ftp://ftp.xfree86.org/pub/xfree86/4.0/binaries
[174] Pidd, M., 1990, Computer Simulation in Management Science, Chapter 1, 2nd Ed., John Wiley &Sons Ltd., New York, pp 7
[175] Oswalt, I., 1993, "Current Applications, Trends, and Organizations in U.S. Military Modeling and Simulation.", Simulation &Gaming Volume 24 Issue 2,pp 153

4.2- TRENDS IMPACTING SIMUALATION USE

Live training has always been the method of choice for training soldiers. As the lethality, expense, and complexity of modern weapon systems has increased and training budgets have tightened, live training is no longer sufficient as the sole training method.[176] Cost effective training requires a mix of live, virtual, and constructive simulations to meet the student throughput. This throughput is increasing as the Army competes for the same digital and electrical/mechanical skills that are in high demand in the civilian economy.

Considered against real experimentation, simulation has following advantages:

The principle reason to use simulation is the cost effectiveness that it provides in a world of ever shrinking defense budgets. It is very expensive to train soldiers in the field as fuel, rations, ammunition, and all the other supplies required to conduct field training quickly add up in cost Simulation can therefore be used to maximize the money to be spent on training in a number of ways.

Firstly it can prepare "participants for field events through procedural training and the achievement of skill gateways prior to live training." Secondly, it can maintain skill sets that would otherwise be unaffordable to maintain such as the skills required to fire expensive munitions as well as the command of higher formations and joint and combined exercises. As an example, when simulation is used to prepare commanders prior to a field deployment, units can then immediately commence field training without having to waste valuable and expensive field training days developing command and staff procedures that could more economically be learned in simulation training. [177]

Although the capital cost of some simulators may be high, their use helps to preserve such scarce resources as fuel and ammunition. Moreover, the running cost of a simulator is generally lower than that of operational equipment, particularly when tasks or elements of tasks have to be practiced repeatedly to reach the required level of proficiency. Finally, the early stages of learning are characterized by errors, many of which could be costly in terms

---

[176]The US Army Training Support Center, 1999, Proceedings of the Second Training Effectiveness Symposium, Hampton, VA.

[177] Ewing, R.B., 1998, “The Benefits of Using Simulation in Training- Does the Land Force Leadership Understand?”, Ex- New Horizons 1997-1998 Available on site: http://www.cfcsc.dnd.ca/irc/nh/nh9798/0032.html

of human and financial resources, if operational equipment were being used in a "live" situation. Flying training is an obvious example; even with less complex tasks but with many trainees, the cost of errors could be unacceptably high. On many counts therefore, simulation can be used to reduce costs.[178]

As the military moves into the 21st century, two problems will affect training: personnel tempo and the high cost of manpower- and resource-intensive exercises. Large exercises such as Ocean Venture or Solid Shield have traditionally cost upwards of 800,000 man-days and $40 million. By using innovative modeling and simulation tools, we can provide the same level of training for commanders and other leaders for about 80,000 man-days and $3.5 million--a 90 percent reduction in cost and personnel tempo. This method of training allows Service forces and unit commanders to focus on tactics, techniques, and procedures rather than function as a training tool for the joint force commander, component commander, and staffs.[179]

Clearly, one of the greatest benefits of simulated training is the cost-savings that it affords. This benefit is realized in several ways. First, simulators cost less to run than the real devices that they mimic. For example, the Army' s M1 Tank Driver Training device has been shown to cost only $6 per simulated mile, versus an estimated $92 per actual mile for using a real M1[180]. Second, simulators can effectively reduce training costs, thereby saving on wear and tear to the actual devices. For instance, practicing a series of actual landings on an aircraft carrier stresses the airframe, thereby shortening its life cycle. Practicing the same landings on a simulator avoids stressing the actual aircraft, keeping it in the loop longer for actual combat. [181]

---

[178] The NATO Training Group Working no Individual Training and Education Developments, 1998, "Simulation in Training" Available on site ftp://ftp.xfree86.org/pub/xfree86/4.0/binaries

[179] Berndt, Martin R., 1999, "The USACOM Joint Warfighting Center", Engineer, April 99,Volume 29, Issue 2, pp 19

[180] Raisler, R. B. and Lampton D. R., 1995, ". Simulator sickness in tank driver trainers.", Army Institute for the Behavioral and Social Sciences, Orlando, FL, Available on site http://www.stricom.army.mil/PRODUCTS/TDT/simsick.html

[181] Westra, D.P. et al, 1986, "Simulator design and instructional features for carrier landing: a field transfer study (NAVTRASYSCEN 85-C- 0044-2).", Naval Training Systems Center, FL: Naval Air Systems Command. (No. AD A169962) Cited in: Cohn et al, 2000, "Training-Transfer Guidelines for Virtual Environment (VE)", Interservice/ Industry Training and Simulation Conference November 27-30, 2000, Orlando, FL

Although initial costs to purchase some types of simulation are often expensive, the subsequent operating costs are where the savings are realized and simulation systems generally pay for themselves over a few years timeframe. For example, the British Army has concluded that the use of a tank driver simulator for 50% of the driver training for tank drivers produces a comparably skilled driver with a substantial financial savings. In the case of the Link Miles Chieftain tank driver simulator, the savings from training every 285 Chieftain drivers paid for the cost of the simulator[182]. As another example, it has been determined that command and control simulation training is substantially lower in cost than trying to accomplish the same training in a field exercise. Whereas the cost for a Battle Group to train in the field for one day would range from $250,000 to one million dollars for deployment, sustainment and ammunition expenditure, a day of JANUS command and control simulation training would cost about $4,000. It would also be able to provide "a more realistic scenario than that of an Field Training Exercise" as it could also simulate all the flanking and higher headquarters.[183] As well, when exercises require participants from different geographical locations to be represented, their participation could possibly be remote or conducted from their garrison location thus saving the related travel costs as well. The end result is similar or better training achieved at substantially less cost.

Safety continues to be a primary concern in the training of personnel in hazardous activities within dangerous and hostile environments, a description that fits most combat operations. In a simulation, it is possible to employ weapons, maneuver vehicles, and command troops without regard to the physical dangers that often limit such activities. For example, a user can take a combat vehicle through its full performance envelope or a commander can direct troops without jeopardizing personnel[184]

---

[182]Brown, A.M., 1984," The Use Of Training Simulations By Land Forces.", Unpublished CFCSC essay, Canadian Forces College, p 1 Cited in: Ewing, R.B., 1998, "The Benefits of Using Simulation in Training-Does the Land Force Leadership Understand?", Ex- New Horizons 1997-1998 Available on site: http://www.cfcsc.dnd.ca/irc/nh/nh9798/0032.html

[183] Department of the Army, 1998, "Training With Simulations: Handbook for Commanders and Trainers" Fort Leavenworth: DOD USA, p 39. Cited in: Ewing, R.B., 1998, "The Benefits of Using Simulation in Training- Does the Land Force Leadership Understand?", Ex- New Horizons 1997-1998

[184] Oswalt, I., 1993, "Current Applications, Trends, and Organizations in U.S. Military Modeling and Simulation.", Simulation &Gaming Volume 24 Issue 2,pp 153

Improved safety is one of the most potent arguments for the increased use of simulation as the profession of arms is very dangerous even when a country is not in a conflict. This danger is because accidents with the equipment and weapons with which soldiers train can easily cause serious injury or even death to these same soldiers if they are not careful. Whenever live ammunition is used, the potential for accidents increases dramatically. When simulation is used instead of live ammunition and heavy equipment, unlimited ammunition can be expended and unlimited kilometers driven without the risk of any casualties ever occurring. Soldiers can thus be placed in a realistic, stressful and dangerous battlefield environment where they are forced to react to situations that they would not be able to train in without the use of simulation. As such, simulation provides a high degree of realism with no risk to life or equipment.[185]One of the objectives of a simulation study may be to estimate the effect of extreme conditions and to this real life may be dangerous or even illegal. An airport authority may take some persuading to allow a doubling of the flights per day even if they do wish to know the capacity of the airport. Simulated aircraft cause little damage when they run out of fuel in the simulated sky.[186]

The sensitivity for the dangerous effects of live training including the life security of soldiers will be more important in future. So that to decrease the injury even death rate caused during the live training exercises the armed forces will use simulated environments for training in future.[187]In general, simulation provides a safe environment in which to acquire skills, knowledge and attitudes. It permits dangerous tasks and even emergency drills to be rehearsed; it permits technical malfunctions of equipment to be introduced and corrected in safety and allows to the trainee to be subjected to critical situations and stress but under controlled conditions.

No matter how careful soldiers are, military training in the field will cause some environmental damage. Maneuvering in a training area tears up the ground and the use of fuel and ammunition causes both air and soil pollution. The use of most forms of

---

[185] Norford, P.F., 1993,"Maintaining The Edge - The Need To Enhance Combat Readiness In The Royal Australian Air Force.”, Unpublished CFCSC essay, Canadian Forces College, p 5. Cited in: Ewing, R.B., 1998, “The Benefits of Using Simulation in Training- Does the Land Force Leadership Understand?”, Ex-New Horizons 1997-1998 Available on site: http://www.cfcsc.dnd.ca/irc/nh/nh9798/0032.html

[186] Pidd, M., 1990, Computer Simulation in Management Science, Chapter 1, 2nd Ed., John Wiley &Sons Ltd., New York, pp 8

[187] Berk, Y., 2000, “Sanal Ortam Eğitimi”, Hedef 2020 ve Ötesi, Özel sayı, T.C. K.K.K Eğitim ve Doktrin Komutanlığı, Ankara, pp39-41

simulation substantially reduces, if not eliminates, these environmental side effects of training as most simulation is conducted without using vehicles or live ammunition. [188] Using operational equipment for training, especially military equipment can be quite hazardous. Some skills can be practiced much more safely by means of simulators. Some risks associated with military training involve both universal hazards (such as equipment malfunction, bad weather, collision, inadvertent activation of vehicle controls, and fire), and military hazards (such as operating in close formation and carrying explosive ordnance).

Over the past few years, increases in the amount of legislation governing pollution and environmental damage have lead to a need for simulations since large-scale, realistic (live-fire) training tends to be harmful to the environment. Many unit commanders have found themselves financially liable for repairing whatever damages may result from their training, as well as for punitive damages for repeated violations of environmental protection laws. The result has been that many units either trains on simulators, or they do not train at all.[189]

Many of the NATO countries have difficulty in acquiring accessible training sites ranges on which to carry out training with today's weapon systems under a variety of weather conditions. Apart from the obvious economic reason, there is a growing awareness of the adverse impact on the environment of man; training exercises. Further, there is a need to take notice of public opinion and concern over the effects of modern weapons on the environment. Simulation can permit training to be carried out under realistic, but simulated, conditions while protecting the environment and avoiding adverse public opinion.[190]

---

[188] Ewing, R.B., 1998, "The Benefits of Using Simulation in Training- Does the Land Force Leadership Understand?", Ex- New Horizons 1997-1998 Available on site: http://www.cfcsc.dnd.ca/irc/nh/nh9798/0032.html

[189] Child, David A., 1997, "Patterns of Simulator Use Within a Military Training Environment", International Journal of Instructional Media, Volume 24 Issue 1,pp 43

[190] The NATO Training Group Working no Individual Training and Education Developments, 1998, "Simulation in Training" Available on site ftp://ftp.xfree86.org/pub/xfree86/4.0/binaries

4.3- USING MODELLING & SIMULATION FOR MILITARY TRAINING

One of the most important impacts for using simulation is training effectiveness. Computer simulation is one of the most potent and cost-effective means to plan and train military forces, and deploys to meet an expanding range of mission assignments. The first and most obvious use for this still-developing technology, training, remains a primary mission for military simulators worldwide. Due to complex and rapidly changing battlefield technology, as well as to the need to gain readiness from tight training budgets, computer simulators routinely help train personnel to use new and existing weapons, to work together in joint forces, and to function in special forces. [191]

While other factors of simulation must be in the design and development of a simulation or any training system, the one primary concern is the effectiveness of system in meeting its objectives. Simulation is particularly useful from this standpoint in two situations: A task can not always be practiced in the actual environment or with the actual equipment due to the various considerations (e.g. Safety or environmental protection), or the task to be performed is so complex that it must be broken down into smaller elements or taught more feedback than is possible in the actual environment. In the first instance simulation may be the only available to means to train students, thus offering an opportunity to train n areas that would not be otherwise possible. In the second instance, the characteristics of simulation allow the addition of instructional features to enhance training, thereby increasing training effectiveness or what could be achieved in the actual environment. According to Campbell et al (1995), the defining features and primary advantages of using simulation for training effectiveness are summarized in Table 4.2[192]:

[191] Collard, P., 1997, "The COTS Revolution: As Defense Budgets Shrink, Military Planners Turn to Smart, Flexible, Affordable Simulators", Military& Aerospace Electronics, Sep/97 Volume8, Issue 9, pp 33

[192] Wilkinson, Jeffery G. et al, 1999, Structured Simulation-Based Training Program for a Digitized Force: Approach, Design and Functional Requirements Volume 1,Research Report 1737, U.S. Army Research Institute for Behavioral and Social Sciences, Alexandria, Virginia 22333-5600, pp 10

Table 4.2- Defining Features and Primary Advantages of Structured Simulation-Based Training

DEFINING FEATURES

- Training exercises implement mission, enemy, terrain, troops, and time available
- Training is conducted in accordance with accepted tasks, conditions, and standards
- Exercises use documented task sources for the selected unit and mission types
- Training fits within the unit's available time and personnel
- Exercises support an appropriate training sequence with regard to tasks and difficulty
- Critical tasks are performed more than once to reinforce learning
- Training support materials result in a turn-key program
- Trained observer/controllers manage the exercises, providing feedback and coaching
- Observer/controllers use observation forms focused on actions dictated by exercise flow
- Training exercises use scripted message traffic and pre-established operation orders
- Subordinate and supporting element activities are controlled within specific guidelines

PRIMARY ADVANTAGES

- Minimizes training development and administration requirements
- Immerses unit in realistic tactical situations
- Supports crawl-walk-run approach to training
- Focuses on critical tasks
- Compresses training time

Source: Wilkinson, Jeffery G. et al, 1999, Structured Simulation-Based Training Program for a Digitized Force: Approach, Design and Functional Requirements Volume 1,Research Report 1737, U.S. Army Research Institute for Behavioral and Social Sciences, Alexandria, Virginia 22333-5600, pp 10

Simulation would increase time available to conduct this type of training by approximately one-third allowing a unit to remain more proficient all year. Simulation also allows both individual and collective training to be conducted that in many cases would not otherwise be able to be conducted because of financial or training area restrictions.

With respect to individual training, some weapon systems such as long range anti-tank guided missiles and air defense missiles cannot be fired on most bases because of safety implications due to the long range of the weapon system. When they are fired it is often in a very restricted area and with a target that does not offer the operator much of a challenge. The limited challenge is because the operator already knows roughly where the target is coming from or because the target is likely not moving. These same weapon systems are also very expensive and usually a soldier who has one of these systems as his primary weapon is lucky if he has the chance to fire one round per year. For example, one TOW anti-tank missile costs $35,692.37 and one Javelin anti-aircraft missile costs $51,494.51. To put this into perspective, the Operations and Maintenance (O&M) funds required to support a 550 man Infantry Battalion on a five day patrol exercise is only $40,015.07. (this includes all costs except ammunition). [193] Training proficiency cannot be maintained at this rate. Simulation allows these soldiers to become and remain proficient. In fact, it provides the trainee better training overall as it can duplicate situations that would not otherwise be able to be represented with live ammunition.

For collective training, many training areas are not large enough to conduct training over a certain level and money is often not available either to conduct the training or to travel to a larger base where the training might be possible. In these cases the use of simulation allows collective training to take place that would otherwise not be conducted at all.

The effectiveness of training and the measurement of training objectives are often very difficult to evaluate. The army generally has standards for all training but to evaluate training against these standards tends to be very subjective. Many simulations allow objective evaluation because they can often report processes and events that were conducted. As such it allows both the supervisor and the personnel being trained or evaluated to see what mistakes -or good points - were conducted and thus "permit measured improvement in performance" which helps to improve confidence and subsequently could help to save lives. It also allows the same evaluation criteria to be used for all personnel or organizations being trained and the subjectiveness of umpires can be eliminated or at least much reduced. [194]

Simulations, which are used to train personnel in weapon systems that include personal firearms, aircraft, tanks, guns, and ships, can vary in the management responsibility represented from the individual to hundreds of subordinates. Personal weapons training, which initiates every soldier to military service, has reached the point at which many of the skills once learned on the range can be simulated. Training infantry soldiers for tactical engagements has been significantly improved by Tactical Engagement Simulation (TES) systems, which use a small eye-safe laser transmitter fitted on a weapon muzzle to fire a beam at a target instead of a bullet. The target, fitted with a detector system, emits an aural

---

[193] Tarrant, T., 24 Mar 97, "1RCR FY 97/98 Budgeted Activities", 1st Battalion, The Royal Canadian Regiment: 7000-1(A/DCO), p A-1 Cited in: Ewing, R.B., 1998, "The Benefits of Using Simulation in Training- Does the Land Force Leadership Understand?", Ex- New Horizons 1997-1998 Available on site: http://www.cfcsc.dnd.ca/irc/nh/nh9798/0032.html

[194] Ewing, R.B., 1998, "The Benefits of Using Simulation in Training- Does the Land Force Leadership Understand?", Ex- New Horizons 1997-1998 Available on site: http://www.cfcsc.dnd.ca/irc/nh/nh9798/0032.html

signal if hit and can be tracked throughout an exercise. Training personnel in platform operation and tactics is another popular application for simulation. Aircraft simulators, for example, have long been used for pilot training and were, in fact, the cornerstone of the simulation industry. Weapon system simulators are now also used for training crews of tanks, ships, and submarines. Team trainers or combat watch games use similar simulations to explore tactics and operational employment concepts at the platform level.[195]

Characteristics specific to simulation-based technologies (i.e. simulators and networked devices), for instance, make them variously appropriate for supporting training management, training simulations, and instructional technology functions. Training management functions, for example, deal with managing the practice/training environment (such as degree to which the system supports end-of-session training summaries, and generation of exercise scenarios). Training simulation functions refer to the capability to simulate the physical and functional fidelity of real-world environments, while instructional technology functions concern the extent to which the technology supports features known to enhance skill acquisition, retention, and transfer to operational settings (such as the capability to support both objective and subjective performance measurement, and feedback to be presented during various mission phases) The interaction that a simulation provides can also help employees build confidence in their decision making skills, try new techniques, implement major process changes and to observe the effects of decisions, before applying them in real-world conditions.

Computer simulations can be designed to pack a great deal of learning into a short time period, creating intensive events. As a result, participants are forced to make many more decisions in the simulation than they would in real working conditions. The time required for training can be significantly decreased, thus reducing both training expenses and the impact on operations. However, to be effective for training, participants of a simulation must be willing to use it. Also, the management must be committed to the use of

[195] Oswalt, I., 1993, "Current Applications, Trends, and Organizations in U.S. Military Modeling and Simulation.", Simulation &Gaming Volume 24 Issue 2,pp 153

simulation being involved in setting the objectives of the simulation component of training activity.[196]

Devices classified as `networked simulations' expand upon `simulation' capabilities by providing task and teamwork skill development opportunities among various devices involved in coordinated activities. Although both simulated equipment/setting and networked simulations deal with simulation-based technologies, the latter category encompasses a much broader definition of teamwork, i.e. large-scale co-ordination and integration of task activities across diverse training situations. [197]

Consequently, apart from consideration of costs, resources and the environment, the use of simulation can bring training benefits. Being in an operational situation or using real equipment in training environment is often the best way of learning to perform a task. This may be due to the nature of human learning and/or the characteristic of the task and its context. The learning process involves various factors from including: 1) The progression from easy to more complex and difficult operations. 2) The involvement of more than one sense. 3) The need to concentrate interest in single problems 4) The trainee's control of his own activity and of possible mistakes. Because of using real equipment in an early stage of training may be ineffective. As an illustration consider a student, who having completed the on-job-training, is to continue his training directly on an aircraft. He should suddenly be faced with a multitude of complex and difficult problems, stress and noise may well divert his attention and there could be no guarantee that all his mistakes will be pointed out. Under such circumstances his training will be less effective and more time consuming. In contrast by using a simulator and simulation6modelling techniques it is possible to conduct training gradually and in relation to the trainee's learning capability. As second, it is possible to increase training effectiveness by the activation of many sensory stimuli, by continuous monitoring and through the initial absence of external disturbing factors. And thirdly it will be possible to reduce time to reach a certain level of training, because of that training is no longer dependent on the availability of real equipment that must be used for mission-related purposes.

---

[196] Kornecki, Andrew J. and Vargas, D., 2000, "Simulation-Based Training for Airline Controller Operations", Embry Riddle Aeronautical University, Daytona Beach, FL 32114, pp 2

[197] Swezey, Robert W. and Owens, Jerry M., 1998, "Task and Training Requirements Analysis Methodology (TTRAM): An Analytic Methodology for...", Ergonomics, Nov 98 Volume 41 Issue 11, pp 1678

Finally, it may be possible to gain extra information through simulation. Simulator and simulation provide environment in which errors or poor performance can be allowed and where it is possible to give appropriate feedback to the training. The simulation can thus give extrinsic feedback or guidance. It may no be possible to actually measure the performance and give feedback on a field training exercise, but simulation can be designed to incorporate this information, which is essential for efficient learning. This simply means that simulation has always has additional features not represent in the real situation and live exercises.

4.4- USING SIMULATIONS DURING OPERATIONS

Operationally focused simulations (OpSims) leverage simulation technology to improve situational understanding, prevent information overload and keep the commander inside the enemy's decision cycle. Armywide efforts to improve situational understanding are under way. An OpSim enables the commander to analyze past events, observe current operations or predict the future. An OpSim provides more than just a view of the battle; it analyses the implications of friendly and enemy decisions in real time. An OpSim, like a computer chess analyzer, simulates Course of Actions (COAs) into the future and provides timely, accurate information so the commander can make timely, proper decisions. [198]An OpSim will improve situational understanding by preventing information overload. Using multiple digitized tools can give commanders more information than they can process.[199] OpSims, as part of a larger system, draw attention to aspects of the current operation that could lead to failure. This helps the commander and staff focus on important information and screen out unimportant data. Ultimately, the commander's decision cycle will be faster than the enemy's.[200]

Conducting military operations generally consists of planning, rehearsal, execution and after-action review. These are not distinct phases but usually are concurrent and continuous actions. However, it is helpful for discussion to treat each action as a distinct phase and consider the effects of simulation technology during each.

---

[198] Surdu, J.R. and Pooch, U.W., 2001, “Simulations During Operations.”, Military Review March/April 2001Volume 81 Issue 2, pp 38

[199] Bateman III, Robert L., 1998, "Avoiding Information Overload," Military Review, July-August, pp53-54 Cited in: Surdu and Pooch, 2001, “Simulations During Operations.”, Military Review March/April 2001Volume 81 Issue 2, pp 38

[200] Ibid

4.4.1-Planning Phase

According to Chan, another use of simulation models that can aid in decision making is the use of “what-if” scenarios. In this situation the modeler or system designer uses the model to answer “what-if” type questions. For example, what if an extra operator is put on the job? By using simulation it is simply a matter of modifying the model with an extra operator, running the simulation, and analyzing the relative results.[201]The right combination of simulations in the overall planning phase can have a critical impact on the success of the implementation. Simulation can serve as a test bed of ideas for improvements, which come from a critical analysis of processes and data, brainstorming, and consultation with experts.[202]

During the planning phase, staffs develop courses of action (COAs). The current method, as outlined in U.S. Army Field Manual FM 101-5[203] and U.S. Army Command and General Staff College ST 100-9, is an ad hoc process involving members of the staff discussing the various COAs.[204] Each phase of the operation is analyzed according to an action-reaction-counteraction paradigm. The effectiveness of an action-reaction-counteraction analysis of COAs is also dependent to a large extent on the interaction between the various members of the planning staff. The reality of the current personnel management policies is that a staff rarely has time to coalesce. Except for lock-ins and ramp-ups for deployments to large scale training exercises, personnel rotations ensure that a fair portion of a planning staff will be new to the group. Finally, the same officers who develop the COAs are the ones who analyze them for strengths and weaknesses and determine the criteria used to evaluate the COAs.

Despite the best intentions, the members of the planning staff carry with them personal biases as to which plan is better than others. This notion of the developers also being the evaluators can lead to group think, in which the decision developed by the group is unduly

[201] Chan, Felix T.S., 1995, “Using Simulation to Predict System Performance: A Case Study of an Electro-Phoretic Deposition Plant, Integrated Manufacturing Systems, Vol. 6 No. 5, pp. 27-38

[202] Shtrichman et al, 2001, “Using Simulation To Increase Efficiency in an Army Recruitment Office”, Interfaces 31: 4 July- August 2001, pp 61-70

[203] U. S. Army, 1998, FM 101-5: Staff Organization and Operations, Headquarters, Department of the Army, Washington, DC:

[204] U. S. Army, 1991, ST 100-9: Techniques and Procedures for Tactical Decisionmaking, U.S. Army Command and General Staff College, Fort Leavenworth, KS,

affected by a desire to conform. Given a bias toward one COA, it is easy to manipulate the criteria, weights on the various criteria, and resultant decision support matrix to support the pre-ordained "best" COA. This bias may be manifested consciously or unconsciously, but it is clearly a risk associated with this ad hoc procedure. In the current planning process, once the formal decision briefing to the commander commences, no one in the staff is likely to openly oppose the staff's COA recommendation. Normally, only a forceful commander, assistant commander, or chief of staff can counter this groupthink.

Operationally focused simulations provide powerful new tools to the planning process.[205] As part of this process, the staff can enter enemy and friendly COAs and then simulate them to assess their effectiveness. The results of numerous simulation experiments can then be used as an evaluation criterion for the staff and commander to evaluate the courses of action. The use of simulations will provide better feedback with higher granularity than current procedures. It will highlight problems, especially synchronization issues, within the proposed COAs. The end result is a timely, more accurate assessment of the effectiveness of the proposed COAs. A staff usually proposes two valid courses of action and one "throw away," since the commander usually wants three choices; therefore, the staff only considers two viable COAs. This is due to time constraints; there is usually insufficient time to adequately analyze three COAs. A staff armed with a valid simulation with which to conduct COA analysis will be able to adequately analyze more viable COAs -- and do a better job of analyzing the COAs -- than under the current, manual, ad hoc method. While the manual method was appropriate in an industrial-age Army, it is no longer appropriate for an information age Army that needs to make better decisions faster than the enemy. An additional advantage of a simulation-based process is that the commander can conduct experiments in parallel with his planning staff. One of the requirements of operationally focused simulation was that it be capable of being operated by a single user on a single workstation. The commander can experiment with one or more COAs, conducting mission and COA analysis himself, while his planning staff works on the same ones or others.

If time permits during military operations, the planning staff explores possible alternative actions during the operation (branches) and follow-on operations (sequels). Simulation of

[205] Surdu, J.R., 2000, Connecting Simulation to the Mission Operational Environment, A Dissertation for degree of Doctor of Philosophy, Texas & AM University, May 2000, pp 35

the plan makes it much easier for the commander and planning staff to explore more branches and sequels, in more detail, and with greater fidelity. There is little time to conduct analysis of branches and sequels in the current procedure.

As a result, only the most likely, and maybe the most dangerous, branches and sequels can be explored -- and that analysis is often superficial. With the operationally focused simulation, these branches and sequels can be quickly simulated to provide feedback to the planners. Finally, having the operationally focused simulation at multiple echelons will speed the planning cycle.[206] Once a division headquarters has completed the plan, for instance, they could transmit the plan file electronically to each of the subordinate brigades. The Brigade planning staff can then delete entities that do not pertain to them at the brigade level, partially disaggregate the entities in the division plan that do pertain to them at the brigade level, and begin to flesh out the brigade plan. Once again, this aids in contemporary Armed forces making faster decisions than an enemy. If lower level headquarters need to spend less time recopying overlays and redrawing plans created at higher headquarters and more time conducting mission and COA analysis, the planning cycle of forces can be compressed without degrading the effectiveness of the process.

4.4.2-Rehearsal Phase

Silicon Graphics Inc. describes mission rehearsal to illustrate the today's capabilities as follow[207]: In the early morning on a hot August day, a flight leader from a U.S. squadron enters a secure building near Italy's Adriatic coast to be briefed for the day's mission. An ammunition depot in eastern Bosnia is his designated target. The rules of engagement are stringent: No collateral damage. No civilian casualties. Strike only the target. His four-plane flight of F-16's will be coming up on the target at 650 miles per hour. He will have a few seconds to make a strike/no strike decision. Inside the Intelligence Center, the flight leader sits before a computer display that presents a high-fidelity view of the flight path he will take today. The topography and landmarks are precisely accurate. Below the windscreen, he sees a synchronized plan view of the flight path showing map coordinates. The pilot uses a joystick to guide himself up a steep Bosnian valley to the target. He

[206] Ibid, 37
[207] Onyx™ at Bosnia – Mission Rehearsal, " Creating the Virtual Attack.", Available on site: http://www europe.sgi.com/products/remanufactured/onyx/onyx_bosnia.html

repeats the run, experimenting with headings, altitudes, and maneuvers. At 15,000 feet, 16 miles from the target, he freezes the image, studies target pointers --a bridge, a village, a cluster of trees--and prints full-color copies of the scene. He flies to seven miles from the target, freezes the image again, and calls up a six-degree view up the narrowing valley. He orders more color prints, closes to four miles, and freezes the image again--this time with the target in plain view. He orders a final set of prints and a videotape of the simulated flight, and leaves the building. An hour later, after he and three other pilots have reviewed the tape and verified the target coordinates, they fly the mission with the color prints in their laps. There are clouds in the valley but they identify the target with confidence and drop with accuracy.

The purpose of a rehearsal is to identify synchronization issues and to make sure that everyone fully understands the plan. Certain rehearsals (e.g., fire support (artillery), close air support (helicopters and airplanes), nuclear-biological-chemical (NBC), and mobility/counter-mobility/survivability) are difficult to conduct over sand tables and maps. Clearly simulation would be an asset for these types of rehearsals; however, a simulation-based rehearsal would also be useful for the traditional, centric-centric rehearsal as well. A simulation that can be halted at will facilitate a rehearsal just as large sand tables and map boards do today. A significant advantage of a simulation-based rehearsal is that it could potentially be distributed geographically. With a number of distributed graphical interfaces connected to the same simulation, the commander and operations officer could control the execution of the playback of the plan while the subordinate commanders and other staff members watched at remote locations. The rehearsal could be conducted without all the key players getting within grenade-burst radius of each other.[208]

4.4.3-Execution Phase

After the plan has been chosen, refined, and rehearsed, and the operation commences, the operational simulation methodology, which is depicted in Figure 4.1 can be used to monitor the progress of the simulated plan compared to the real operation. Intelligent software agents, referred to as Operations Monitors, will compare the progress of the real plan against the simulation of that plan. When significant deviations from the plan occur,

[208] Surdu, J.R., 2000, Connecting Simulation to the Mission Operational Environment, A Dissertation for degree of Doctor of Philosophy, Texas & AM University, May 2000, pp 38

the Operations Monitors launch tools that explore the impact of these deviations. Finally the commander is advised if the Operations Monitors determine that the success of the plan is in jeopardy.[209] (Surdu and Pooch, 1998; Surdu et.al, 1999; Surdu and Pooch, 1999; Surdu et. al, 1998; Surdu, 2000)

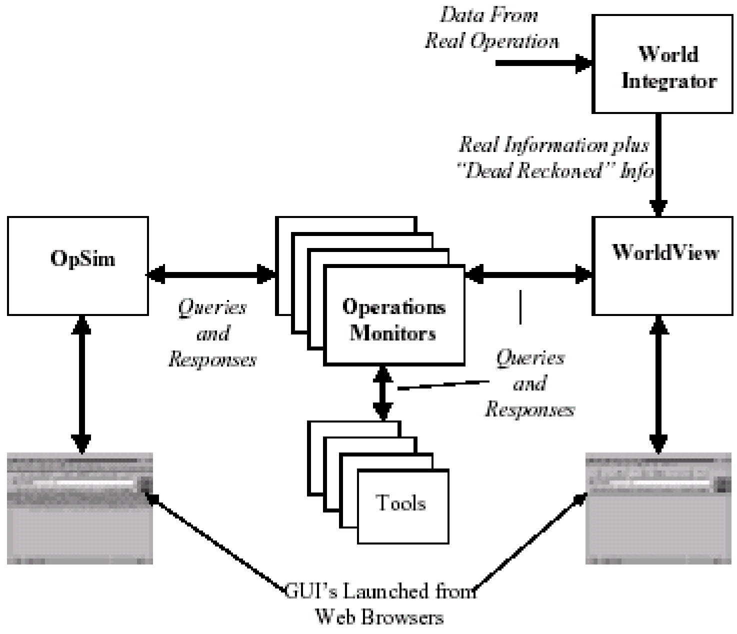

Figure 4.1- Proposed Methodology

Source: Surdu, J.R., 2000, Connecting Simulation to the Mission Operational Environment, A Dissertation for degree of Doctor of Philosophy, Texas & AM University, May 2000

209 Surdu, J. R. and Pooch, U. W., 1998,"A Methodology for Applying Simulation Technologies in the Mission Operational Environment," in Proc. IEEE Information Technology Conference, Syracuse, NY, 1-3 September 1998, pp. 45-48; Surdu, J. R., Haines, G. D., and Pooch, U. W., 1999,"OpSim: a Purpose-built Distributed Simulation for the Mission Operational Environment," in Proc. International Conference on Web-Based Modeling and Simulation, San Francisco, CA, 17-20January 1999, pp. 69-74; J. R. Surdu and U. W. Pooch, "Connecting the Operational Environment to Simulation," in Proc. Advanced Simulation Technology Conference: Military, Government, and Aerospace Simulation, San Diego, CA, 11-14 April 1999, pp. 94-99.; J. Surdu, D. Ragsdale, B. Cox, J. Yen, and U. Pooch, "Implementing Entities in Simulation as Intelligent Agents," in Proc. Military, Government, and Aerospace 1998, Boston, MA, 5-9 April 1998, pp. 90-95.; Surdu, R.John, 2000, Connecting Simulation to the Mission Operational Environment, A Dissertation for degree of Doctor of Philosophy , Texas & AM University, May 2000, pp 38

4.4.4- After Action Review Phase

After action reviews are important – even during a war. The course of the real operation could be recorded and archived for later review. As time permits, the operation can be "played back" for the key leaders. This would give the commanders and staffs the opportunity to identify synchronization problems or other errors that lead to the final outcome of the operation. During training exercises there are often observer/controllers to dispassionately observe the conduct of planning and operations and provide feedback afterwards. This capability is unlikely to be available during real operations. The use of an operationally focused simulation could help fill this void.

4.5-USING SIMULATION FOR ANALYSIS

Simulation in project evaluation is a sophisticated analysis technique examining both risk and profitability of the project. It is not a kind of method, which is applied daily, but when used necessarily, the most effective results are obtained by simulation.[210] According to Gedik simulation is the popular technique of the last decades for the managers who search for better decision tools in the increasing business complexity of the business world. Managers, who are living in a world of rapid change and extensive interaction, must improve their decision making tools in analyzing the situation.[211]

According to the Kantarcı's thesis the simulation model is used for to analyze the ongoing systems, to develop a system in a project phase, and to improve the configuration of a new developed system. [212] Some of the application methods of simulation models are Monte-Carlo Simulations, Management simulations and System simulations. These methods are explained in Kantarcı's thesis. Reliability analysis using simulation, in which reliability analyses are performed for a large number of times on data sets that have been created using Monte Carlo simulation, can be a valuable tool for reliability practitioners. Such simulation analyses can assist the analyst to a) better understand life data analysis concepts, b) experiment with the influences of sample sizes and censoring schemes on

---

[210] Gedik, H., 1995, Simulation Applications in Project Evaluation, A Master Thesis, The Institute of Social Sciences of the Middle East Technical University, Ankara, pp iii

[211] Ibid, 1

[212] Kantarcı, H., 1999, Simülasyon Modelleri ve Kuyruk (Bekleme Hattı) Sistemleri ile Askeri Alanda Örnek Bir Uygulama, Master Tezi, Gazi Üniversitesi Sosyal Bilimler Enstitüsü İşletme Ana Bilim Dalı, Ankara, Sahife 13

analysis methods, c) construct simulation-based confidence intervals, d) better understand the concepts behind confidence intervals and e) design reliability tests.[213]

Simulation must be able to model complex situations and decision making process. It is essential to understand what simulation is doing. Simulation is an activity whereby one can draw conclusions about the behavior of given system by studying the behavior of a corresponding model whose cause and effect relationships are the same as those of the original. Simulation works by converting all activities, events and consequent reactions. These events are processed at one time until the simulation ends. Simulation software consists of several modules with which the user interfaces. Internally, model data is converted to simulation data, which is processed during simulation. At the end of the simulation statistics are summarized in and output database can be tabulated or graphed in various forms.[214] So that, by applying simulation steps organizations can have useful outputs to evaluate current situation and to prepare future plans. Simulation is not a theory but a methodology to solve a problem. Simulation has a common usage for solving the problems of business environment and industry as a decision making tool. The real reason for increasing applications of simulation is the structure of decisions and the problems, which is related with these decisions. While easy problems do not need a mathematical design, the complex problems cannot be solved without a mathematical consideration. On the other hand, a laboratory study is not always possible for business sector because of the economical problems and absence of a laboratory system. So that simulation is used to make the laboratory experiments as a tool.

Modeling and Simulation (M&S) can assist in evaluating scenarios and enhancing the performance of operational systems. Fully integrated use of M&S can enable the evaluation of the effectiveness of proposed equipment or software in realistically simulated environments and can provide an assessment of the impacts of specific equipment or capabilities on battle outcomes. Every level, from strategic planners, technology experts (R&D and engineering), operations research analysts, weapons systems designers and users, testers, maintainers, and cost analysts, has to be interactively involved to maximize

---

[213] ReliaSoft Corporation, 2001, Exploring Reliability Analysis Using Simulation, Reliability Edge Home, Quarter 1, 2001: Volume 2 Issue 1

[214] Geyik, Kemal Ç., 1999, Sistem Benzetimi, İnternet Tabanlı Benzetim ve Bir Modelin Tasarlanması, Master Tezi, Gazi Üniversitesi Sosyal Bilimler Enstitüsü İşletme Ana Bilim Dalı, Ankara

the benefits of this approach. Models and simulations offer powerful tools to support strategic and operational analysis, foster research and develop technology to meet defense requirements. Simulations will allow tests, evaluations and analyses that would otherwise not be feasible because of limited test resources, environmental restrictions and/or safety constraints. M&S allows users the opportunity to 'fight' a system in alternative scenarios. This approach can assist the decision makers to visualize and appreciate possible outcomes and make informed decisions based on tradeoffs involving risk, utility and affordability prior to the procurement of new systems.[215]

The concept of using simulation for performance validation is analogous to model-based fault detection. The idea is to compare the behavior of a model with the observed behavior of a real system. A simulation contains a number of different models that are linked together to represent a complex system. Individual models within a simulation may wholly interact with other models, or they may derive some of their inputs or outputs externally.

Figure 4.2 shows one way of using simulation for performance validation.[216]

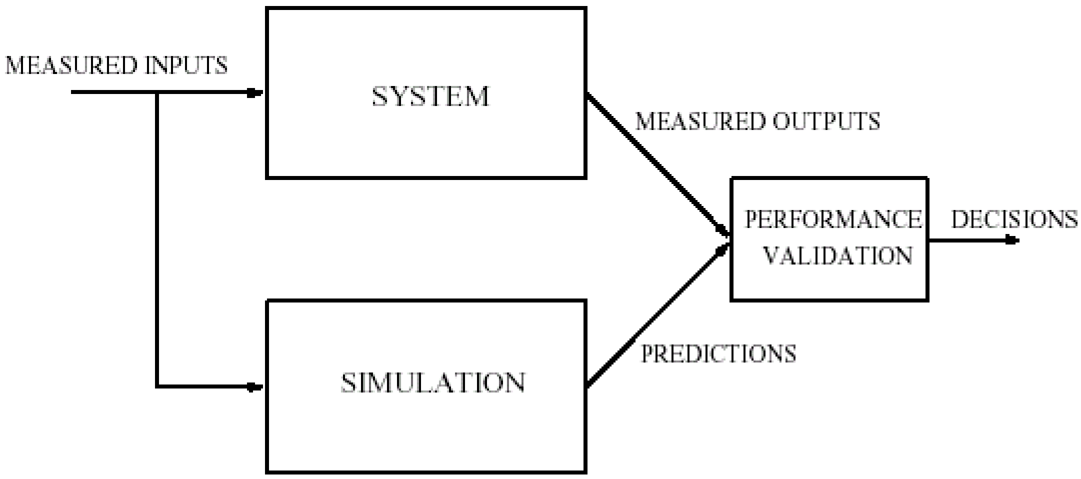

Figure 4.2- Performance Validation Methodology

[215] Bovenkamp, J., 1999, Modeling and Simulation: Enabling Better Decisions, Defense Science and Technology, November 99,pp 1
[216] Salsbury, T. and Diamond, R., 1998, "Performance Validation and Energy Analysis of HVAC Systems Using Simulation", Indoor Environment Department, Berkeley, California, pp 2

In this example, the idea is to configure the simulation to represent the real system in its correctly operating (optimum) mode of operation. Measured inputs to the system under observation are used as inputs to the simulation, which then makes predictions of the same variables designated as system outputs. As the simulation represents the correctly operating system, differences between output predictions and measurements will be indicative of incorrect or sub-optimal operation.

Simulations, which are used in Armed Forces for analysis, can be categorized as follows:[217]

The simulations supporting the operations: These simulations are used for to control the daily activities of operations. These operations can be classified as from logistics to tactical decisions.

Evaluation simulations: These simulations are used for the activities except the daily operations support. These simulations also can be divided into two sub categories: First are the simulations, which are used for defining the Armed Force requirements and Armed Force capabilities. These simulations support the force effectiveness studies, force structure, cost effectiveness analysis, joint operation evaluations, and resource planning. Second sub category consists of battlefield developing simulations. These simulations are used for the development of concepts, doctrines and policies.

The paper which was prepared by the Institute for Defense Analyses (IDA) under the task order, Defense Modeling and Simulation to describe the Task Force's efforts and findings, which conducted its collection effort during the period of March to September of 1995 about quantified impacts for M&S applications in acquisition, training, and analysis is a well documentation to show the benefits of using simulation for Armed Forces.[218] The findings about using simulation for analysis are as follows:

M&S contributes to innumerable decisions involving system evaluation and force sizing. In addition, it contributes significantly to combat operations. In 1990 and 1991, the Air

---

[217] Aslan, A., 2000, Ülkelerin Kullandıkları Modelleme ve Simulasyon Sistemleri Nelerdir? Bu Sistemlerden TSK'lerinde Nasıl Yararlanılmaktadır?, Harp Akademileri Komutanlığı, Yenilevent, İstanbul, Sahife 2-2
[218] Worley, R. et .al, 1996, The Utility of Modeling and Simulation in the Department of Defense: Initial Data Collection, IDA Paper D-1825, Institute for Defense Analysis, Alexandria, Virginia, pp 17

Force Studies and Analyses Agency (AFSAA) performed a series of Gulf War analyses that Lieutenant General Glosson (then chief of Central Air Forces Special Projects) asserted "…saved literally hundreds of lives" [Case 1991]. A team of AFSAA analysts was quickly deployed to the Air Force Operations Center in Riyadh, Saudi Arabia, where they analyzed the air campaign both before and after it began. For their analyses, they used primarily the Army's Space and Strategic Defense Command's Extended Air Defense Simulation (EADSIM) (also called the C3ISIM) model. At the time, EADSIM was a new model to AFSAA and had been selected because it did an excellent job of analyzing command, control, and communications. It was a hybrid model with Monte Carlo and deterministic features. The combat operations planners were able to watch a preview of the attack as it unfolded in a way that graphically revealed the plan's strengths and weaknesses. Unlike the actual air defenses, the modeled air defenses acted in a rational manner, with the simulation results showing a worst-case scenario for the actual air assault. One main contribution was to choreograph the masses of aircraft into and out of the Kuwaiti Theater of Operations. To ensure that aerial tankers would make their rendezvous with fighters in need of refueling, missions were played out in advance. Attacks were carefully choreographed to avoid mid-air collisions, especially during the first day's intense activity. Planners also analyzed the best use of defense suppression assets, and alerted planners of missions that were too hazardous for some aircraft. For instance, the AFSAA team analyses indicated that it would be too dangerous to carry out plans to send A-6 and Tornado aircraft directly over Baghdad. As a result, only F-117 stealth fighters (none of which was lost) were assigned targets in this highly defended area. Undoubtedly, these changes saved allied lives and the needless loss of aircraft. When planners determined that Scud sites in Western Iraq were too well defended and (as existing prior to the attack) too hazardous for F-15E attacks, defense suppression missions were reconfigured to correct the problem. When aircraft losses did occur, computer simulations were used to help determine the most likely cause so that later missions could be made less dangerous.

4.6- USING SIMULATION FOR ACQUSITION: SIMULATION BASED ACQUSITION

SBA is fast developing into the key-way to shave costs off a budget and increase the speed of project development. At this point in time, when achieving a reduction in costs is a very high priority for all defense organizations, SBA provides a new dynamic approach to this issue. According to Konwin, the definition and characteristics of simulation-based acquisition are as follows[219]:

SBA is a robust M&S engineering environment:

- Starting early, from initial requirement & concept
- Intensive "wringing-out" in synthetic, collaborative environment of cost, function, performance across system life cycle
- Reuse of M&S across system life cycle, across programs/services

SBA is a revised acquisition process:

- Integrating Requirements, Acquisition, Training, Operations, Sustainment, T&E, etc functions using collaborative environment
- Rapid, multiple assessments of trade space prior to locking requirements
- Thorough understanding early of total ownership cost implications of performance requirements & design

SBA is cultural change:

- New educational curriculum
- Empowered collaborating teams, including industry partners
- Up-front emphasis & investment on M&S

[219] Konwin, Crash K., 2001, " Simulation Based Acquisition The Future Way DoD will Do Business", Defense Policy, Acquisition, Research, Test &Evaluation Conference, 26 March 2001, Long Beach, California

- Increasing reliance on M&S to reduce design risk

Konwin also defines the goals of simulation-based acquisition. Figure 4.3- summarizes the goals of simulation-based acquisition:

Figure 4.3- Goals of Simulation Based Acquisition

Source: Konwin, Crash K., 2001, " Simulation Based Acquisition The Future Way DoD will Do Business", Defense Policy, Acquisition, Research, Test &Evaluation Conference, 26 March 2001, Long Beach, California

Davis defines the whole acquisition process and he argues that existing simulations have limitations to process overall acquisition process. Figure 4.4 provides an alternative concept of operation for system acquisition process.[220] Current simulation tools are incapable of directly employing the information contained within the processing plan. Instead, they force the modeler to aggregate the process plan into two pieces of data: the time to perform the processing step and the reliability of executing the step. Thus, current simulation tools are incapable of assessing the impact that the more detailed production constraints will have upon the proposed manufacturing.

[220] Davis, Wayne J., 2000, "Simulation-Based Acquisition: An Impetus for Change", Davis Proceedings of the 2000 Winter Simulation Conference eds. J. A. Joines, R. R. Barton, K. Kang, and P. A. Fishwick, pp 1061-1067

Current tools are capable of modeling a single manufacturing cell or line only. Models of individual cells cannot be integrated in order to develop models for an entire manufacturing facility. Furthermore, current simulation tools cannot assess the consequences that an existing control architecture that coordinates the production among the lines has upon the system.

The manufacture of a complex system will likely require coordinated production among several manufacturing lines or facilities. In addition, these facilities will likely be geographically distributed throughout the country or the world. The goal is to link all of these remote facilities into a single virtual enterprise when full-scale production of the system is initiated. The current tools typically only model a single subsystem with limited detail. It will be difficult to capture the system of systems nature that characterizes most complex systems using current tools.

In order to support virtual manufacturing, new simulation tools must provide the following capabilities: They must address the detailed process plans. In addition, they must consider the detailed resource requirements needed to execute each processing step. This capability is essential when one attempts to implement activity-based accounting procedures for estimating the true costs of manufacturing a given component or subassembly. They must effectively model distributed manufacturing systems and thus capture the system-of-system nature that characterizes the virtual enterprise for manufacturing the designed system. In particular, they must consider the control architectures that are needed in order to coordinate production across several manufacturing cells and facilities.

In fact, the simulation model itself should provide the control architecture that is needed to manage the integrated manufacturing system. They must employ distributed simulation and maximize the use of the World-Wide Web. The web should provide a means to model sharing as well as perform collaborative simulation analyses associated with the functional interactions as shown in Figure 4.4. Finally, they must support on-line simulation analyses for the development of advanced intelligent control capabilities that are needed for the distributed on-line management of these systems.

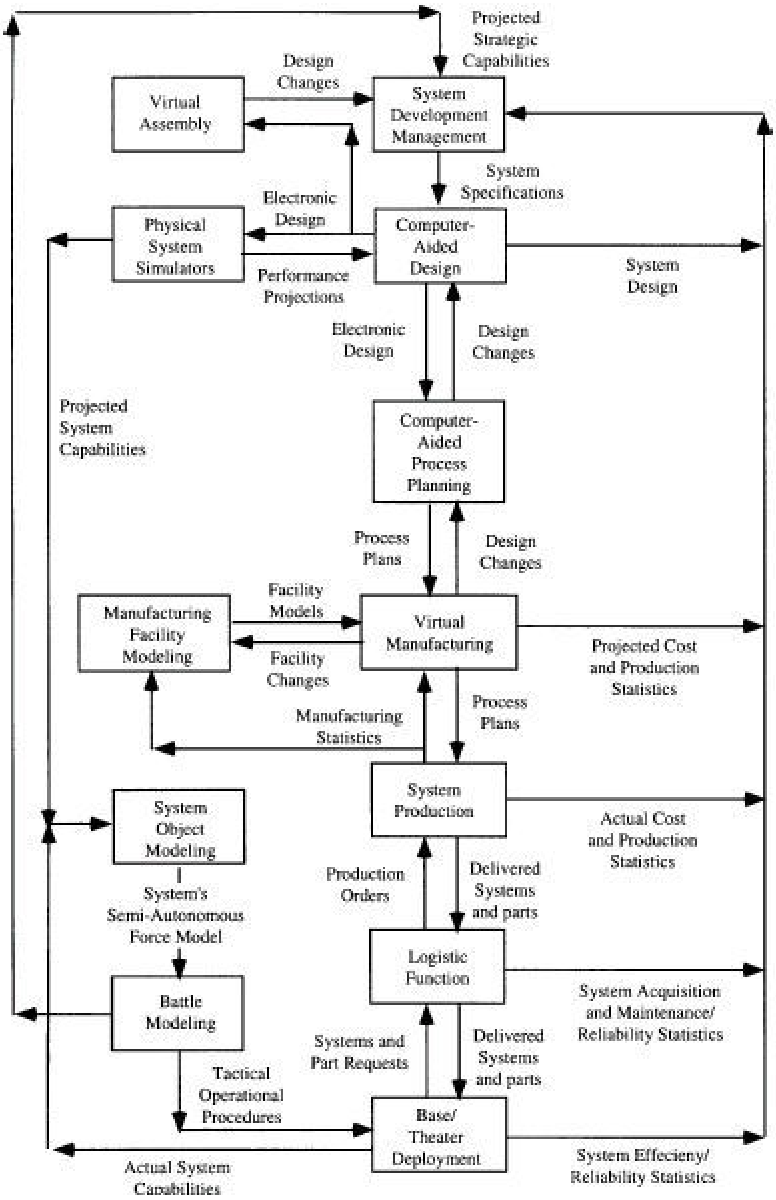

Figure 4.4- Schematic for the Overall System Acquisition Function

Source: Davis, Wayne J., 2000, "Simulation-Based Acquisition: An Impetus for Change", Davis Proceedings of the 2000 Winter Simulation Conference eds. J. A. Joines, R. R. Barton, K. Kang, and P. A. Fishwick

For acquisition of a weapon system or any system the characteristics and specifications which user wants must be defined carefully. In the beginning of a prototype phase using simulation can bring benefits. Simulation based acquisition can be summarized shortly as in Figure 4.5:[221]

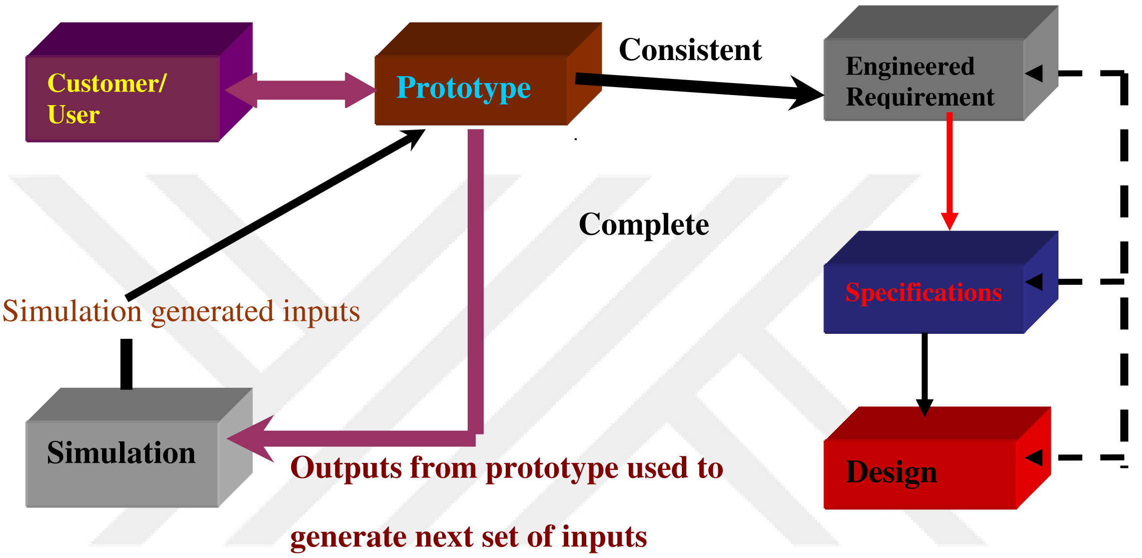

Figure 4.5- Simulation- Based Acquisition

The benefits of using simulation-based acquisition are directly related with risk reduction. Some benefits of this architecture according to Konwin[222] are continuous evaluation of system development, rapid evaluation of concept design, reducing and delaying need for physical prototype, facilitating continuous user participation in development process, efficient development/evaluation of manufacturing plans, reusing of system software and hardware in training simulators and, ability to test proposed system at sub-component, component, and system level.

The paper which was prepared by the Institute for Defense Analyses (IDA) under the task order, Defense Modeling and Simulation to describe the Task Force's efforts and findings,

[221] Hamilton, John A., Deal, John. C., and Murtagh, Jeane L., 1999, Simulation-Based Requirement Engineering, Available on site: http:// www.drew-hamilton.com/astc99
[222] Konwin, Crash K., 2001, " Simulation Based Acquisition The Future Way DoD will Do Business", Defense Policy, Acquisition, Research, Test &Evaluation Conference, 26 March 2001, Long Beach, California,

which conducted its collection effort during the period of March to September of 1995 about quantified impacts for M&S applications in acquisition, training, and analysis is a well documentation to show the benefits of using simulation for Armed Forces.[223] According to this paper the applications of M&S to acquisition are many. Twenty case studies of Target Interaction, Lethality and Vulnerability showed a 30-to-1 return on investments in M&S support for milestone decisions and the Cost and Operational Effectiveness Analysis process. The Army Missile Systems Command reported a total of over $320 million in cost avoidance or savings from 10 case studies. Eight case studies were provided from the Virtual Proving Ground, U.S. Army Test and Evaluation Command. Two similar events were conducted for Apache Longbow Force Development Test and Experimentation, one using extensive simulation and the other using physical equipment. The simulation-supported event executed twice as many trials, with fewer personnel, in less time, at lower risk to personnel, for $700,000 versus the $4 million spent in using physical equipment.

4.6.1-Target, Interaction, Lethality, and Vulnerability (TILV)

TILV refers to the mechanisms by which a warhead or similar device can defeat a target [TILV 1995]. The TILV area addresses the tools, methods, databases, and supporting techniques needed to assess the lethality and vulnerability of all weapon systems, including aspects of design, effectiveness, and survivability. Modeling and simulation provide a significant portion of the TILV capability and, in particular, an attractive alternative to destructive test. Table 4.3- [TILV 1995] depicts the Return on Investment (ROI) of M&S support for milestone decisions and the Cost and Operational Effectiveness Analysis process. The typical ROI was between $20 and $30 returned for each $1 invested.

---

[223] Worley, R. et .al, 1996, The Utility of Modeling and Simulation in the Department of Defense: Initial Data Collection, IDA Paper D-1825, Institute for Defense Analysis, Alexandria, Virginia, pp 9-15

Table 4.3- TILV Return on Investment

Program	Type Analysis	Total Invest ($M)	Direct Savings ($M)	ROI	Program Result
AMRAAM	End Game	6.5	250.0	38	Continued
Bomb Fragment Data	Arena Tests	0.0825	0.9	11	Continued
BLU-109	Lethality Testing	0.0825	3.0	36	Continued
Air-to-Air Missile	Lethality plus Engagement	20.0	75.0	4	Continued
Wide Area Anti-Armor Munition	Lethality Analysis	0.75	30.0	40	Canceled
Hypervelocity Missile	Lethality Analysis	0.5	10.0	20	Canceled
ISAS	Lethality Analysis	0.75	40.0	53	Canceled
Kinetic Energy Penetrator (KEP)	Lethality Analysis	1.1	50.0	45	Canceled
JP 233 Runway Attack Munition	Lethality and Vulnerability Analysis	1.1	54.0	49	Canceled
Boosted Kinetic Energy Penetrator	Runway Vulnerability Models	2.75	130.0	47	Canceled
JAVELIN ATGM	Analytic Simulation	0.62	14.0	23	Accepted
M2 Bradley FVS	Engineering Design	0.88	30.0	34	Accepted
M1A2 Vulnerability	Damage Prediction	1.83	30.0	16	Cost Avoidance
M1A2 Block 3	Design Vulnerability	1.76	100.0	57	Terminated
Standard Missile SM-2 BLK IIIA	Cost Reduction	2.25	47.0	21	Accepted
Phalanx CIWS	Performance Evaluation	8.12	125.0	15	Continued
Phalanx CIWS	Product Upgrade	6.63	200.0	30	Accepted
AIM-7P Sea Sparrow	Lethality Analysis, End Game	0.7	16.0	23	Accepted
Phoenix Missile	Lethality Analysis, End Game	2.23	70.0	31	Accepted
ECM vs. AMRAAM	Lethality Analysis, End Game	0.58	10.5	18	Eval. Continues

Source: Worley, R. et .al, 1996, The Utility of Modeling and Simulation in the Department of Defense: Initial Data Collection, IDA Paper D-1825, Institute for Defense Analysis, Alexandria, Virginia

4.6.2-Tecom Virtual Proving Grounds (VPG)

For M&S to be useful and valid, the applicable tools must be based on real data derived from testing [TECOM 1995]. The Army's Test and Evaluation Command (TECOM) supports this concept with an approach known as Simulation and Modeling Anchored by Real Testing (SMART). TECOM is employing SMART as a means for researchers and developers to verify that their models and simulations are based on empirical data. VPG is a network of models and simulations, using empirical data that enables interactive testing in a synthetic environment. A number of projects undertaken by TECOM use these models and simulations to determine the various effects on systems and to replicate actions without undertaking the time and expense of actual testing Table 4.4 represents a summary of selected TECOM systems that used VPG in conducting tests and evaluations with cost avoidance as an MOE. Actual cost includes investment in simulation when appropriate and available.

Table 4.4 - TECOM VPG Costs

Project	**Use**	**Simulation**	**Actual Cost ($M)**	**Cost Avoidance ($M)**
Firing Impulse Simulator	Recoil loads and ballistic shock effects	Replicate actual firing without the use of ammunition for tanks and howitzers	6.9	23.0
M830E1 Fuse Testing	Evaluates tank vs. helicopter engagements	Virtual test range simulation using simulated helicopter engagements with manned tank	0.26	1.5
Moving Target Simulator	Immersion of entire weapon system (air or ground) into moving visual target environment	Assess the ability of an M1A2 tank crew to track and simulate firing on images of simulated maneuvering targets	—	1.5 per year
Simulation/Test Acceptance Facility (STAF)	Test millimeter wave radar-guided missiles	Hardware-in-the-loop simulator providing test of a "live" missile with multiple computer-based test scenarios	—	10.6 per year
Aerial Cable Range (ACR)	Test missile tracking of heat sources	Uses a 3-mile long suspended Kevlar cable that serves as path for captive vehicles	0.7	13.8
Test Item Stimulators (TIS)	Non-radiating simulated message traffic to C3 systems	Test of Enhanced Position Location Reporting System (EPLRS)	4.7	2.0
Trajectory Sense and Destroy Armor Simulation (SADARM)	Model ballistic simulation for the SADARM projectile	Enables downrange auto-trackers to acquire and track incoming projectiles and transition quickly to acquire end-game data	—	12.0
Physical Simulation of Bridge Crossing	Bridge durability tests	Mix of physical and simulated bridge crossings	0.325	0.11

Source: Worley, R. et .al, 1996, The Utility of Modeling and Simulation in the Department of Defense: Initial Data Collection, IDA Paper D-1825, Institute for Defense Analysis, Alexandria, Virginia

4.6.3-Army Missile Systems

The Army Missile Command (USAMICOM) Research, Development and Engineering Center (RDEC) uses M&S extensively in the development of Army Missile Systems [Jolly and Ward 1995]. During the course of numerous simulation projects, the benefits of hardware-in-the-loop (HWIL) simulations have translated into cost savings and avoidance for many weapon system development programs. Examples of cost saving and avoidance totaling in excess of $320M are presented in Table 4.5:

Table 4.5 - Army Missile Systems Costs

Project	Application of HWIL and DIS Simulation	Save/Avoid ($M)
MLRS-TGSM	45% reduction in flight/drop test program	6.0
FOG-M/NLOS	HWIL simulation identified all hardware and software faults prior to flight tests, resulting in reduction in flight test costs	15.0
Longbow	Successful Proof-of-Principle and EMD flight test programs with prevention of at least 2 test failures and reduction of risk in several other cases	6.5
Classified Program	Viability of this development program possible only through HWIL simulation; estimated flight test cost savings	60.0
HAWK	Flight test cost savings on counter ECM and other system improvements	80.0
STINGER	Flight test cost savings for benign, countermeasured, and untestable scenarios	> 90.0
ATACMS	Analysis of flight test anomaly possible only with hardware-in-the-loop simulation; rapid identification of source of anomaly saved extensive investigation	0.5
JAVELIN	Performance assessment data for milestone 3 decision produced by simulations, avoiding several flight tests	5.0
Foreign Materiel Exploitation	ECM hardware/software/techniques evaluation and optimization against foreign threat missiles (Desert Storm payoff in identified saving of at least one aircraft and pilot)	> 25.0
FAADS-BSFV (DIS)	Evaluate options using real soldiers, without requiring costly development of prototype systems, and save substantially on field testing	32.1
	Cost Savings and Avoidance	**> 320.1**

Source: Worley, R. et .al, 1996, The Utility of Modeling and Simulation in the Department of Defense: Initial Data Collection, IDA Paper D-1825, Institute for Defense Analysis, Alexandria, Virginia

4.6.4-Apache Longbow

An example of some of the benefits of using M&S in the Apache Longbow program is summarized in Table 4.6 [Swinsick 1995]. Phase I of Force Development Test and Experimentation (FDT&E) was based on manned simulation. Phase II employed approximately the same test scenario and activities but used live equipment. Twice as many trials were conducted in Phase I than in Phase II, at less cost, with fewer personnel, in less time. Phase I tests allowed the helicopter crews to train on the new equipment without the risk associated with flying real equipment. It also allowed development and practice of new tactics, techniques, and procedures. Those responsible for developing scenarios for Initial Operational Test and Evaluation (IOT&E) have the opportunity to structure the very expensive operational test to gain the most critical information

Table 4.6 - Apache Longbow FDT&E Tests

Resources	**Phase I Manned Simulation**	**Phase II Field Test**
Cost (O&M Army)	$.712M	$4.049M
Equipment	1 Simulator	4 AH-64D 2 UH-60 14 M1 Tanks 10 M3 Fighting Vehicles 2 2S6 20 + Air Defense Units 47 + Vehicles
Personnel (Government)	27	663
Mission Turn-Around Time	2 Hours	6 Hours
Data Reduction Time	4 Hours	80 Hours
Number of Trials	32	16
Test Period	4 Weeks	6 Weeks
Safety	No Risk	Moderate Risk

Source: Worley, R. et .al, 1996, The Utility of Modeling and Simulation in the Department of Defense: Initial Data Collection, IDA Paper D-1825, Institute for Defense Analysis, Alexandria, Virginia

4.7- THE DEMAND FOR USING MODELLING AND SIMULATION IN JOINT TRAINING

As mentioned in Chapter 2 the first goal of the Joint training is preparing for war. The other four goals of joint training include: Preparing for small-scale operations, preparing for multinational operations, integrating the interagency process, and facilitating joint vision. So that to accomplish these goals through the complex structure of battlefield of future is possible with virtual, computer assisted training. And applying the field training is much more difficult than past to achieve the standards of a contemporary armed force and to gain the capability of operations both in inside operations also in overseas operations because of the reasons of trends in changing world which was mentioned in Chapter 1. The future concepts of battlefield will be created by global and changing information environment of the world so that command, control, computer, communication, intelligence, surveillance, reconnaissance (C4ISR) systems [224] of the Armed Forces will be more important than past. When the principles of Joint training was remembered from Chapter 2, it can be said that joint training intends to prepare both commanders and soldiers by using a mission focus and centralized planning of operations. So that to achieve the victory for overall picture of the battlefield, every commander and soldier must be trained and prepared for accomplishing his mission. From that point simulation will be an important tool to gain the decisive characteristics for achieving the victory of the Contemporary Armed Forces from a single soldier to staff commanders of joint forces.

Sun Tzu defines modeling the warfare as " A commander who can calculate the more wining possibilities before operations wins the warfare and the other generals who makes a few calculation loss the war. So that, more calculation before the war brings the victory. Defining the winner at the beginning is possible for me with this way." [225]The primary goal of M&S is to enhance the value and increase the efficiency of joint training. Effective use of modeling, simulation, and simulators can also have a significant impact in reducing Operational Tempo (OPTEMPO), Personnel Tempo (PERSTEMPO) and Deployability Tempo (DEPTEMPO) with associated cost savings.

Training with M&S tools must (1) be requirements based; (2) be able to train to objectives derived from task(s) qualified by required conditions of realism set by the commander; (3) be appropriately scaled, based on clear identification of primary training audiences for each event; (4) keep overhead support requirements to a minimum -- the recommended ratio of supporting staffs or secondary training audiences to primary training audiences should not

[224] Bingham, Price T., 2001, "Transforming Warfare with Effects-Based Joint Operations", Aerospace Power Journal, Spring 2001 Volume 15 Issue 1, pp 58
[225] Nazar, R., 1998, Küçük Birlik Muharebe Modelleme Simülasyonu, Yüksek Lisans Tezi, Gazi Üniversitesi Fen Bilimleri Enstitüsü, Ankara, Sahife 8

exceed 1 to 1; (5) be cost effective and mission effective in training to standards.[226] To accomplish this some field training exercises (FTX) will be superceded by computer assisted exercises (CAX)/command post exercises (CPX)/staff exercises (STAFFEX) in the interest of cost efficiency.

On the battlefields of the approaching century where intelligent new weapons systems will project lethal force with ever-increasing precision and efficiency, the technologies of virtual simulation will be the decisive factor that tips the balance between victory and defeat. Even in an era of dramatically reduced defense spending worldwide, simulation now enables military planners to prepare and train their forces for the complex engagements of the future. Advanced simulators are used to forecast, analyze and plan potential conflicts with degrees of precision that were impossible with previous-generation technologies. Emerging simulation technologies will enable manufactures of the 21st century to build military and commercial systems faster, better and at lower cost than they can today.[227]Applying a field exercise for a battalion or brigade level with the cost of whole equipment, weapons and ammunition has a much more cost than applying this exercises on a computer assisted or network environment. All of the equipment, weapon, ammunition and tactics of operations can be modeled and it is possible to simulate the battlefield in a runtime capability. Especially, the multinational field exercises can be applied by using the data communication, satellite and network systems without losing time, reality and security. [228]

The simulation systems are expensive to develop, require large support organizations, and often specialize in specific battlefield domains. The vision is simple: “training thousands of entities in a common virtual environment from the whole domains to gain benefit of joint training.” There are numerous simulation systems used in Armed Forces specialized in specific domains. To catch up with the vision, the cheapest solution is to interface the existing simulation systems so that they all operate synchronously.[229] Although the use of

---

[226] Joint Chiefs of Staff, 1999, Joint Training Policy For The Armed Forces Of United States, CJCSI 3500.01B, 31 December 1999

[227] Collard, P., 1997, “The COTS Revolution: As Defense Budgets Shrink, Military Planners Turn to Smart, Flexible, Affordable Simulators”, Military& Aerospace Electronics, Sep/97 Volume8, Issue 9, pp 33

[228] Yürekli A., 1996, “Simülasyon ve Simulatörler”, Bilgi Teknolojileri Sempozyumu TEDEB-96, 10-11 Temmuz 1996, Eğitim Doktrin Komutanlığı, Ankara, Sahife 28

[229] Topçu, O., 1999,Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-, Chapter 1,Middle East Technical university, December 1999,Ankara, pp 6

simulation is not a panacea for obtaining operational readiness, it is a very valuable aid to training as it can generally make training more effective and more efficient. Simulation can be incorporated into everything from initial training to maintaining skills, evaluation, and mission planning. At the same time it provides both commanders and soldiers with the opportunity "to realistically experience the friction, stress and uncertainty of actual combat[230]

The myriad of actors within the international system- be they members of planning units in foreign ministries, entrepreneurs, in business operating overseas, or officials within governmental and non-governmental international organizations- base their decisions for actions upon their assumptions of the ways in this system functions, combined with their assessments of its present state. Simulations may increase the adequacy with which knowledge about international affairs is utilized in the conduct of foreign affairs, by providing explicit theories as how to system operates, as well as by providing a continuously up –dated data- base.[231] So that using simulation as in instrument for policy development will be having a powerful tool by using the data base about international affairs and it will be also useful tool for achieving the interagency operations and operations other than war in future.

The paper which was prepared by the Institute for Defense Analyses (IDA) under the task order, Defense Modeling and Simulation to describe the Task Force's efforts and findings, which conducted its collection effort during the period of March to September of 1995 about quantified impacts for M&S applications in acquisition, training, and analysis is a well documentation to show the benefits of using simulation for Armed Forces.[232]: According to this paper, training applications of M&S were commonly used and the results were positive. Reporting was thorough on individual skills training, including both cognitive and psychomotor skills. Cognitive skills trainers, typically computer-aided instruction, paid for themselves in five years or less. Psychomotor skills trainers, e.g.,

---

230 Ewing, R.B., 1998, "The Benefits of Using Simulation in Training- Does the Land Force Leadership Understand?", Ex- New Horizons 1997-1998 Available on site: http://www.cfcsc.dnd.ca/irc/nh/nh9798/0032.html

231 Guetzkow, H., 1971, "Simulations in Consolidation and Utilization of Knowledge about International Relations", Cybernatics, Simulation and Conflict Resolution Edited by Knight and et al, Spartan Books, New York, pp 128

232 Worley, R. et .al, 1996, The Utility of Modeling and Simulation in the Department of Defense: Initial Data Collection, IDA Paper D-1825, Institute for Defense Analysis, Alexandria, Virginia, pp 9-15

flight simulators, driver trainers, conduct of fire trainers, and maintenance trainers, were all shown to be cost effective when properly mixed with training on the real equipment. At this level, analysts have well-established theories and experimental methods for conducting analysis. The same is not true for unit training, particularly of high echelon units. The high cost of a Joint or Combined exercise precludes the repeated, controlled experiments necessary to gather meaningful data on the benefits of additional learning trials. However, multi-million dollar savings are reported when comparing computer-assisted command post exercises to field training exercises. The findings are depicted as follows and the documentation information, which was used to write this part of report, is depicted in **Appendix A.**

4.7.1- Individual Skills Training

Individual training is supported most often by stand-alone simulators. These simulators range from simple devices (such as rifle marksmanship trainers) to more complex devices (such as maintenance simulators, tank gunnery simulators, and flight simulators). Simpson et al. [1995] drew these general conclusions about the effectiveness and cost of such simulators: "…in aggregate, simulators provide significant beneficial transfer from simulator to aircraft at a median operating cost of about one-tenth of an aircraft…Because of their scope, the body of studies probably provides the strongest case for the value of any type of simulation. Students trained using maintenance simulators perform about as well as those trained with actual equipment, but simulators cost a fraction…of the equipment…where time to train was reported, training with simulators took…less time than with actual equipment."

4.7.1.1- Aviation

The Army estimates that it substitutes simulation for $68M of flight operations training in the active force and $55M in the Reserves each year. The Navy considers simulation to be effective in initial training in unfamiliar aircraft, as is reflected in the ratio of simulator to actual aircraft training flights (40 to 77) in the fleet replacement training program for F/A-18 aircraft. The Air Force Air Mobility Command plans to replace up to 50% of flight training hours with flight simulators and other training devices for training air transport crews [Orlansky et al. 1994; Department of the Army 1993]. The operating cost of flight simulators is estimated to be between 5 to 20% that of aircraft. Many studies have shown that skills learned in flight simulators can be performed successfully in aircraft, and the use of simulators for training can reduce flight time [Orlansky and String 1977]. In a more recent study, the median cost ratio of operating simulators to aircraft was estimated to be 8% [Orlansky et al. 1984]. A review of several studies showed that the operating costs of flight simulators are about 10% of actual equipment per hour trained or 33% if acquisition cost is taken into account. The majority of tasks trained on simulators (59%) have significant positive transfer to flight performance [Angier et al. 1993]. Bombing and air drop accuracy data indicate that additional simulator hours seem to have a greater positive effect than additional flying hours, and simulator hours cost at most a third as much. Helicopter accident data indicate that both flying hours and simulator hours reduce accidents, but simulator hours do not increase exposure to risk [Horowitz et al. 1992].

4.7.1.2- Small Arms

Several studies relating to the use of simulation in lieu of live fire indicate that performance with simulation is at least equal to live fire training, but that cost is lower. Soldiers with MACS (Multipurpose Arcade Combat Simulator) training expended less rounds during live-fire qualifications and fewer soldiers failed to qualify as compared to those trained using traditional methods. Several studies with the Squad Engagement Training System (SETS) have shown positive transfer from SETS to live fire. Training with the Indoor Simulated Marksmanship Trainer (ISMT) has been demonstrated to benefit live-fire performance. The Precision Gunnery Training System (PGTS), an inexpensive trainer for TOW and DRAGON missiles, whose rounds are very expensive ($11,500 and $19,145, respectively, per round), has been demonstrated to be cost effective, and also permits training that would otherwise cost several hundred million dollars per year if actual missiles were used [Bailey and Hodak 1994; Wilhoite 1993; Eisley et al. 1990; Schendel et al. 1984; Berg et al. 1993b].

4.7.1.3- Maintenance

A review of maintenance simulators found that they are as effective for training as actual equipment trainers when measured by student achievement in school. In the majority of cases examined, the cost to develop and fabricate one unit was less than 60% of actual equipment and the cost of fabricating a second unit was less than 20%. Acquisition and use of a maintenance simulator over a 15-year period cost 38% as much as the actual equipment. In studies where time to train was reported, simulators took 25 to 50% less time than actual equipment [Orlansky and String 1981].

4.7.2- Collective Skills Training

Collective training focuses on tasks performed collectively by groups of individuals (e.g., crews, teams, units) who must work together and coordinate their activities. The size of a collective may vary greatly and hence collective training varies considerably in scale. It is supported most commonly by live or virtual simulation. Some stand-alone simulators train smaller personnel collectives (e.g., flight crews, tank crews). Advanced distributed simulation—a set of varied models or simulations operating in a common synthetic environment composed of live, virtual, and/or constructive simulations—can also be used for collective training. A recent analysis by the General Accounting Office (GAO) [GAO 1993] conducted for Congress cited as exemplary several simulations used by the Army for collective training: COFT (Conduct of Fire Trainer), used on tanks and Bradley Fighting Vehicles; MILES (Multiple Integrated Laser Engagement System), used to simulate direct fire weapons from rifles to tank and helicopter gunnery systems; and SIMNET (simulator networking), used to provide crew-, platoon-, and company-level training. A 1994 review of technologies supporting virtual simulation indicated that it is becoming increasingly powerful and cost effective [OTA 1994].

4.7.2.1-Crew/Team

Evaluations of the UCOFT (Unit Conduct of Fire Trainer) have been positive. Tank gunners trained with UCOFT fire their opening rounds about 25% faster than conventionally trained gunners. Based on an analysis of a hypothetical force-on-force engagement, UCOFT-trained gunners would be expected to kill significantly more opposing tanks than conventionally trained gunners [Operational Research and Analysis Establishment 1990]. Boldovici et al. [1985] reviewed UCOFT tests and concluded that UCOFT provides improvements in gunner proficiency. Substantial gains were found in percents of targets acquired, engaged, hit, and killed for groups undergoing sustainment and transition training. Gains were attributed to improvements in acquisition time, engagement time, and first-round hits, which in turn allowed time to scan, acquire, and engage available second and third targets. Hughes et al. [1988] evaluated the training effectiveness of the UCOFT empirically with 369 tank commander-gunner pairs and found that UCOFT training accelerated skill acquisition, improved performance in subsequent training events, and was well accepted by users.

In tank gunnery, the introduction of COFT reduced the annual expenditure of ammunition from 134 to 100 rounds per tank and improved marksmanship. This resulted in an annual cost avoidance of approximately $29M. The new Tank Weapons Gunnery Simulation System is expected to reduce the annual consumption to 78 rounds, for an additional saving of $21M to $50M each year [Orlansky et al. 1994; Department of the Army 1993; Morrison et al. 1991a, 1991b; Turnage and Bliss 1990].

4.7.2.2-Multiship Air Combat

In evaluations of developmental distributed interactive simulation (DIS) systems designed to support multiship air combat training in a combat engagement simulation environment, participating pilots and air weapons controllers indicated that simulation enhanced their combat readiness and was more beneficial in some areas than traditional unit training [Bell and Crane 1992; Houck et al. 1991].

In evaluations of a SIMNET-compatible air combat simulator, pilots received training and then rated their interest in receiving additional training on each of 30 tasks. Tasks with the highest rated interest can usually be practiced only in large exercises or cannot be practiced except in simulation. It was concluded that multiplayer simulator-based training is a valuable training medium for increasing wartime readiness, especially for less experienced pilots [Crane and Berger 1993].

4.7.2.3-Tactical Ground Combat

During the Persian Gulf War, at the battle of "73 Easting," U.S. troops destroyed an opposing force three times their size while fighting in an area the Iraqis had previously used for training exercises. Leaders of the U.S. force cited the training they had received with live simulation, virtual simulation, and stand-alone crew training simulators as important factors in their success [Orlansky 1993].

The Army Science Board [1989] has estimated that simulators would enable a reduction in aviation and vehicle OPTEMPO (Operating Tempo) and training ammunition by 15 to 20% while maintaining the same or better level of unit performance.

A series of tests and evaluations have demonstrated SIMNET's value for collective training. Schwab and Gound [1986] evaluated SIMNET's capability to support platoon-level command and control exercises to train individual and collective tasks. The eight platoons were divided into two groups, one with prior SIMNET training and the other without. Three of the four platoons in each group improved their performance between the first and second set of situational training exercises. The SIMNET group improved its average group score by 13% while the baseline group improved its score by 6%. Findings of Kraemer and Bessemer [1987] suggest that SIMNET training helped units develop and improve their fire control distribution plans and helped unit leaders develop the command, control, and communications skills to effectively execute those plans during platoon battle runs. Brown et al. [1988] found that SIMNET training increased field exercise platoon performance, command and control, and leadership skills, and adequately portrayed vehicle and battlefield sounds. SIMNET also improved performance of command and control, platoon movement, leadership, and fire distribution during the company team Army Training and Evaluation Program (ARTEP). Burnside [1990] found that 35% of ARTEP Mission Training Plan (MTP) tasks can be trained with SIMNET. Bessemer [1991] found positive transfer of tactical training from SIMNET to field training. Analysis of an effectiveness comparison between SIMNET and home-station field training indicates that SIMNET is extremely effective in increasing performance for SIMNET-trainable tasks relative to field training. Tradeoff analyses show that investment in SIMNET-like facilities could be repaid by an 8 to 14% decrease in OPTEMPO [Angier et al. 1993].

An analysis of the training capabilities and cost effectiveness of the Close Combat Tactical Trainer (CCTT) concluded that it has the potential to train tasks relating to command, control, and communications; maneuver and navigation; and teamwork and leadership. When fielded, CCTT would be cost effective and its life cycle costs would be paid back fully during its service life [Noble and Johnson 1991].

4.7.2.4-Multi-Service and Joint Training

The Army Research Institute for the Behavioral and Social Sciences (ARI) has successfully demonstrated the use of virtual simulation for multi-Service close air support training and is currently expanding its demonstration platform to include the Joint fire support mission [ARI 1995a, 1995b; Hawley and Christ, in press].

Virtual simulation has the potential to enable Joint and inter-Service training in mission areas not being trained sufficiently now (e.g., close air support). The technology permits coordinated training among the Services while individual Service elements remain at their home stations [Simpson et al. 1995].

4.7.3- Command Staff Training

Command and staff training occurs within constructive, live, and/or virtual simulations. The participating commanders and staffs range from the lowest to the highest echelon and from a single Service up through Multi-Service, Joint, and Combined commands. The most economical way to conduct such training is with constructive simulations, as they enable commanders and staffs to experiment without the cost of fuel, ammunition, and military personnel. Command and staff training does occur during live and virtual simulations, but usually these simulations are intended to train all participants at all levels. Because of their economy and relative ease of implementation, constructive simulations have proliferated in many different training domains.

4.7.3.1-Single-Service Training

The 1990 REFORGER (Return of Forces to Germany) exercise made extensive use of constructive simulation to train leaders at brigade, division, and corps level. Benefits of such training were the emphasis on battle planning, staff procedures, and command and control; more efficient use of training time; focus on higher echelons that would otherwise be cost prohibitive; and reduced adverse environmental and political impacts. The transportation and cargo handling costs of the 1990 exercise were more than $4M less than costs historically [GAO 1991]. In 1992, constructive simulation was used to avoid $34M in costs as compared with the equivalent exercise done without simulation in 1988. Participants also believed that the training of staffs and planners involved was improved

[Simpson et al. 1995]. However, previous REFORGER exercises satisfied a treaty obligation to return forces to Germany, and they provided extensive training to those responsible for physical movement of troops and equipment.

GAO noted that at the brigade level and above, simulations can be used to improve the decision-making skills of senior battle officers before they command units in large-scale training exercises [GAO 1993].

Formal evaluations have demonstrated that constructive simulations train commanders and staffs effectively and are relatively inexpensive. The JANUS (A) is effective in training company level officers and platoon leaders on current tactics and doctrine. The Brigade/Battalion Battle Simulation (BBS) has proven effective at training brigade and battalion staffs [Bryant et al. 1992].

4.7.3.2-Multi-Service and Joint Training

The Defense Science Board [1988] concluded that computer-based simulated scenarios offer the only practical and affordable means to improve the training of Service operational commanders, their staffs, and the commanders and staffs who report to them. Battle simulation offers the only opportunity to practice the use of certain weapon systems, sensors, tactics, and techniques against a skilled adversary.

Agile Provider (AP), a Joint exercise sponsored by the United States Atlantic Command (USACOM), replaced Unified Endeavor (UE) in 1995. AP was a field exercise last held in 1994. UE was supported by a Joint Training Confederation (JTC) of models interacting through the Aggregate Level Simulation Protocol (ALSP). The models replaced steaming days and flying hours, and focused on the primary training audience, the JTF commander and staff. Total costs for AP-94 were $40M, with $8M in strategic lift costs. UE-95's costs totaled $2.9M with approximately $0.5M in strategic lift. Approximately 85% of the UE-95 participants rated their training as good and 82% rated it better than a similar field exercise like AP-94. The conclusion was better training at 7.5% of the cost.

4.8- JOINT SIMULATION DRIVEN EXERCISES

Simulation-Driven Exercises are CPXs that use computers to present a scenario and simulate conditions, environment and progression of events.[233] These exercises also use analytical models to aid decision making and to portray responses to and results of friendly actions. They can be used for training and rehearsals, and may also be used for purposes of research and development. As training tools, they provide commanders and staff with high quality, cost-effective training alternatives to other, more resource intensive exercise methods.

4.8.1- Resources, Scenarios and Uses

Resources: Simulation-Driven Exercise requirements depend on the scope of the supported exercise, the level of detail required in the information presented, and the complexity of interoperability between the different models used in the exercise. Different models require a wide variety of computer hardware and software, with related numbers of personnel involved in preparing data bases and operating the models during the exercise.

Time of preparation is a key factor. Major joint exercises may take up to a year to build data bases, although this time will decrease as valid data bases are constructed.

Scenario: Scenarios for Simulation-Driven Exercises are developed much the same as for CPXs and FTXs, although exercise designers must ensure that the Joint Operations Area (JOA) and force structure designated for the exercise can be supported by the desired simulation model and data bases.

Uses: Simulation-Driven Exercises place C2 elements in war or other-than-war environments that stimulate decision making, command and staff interaction, and coordination. They assist in the following areas:

- Preparing a joint headquarters and its subordinate units for conducting major operations while minimizing costs and resources

---

[233] Joint Chiefs of Staff, 1997, Joint Task Force Headquarters Master Training Guide, CJCSCM 3500.05, 15 April 1997, Washington D.C. 20318-0400, pp 4 –3

- Rehearsing wartime missions and possible contingency operations using real world operational area and threat data bases
- Exercising and evaluating doctrine and internal training and operating procedures
- Developing awareness of the lethality and awareness of war and operations in other than war environments
- Assessing written and verbal communication processes between commanders and staff, different headquarters, and various echelons
- Providing feedback to aid in decision making, such as assessing and wargaming courses of action, measuring the effectiveness of force combinations, and determining transportation feasibility
- Providing feedback to assess the results of situational responses; supporting after action reporting efforts
- Training of new personnel and sustaining the proficiency of command groups and staffs

4.8.2- Types of Simulation Models

There are a wide variety of simulations and models that support an equally broad range of exercises. Many are flexible with regard to level of resolution in the information presented and provided. The choice of which to use is based on the training audience and the training objectives. If, for example, the trainer wished to conduct a seminar wargame for commanders and staff in a joint force, he might use a simulation that presents information of operational and strategic importance, and supporting analytical models that do the same. The resolution would be in terms of major results to large units. If the intent were to exercise and assess detailed logistics coordination, a simulation with higher resolution would be required. Generally, the higher the resolution means the more realistic the training environment and the more stressful the training. Joint CPXs that use computer assistance generally require simulations and models with relatively high resolution.

4.8.2.1- Aggregate Level Simulation Protocol (ALSP)

Currently, there is a multi-service program of conventions that ensures interoperability of simulation models and provides maximum flexibility. Together, these conventions, or protocols, are known as the ALSP; they permit disparate simulations to work together in an integrated whole. An ALSP confederation consists of multiple Service oriented models that share information with each other via ALSP. Before a model can join the ALSP confederation, it must be modified to accommodate the ALSP protocol for both technical and operational functionality. A number of models, used independently by the Services, are in various stages of integration into the ALSP confederation:

- Corps Battle Simulation (**CBS**) is the designated US Army combat simulation model. It is a member of the ALSP confederation, modeling air-ground, ship-ground and cruise missile activities through ALSP. Capabilities for modeling of CA/CMO and PSYOP are being developed and integrated.

- Air Warfare Simulation (**AWSIM**) is the designated US Air Force combat simulation model. It is a member of the ALSP confederation, modeling air-ground, air-air, ship-air and cruise missile activities through ALSP.

- Research, Evaluation and Systems Analysis (**RESA**) is a naval simulation model that has been used in conjunction with exercises in Korea and Germany. Air-ground, air-air, ship-air, ship-ground and cruise missile activities occur via ALSP.

- MAGTF Tactical Warfare System (**MTWS)** is the developing US Marine Corps warfare simulation model. It interacts with AWSIM and RESA for air to- air, air-to-ground, air-to-ship, and ground-to-air in the ALSP configuration. Future efforts will include the development of a ground-to-ground protocol.

- Combat Service Support Training Simulation System (**CSSTSS**) is a logistic model designed for exercising supply, maintenance, and transportation and health services personnel for the US Army and is being adapted and tested for use with the ALSP confederation.

- Joint Electronic Combat Electronic Warfare Simulation (**JECEWSI**) is a member of the ALSP confederation and provides electronic warfare simulation for the Service models. The Joint Command and Control Warfare Center (JC2WC) is expanding the capability of JECEWSI to simulate the other key elements of C2W: PSYOP, OPSEC, EW and destruction.

- Tactical Simulation (**TACSIM**) is a model originally designed to exercise US Army intelligence officers and has been used in conjunction with CBS. It has been configured to supersede the intelligence portion of specified models when used in the ALSP confederation.

4.8.2.2Other Key Models

There are literally hundreds of wargame simulation models. Some are used as exercise drivers, others as analytical tools to support military decision making within the context of exercises or actual conflict, or to support research and development efforts. In addition to the ALSP models, the following are a few of the principal models used by Services and unified commands.

- Enhanced Naval Warfare System (**ENWGS**) is a US Navy simulation model.

- Joint Conflict Model (**JCM**) can be used from theater strategic to tactical levels as a wargame driver for joint exercises, as an analytical tool to wargame courses of action, and as a research and evaluation tool to evaluate the effectiveness of new weapons systems and new tactical doctrines. Its domain includes land, with limited air, and naval operations for joint and multinational forces in conventional and unconventional warfare mission areas, including sea control, airlift operations, and air-to-ground and ground to-air operations.

- Urban Combat Computer Assisted Training System (**UCCATS**) was originally designed as a wargame driver for urban combat scenarios in Europe, but is now used in other regions.

- Joint Theater Level Simulation (**JTLS**) is used primarily to analyze theater level operational plans. It is designed to serve as both an operations support and a force capability tool to assess the value of different mixes of forces or resources. The model has also been used as an exercise driver. Its domain includes land, air and limited naval operations for joint and multinational forces in conventional air, ground and naval missions. The effects of special operations can be modeled. It has full intelligence and logistics modules capability.

- **Joint Simulation System** (**JSIMS**): JSIMS will support combatant commands, Services, and JTF training by simulating the actions and interactions of all ground, air, space, and sea entities within a designated area of operations. Initial operating capability is due in FY 1999 with full operational capability in FY 2003.

In this chapter, I wanted to take a brief look at the application areas of simulation and benefits of using simulation in contemporary Armed Forces. At the end of the chapter common simulation types were defined. As it was talked about in Chapter 3, High Level Architecture will compose the technical frame of simulation use for Armed Forces in near future and developed countries have a great effort to complete the transition of their simulation models to High Level Architecture. As it will be talked about in next chapter, Joint Simulation System will have the overall capability of the currently being used simulations, by using High Level Architecture.

Chapter 5

A FUTURE APPROACH FOR MODELLING & SIMULATION: JOINT SIMULATION SYSTEM

5.1- JOINT SIMULATION SYSTEM (JSIMS) IDENTIFICATION

The Joint Simulation System (JSIMS) is "a single, distributed, seamlessly integrated simulation environment. It includes a core infrastructure and mission space objects, both maintained in a common repository. These can be composed to create an interactive simulation capability to support Joint or Service training, rehearsal, or education objectives.[234] The Joint Simulation System (JSIMS) will provide readily available, operationally valid, computer-simulated environments for use by the Commander in Chiefs (CINCs), their components, other joint organizations, and the Services to train, educate, develop doctrine and tactics, formulate and assess operational plans, assess warfighting situations, define operational requirements, and provide operational input to the acquisition process. [235]

The operational tempo (OPTEMPO) and the growing complexity of military operations demand more robust simulation training systems. The primary purpose of JSIMS is to support training and education of ready forces by providing realistic joint training across all phases of military operations for all types of missions. A distributed, constructive wargaming simulation, JSIMS is designed to create a single, seamlessly integrated joint synthetic battlespace (JSB). JSIMS will provide command, control, communications, computers, and intelligence (C4I) training in a simulated, full-range military operations environment using joint and combined force capabilities.

Initially, JSIMS will support joint, Service, and agency training. Eventually, it will include doctrine development and validation, mission rehearsal, joint experimentation, and professional military educational objectives. Above all, it is an "alliance," a formal

[234] SIMTEC, Inc., 1998, Air Force Distributed Mission Analysis, Prepared for Aeronautical Systems Center Training Systems Program Office, SIMTEC Inc., March 9,1998, Manassas, VA 20109, pp 64
[235] Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000, pp 1

agreement establishing an association of groups to advance common interests.[236] Figure 5.1 depicts the JSIMS environment[237]:

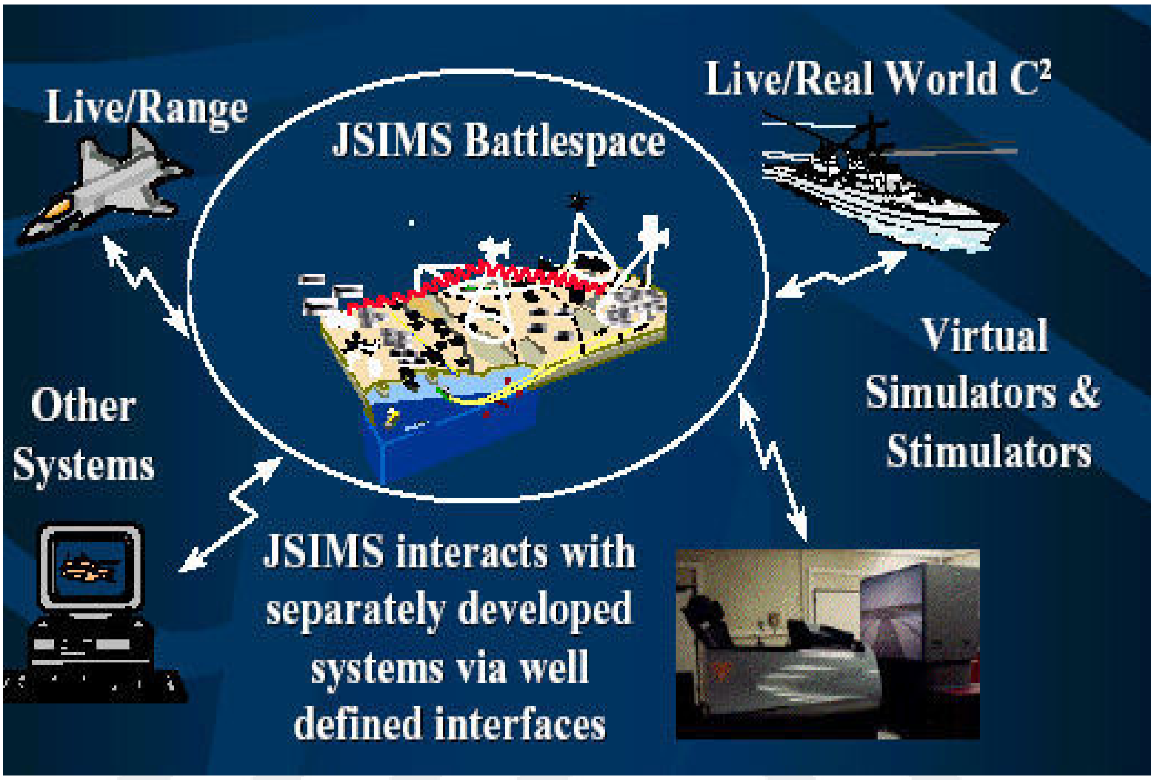

Figure 5.1- JSIMS environment

Source: Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

Figure 5.2 describes the model genealogy beginning in the early 1970's and leading up to the current development of the members of the Joint Simulation System (JSIMS).[238] The Joint Training Confederation (JTC) was an interoperability program that joined together several models that had originally been designed to operate independently. Joining models after they are created has proven to provide only a very limited degree of interoperability. Each model has a specific representation of the world that allows it to share/export information in very limited ways**.** However, the JTC program proved that interoperability

[236] Knight, L., Crabtree, G. and Olson, S., 2001, "Building the Joint Simulation System (JSIMS)", Army AL &T, September-October 2001,pp 36
[237] Stanford, T. and Snead, C., "MS 101 Introduction to Modeling and Simulation Presentation", Available on site http://www.dmso.mil
[238] Smith, Roger D., 1999, "Military Simulation: Techniques & Technology", Information & Security. Volume 3, 1999, ISSN 1311-1493. The simulation models in Figure will not be included in thesis because each of them has a complex and long structure.

at this level is feasible**.** JSIMS is attempting to design the entire family to operate together from the beginning**.**

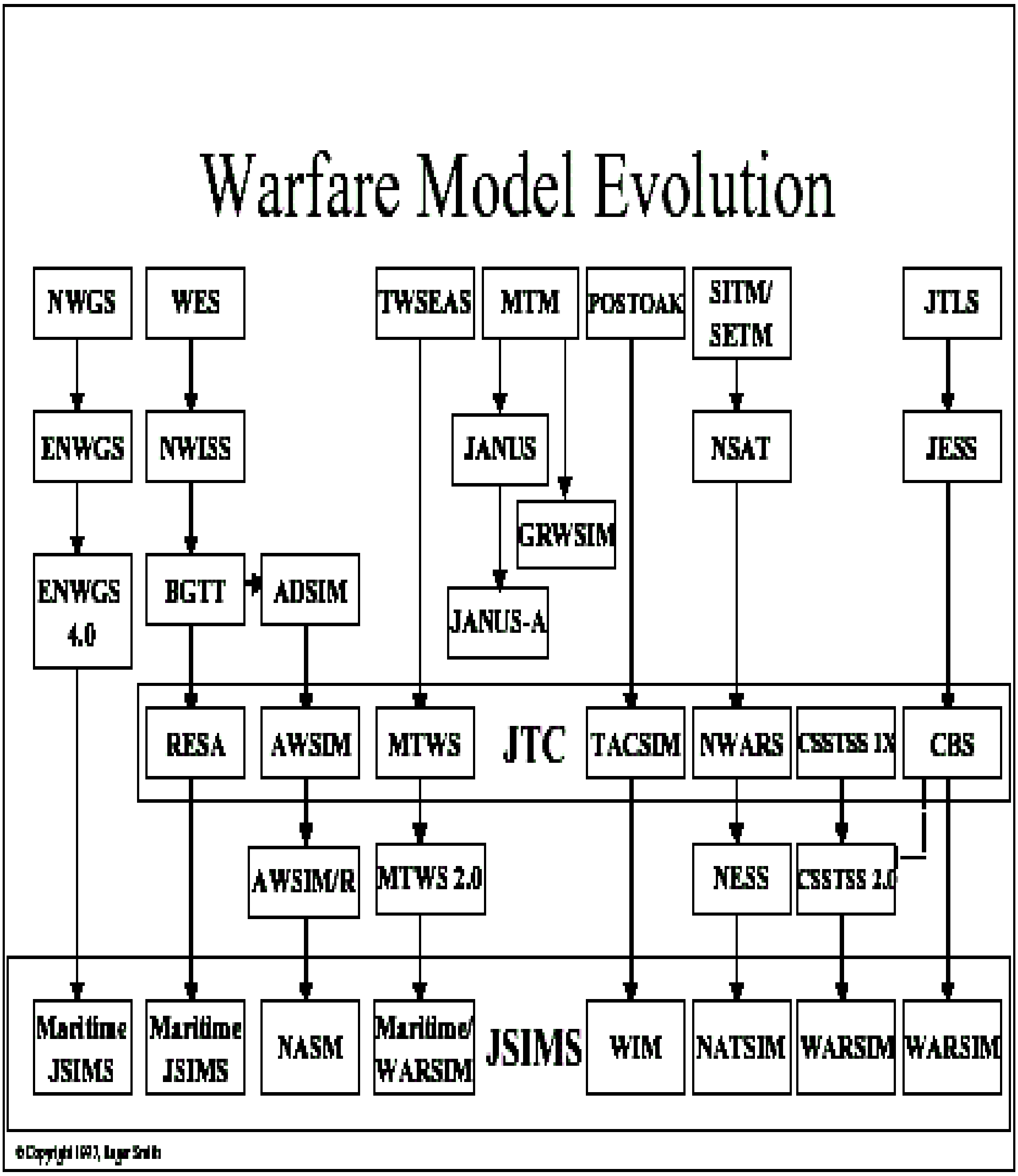

Figure 5.2- Warfare model evaluation

Source: Smith, Roger D., 1999, “Military Simulation: Techniques & Technology”, Information & Security. Volume 3, 1999, ISSN 1311-1493)

5.2- JOINT SIMULATION SYSTEM (JSIMS) OVERVIEW

National military strategy is shaped by the dynamic, global interests of the countries' in the post-cold war era. Military force levels, structure, and doctrine must continually respond to new global engagement requirements as they evolve. The effectiveness of these responses is directly related to the training that precedes them. Realistic and relevant training is an essential component of creating and maintaining readiness. Training brings its own set of challenges mirroring many of the broader challenges of national military strategy. These training challenges stem from several sources[239]:

- Joint and multinational character of contemporary military activities.
- Numerous, nontraditional applications of military power.
- Requirement for rapid planning, rehearsal, and response to contingency operations.
- The need to improve efficiency and effectiveness in training.

Increased reliance on synthetic training environments can satisfy many of the training and education responses to these challenges. However, the existing modeling and simulation (M&S) tools, such as the Joint Training Confederation (JTC), are not suited to current challenges. In 1993, the Services began to define a process for shared cooperative development of follow-on to the JTC. After significant effort, the Services agreed to begin the development of JSIMS, a single, seamlessly integrated simulation environment.

JSIMS will be the primary M&S tool to support future joint and Service training, education, and mission rehearsal. At initial operational capability (IOC), JSIMS will focus on training joint force commanders (commanders of unified commands and prospective joint task force commanders) and staffs, and principal subordinate Service and functional component commanders and staffs) in operational and strategic-theater joint tasks.

JSIMS will be progressively developed into a robust, interactive joint synthetic battlespace (JSB) for training strategic-national joint tasks and joint and Service tactical tasks in all phases of operations (mobilization, deployment, employment, sustainment, and

[239] See also Chapter 1

redeployment). At full operational capability (FOC), JSIMS will have a comprehensive capability to satisfy a full range of training, education, doctrine development and mission rehearsal needs.

5.3- JOINT SIMULATION SYSTEM (JSIMS) OPERATIONAL REQUIREMENTS

The JSIMS operational requirements and performance parameters are organized into the three key attributes: Tailorability, composabi1ity, and efficiency.[240]

5.3.1. Tailorability

Tailoring is the act of modifying the simulation. Tailorability refers to the characteristics of JSIMS objects and architecture that produce the operational flexibility needed by JSIMS to create a realistic training, education, or mission rehearsal environment for the unique requirements of each user. JSIMS must provide the using commander the capability to create a simulation environment to meet requirements derived from mission analysis using the UJTL and appropriate STLs under the conditions and to the standards (measures and criteria) set by me commander. Tailorability-related requirements can be defined as the ability to:

1. Provide a JSB representing all warfare domains and applicable functions at a level of resolution appropriate for the training, educational, or mission rehearsal simulation event.
2. Incorporate the effects of non-military factors on mission critical tasks.
3. Provide the capability to support unique simulation environments to meet the needs of both the training audience and the exercise control group.
4. Provide the capability to modify JSIMS objects so that new warfighting concepts or equipment can be simulated.

Tailorability requirements are listed in Table 5.1

[240] Joint Chiefs of Staff, 1997, Joint Simulation System Operational Requirements Document Version 2.9 (7 November 1997), Concept Division Joint Warfighting Center, Fort Monroe, VA 23651-5000, pp 8

Table 5.1 – Tailorability Requirements

1.	**Provide a JSB representing all warfare domains and applicable functions at a level of fidelity appropriate for the simulation event**
1.1	JSIMS must support a range of scenarios defined in terms of: scope; size of the battlespace; and inclusion of unique warfare areas. 1. Major Theater Wars (MTWs). 2. Smaller Scale Contingencies (SSCs). 3. Military operations other than war (MOOTW) 4. Global operations battlespace 5. Multiple non-contiguous theaters battlespace 6. Single theater battlespace. 7. Nuclear-biological-chemical (NBC) warfare. 8. Theater missile defense (TMD) warfare. 9. Weapons of mass destruction (WMD) warfare. 10. Space warfare. 11. Information Operations. 12. Non-battlespace areas needed to show strategic infrastructure targets.
1.2	Model all five phases of military operations: 1. Mobilization. 2. Deployment. 3. Employment. 4. Sustainment. 5. Redeployment. 6. The system must also move seamlessly from one phase of operation to the next 7. Simultaneously represent different phases for multiple MTW scenarios

1.3.	For supporting the training requirements of both regional and functional CI7NCs, JSIMS must incorporate or support: 1. Simulations of land, maritime, air/space, and special operations forces across the full range of military operations from multiple major theater wars (MTWs) to military operations other than war (MOOTW). 2. The full range of military operations (including special operations), intelligence, environmental information support, logistics, communications, origin to destination transportation, and medical. 3. UJTL tasks associated with CTNC JMETLS and common tasks contained in CJCSI3500.02A. Tasks must be performed under conditions associated with CINC JMETLs and the common task list contained in CJCSI3580.02A. Tasks must be performed to standards associated with CINC JMETLs and tasks contained in the JTF-HQ-MTG and subordinate MTGs. Capability to support Service specific training will be that associated with Service Task Lists. 4. Links between training objectives (performance, training situation, level of performance) and tasks. 5. The capability to model the effects of planned or simulated military actions and operations on physical, military, and civil environmental conditions, particularly the effects of military actions on political, economic, and social conditions. (Note: While the regional CINCs may focus on the execution phase of military activities, functional CINCs often focus on deployment, sustainment, and specialized actions during the employment. Functional CINCs, therefore, will require more use of computer generated forces (CGF) and automation of functions.)
1.4	For operational assessment and crisis action planning, JSIMS must incorporate or support: 1. Warning indicators, improved assessment of capabilities and intentions. 2.Tools for analyzing vulnerabilities and means for developing course of action recommendations on existing or emerging threats. 3.Timely identification of data and information to support intelligence cycle functions of planning and directing, collection, processing, production, dissemination, and evaluation. 4. Functional capability to simulate effects of mission rehearsal actions or proposed operations in courses of action on the physical, military, political, economic, and social environments in the simulated region

1.5	For operational planning and analysis, JSIMS must incorporate or support: 1. Greater fidelity and levels of resolution down to individual entity level, with a higher degree of behavior complexity. 2. Automation of large portions of the simulation. 3. Independent excursions without disrupting the main scenario. (Note: For this application, user audiences are much smaller than in training exercises requiring more use of CGF and automation of functions (3.3.8)).
2	**Incorporate the effects of military and non-military factors and special operation activities on mission critical tasks.**
2.1	Provide the capability to model and simulate interactively the primary and follow-on effects of the following factors on the outcomes of simulated military operations, as well as model and simulate interactively the primary and follow-on effects of military and non-military operations on these factors: 1. Political organizations. 2. Social factors. 3. Economic and physical infrastructures. 4. Psychological operations. 5. Civil affairs.
2.2	Provide the capability to simulate impacts on, the natural behavior of, or effects of: 1. Terrain. 2. Ocean environment. 3. Atmosphere. 4. Space environment.
2.3	Have the capability to model: 1. At least 10 sides. 2. Any combination of up to 30 sides and factions. 3. Factions must be allowed to form and change sides during an exercise. 4. Military operations in urban terrain. (Note: Sides are composed of objects that share the same relationship to other sides, for example: enemy, suspect, neutral, or friendly. Factions are subsets of sides that include a wide range of organizations: military units; government agencies; international organizations; private volunteer organizations; paramilitary groups; and groupings.)

3	**Provide the capability to support unique simulation environments to meet the needs of the simulation audience and the exercise control group.**
3.1	Support a simulation environment that approaches actual operational conditions for the training audience. 1. The training audience should be able to employ their standard operating procedures. 2. The training audience should not be able to distinguish between real and simulated entities. 3. Where real C41 systems are not available, such as educational institutions, JSIMS must provide the capability to emulate designated Service and joint C41 systems with highly stylized and compressed formats. 4. Provide the capability to select between a 2D and 3D display of any point in the JSB from any perspective that is consistent with the position, status, and capabilities of assigned units. 5. Displays must reflect the tactical environment at the point of observation and be subject to real-world constraints such as line of sight, time of day, battlefield obscurants, the degree to which opposing units are in defilade, etc. 6. Provide a multilingual capability. Target languages include Arabic, French, German, Hangul, Portuguese, and Spanish. (Note: This is not to imply that JSIMS will interface with foreign C41 systems.) 7. Provide for implementation and employment of non-U.S. C41 systems when developed by U.S. or foreign agencies to applicable DLSA and JSIMS standards

3.2	Allow selection of different functional applications and levels of detail, to include all potential opposing forces (OPFOR), allies, and neutrals, within an application (e.g., tactical, operational, and strategic levels of warfare for training and exercising). 1. Represent units down to company, aircraft, and team level (3.2.2). 2. The capability to task-organize while the simulation is running must be provided. 3. Provide the capability to track information at the lowest level, including the entity level in selected situations, with the volume, frequency, and quality of information metered by real-world capabilities. 4. Include the behavioral characteristics of OPFOR units to exploit frilly the strategic and tactical advantages of information operations (JO), without a significant increase in OPFOR role players and controllers. 5. Scale opposing forces to a level commensurate with U.S. and friendly force levels, training objectives, intensity of anticipated combat, and length of exercise. 6. Provide a rule-based system of on-line queries, to highlight major areas of interest and critical events consistent with the role player's field of influence and assigned area of responsibility. 7. Provide multimedia capabilities for simultaneous, synchronized display of high-resolution, 3D, out-the-window and stealth views of the battlefield communications traffic from selected nets; map views with terrain and cultural features; overlays and entity icons; graphic and tabular displays; text and graphic displays from operational orders, messages, doctrinal references, stored demonstrations, and lessons learned resource libraries.
3.3	Model information operations and represent its adverse effects on C41 systems performance within simulated environments: 1. Degradation of the battlefield, or decision making in a peacetime or pre-conflict situation, when critical technology-based "information systems" are attacked or damaged. 2. Impact of electronic, information, and general warfare on friendly and enemy computer networks, communications systems, integrated radar systems, environmental information systems, and intelligence support systems. 3. Impact of electronic, information, and general warfare on a friendly or a threat organization's ability to function and carry out missions.

3.4	Replicate real-world intelligence sensors and provide associated products: 1. Provide the capability to replicate sensors and platforms, such as JSTAIRS, that are not yet operational. 2. Model the ability to task tactical and national intelligence assets to include sensors, special operations personnel, and their associated platforms. 3. Provide training audiences with the information necessary to execute the battle damage assessment (BDA) process. 4. Provide comprehensive BDA assessments or reports suitable for use by the training audience when the training audience does not perform the BDA process. 5. Products must mirror current DOD standards as appropriate for the sensor. 6. The intelligence collection manager (CM) must be able to use existing, real-world CM tools to plan and direct collection by available assets, determine success and failure rates, and optimize allocation of intelligence assets.
3.5	Provide the exercise control group the capability to: 1. Compare game truth with the C41 displays being provided to the training audience. 2. Change, add, or delete, in whole or in part, the conditions that trigger automatic, game-generated responses and the form those responses take (e.g., report, flashing icon, on-line message, file entry, etc.). 3. Query the status of any object, real or simulated, using windows-type pull down menus. 4. Modify or override any game command, regardless of source. 5. Provide 2D and 3D visualization of the JSB from the perspective of both the training audience and the exercise control group. 6. Provide capabilities to compare continuously training audience performance to standards on a real-time basis. Comparisons must include process and product standards of performance (objective and subjective).
3.6	For educational uses, JSIMS must provide the capability to manage up to 10(threshold)/54 (objective) concurrent and distinct scenarios to support education, including the ability to: 1. Interact with objects, to modify object characteristics (e.g., behavioral attributes, location, combat or supply status, side and faction relationships, organization relationships, etc.). 2. Introduce new objectives during the course of a scenario, all on a selective basis in terms of which games are being modified, without disrupting the simulation.

3.7	Provide the capability for the exercise control group to select between automated or manual control of assigned units, definable down to unit level: 1. Permit manual control of one *unit,* while automating the control of others. 2. Permit either automated control or manual control to entire sides. factions, functions, etc. 3. Permit direction of support functions (movement, logistics, etc.) for units under manual control. 4. Customize unit representations on-site, including force composition; force behavior and doctrine; force lay-down; command and support relationships; and the allocation of forces among the training audience, role players, and semi-automated/automated decision makers for all sides and factions. 5. Customize unit representation of sensors to allow exercise control group to negate or create contact information as necessary to achieve training objectives (e.g., radar or sonar contacts).
3.8	Have the capability to vary the game speed: 1. Step back in time. 2. Jump forward. 3. Pause the simulation. 4. Return to previous time without altering the state of the simulation prior to the step back. (Note: Jump forward capability includes moving the simulation forward in time as many as 100 days while representing the effects of simulated activity—consumption, attrition, maneuver, weather, etc. —that would have occurred during the period of the jump,)
3.9	Provide the capability to support daily, intermittent, and final after action reviews (AARs): 1. Capability to determine how the AAR process and products will be distributed to training audience elements located in dispersed sites. 2. Identification of the products (summaries, post-exercise reports, take home packages) and determination of the process and elements of evaluation of the suitability of the training environment to meet training objectives. 3. Planning for the comparison of results of the current event with evaluations of similar or related events carried out previously or with established performance standards

3.10	For mission rehearsal, JSIIMS must provide a virtual environment that includes immersive 3D visualization of the battlespace. 1. View and interact in a simulated 3D environment in which the simulation recognizes and reacts to the users' presence. 2. Represent multi-spectral, correlated signatures of objects (e.g., an infrared source viewed through night vision goggles and radar depictions that correlate with visual displays).
4	**Provide JSIMS users the capability to modify JSIMS objects so that new warfighting concepts or equipment can be simulated.**
4.1	Be capable of displaying the status of any simulated infrastructure or network (e.g., communications, power distribution grids, lines of communication, pipelines, etc.).
4.2	Be capable of modeling new capabilities to improve protection against weapons of mass destruction: 1. Point and standoff detection. 2. Assessment and warning. 3. Prediction of effects. 4. Anti-satellite and satellite defense capabilities. 5. Improved capabilities for deception and use of decoys.
4.3	Be capable of modeling logistics (including the Defense Transportation System): 1. The effects of logistics and transportation on operational tempo, battlefield densities, service life of weapons systems, deadline rates and down-time, etc. 2. The effects of precision operations on demands for logistical and transportation support. 3. The vulnerability of logistical and transportation infrastructure to traditional enemy actions. 4. The increased threat to logistical and transportation infrastructure from information warfare. 5. Non-traditional logistical and transportation structures, including decreasing reliance on shore-based facilities, multinational logistic and transportation cooperatives, civilian or contracted capabilities, joint logistics over the shore (JLOTS), etc. 6. The effects of OPTEMPO on logistical and transportation resources and ability to provide support including joint total asset

4.4	Be capable of modeling target acquisition and fire support organizations that streamline decision-making and control, including the ability to: 1. Simulate nontraditional, cross-Service links between target acquisition systems and weapons systems. 2. Simulate direct shooter-sensor links such as sensor-fused weapons systems.
4.5	Be capable of modeling: 1. Attack of hardened, underground targets employing non-explosive warheads. 2. Effects of less-than-lethal munitions. 3. Projected space force application systems such as space based laser and military space plane munitions. 4. New capabilities to detect, acquire, track, destroy, and perform kill assessment of enemy strategic and theater ballistic and cruise missiles. 5. Dissemination of missile-strike warning across the theater. 6. New capabilities to differentiate potential targets as friend, foe, or neutral. 7. Improvements in enemy and friendly signature control, including increasing use of stealth technology with air, ground, and sea maneuver platforms, as well as on an individual basis. 8. Reconnaissance, surveillance, and target acquisition (RSTA) capabilities to be provided by remotely piloted vehicles and unmanned aerial vehicles. 9. Wide-area, linked, air-ground sensor systems; advanced radars; pattern-recognizing software (e.g., automatic target recognition algorithms); and improved space-based platforms.
4.6	Be capable of modeling vulnerabilities that accompany increasing reliance on information systems for military operations: 1. Adversary actions to destroy, disable, jam, saturate, misinform, deceive, or exploit U.S. information systems (e.g., computer viruses, hacker activities, focused electromagnetic pulse strikes, electronic deception, etc.). 2. Actions taken to defend against adversary attacks. 3. Be capable of simulating military operations under various levels of information superiority or information degradation. 4. Degradation of satellite constellations and ground stations disrupted by hostile operations.

Source: Joint Chiefs of Staff, 1997, Joint Simulation System Operational Requirements Document Version 2.9 (7 November 1997), Concept Division Joint Warfighting Center, Fort Monroe, VA 23651-5000

5.3.2. Composability

Composing is the act of bringing simulations or parts of simulations together to create an appropriate training, education, or mission rehearsal environment. Composability refers to the technical flexibility needed by JSIMS to construct that environment for the unique requirements of each user. JSIIMS must provide the capability to link to other simulation resources and operate using all or a portion of the non-core components or domains. Composability-related requirements can be described as the ability to:

1. Provide the capability to operate in a distributed mode to dispersed training audiences, with or without external support, as well as the ability to conduct smaller events in a stand-alone mode using organic resources.
2. Provide the capability to access and manipulate information from other resources.
3. Draw HLA compliant objects from various repositories to compose a joint synthetic battlespace (JSB) to support a specific training event or create a JSB within which another use application might be undertaken.

The composability requirements are depicted in Table 5.2:

Table 5.2- Composability Requirements

1	**Provide the capability to operate in a more distributed mode to dispersed training audiences, with or without external support, as well as the ability to conduct smaller events in a stand- alone mode using organic resources**
1.1	Distribution of the system's multiple capabilities must be customized to each level, present the appropriate fidelity at each level, and be active or available from planning through post—event assessment: 1. Provide ability to link live, virtual, and other constructive simulations between users at various echelons to form an environment that stimulates a user's C41 systems. 2. Display simulation results on users' C41 systems or their emulation for training and exercises. 3. Display after action review material on organic C41 equipment. 4. Emulated displays should use operational symbols, notations, and terminology. 5. Provide the system with the safeguards to prevent confusion with real-world events and permit orderly transition from exercise to real-world operations.

	6. Distribute required information to all JSIMS elements in such a manner that no single element's picture of the simulation is more than 30 seconds (threshold)/10 seconds (objective) behind that of the simulation, and all real-time C4I systems are updated in real-time and reflect current game state within the performance factors that represent real—world system performance.
1.2	Provide the ability to use JSIMS from real-world duty locations. 1. Maintain time and spatial consistency as the number of entities and accompanying interactions increase. 2. Accommodate multi-echelon exercises in which different scales of simulation, including live, virtual and other constructive simulations, are interacting. 3. For operational planning and analysis, interface with real-world planning systems and provide "what-if' capabilities; the system must be able to run independent excursions without disrupting the main scenario. 4. Have the ability to operate in a distributed mode , to various dispersed training audiences, with or without external support, coupled with the ability to conduct smaller events in a stand-alone mode using organic resources.
1.3	Provide for Humans-in-the-loop (HITLs) control, even if the procedure can be executed automatically. 1. HITLs capability must be available with all simulations executing concurrently, including those above and below the echelon of command of the simulation being played. 2. HITLs must be available with computer generated forces CGF representing friendly, neutral, and opposing forces. 3. HITLs must be able to combine with and to switch between HITLs and semi-automated forces during execution.
1.4	Support network switching and related communication management functions. 1. Support test of systems configuration (including communications protocols), equipment operation, network connectivity, and integrity of network security in a distributed environment. 2. Support test of the operational integrity of C4I systems with dual access to real world and exercise data.

1.5	Provide exercise controllers the ability to start, freeze, stop, fast forward, restart, shutdown; to take a snapshot of all data in the system; to record selected events; to select the time scale in which to operate; to vary game speed; and to manage system configuration (i.e., distributed, single site). 1. Support technical management functions such as time control game ratio; check points and archiving functions; systems/networking monitoring; crash recovery and record keeping. Systems saves should be accomplished in background mode without pausing the simulation. System monitoring includes interfaces with other simulations, simulators, live forces, and ranges. 2. Include the capability to save all components without affecting the speed/game ratio (e.g., if system was set at 1:1 before "save," it remains 1:1 during "save").
2	**Provide the capability to access and manipulate information from other knowledge and information resources.**
2.1	Access and download data from command and control systems: 1. Service and joint planning systems (e.g., time phased force deployment list (TPFDL) and air tasking order (ATO). 2. Database repositories. 3. Other simulations. 4. Service and joint analysis systems. 5. Archived data from real-world operations (including operationally derived performance data), field training exercises (FTX), and other computer assisted exercises.
2.2	Support the synthesis of generic, real, real-displaced and other databases using data from multiple real-world sources. JSIMS must be capable of: 1. Building databases in all four categories (e.g., Generic -representation of a generic physical environment; real - representation of a real-world physical environment; real-displaced - representation of a real-world physical environment translated to another geographic location; other - representation of a physical environment influenced by other factors, i.e., smoke/obscurants, nuclear effects, virtual simulation, etc. 2. Electronically passing data from a central facility to remote C4I nodes. 3. Populating replicated C4I databases with exercise data generated using scenario and database preparation tools. 4. Modification to environmental, object, and JSIMS replicated C4I database structures during the exercise without disrupting the simulation.

	5. Representing four types of environmental data: historical, climatic extremes, observed, and forecast. 6. Formatting data into three categories: dynamic, interactive, or static. 7. Providing real-time interactions between the JSIMS scenario and replicated or actual real-world database structures. 8. Accessing intelligence networks and databases to update electronically location and status of real-world threat systems, units, etc., from operational systems/nets (Joint Deployable intelligence Support System (JDISS), SIPRNET, Intelink, etc.) depicted within the JSIMS replication of the real-world database. 9. Accessing current environmental data in real-time, downloading it, and populating appropriate environmental databases. 10. Modifying data to support accomplishment of training objectives.
2.3	In the event of a software failure, JSIMS must include capability to resume the simulation such that simulation time and state are the same as at the point of failure. 1. JSIMS must resume operations no later than 1 hour (threshold)/within 15 minutes (objective) after fault detection. 2. JSIMS will he fault tolerant; no single JSIMS component will cause total system failure; and system operation will be able to continue, albeit in a degraded fashion, if a component fails.

Source: Joint Chiefs of Staff, 1997, Joint Simulation System Operational Requirements Document Version 2.9 (7 November 1997), Concept Division Joint Warfighting Center, Fort Monroe, VA 23651-5000

5.3.3. - Efficiency

Efficiency refers to operational and technical responsiveness in presenting a training, education, or mission rehearsal environment. JSIMS must reduce the personnel and time required to provide a training, education, or mission rehearsal event. Chapter 4 further describes efficiency-related requirements as the need to:

1. Incorporate tools and automated routines to facilitate responsive design, planning, and preparation processes for JSIMS events.
2. Incorporate tools and automated routines to reduce the effort required to execute a JSIMS event and provide a relevant after action review (AAR).

The efficiency requirements are listed in Table 5.3 below:

Table 5.3- Efficiency Requirements

1	**Incorporate tools and automated routines to facilitate responsive design, planning, and preparation processes for JSIMS events, including the creation of verified and validated databases and scenarios for certification and accreditation.**
1.1	Incorporate tools and features to reduce the time required to tram organic and system operators.
1.2	Interface JSLMS tools with supporting and supported command planning systems, including the ability to transfer electronically developed plans and databases from operational systems to JSIMS**.** 1. Include tools to access, download, and manipulate data in training support systems such as JEMP and other similar Service training support systems (1.2.1.1). By entering information correlating to one or more of the JEMP components, this planning tool should return relevant information on the remaining components. 2. Automate design of composable communications architectures from user-defined assets (communications equipment, C41 systems, M&S related equipment/computers, exercise architecture, encryption devices, access to SATCOM, etc.).
1.3	Provide scenario generation tools to create and modify scenarios using graphical user interfaces and scenario tools: 1. Provide scenario tools to accomplish staff-related functions employing products that may be developed at various times and locations. For example, the exercise planner may use previously developed exercise objectives to plan an exercise, even though he or she may not have been a participant in the process that produced the objectives. 2. Provide scenario tools that allow the exercise planner to compile and integrate these products into a coherent, meaningful, and executable scenario. 3. Provide tools to support the rapid development of environmental and object databases. 4. Support the development, testing, and installation of new databases within 96 hours (threshold)/48 hours (objective); major modification, testing, and installation of an existing database within 24 hours (threshold)/12 hours (objective); and testing and installation of an off. the-shelf database in 4 hours (threshold)/2 hours (objective).

1.4	Provide tools and embedded routines to facilitate database development and accreditation of scenarios to support training events. 1. Database preparation tools provide users both the means to rapidly access, collect, and populate JSIMS data structures with information from multiple sources and the ability to test the synthesized databases for internal consistency and operational soundness. 2. Automate the identification of conditions required to support event objectives by correlating training objectives, supporting and enabling tasks, and associated standards with the requisite civil, military, and physical conditions described in the HITL. 3. Test modifications to approved databases to include verification that modifications have the desired result without incurring unexpected side effects in other areas; internal consistency between data structures is maintained; and operational soundness is preserved. 4. Provide tools and routines to support the capability to make, archive, and compare multiple runs. Repeatability is not required, but the ability to support, comparative and statistical analysis is required (3.3.4). This process includes the ability to define measures of effectiveness, automate data collection, and provide basic post-process capabilities (i.e., standard statistical packages, use of relational databases, automated formatting, and transfer to graphics support packages, etc.).
2	**Incorporate tools and automated routines to reduce the effort required to execute a JS [MS event and provide a relevant after action review (AAR).**
2.1	Provide operational assessment and crisis planning tools that incorporate warning indicators, improved assessment of capabilities and intentions, tools for analyzing vulnerabilities, and means for developing course of action recommendations.
2.2	Provide embedded tools to gather and display information on JSIMS performance before and during the training event. 1. Provide the resource manager performance data on use of computer resources during the event. 2. The impact of JSIMS use on the communications network. 3. Downtime attributed to software and hardware components. 4. Performance data related to interfaces with other live, constructive, and virtual simulations. 5. A pre-exercise tool that considers both processing and bandwidth requirements to determine total system requirements for a given training scenario

2.3	Provide automated AAR functions or tools to minimize the personnel required to prepare the AAR. 1. Provide comprehensive AAR tools to plan and evaluate the suitability of the training environment (conditions) and assessing task performance. 2. Automate the production and nomination of candidate AAR aids by providing expert logic aids for correlating exercise objectives to the data collection plan. 3. Automate the correlation of objectives, supporting and enabling tasks, and associated measures/criteria of standards, with the requisite civil, military, and physical conditions described in the UJTL. 4. Support pre-event train-up for AAR analysts and observers detailed as members of the AAR cell. 5. Allow AAR analysts to select critical AAR events occurring over the electronic data stream to be monitored. JSIMS must have the capability to alert AAR analysts when a critical event or the conditions requiring a critical action occur. 6. Provide standardized AAR products ificol7porating playback capability: C41 and/or video products; access to doctrinal resources; UJTL statistical products; physical environmental conditions analysis; and observer inputs. Compare recorded ground truth with player perspective of the training event. Standardized products must be appropriate, related to UJTL/STL-derived training objectives, and distributable to each echelon being trained. 7. Provide capability for on-line analysis to capture, store, retrieve, and manipulate relevant, archived AAR information, particularly with respect to comparing the current training event with AARs of related, previous events. 8. Automatically archive information to other systems and organizations engaged in collecting lessons learned, training management, and determination of future training requirements. 9. Allow AAR analysts to integrate observed data with simulation data. Process or merge AAR information collected from different simulation environments. Tailor data collection to each training objective in terms of tasks, conditions, and standards to facilitate proficiency observations. 10. Provide tools to permit observers to enter observation data and AAR analysts to receive near real-time observations. 11. Provide AAR analysts the capability to modify automated data collection at any time, including the ability to define new conditions and standards and to modify or delete existing conditions and standards. 12. Provide immediate feedback for interim and final AARs within 1 hour (threshold)/30 minutes (objective) and a comprehensive debrief within 6 hours (threshold)/3 hours (objective).

Source: Joint Chiefs of Staff, 1997, Joint Simulation System Operational Requirements Document Version 2.9 (7 November 1997), Concept Division Joint Warfighting Center, Fort Monroe, VA 23651-5000

5.4- SHORTCOMINGS OF EXISTING SYSTEMS

With the existing Armed Forces M&S systems, a robust, complete electronic representation of the full operational environment cannot be crested without excessive overhead in personnel, time, and other resources. This is because current M&S systems do not possess the critical characteristics of tailorability, composability, and efficiency that will be designed into JSLMS to redress these shortfalls. Examples of tailorability, composability, and efficiency shortcomings in the existing systems are described below.[241]

5.4.1- Tailorability Shortcomings

Functional Limitations: Existing models do not portray the full range of military operations. In addition, the existing M&S systems that replicate functions such as transportation, logistics, intelligence, space, and special operations do not interact with desired resolution and fidelity with combat models. An additional functional limitation of existing M&S systems is a failure to address the full range of military operations other than war (MOOTWI). Addressing these shortfalls has the potential to enhance the effectiveness of US Armed Services performance.

Links Between Phases of Operations: Existing simulations do not link the phases of operation. Most training events focus on employment without addressing the constraints imposed by force deployment and sustainment issues. Although some useful tools to support deployment and sustainment have recently emerged, they have not been fully integrated into the simulation environment. Mobilization and redeployment issues are normally not addressed.

Strategic Effects: Existing simulations do not reflect the strategic effects of military operations. Deficiencies in current simulations require excessive intervention and tedious workarounds to inject effects of strategic attack.

5.4.2- Composability Shortcomings

Service Interoperability: Currently, no single M&S system or combination of M&S systems provides a complete representation of the joint operational environment. Each

[241] Joint Chiefs of Staff, 1997, Joint Simulation System Operational Requirements Document Version 2.9 (7 November 1997), Concept Division Joint Warfighting Center, Fort Monroe, VA 23651-5000, pp 13

Service has independent M&S systems that support their needs. While these legacy systems have served their purpose with respect to individual Service training needs, they do not adequately or efficiently operate with other Service systems to satisfy joint force commanders' training needs.

Database Construction: Certified, consolidated data repositories are not readily available and database construction remains a time-consuming, manpower-intensive process. For example, each individual model component of the current HC has its own unique database format that must be carefully coordinated prior to each training event. An update or change in a single model's database can adversely generate additional change requirements throughout the other confederation models. Standardized tools to automate the archiving, cross-checking, manipulation, retrieval, and transfer of data elements do not exist.

Environmental Effects and Environmental Impacts Standardization and Integration**:** There is no standard method to incorporate consistent, natural, or physical environmental effects such as the effects of the environment on military operations in a simulation integrating two or more models. Neither is there a standard method to incorporate impacts on the environment caused by military actions and interactions.

Enhancement Capability**:** It is difficult and expensive to make significant enhancements to existing models, and it is no longer cost-effective to update the models to support evolving joint and Service training requirements. Proprietary software, limited graphics capabilities, non-modular design, and hard-coded data representations do not integrate easily into an open systems environment.

Interaction and Connectivity: The existing simulation systems do not provide users the ability to interact freely with each other through the simulation, nor can they leverage other simulation capabilities through electronic connectivity.

C41 interface**:** In general, existing systems do not allow the simulation to interface with existing C41 systems in a comprehensive fashion. Existing simulations require specialized equipment to display information. There are also limitations in the design of human interface equipment supporting the C41 systems. Therefore, users are often forced to participate in simulation-supported events using unfamiliar equipment and interfaces.

Links to Virtual and Live Entities**:** Current constructive simulations have a very limited capability to link virtual and live entities.

Links to Joint Training System**:** Existing simulations do not fully support the design, planning, preparation, execution, and post-exercise stages of the joint exercise life cycle, which supports the Joint Training System. Current simulations do not possess capabilities that provide linkages between critical scenario components (e.g., UJTL, JMETLs, training objectives, MSEL, data collection, AAR, etc.). The lack of systematic linkages has the potential to require unnecessary system processing and bandwidth resources.

5.4.3- Efficiency Shortcomings

Manning Levels: Existing US Armed Forces M&S systems require extensive personnel support for Service and joint exercises. Deficiencies in current simulations require personnel to intervene in simulations or script actions. Numerous role players must portray higher, adjacent, and lower echelons of friendly forces that are not participating in the exercise. Other personnel are required to execute opposing force activities. In addition, substantial personnel augmentation is required to operate computer systems and to enter manually plans, instructions, and orders to support the training scenario.

Trainer and Provider Tools**:** Existing M&S systems also lack a complete array of trainer and provider tools required to facilitate efficient planning and execution of training events. For example, no existing system has adequately integrated joint after action review (AAR) functionality, and tools to support rapid scenario generation do not exist. Those tools that do exist generally provide stand-alone capabilities (i.e., the output from one tool does not necessarily provide input for another tool). This often results in the requirement to re-enter data required during exercise development. A particular deficiency in current systems is related to tools to support the real-time control of or data collection during exercise execution.

Combat Adjudication**:** The combat adjudication process in current models developed by the joint and Service communities does not replicate a complete operational environment, requiring significant manpower to replicate the battle damage assessment (BDA) process.

Military Operations Other Than War (MOOTW) Scenario Support: Although MOOTW has dominated recent employment of US Armed Forces, existing M&S systems do not replicate MOOTW scenarios, particularly with respect to burgeoning joint training requirements. On a larger scale, social, economic, and political factors affecting missions across the full range of military operations are not adequately modeled to support joint training, requiring significant manpower to script this into an exercise.

5.5- JOINT SIMULATION SYSTEM (JSIMS) SIMULATION ENVIRONMENT

Figure 5.3 describes the simulation environment of JSIMS. The JSIMS simulation environment, in contrast to the JTC, will provide an integrated representation of the battlespace domains. In addition to integrating land, maritime, and air/space domains, JSIMS will encompass other linked capabilities, such as transportation, logistics, intelligence, C4, special operations, and information operations.

The JSIMS core will include common and joint representations and simulation Services, a run-time hardware and software infrastructure and interfaces. JSIMS efficiency, composability, and tailorability will allow it to represent tertiary domains when JSIMS is used for focused Service, functional, and mission rehearsal training and education. High Level Architecture (HLA) will enable JSIMS to exchange data with other systems such as weapons platform simulators.

JSIMS can be composed to provide partial replication of adjacent domains for Service use. The fidelity of JSIMS can also be tailored to the full range of tactical, operational and strategic tasks. High Level Architecture will enable data transfer between JSIMS and other systems such as simulators.

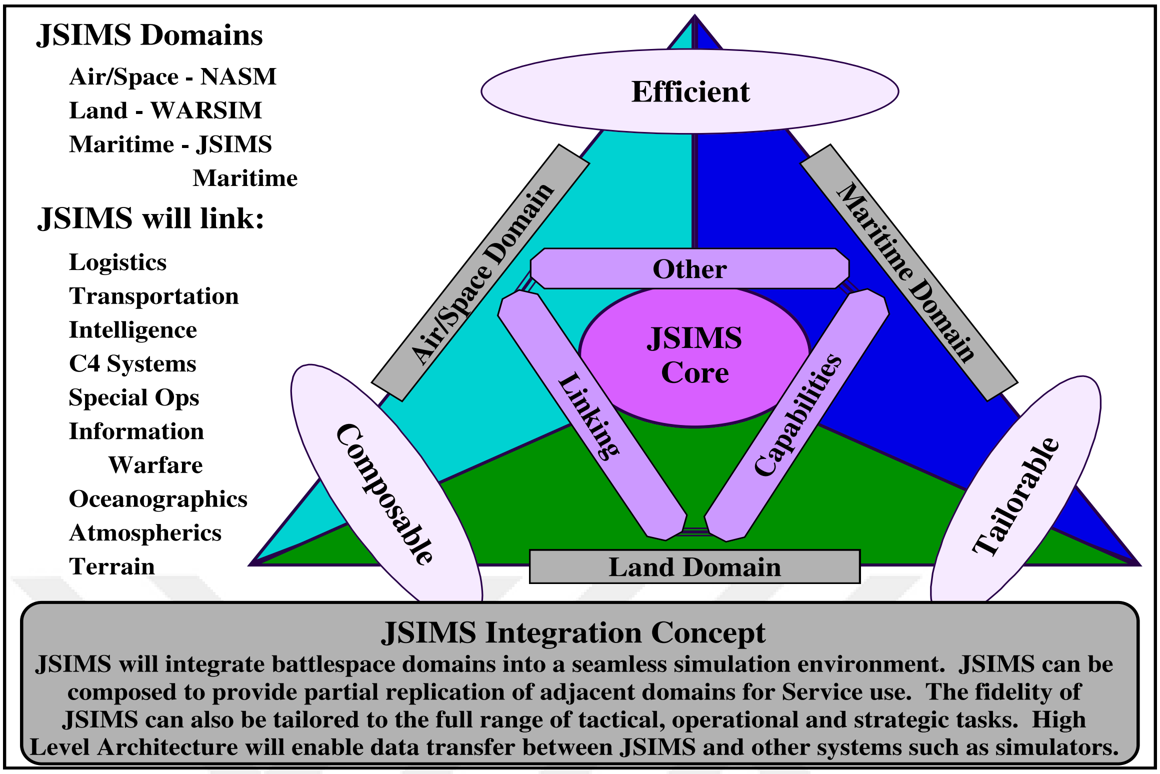

Figure 5.3- JSIMS Simulation Environment

Source: Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

5.6- JOINT SIMULATION SYSTEM (JSIMS) TECHNICAL ARCHITECTURE

Although technical architecture is not a sub-objective of the thesis a short brief was included to familiarize the Turkish modeling &simulation designers and developers. JSIMS must comply with DOD standardization and interoperability policies for modeling and simulation, including: the DOD Technical Reference Model (TRM) part of the Technical Architecture Framework for Information Management (TAFIM); the Defense Modeling and Simulation Office (DMSO) High Level Architecture Management Plan; Modeling and Simulation Resource Repository; DMSO Conceptual Model of the Mission Space Management Plan; and the DOD Modeling and Simulation Master Plan. These policies include the directive that the JSIMS core infrastructure and constituent components meet requirements for verification, validation, and accreditation (VV&A).[242] The JSIMS architecture includes planes, tanks, ships, and intelligence sensors that

[242] See Chapter 3 about interoperability policies.

interoperate in a JSB.[243] This synthetic operational environment must be coherent between the levels of war, synchronized between types of events, and realistic in the context of the specific joint training scenario. JSIMS uses high level architecture (HLA), the DOD standard for modelling and simulation interoperability. HLA provides the flexibility not only for development by the partners within JSIMS, but also for JSIMS to interact with other simulations as required. HLA also provides the means by which JSIMS can interface with C4I systems. Additionally, HLA provides JSIMS the following:

- A standard mechanism to record alliance-wide decisions on how domain objects and their relationships are characterized,

- A software integration framework for major components of JSIMS,

- A standard means to extend JSIMS through the addition of non- JSIMS developed federates, and

- Cost reduction by using existing government and commercially developed HLA tools.

The JSIMS system/subsystem design description defines four JSIMS component classes as follows:

Domain Federate: This simulates combat environments such as land, water, air, and space. Domain federates[244] are as follows:

- JSIMS Maritime Domain
- Joint Domain
- National Air and Space Model (NASM)
- Joint Information Operations Center Operation, Intelligence, Surveillance, and Reconnaissance Simulation (JOISIM)
- Civil Environment Battlespace
- Warfighter's Simulation (WARSIM)

---

[243] Knight, L., Crabtree, G. and Olson, S., 2001, "Building the Joint Simulation System (JSIMS)", Army AL &T, September-October 2001,pp 36
[244] O'Brien, P., "Options for Space Representation in Joint Simulation System (JSIMS)", Air Force Space Command Representation, Slide number 16, Available on site: http://ax.losangeles.af.mil/axl/jsims.ppt

- Warfighter's Simulation Intelligence Module (WIM)
- Joint Signals Intelligence Simulation (JSIGSIM)
- National Simulation (NATSIM)
- DIA Object Oriented Model of Intelligence Operations (DOMINO)

Support Federate: This provides functions other than those included in a domain federate, such as the technical control federate that is used to perform technical management of the federation. Support Federates includes[245]:

- C4I Adapters
- Federation Control Manager (FCM)
- Technical Control (CCHLA)
- Common Component Workstation (CCWS)

Library: This directly links into one or more other components but is not a federate (e.g., synthetic natural environment models or the HLA runtime infrastructure) Common library of JSIMS includes:

- Common Component SimEngine (CCSE)
- Common Algorithm Support Service (CASS)
- Synthetic Natural Environment (SNE)
- Security Common Services (SCC)
- Runtime Infrastructure Services (RTI)

Application: This stands alone and is not a federate (e.g., scenario generation tool). Each component class has one development agent responsible for its construction. Application includes:

- Civil Environment Database Generation Tool
- Synthetic Natural Environment Database Generation
- Workstation Server
- Workstation Tools
- Security Out Guard

---

[245] Ibid,

Figure 5.4 depicts the federate composition.[246] There are two basic kinds of federate in system: RTI-direct and Sim Engine.

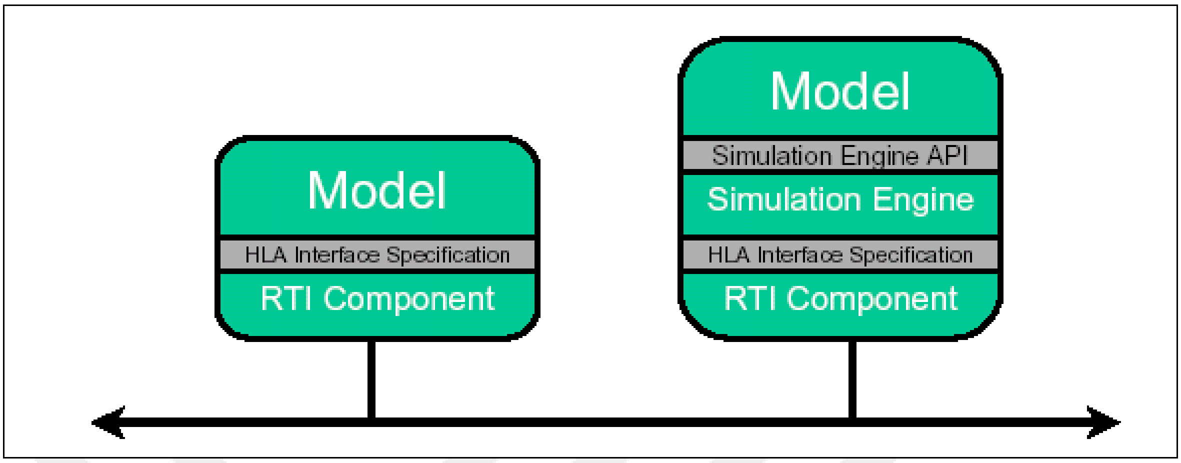

Figure 5.4- Composition of Federates

Figure 5.5 depicts the major federates and their parts:[247]

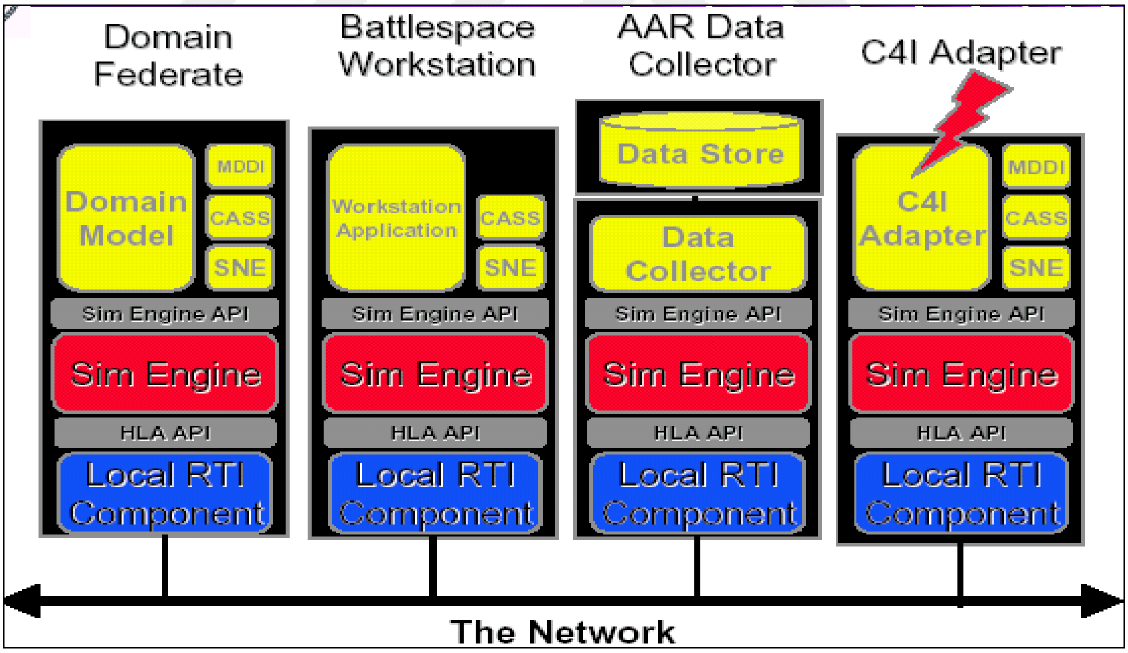

Figure 5.5- Major Federates and Their Parts

[246] RTI and HLA Tool Developers and Users Forum, 25 July 2001, "Joint Simulation System", Slide 7of 9
[247] Knight, L., 2000, "Joint Simulation System (JSIMS) Program Upgrade", DMSO Industry Days 24 May 00 Briefing, Slide 9 of 13

Figure 5.6 depicts the Security Federation Connector. Security Federation provides Low to High transfer.

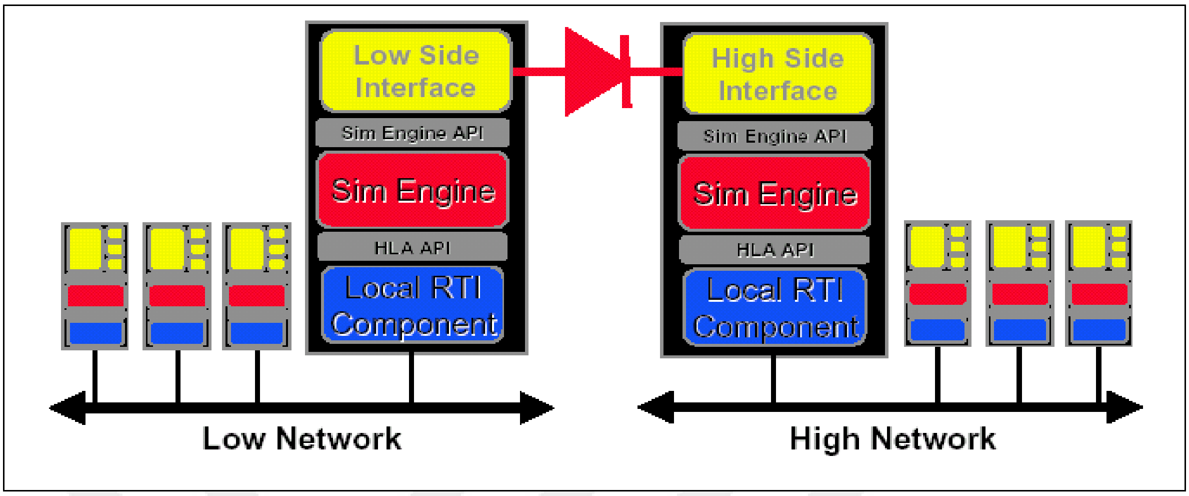

Figure 5.6- Security Federation Connector

Source: Knight, L., 2000, "Joint Simulation System (JSIMS) Program Upgrade", DMSO Industry Days 24 May 00 Briefing

The overall architecture is depicted in Figure 5.7[248] and Figure 5.8:[249]

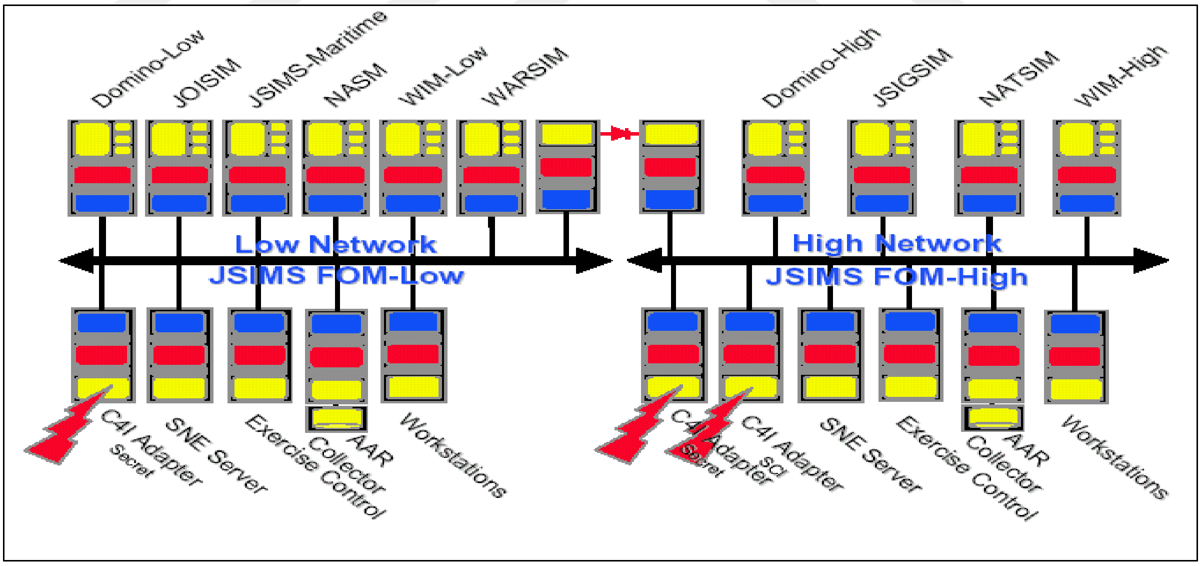

Figure 5.7- Overall JSIMS Architecture

---

[248] RTI and HLA Tool Developers and Users Forum, 25 July 2001, "Joint Simulation System", Slide 8of 9
[249] Knight, L., 2000, "Joint Simulation System (JSIMS) Program Upgrade", DMSO Industry Days 24 May 00 Briefing, Slide 12 of 13

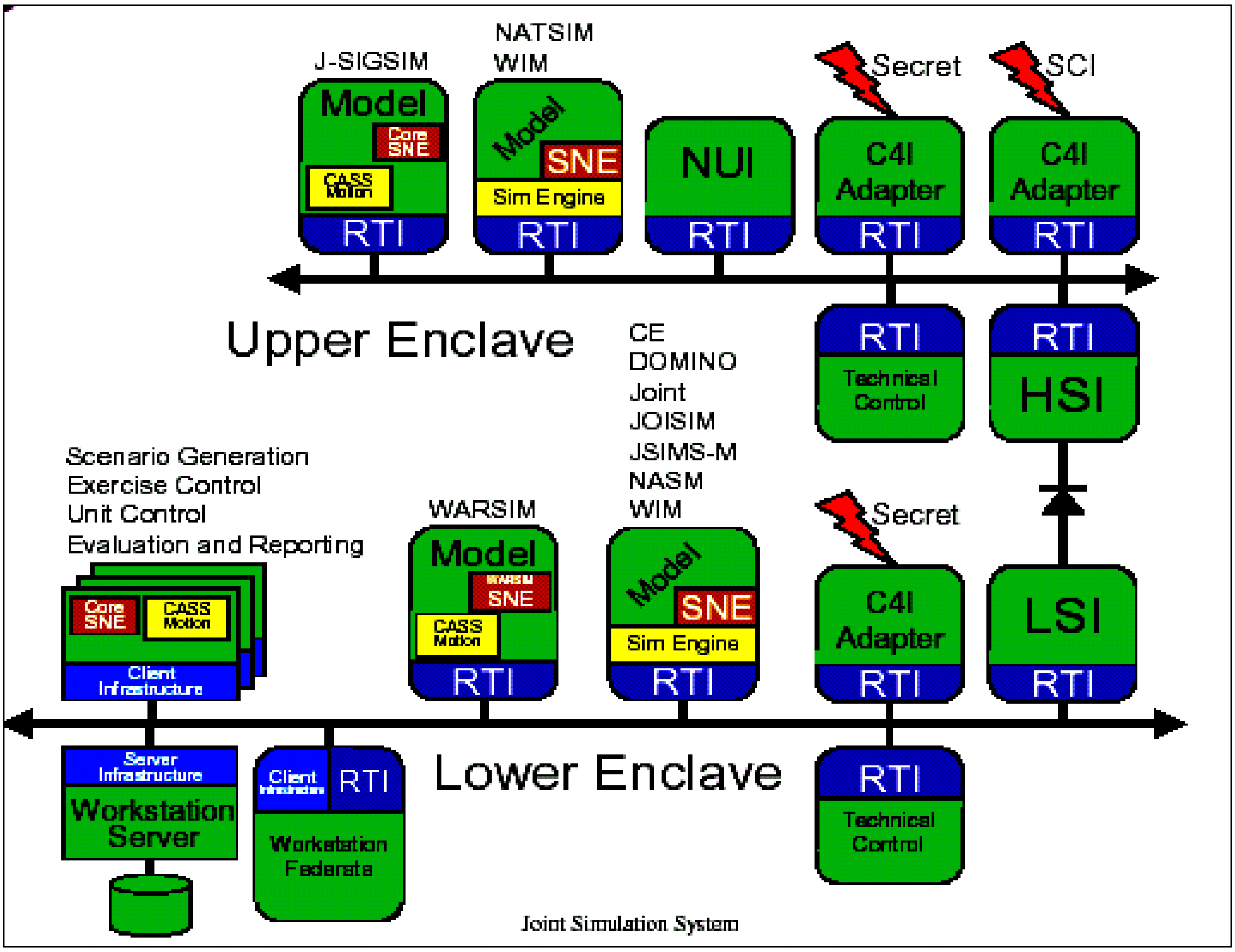

Figure 5.8- Overall JSIMS Architecture II

JSIMS is a large-scale, distributed, constructive wargaming simulation consisting of Service, Agency, and Joint models; a Synthetic Natural Environment; interfaces with command, control, communications, computers, and intelligence (C4I) equipment; and other applications and tools employing the DoD High Level Architecture (HLA) for Modeling and Simulation. The scale, complexity, and importance of such a training system make a comprehensive and innovative Federation Management capability a necessity. The Technical Control (TC) tool will provide JSIMS with a complete federation management capability based upon Virtual Technology Corporation's (VTC's) commercial HLA federation planning, execution, and performance monitoring tool, hlaControl™.[250]

[250] Perkinson, P.et al, 2001, "A Comprehensive Management Capability for the Joint Simulation System (JSIMS)", 2001 FALL Simulation and Interoperability Workshop, 9-14 September 2001, Orlando, FL.

Each of the JSIMS runtime components will interface either directly or indirectly to the RTI. There are several ways a JSIMS component can interface the RTI, which can be summarized in three categories[251]:

- establish a direct connection to the RTI (RTI-direct),
- using the Common Component Simulation Engine (CCSE) software infrastructure, or
- using a C4I Adapter or other piece of intermediate software.

An important objective of the Joint Simulation System (JSIMS) program is to provide a physically consistent synthetic natural environment (SNE) (atmosphere-ocean-space-terrain) that will yield new levels of realism and consistency across heterogeneous simulations.[252] The Civil Environment module of JSIMS is the set of behaviors associated with non-battlespace objects, both physical and conceptual, which support a country's ability to wage war. The CE interacts closely with both the JSIMS Synthetic Natural Environment (SNE) and battlespace elements.[253] The synthetic and natural environment structures (e.g. bridges, highways, power lines, dams) that belong to the SNE are modeled by the SNE model. The SNE model is therefore responsible for creating the damage model for structures belonging to the SNE (i.e. for providing damage assessment data to the CE as damage occurs to SNE objects and for responding to reduced product output data from the CE as the reduction occurs).

In a similar fashion, battlespace elements (e.g. trucks, tanks, ships, aircraft, C^2 nodes) are modeled by the Service developers. The Service developers are therefore responsible for creating the damage model for objects belonging to their respective domain (i.e. for providing damage assessment data to the CE as damage occurs to battlespace objects and for responding to reduced product output data from the CE as the reduction occurs). Although the CE developers will not build the damage models for SNE and battlespace elements, the CE model will use the resulting damage assessment information received

---

[251] Ibid

[252] Fournier, Ronald F., 1999, "An Architecture for Tailoring Synthetic Natural Environment within the JSIMS Framework.", 1999 FALL Simulation and Interoperability Workshop, 12-17 September 1999, Orlando, FL.

[253] Johnston, Scott J., 2001, "Modelling and Strategic Cascading Effects in the Joint Simulation System (JSIMS)", 2001 SPRING Simulation and Interoperability Workshop, 25-30 March 2001, Orlando, FL.

from the SNE and battlespace element damage models as inputs into the CE model to determine the strategic and cascading effects of the primary damage. The CE is a component of an overall JSIMS training environment that uses primary damage model results from the respective domains to determine strategic and cascading effects on the overall battlespace.[254]

Another important objective is creating a database. The JSIMS Modeling and Simulation Resource Repository (JMSRR) is a virtual, distributed, hierarchical object oriented database that allows users to describe the complex relationships that their real world models contain.[255] The JMSRR is distributed across a wide variety of platforms and works to present a seamless, integrated whole to the user by capitalizing on web related technologies. One of the crucial components of the JMSRR is the metadata that the JMSRR manages. It is through the metadata that the JMSRR is able to enforce relationships and retrieve the appropriate content. The metadata is translated into objects that are stored in a commercial object-oriented database. The metadata is put into the JMSRR by the means of HALO (Highly Abstract Language for Objects), a descriptive framework for allowing general objects to be composed. HALO tackles the issue of real world objects as opposed to the purely traditional programmatic objects that are the basis for much of the current programming effort. The objects that are stored have properties that need to be fulfilled and in turn can fulfill the requirements of another object. Also, the objects have usage restrictions on them that prevent or demand the inclusion of certain other objects. The ramifications of how to best represent these general objects and their relationships by means of HALO are explored.

JSIMS databases was developed using IDEF0 modeling[256]. IDEF0 modeling is used to produce a function model of a system or subject area. A function model is described by the IDEF0 standard as “a structured representation of the functions, activities or processes within the modeled system or subject area”. IDEF0 is based on the Structured Analysis and

[254]Ibid
[255] Jimenez, Victor J., 1998, “The Joint Simulation System (JSIMS) Modelling and Simulation Resource Repository: An Application of Highly Abstract Language for Objects”, 1998 SPRING Simulation and Interoperability Workshop, 9-13 March 1998, Orlando, FL.
[256] Kruck, M. et al, 1999, “The Joint Simulation System (JSIMS) Terrain Data Fusion Process Model”, 1999 FALL Simulation and Interoperability Workshop, 12-17 September 1999, Orlando, FL.

Design Technique™ (SADT™) developed by Douglas T. Ross and SofTech, Inc. and is required methodology for defining processes per the Joint Technical Architecture (JTA)

The value of a warfare simulation is directly related to the credibility of its representation of real-world military operations, equipment and systems, and environmental factors. Simulation designers must have a clear understanding of the domain to be simulated in order to produce a model or simulation that is valid and sufficient for the intended purpose or use. The domain description must be multi-dimensional and must include a depiction of the entities, actions, tasks, and interactions that must be represented. The primary purpose of a conceptual model of the mission space (CMMS) is to provide that understanding.[257]

For the development of JSIMS, the mission space has been divided into areas of responsibility called "domains." JCMMS development domains are constituted by Service responsibilities, not geospatial boundaries. Associated with each domain is a JSIMS Executive Agent (EA) who is responsible for providing conceptual models of that domain. For example, the US Army is the JSIMS EA for the Land domain. In practice, the JSIMS EAs typically delegate the conceptual modeling task to a JSIMS Development Agent (DA). The JCMMS products:

- Establish a base of mission space knowledge for developing JSIMS,
- Support JSIMS Enterprise object-oriented analysis and design, and
- Provide a basis for Verification, Validation and Accreditation of JSIMS

JSIMS design must provide the mechanism to interface with appropriate Joint and Service C4I systems as identified in the JCMMS and system requirements[258]. Adherence to the DoD High Level Architecture (HLA) is required to ensure interoperability with legacy and future simulations that encompass the full spectrum of the joint and service mission space operations as well as automated connectivity to C4I systems. The HLA will provide a standardized foundation for consistent and reliable data exchange between live, virtual, and

---

[257] Risner, S. et al, 1998, “Conceptual Modelling in Joint Simulation System”, 1998 FALL Simulation and Interoperability Workshop, 14-18 September 1998, Orlando, FL.

[258] McKenzie, F. and Risner, S., 2001, “Joint Simulation System (JSIMS) Approach to C4I System Interoperability”, 2001 European Simulation and Interoperability Workshop, 25-27 June 2001, Harrow, Middlesex, UK.

constructive simulations that is necessary to foster maximum reuse of simulation components. JSIMS must use standardized data elements to facilitate interchange of data between JSIMS, external simulations and real C4I systems. Data standardization will be consistent with DoD guidelines and data sets must be from certified DoD data sources. Tools and utilities must be provided to comply with standard formatted files (e.g., Time Phased Force and Deployment List (TPFDL) and Air Tasking Order (ATO)) in order to create efficient information exchange between simulation databases. C4I to simulation interface standards such as the proposed Interface Reference Model (IRM) also provide valuable guidance. Last but not least, safeguards must be present in the system to avoid confusion with real-world events and permit orderly transition from exercise to real-world operations.

Security for any complex system depends sensitively on the architecture and design of the system. JSIMS is a simulation engine, but also is a "stimulator" for real world C4I devices used by a training audience. As such, it contacts potentially sensitive information maintained by those C4I systems—sensitive information which must be protected in the interests of national security.[259] One technology that may simplify the difficulty of dealing with releasability constraints is FORTEZZA. FORTEZZA is a hardware-based encryption and key distribution system, encoded into industry-standard PCMCIA cards, which can be accessed by almost any computer system. While FORTEZZA is designed for use with sensitive but unclassified information, a sister product, KRYPTON, can be used to transport classified information. This technology can be used to protect, through encryption with distinct keys, information with various caveats, which is physically transported over the same network link.

5.7- GENERAL JOINT SIMULATION SYSTEM (JSIMS) CAPABILITIES

JSIMS will be a comprehensive tool to satisfy many uses. JSIMS includes a core infrastructure and mission space objects maintained in a common repository. The objects can be composed to create a simulation capability to support joint or Service training, mission rehearsal, or education objectives. JSIMS have the following capabilities:

[259] Valle, T., 1998,"Security Features of The Joint Simulation System (JSIMS) Design", 1998 SPRING Simulation and Interoperability Workshop, 9-13 March 1998, Orlando, FL.

- Incorporation of simulations across the full range of military operations including: land, sea, air, space, and special operations; associated functions such as logistics, transportation, intelligence, medical, engineering, communications, and electronic warfare; and geospatial, meteorological, oceanographic, and environmental factors.

- Incorporation of simulation of social, economic, and political factors, which affect, or are affected by, missions across the entire range of military operations.

- Tailored displays of simulation results on C4I (command, control, communications, computers, and intelligence) systems or their emulation for training and exercises, or on computer workstations for analysis.

- Distributed and remote computer processing for users characterized by interoperable elements located at many dispersed sites.

- Flexibility to accommodate different functional applications and levels of detail within those applications (e.g., tactical, operational, and strategic levels of warfare for training and exercise).

- Linkage of live, constructive, and virtual forces to form an environment that stimulates a user's C4I systems.

- Accelerated development of data/knowledge bases and the creation of semi-autonomous forces to reduce exercise overhead and allow for crisis rehearsals.

5.8 - OPERATIONAL USE OF JSIMS: UNIVERSAL JOINT TASK LIST (UJTL)

The Universal Joint Task List (UJTL) is one tool used to communicate joint mission tasks.[260] Since JSIMS will be used to train and rehearse joint mission tasks, the structure of the UJTL drives the operational use of JSIMS. The UJTL describes three levels of war: strategic, operational and tactical. To each of the levels, the UJTL assigns a number of tasks. In addition, the UJTL differentiates between strategic tasks performed at the national level and those performed at the theater level. Therefore, in the UJTL, military activities are modeled in a four-tiered hierarchical taxonomy. Figure 5.9 depicts the levels

[260] See also Chapter 2

as a pyramid, with the tactical level as the base followed in turn by the operational, strategic-theater, and strategic-national levels. Although there is no direct link between echelon of command and levels of war, certain echelons tend to emphasize and operate within particular levels and therefore focus on corresponding levels of UJTL tasks.

The UJTL contains a comprehensive listing of tasks that can be performed by a joint military force. Services Tactical Task Lists (TTLs) are being developed and integrated into the UJTL structure. The UJTL also contains a common language of conditions to provide context for tasks. In addition the UJTL contains a menu of measures that can be used to develop standards of performance for accomplishing a joint mission. The application of specific conditions and standards to a given task is the responsibility of the joint force commander.

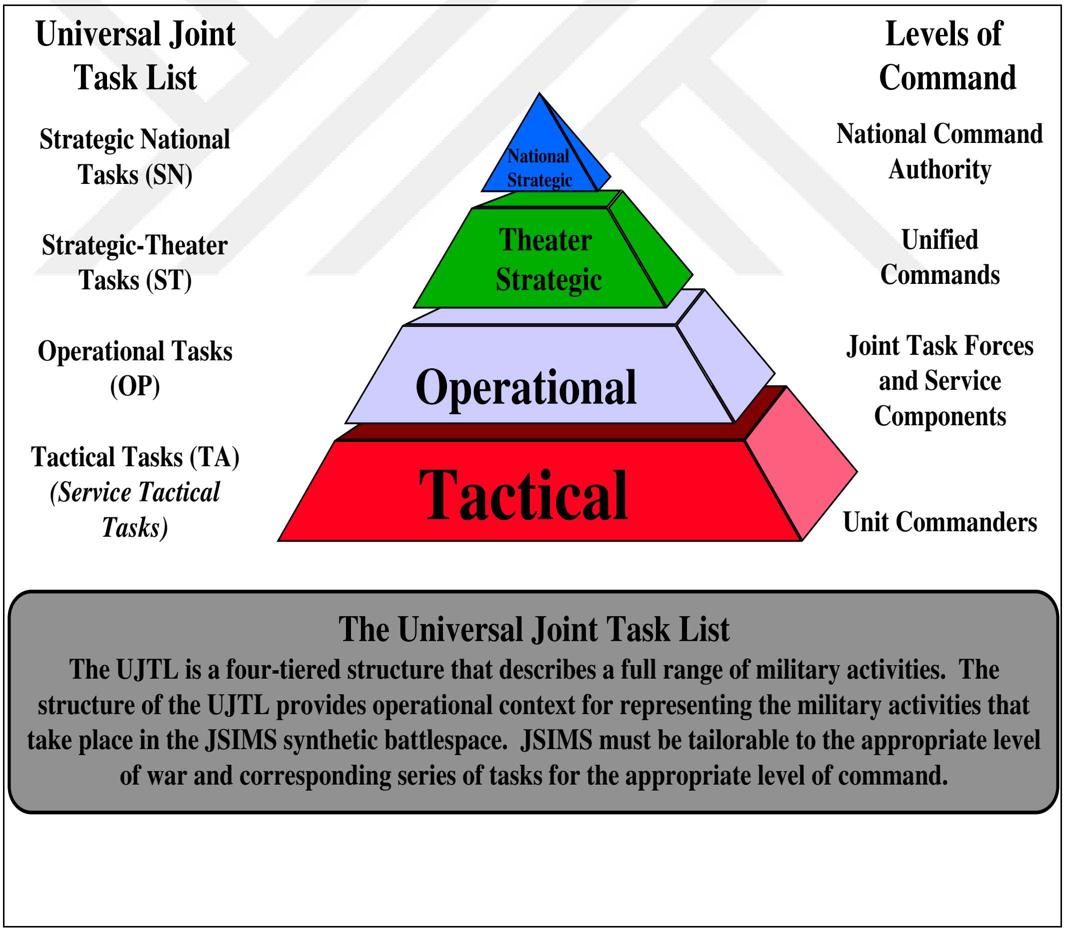

Figure 5.9- Universal Joint Task List

Source: Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

The four levels can also describe both military planning and execution processes, as depicted in Figure 5.10. Of central importance are the joint force commanders (JFCs). JFCs include the commanders in chief (CINCs) of the Unified Commands, joint task force (JTF) commanders, and other commanders authorized to exercise combatant command or operational control over a joint force. CINCs have broad and continuing missions derived from the Joint Strategic Capabilities Plan (JSCP) or other national-level guidance. A JTF commander, in contrast, usually has a single, focused mission of relatively short duration. Joint functional commanders have responsibilities focused on a specific area and usually report to a JTF commander or a CINC. Similarly, JTF and functional commanders often operate under a regional CINC. CINCs and JTF commanders usually direct subordinate Service component commanders.

Figure 5.10- Military planning & execution activities

Source: Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

Joint commanders, whether a CINC, JTF or functional commander, use the UJTL to analyze their respective missions. In planning or preparing for joint missions, numerous joint tasks must be successfully performed, but some are more important than others. Tasks that are essential to the success of the mission become Joint Mission Essential Tasks (JMETs). When combined, the essential tasks become the Joint Mission Essential Task List (JMETL). The JMETL, therefore, will usually be less comprehensive than the UJTL.

The significant difference, though, is not size. It is the addition of specific conditions and standards that apply to performance of the tasks. Service component commanders also use the UJTL, supplemented by Service Tactical Task Lists in a similar mission analysis process. The JMETL process is a key activity in the Joint Training System.

5.9 - JOINT SIMULATION SYSTEM (JSIMS) SUPPORT FOR JOINT TRAINING AUDIENCE EXERCISES ENVIRONMENT

The Joint Training System (JTS) is a four-phase approach to derivation and fulfillment of joint training requirements based on required mission capabilities.[261] In Phase I, the JMETL is derived from mission capability analyses. In Phase II, the JMETL is used to shape the JTP. During Phase III, the specific training events in the JTP are executed and evaluated. Phase IV of the JTS synthesizes evaluations from multiple training events with the commander's assessment of JMET proficiency. Although Joint Exercise Management Plan (JEMP) will link JSIMS to all phases of the JTS, JSIMS development focuses on JTS Phase I and III. Figure 5.11 summarizes the four phases of JTS and defines the general support of JSIMS:

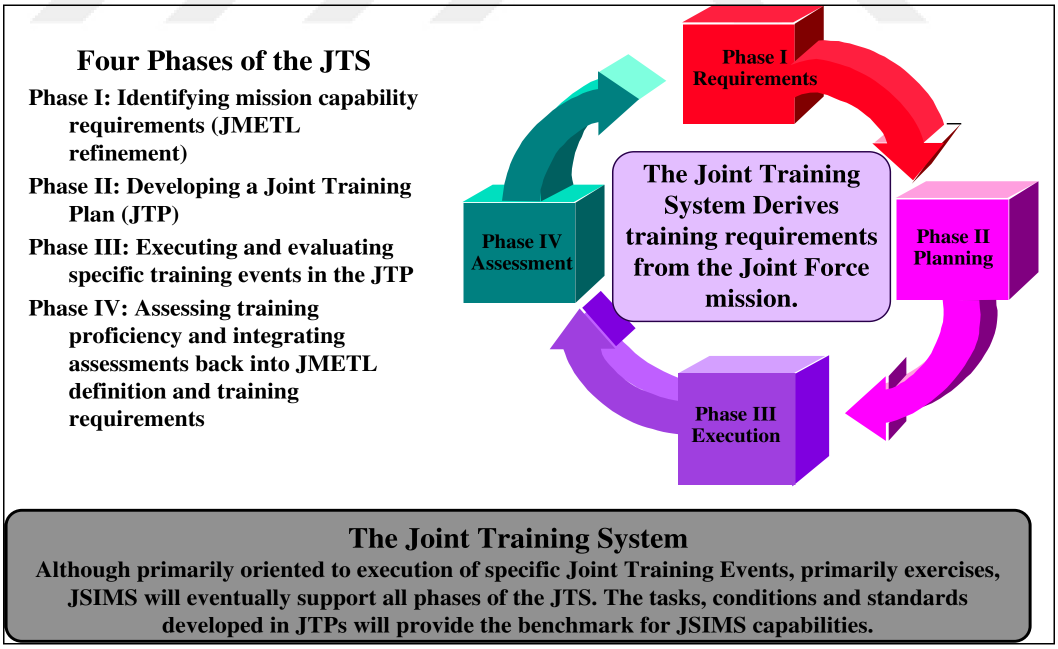

Figure 5.11- Joint Training System
Source: Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

---

[261] See Chapter 2

During the design and planning of a JSIMS-supported event, composability and tailorability attributes will be essential in providing a relevant training experience to the training audience. Using tools embedded in JSIMS and other training systems support tools, such as JEMP, the exercise planning team will tailor the JSIMS event to the specific, detailed training needs of the exercise sponsor. These detailed requirements will include: the particular learning methodology to be supported; specific training objectives; the command and control processes that must be enabled; measurement and collection of training audience performance; and the format for presenting results. Figure 5.12 depicts the training audience exercise environment:

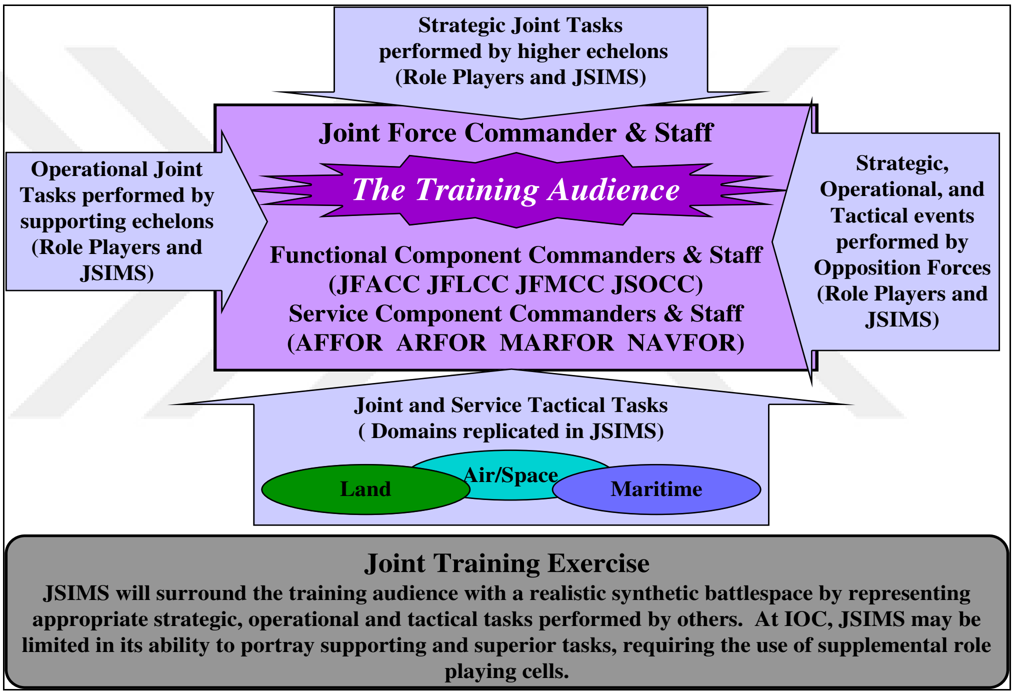

Figure 5.12- Training Audience Exercise Environment.

Source: Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

JSIMS will provide the followings as training audience support[262]:

- Jointly train, educate, develop doctrine and tactics

[262] McKenzie, F. and Risner, S., 2001, "Joint Simulation System (JSIMS) Approach to C4I System Interoperability", 2001 European Simulation and Interoperability Workshop, 25-27 June 2001, Harrow, Middlesex, UK.

- Formulate and assess operational plans
- Assess warfighting situations
- Define operational requirements
- Provide operational input to the acquisition process.

The exercise planning team will then compose the technical structure of the JSIMS event by relying on the distributed resources and characteristics of the system. For example, they will be able to create scenarios and supporting databases by accessing the information in the common Modeling and Simulation Resource Repository (M&SRR). As with some legacy systems, JSIMS will be able to support exercises in which the training audience and associated response cells operate in geographically distributed mode. However, JSIMS will also have the ability to support exercises that have links with other distributed, HLA-compliant mission training systems such as manned aircraft simulators.

As it was defined JSIMS will focus on Phase III (Execution Phase). Execution Phase includes also four phases, which are named as Joint Exercises Life Cycle. (JELC)[263] After JSIMS IOC, during JELC planning stage, the time, effort, and personnel resources required to perform a major part of the simulation-related tasks (i.e., database loading and testing) are expected to be reduced significantly. Also, the availability of JSIMS products as planning tools is envisioned to streamline some non-simulation related planning tasks as well (e.g., AAR operations concept and collection management plans development, exercise control architecture and control plans development).

During JELC preparation stage, JSIMS activities is expected to reduce the time, personnel, and other resources required in completing the database building effort and in conducting database tests #2 & #3. It is possible that capabilities resident in JSIMS may enable reduction in the number of database tests required. It is also anticipated that there will be a major reduction in the number of model/simulation workarounds required and fewer resources involved in development of those that may still be required. There will also be a significant reduction in the numbers of operators to be trained and the time required to train them. As in the planning stage, JSIMS availability will also enhance preparation

[263] See Chapter 2

stage efforts in non-simulation related activities that must be conducted in anticipation of the execution and post-execution stages of the exercise.

The capabilities resident in JSIMS at IOC are expected to reduce substantially the requirements for exercise control and support equipment and personnel during the execution stage. JSIMS is also expected to enhance the fidelity of the scenario presented to the training audience. It is anticipated that the fidelity and reliability of JSIMS at IOC will also reduce the probability of simulation failure and interruptions. This is an important factor in reducing the requirement for workarounds and employment of simulation "crash procedures," which are historically manpower intensive operations. Additionally, the data monitoring and collection capabilities in JEMP that will be associated with JSIMS introduction are expected to reduce the number of exercise observers and analysts currently required to perform AAR operations and prepare AAR support graphics and other documentation.

As in all other stages, it is anticipated that the introduction of JSIMS capabilities at IOC will facilitate the preparation of AAR and other post-exercise documentation. The end result will be increased efficiency in the feedback mechanism within the JTS and an overall improvement in the management of the JELC for follow-on exercise events.

5.10- JOINT SIMULATION SYSTEM (JSIMS) SCENARIO SUPPORT

The capabilities resident in JSIMS are expected to support training in a wide range of military contexts. To facilitate development toward this goal, three distinct training events have been chosen – (1) training of a joint force commander (JFC) and staff in a major theater war (MTW) scenario exercise event; (2) training a joint training audience in a military operation other than war (MOOTW) event; and (3) training a joint training audience in an academic seminar event (e.g., a prospective JTF headquarters staff response to an international disaster, such as an earthquake, hurricane/typhoon, etc.). In addition to the comprehensive range of training to be facilitated, the user expects JSIMS to enhance implementation of the five stages of the JELC, resulting in less time required for exercise development, less manpower to support exercise design implementation, and achievement of a greater training threshold.

JSIMS will focus on support for training at the strategic-theater and operational levels of war for unified combatant command staffs, joint task force (JTF) commander and staff, and JTF components in a training environment. It will further be used to support Service training requirements for component commands within the context of a joint force at the operational level. It will also be used to provide situational awareness and operational engagement adjudication for application in the context of joint force academic seminar training events. JSIMS at IOC will also simulate multiple sides and factions and realistically represent the activities of the forces of allies, neutrals, opposition (OPFOR) and "surrounding force" units within the context of a major theater war. JSIMS will need to present a seamless multi-dimensional battlespace representation to all members of the training audience, i.e., the visible representation of JSIMS simulated forces and their activities as seen by the training audience on real world tactical presentations should make the operation of JSIMS transparent to the training audience.

An example scenario was given in **Appendix B.**

5.11- JOINT SIMULATION SYSTEM (JSIMS) VERSIONS

Because of the cyclic nature of software development and to complement the overall plan for introduction of JSIMS to support the JTS, a phased approach will be used to facilitate that introduction. Each version presented includes justification and description of the changes, as well as assumptions or constraints that apply to the particular version. Figure 5.13 depicts the phased implementation of versions:

By FOC, JSIMS will mature to possess all the capabilities necessary to support joint training from the strategic national level down through tactical level engagements of individual units, including Service specific training requirements, operational rehearsals, doctrine and tactical development efforts, military education, and a yet to be determined level of operations analysis.

When JSIMS version 2.0 is introduced at FOC in 2003, it will be employed to provide full spectrum training through the entire warfare hierarchy for national headquarters staffs, CINCs, JTF commanders, joint force functional/Service component commanders, and Service warfare commanders and their staffs. It will also be employed for operational planning and analysis, including course of action analyses at simulation rates greater than 10:1; mission rehearsal down to tactical (crew/team) level, with interfaces to manned simulators; joint and Service professional military education, joint and Service senior officer education; and doctrine development and evaluation with behavior editing for training audiences.

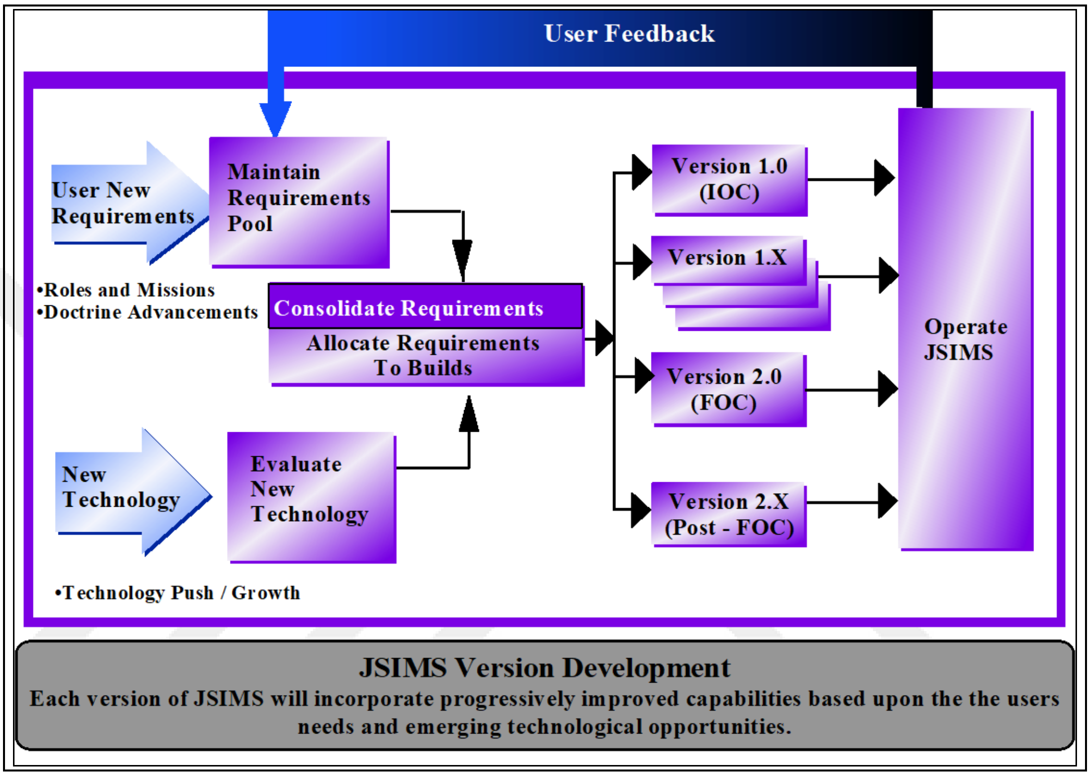

Figure 5.13- JSIMS Versions

Source: Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

It will provide these capabilities using mixed representations of ground forces in basic employment, sustainment, intelligence (including automated fusion), force application and other (non-force) military operations other than war (MOOTW); mobilization operations, deployment, redeployment, space activities, special operations; nuclear, biological, and chemical (NBC) operations; information operations; and amphibious warfare. JSIMS version 2.0 will also be employed in "jump forward" operations, i.e., execution at rates substantially greater than real time and without human-in-the-loop participation of the simulation audience. It will also be used in activities that require rapid modification of unit behaviors. Additionally, JSIMS version 2.0 will be employed to support education of all joint and Service simulation audiences.

At full operational capability (FOC), JSIMS is expected to present a complete, accredited, interactive joint synthetic battlespace (JSB), spanning strategic national level (e.g., activities involving interactions between Washington headquarters level staffs and agencies with one or multiple commanders in chief (CINCs) and staff(s) and/or theaters to tactical levels (e.g., the prosecution of individual battles or engagements). JSIMS at FOC will be used to represent all warfare domains and in training and preparation for all phases of operations (mobilization, deployment, employment, sustainment, and redeployment). The JSIMS JSB will also be used to support training and preparation for all forms of military operations other that war (MOOTW), including peacekeeping or peace enforcement operations, arms control, psychological operations, migrant-refugee operations, counter-terrorism, DOD support to counter-drug operations, nation assistance, noncombatant evacuation operations, humanitarian assistance, disaster relief and others.

5.12- JOINT SIMULATION SYSTEM (JSIMS) SUPPORT FOR BATTLESPACE DOMAINS

5.12.1- Land Domains

The Figure 5.14 reflects the introduction of minimum Army Service training functional capabilities. Minimum IOC capabilities include functional training for corps commanders and staffs, or corps commanders and division commanders and their staffs. Army intelligence staff training capabilities are expected to appear in JSIMS version 1.2, with Army logistics staff training capabilities arriving in version 1.3. Brigade/battalion commander and staff training capability will not be available in the land simulation processes at JSIMS IOC. Rather, the goal for initial fielding of this capability is version 2.0 at FOC.

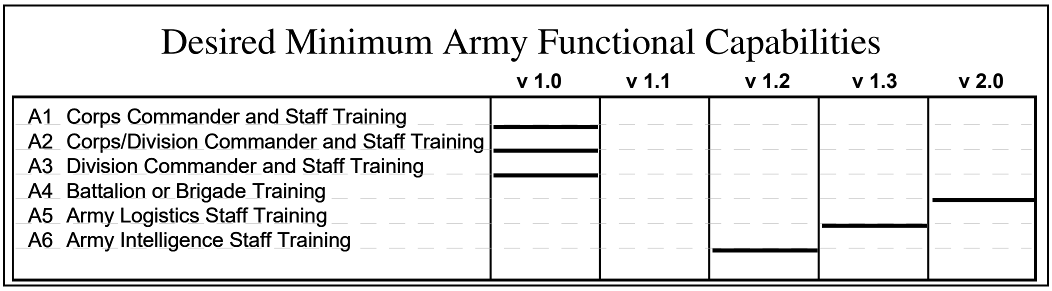

Figure 5.14 - Sequential Introduction of ARMY Use Capabilities

Source: Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

While these are the minimum capabilities JSIMS is expected to deliver, Army Service specific capabilities will be introduced as early as they can be supported by the JSIMS infrastructure. While some of the software required to support Army Service specific functional capabilities will also be used to support other Service or joint capabilities, much of it will be unique to Army requirements and can be implemented with minimal impact on other uses. Education for Army simulation audiences is not expected to be supported until FOC, when the required staff functions will be automated.

5.12.2- Air Force Domains

The Figure 5.15 below reflects the introduction of minimum Air Force component commander and staff training functional capabilities. Training functionality for Air Force component commanders and staffs needs to be resident in JSIMS version 1.0 at IOC, at the same time JFACC and JAOC training support capabilities are expected to be introduced.

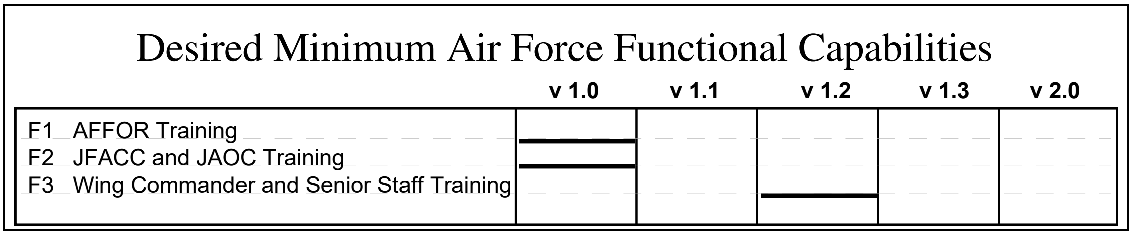

Figure 5.15- Sequential Introduction of AIR FORCE Use Capabilities

Source: Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

Linkages to Air Force designed simulators will support this effort. Low resolution capabilities introduced at IOC are expected to be enhanced in later versions of JSIMS, as technology and program funding can produce higher levels of resolution. Training functionality for wing commanders and staffs needs to be brought on line with the fielding of JSIMS version 1.2. While some of the software required to support Air Force Service functional capabilities will also be used to support other Service or joint capabilities, some is unique to the Air Force and can be implemented as the JSIMS program can deliver it in coordination with other users. Education for Air Force simulation audiences is expected to be supported as automation of staff functions can be incorporated.

5.12.3- Navy Domains

The Figure 5.16 reflects the introduction of minimum Navy Service training functional capabilities. While some of the software required to support Navy Service functional capabilities is also used to support other Service or joint capabilities, most of it is unique to Navy requirements and will be introduced in coordination with other users. Training functionality for Navy numbered fleet commanders and battle group commanders need to be resident in JSIMS version 1.0 to align with the other component commanders resident in this version. Navy task group commander and staff training is expected to be introduced with version 1.1, and the completion of Navy use capabilities needs to be present with the introduction of version 2.0, which incorporates linkages to the battle force tactical trainer (BFTT).

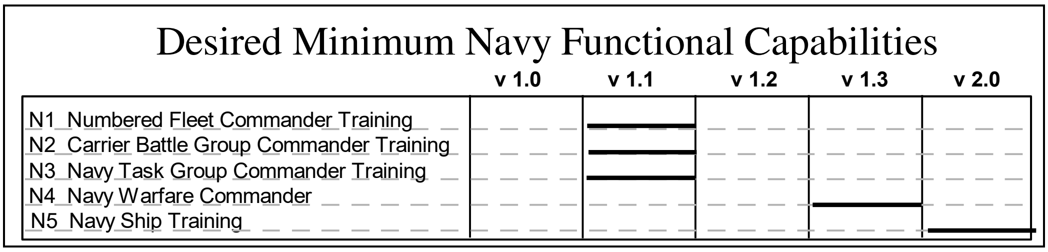

Figure 5.16 - Sequential Introduction of NAVY Use Capabilities

Source: Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

5.12.4- Marine Corps Domains

Figure 5.17 reflects the introduction of minimum Marine Corps Service training functional capabilities. Minimum marine expeditionary force (MEF) and amphibious operations training support needs to be resident in JSIMS version 1.0 to align with other potential JTF and component commander capabilities. Full capability for MEF landing training will be introduced later as mixed detail in the infrastructure and mission space objects; certain Navy context and higher headquarters units; and modeling of amphibious operations, including the transfer of command from the JFMCC to the JFACC and/or JFLCC become available. Marine expeditionary unit (special operations capable) (MEU SOC) minimum training capability needs to be resident by JSIMS version 1.1. MARFOR training and planning capabilities need to be introduced with JSIMS version 1.2. Education for Marine Corps simulation audiences is expected to be supported as automation of staff functions can be incorporated.

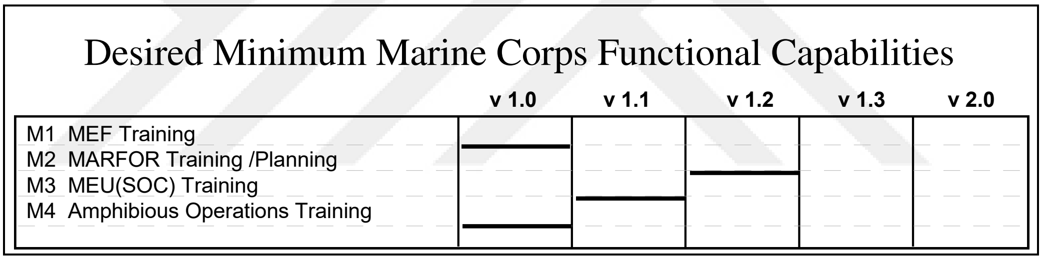

Figure 5.17 - Sequential Introduction of MARINE CORPS Use Capabilities

Source: Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

5.12.5- Joint Simulation System (JSIMS) Support for Other Domains

The Figure 5.18 reflects expected introduction of other specific training minimum functional capabilities and shows when non-training uses are expected to be supported for other simulation audiences.

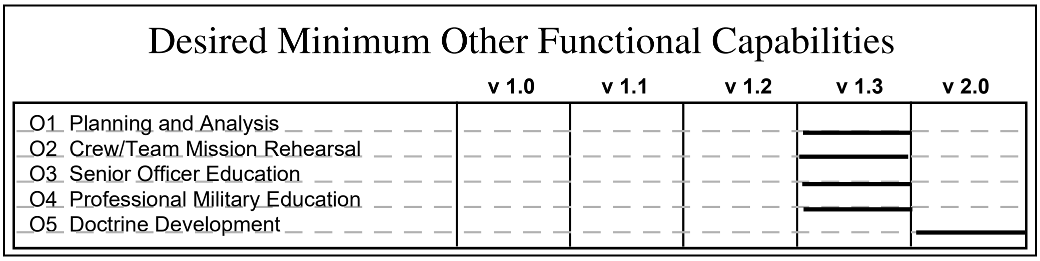

Figure 5.18 - Sequential Introduction of Other Use Capabilities

Source: Joint Warfighting Center, 1997, Joint Simulation System Concept of Operations Version 1.0, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

5.13- ANALYSIS OF JOINT SIMULATION SYSTEM (JSIMS)

5.13.1- Advantages of Joint Simulation System (JSIMS)

Major advantages of JSIMS will accrue in its presentation of a robust, comprehensive synthetic training environment without excessive requirements for personnel, time, and other resources. It will also possess significant military activity training capabilities that do not exist in current legacy models, and it will significantly enhance the implementation of the joint exercise life cycle (JELC). Some of the currently envisioned advantages that will accompany the fielding of JSIMS follow:

- JSIMS will portray the full range of military operations with a high degree of resolution and fidelity, including those functions that have not been fully integrated within the legacy simulations, such as intelligence, space activities, transportation, logistics, special operations, and MOOTW.

- The combat adjudication process in JSIMS will simulate complete operational environments that will satisfy both joint and Service training requirements.

- JSIMS will have access to certified data repositories, which will facilitate efficient, cost effective database construction. JSIMS model components will have compatible database formats to eliminate the “ripple effect” of a single model’s database change requiring additional changes in other models. This is intended to reduce coordination requirements prior to each training event. JSIMS will incorporate standardized tools to automate archiving, cross checking, manipulation, retrieval, and transfer of data elements.

- It is envisioned that JSIMS will incorporate a standard method to implement consistent, natural, or physical environmental effects.

- At FOC, JSIMS will accurately simulate the full spectrum of MOOTW scenarios, which have been the major focus of US military operations since the Gulf War and which are likely to remain so for the foreseeable future. It will also enable effective simulation of social, economic, and political factors affecting missions across the full range of military operations, none of which are currently modeled adequately to support joint training.

- JSIMS will significantly reduce the numbers of support personnel currently required for Service and joint exercises by automating the actions of higher, adjacent, and lower echelons of friendly forces that are not actually participating in the exercise, as well as personnel who are currently required to simulate opposition force actions. Substantial personnel savings are also anticipated in the level of personnel augmentation required to operate computer systems and to enter manually the plans, instructions, and orders to support the training scenario.

- By FOC, JSIMS will eliminate much of the difficulty and expense involved in making significant enhancements to existing models, as it will have all the capabilities necessary to support evolving joint and Service training requirements. The open systems environment of JSIMS is also expected to moderate or eliminate the integration difficulties associated with proprietary software, limited graphics capabilities, non-modular design, and hard-coded data representations that exist with legacy models.

- JSIMS will provide users the ability to interact freely with each other through a composable simulation environment. This will be facilitated through JSIMS' complete joint and Service functionality, interfaces with existing C4I systems, and a common supporting infrastructure that will significantly reduce the need to undertake independent simulation development projects that exacerbate the inability to interoperate and ultimately raise costs and degrade performance.

- JSIMS is intended to link all the phases of military operations, resulting in increased emphasis on mobilization, force deployment, sustainment, and redeployment issues that impact the employment stage of warfare. The synergistic effect of these factors has been largely ignored in past employment-centric exercises.

- JSIMS will interface with existing C4I systems without specialized equipment to display geographic and situation information and accommodate human engineering factors to enable the training audience to participate in JSIMS supported events on equipment with which they are already familiar. This participation will be facilitated without significant additional training on equipment and interfaces. JSIMS will be linked to virtual and live entities, adding substantial realism to the operational environment presented to the training audience.

- JSIMS will also incorporate a complete array of trainer and provider tools to facilitate efficient design, planning, preparation, execution, and post-exercise activities for training events. Among the activities envisioned to be supported with automation tools are rapid core scenario generation; MSEL development; OPFOR campaign plan development; JECG architecture and control plan development; academic seminar training plans development; AAR operations concept and collection management plan development; and AAR data collection, analysis, and graphics preparation. It will also facilitate preparation of lessons learned in the various formats that may be required for feedback into the JTS to improve CINCs' JTPs and to streamline various processes in the JELC for continuous improvement in future exercise events.

5.13.2- Disadvantages and Limitations

As with all newly developed military equipment and software systems, there are technological risks involved in the development and fielding of JSIMS. The sequential fielding of JSIMS versions will be pursued in such a way as to mitigate those risks, but they cannot be fully eliminated. The most probable result of insufficient mitigation of the risks associated with fielding of JSIMS will be possible delays in IOC and potential delays in the sequencing of capabilities peculiar to follow-on versions after IOC.

Should such delays occur, due attention must be paid to avoid potential gaps in joint and Service training support as legacy models are phased out. To assure such gaps do not occur, the legacy models must be maintained until the replacement functions of JSIMS are brought on-line, requiring continued staffing of them at the same time JSIMS must be staffed. For example, if a particular capability in JSIMS is desired by a Service at IOC and it cannot be delivered until a later version, another model with that capability may be retained to provide that capability past its programmed phase-out date. This will result in higher overall levels of maintenance and support personnel than will be required after achievement of the full spectrum functionality programmed for JSIMS at FOC. The JSIMS Transition Plan will be designed to minimize the probability of functionality gaps, and it will be updated to address these issues as they arise throughout the transition from legacy models to JSIMS.

5.13.3- Alternatives and Trade-Offs

Until recently, periodic upgrades to extend M&S capabilities have been pursued to meet joint, Service, and other use demands for simulation support. This has been an effective method of providing improvements within the constraints of that technology, but the high costs associated with developing continued marginal improvements in those legacy models have made continuation of that alternative unacceptable.

Continued upgrades were considered for JTC, JTLS, and JCATS (the replacement simulation combining the capabilities of JCM and JTS). In the final analysis, the escalating cost of continued upgrades to those stovepipe models and the emergence of promising new simulation technologies, development of JSIMS was selected as the preferred alternative for achieving added functionality and efficiency in supporting both joint and Service training events.

Chapter 6
EFFECTIVE TRAINING WITH SIMULATIONS

6.1 INTRODUCTION

Determining the best method of training is the most important criteria for effective learning. Military and other educational experience has shown that training with a personal tutor is one of the most effective ways to learn, and that the level of interactivity is a key measure of training, both in terms of cost and effectiveness. The Familirization, Acquiring the skills, Practicing the skills, Validating the skills (FAPV) model describes the level of interactivity in terms of interaction with a tutor.[264] The tutor may be a human instructor, computer software, or a combination. One of the cost-benefit analyses supported by the FAPV model is a determination of the most appropriate form of tutor for each of the steps for learning a task. The FAPV method considers the training methods appropriate for four steps in the learning process for each task to be learned. The four steps are:

Familiarize: Acquire knowledge about equipment, its capabilities, and its location by absorbing a presentation or taking a guided tour. This is a relatively passive process for the student.

Acquire Skill: Learn techniques and procedures by being tutored. The tutor guides the student through each step of the process, prompting the student to perform the action required for each step. If a student makes a mistake, the tutor provides immediate feedback.

Practice Skill: Internalize techniques and procedures by doing the skill with access to help from a tutor. The student performs the actions of the procedure without prompting from the tutor. At any point, the student may ask the tutor for help. If the student makes a mistake, the tutor provides feedback shortly after the incorrect action. The delay before feedback varies from application to application. For example, dangerous or expensive mistakes usually produce immediate feedback, while incorrect but harmless actions may not provide an immediate response.

[264] Frank, Geoffrey A., Helms II, Robert F., and Voor, David J.,2000, "Determining the Right Mix of Live, Virtual and Constructive Training", Interservice/ Industry Training and Simulation Conference November 27-30, 2000, Orlando, FL

Validate Skill: Test the ability to perform the skill without help from a tutor. The student is on his/her own until either the task is successfully completed, or it is determined that the student cannot complete the task successfully. For example, if the student performs a dangerous or expensive mistake, then the test may be aborted immediately. When the performance test has ended, either with success or failure, the tutor provides an After-Action Review (AAR), interacting with the student to determine what went right, what went wrong, and how to improve the performance. If the task was not performed to standard, the AAR includes a prescription for remedial training.

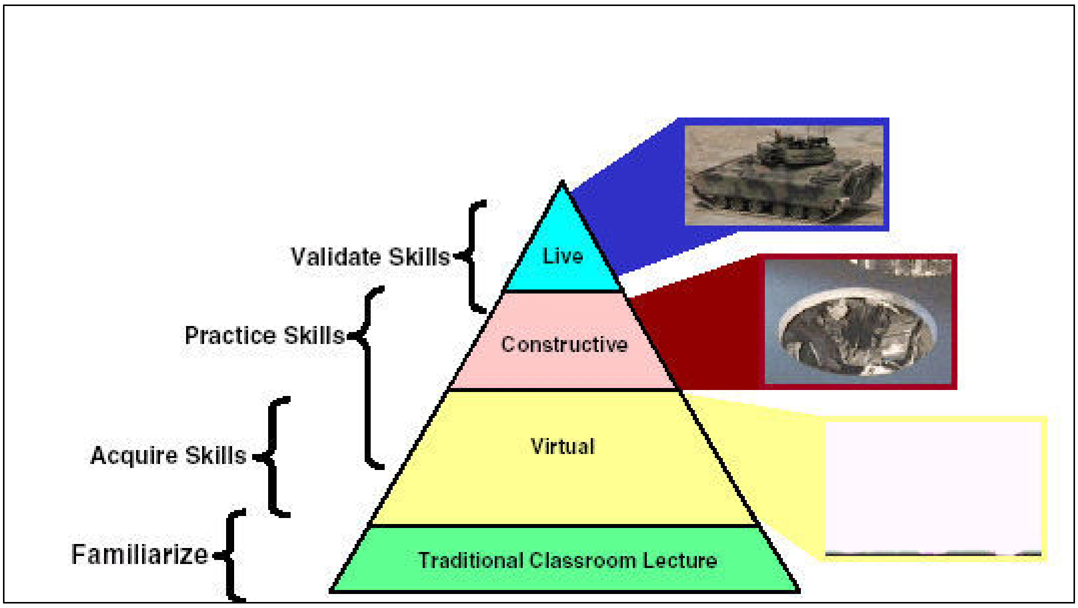

Figure 6.1- The Training Triangle Maps FAPV Steps to Training Methods

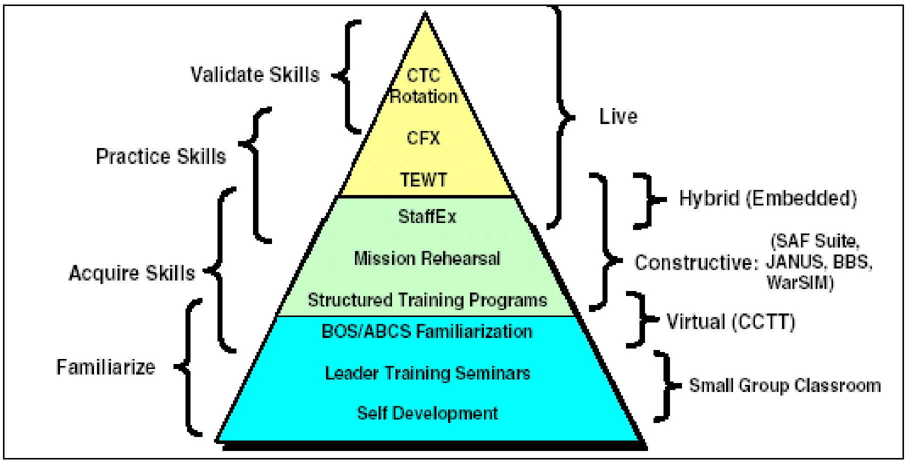

Figure 6.2- Training Method Training Environment Using the Familiarize, Acquire, Practice, Validate model to analyze tactical training.

Source: Frank, Geoffrey A., Helms II, Robert F., and Voor, David J.,2000, "Determining the Right Mix of Live, Virtual and Constructive Training", Interservice/ Industry Training and Simulation Conference November 27-30, 2000, Orlando, FL

The training triangles above (Figure 6.1, 6.2) shows the progression through the four FAPV steps in the vertical direction, and indicates the desired amount of training time as the horizontal direction. At the base of the triangle are low-cost training methods, which include lectures, computer-based training, and levels I, II, and III Interactive Multimedia Instruction (IMI). As you move up the triangle, you apply more expensive training technologies judiciously to train soldiers who have passed through training gates associated with the lower cost technologies. Moving up the triangle represents the student progressing through the four FAPV steps from familiarization to the final validation of the student's skills.

It is clear that only using simulations is not a way to prepare the soldiers to battlefield environment. The above model can be used to determine the skills, proficiencies of soldiers and can help to choose the best method for effective learning by applying on the sample groups for the training tasks. On the other hand, on the battlefields of the approaching century where intelligent new weapons systems will project lethal force with ever-increasing precision and efficiency, the technologies of virtual simulation will be the decisive factor that tips the balance between victory and defeat. Even in an era of dramatically reduced defense spending worldwide, simulation now enables military planners to prepare and train their forces for the complex engagements of the future. Advanced simulators are used to forecast, analyze and plan potential conflicts with degrees of precision that were impossible with previous-generation technologies.

The simulation is also an important training tool for Turkish Armed Forces. Turkish Armed Forces intends to use virtual, constructive and live simulations for training exercises. Up to now, the simulation systems were exported to provide the simulation training. The weapon and vehicle simulators were used as virtual simulation training tools in past. The M60, M48A5T2, and LEOPARD Tank simulators in Armour School and Training Division, Forward Line Observer simulator in Artillery School, Flying simulators in Land Forces Air Units Training School are some examples of virtual simulations used in Turkish Armed Forces.

There also some live simulations, which are used in Turkish Armed Forces to apply training exercises. The studies for developing those systems are still going on in Turkish Armed Forces. The Conflict simulators are the most common live simulations used as a training tool. The MILES Conflict simulator, which is used in Land Forces War School, and the Tank Conflict simulator in Armour School and Training Division are some examples of live simulations.

JANUS is the first constructive simulation in Turkish Armed Forces. JANUS is a battle simulation for battle focus training. JANUS is targeted to Company/Team level. Existing JANUS capabilities are as follows:

- Interactive, six-sided, closed, stochastic, ground combat simulation: Interplay between the opposing players who decide what to do in crucial situations; disposition of opposing force is unknown to the players in control of the work station; way the system determines detection's and the outcome of direct fire engagements, and indirect fire impacts according to the laws of probability and chance; principal focus is on ground forces, but does play (limited close air support

- Entity Based: Unit on unit engagements

- Weather and its effects, day and night visibility, re-supply

Joint Theatre Level Simulation is the last constructive simulation used in Turkish Armed Forces. The Joint Theater Level Simulation (JTLS) is an interactive, multi-sided, joint (air, land, naval, and special operations) and combined (coalition warfare) constructive simulation model. This computer-based war game system uses inherent functions—sea, air, land, special operations, intelligence, and logistics—to model conflict (pre-combat, combat operations, and post-combat) at the operational level of war with tactical fidelity.

When JTLS is used to support analysis of operation plans, it affords several advantages over tools that rely on attrition of units based on combat power within specified movement corridors. The JTLS model provides better fidelity, allows introduction of the effects of maneuver warfare, allows dynamic application of air and naval power, and provides functions to model special operations. However, these capabilities place increased demands on the host computer systems, hence JTLS will not execute multiple runs of a scenario as rapidly as many other models. In addition, the increase fidelity generally requires an increased level of effort to build the initial database.

JTLS can also be used in several ways to provide training support for command post exercises, commonly called Computer-Aided Exercises (CAX). In the CAX support role, JTLS provides several advantages over other fielded models. It models coalition warfare in a Joint and Unified environment. Unlike a federation of models, JTLS has an integrated, coherent database and interactions between warfare functions are consistent and well documented.. In addition, JTLS can operate at faster than real time game speeds to enable modeling of several days of conflict during each day of the CAX.

Turkish Armed Forces intends to prepare a two-phase plan to use developed constructive simulations. In first phase, SPECTRUM (a simulation that models the operations other than war) and Brigade Battalion Simulation (BBS) are planned to be used. In second phase, Turkish Armed Forces plans to use the Joint Training Confederation simulations (CBS, RESA, AWSIM, MTWS, CSSTSS, TACSIM, JECEWSI), which were shortly summarized at the end of Chapter 4. The last goal of Turkish Armed Forces is to use Joint Simulation System (JSIMS) to integrate all of the simulations and to apply the training exercises with a fully integrated system.

6.2 AIM OF THE RESEARCH

The development and use of large-scale training simulations such as JSIMS have only come into widespread use in the last decade or after new simulation and networking technologies have permitted their implementation. They are more complex and costly than the training devices, simulators, and simulations of previous generations by at least an order of importance. In most large-scale training simulations, also in the specific case of JSIMS, development priorities tend to be weighted toward engineering rather than effective learning. So that gaps occur while trying to construct well designed simulations by engineering efforts, because of ignoring effective training environment in simulations. This research aims to depict the expectations of trainers in Turkish Armed Forces about how to apply simulations for an effective learning and make some recommendations for helping to make the simulations an effective training environment

6.2.1 Definition of target population

The target population was randomly selected from Turkish Armed Forces. Turkish Armed Forces intends to use simulations for both strategic and operational levels also tactical levels. So that the target population was chosen from three forces' trainers (Land, Air, Navy Forces) and combatant, combatant support and combatant service support branches to depict the expectations throughout the Turkish Armed Forces. The below figures summarizes the sample description:

6.2.2 Sample description

The sample description was given in the below Figures:

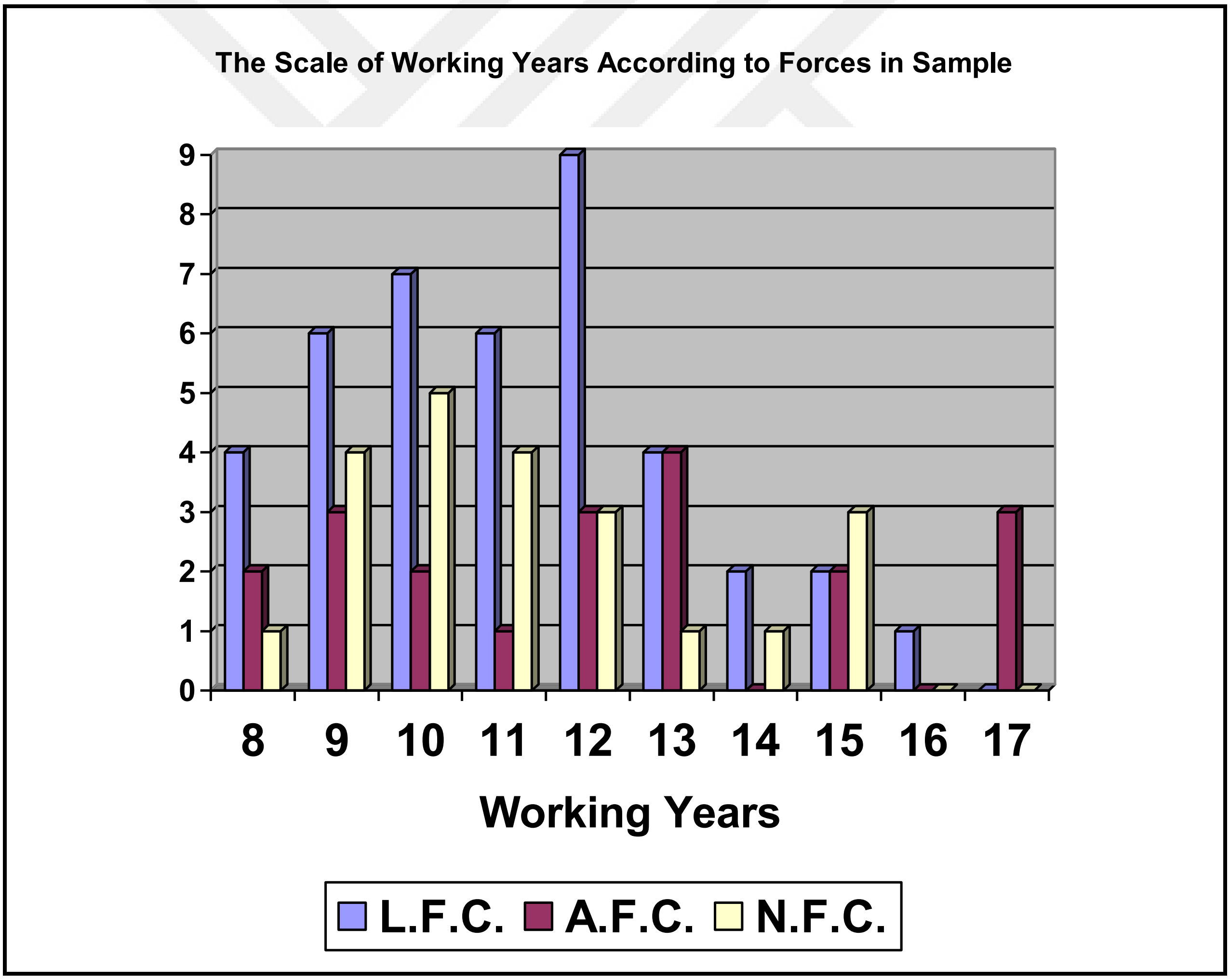

Figure 6.3-The Scale of Working Years According to the Forces in Sample.

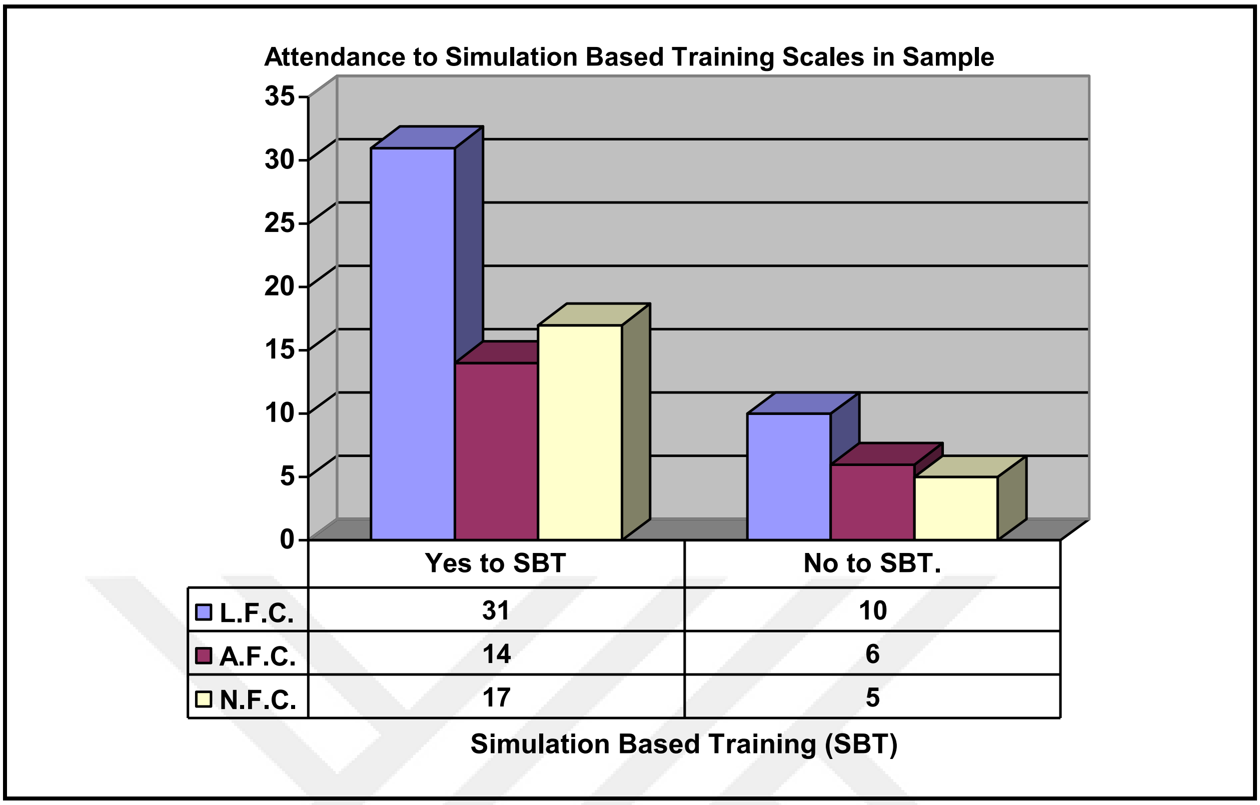

Figure 6.4- Attendance to Simulation Based Training Scales in Sample

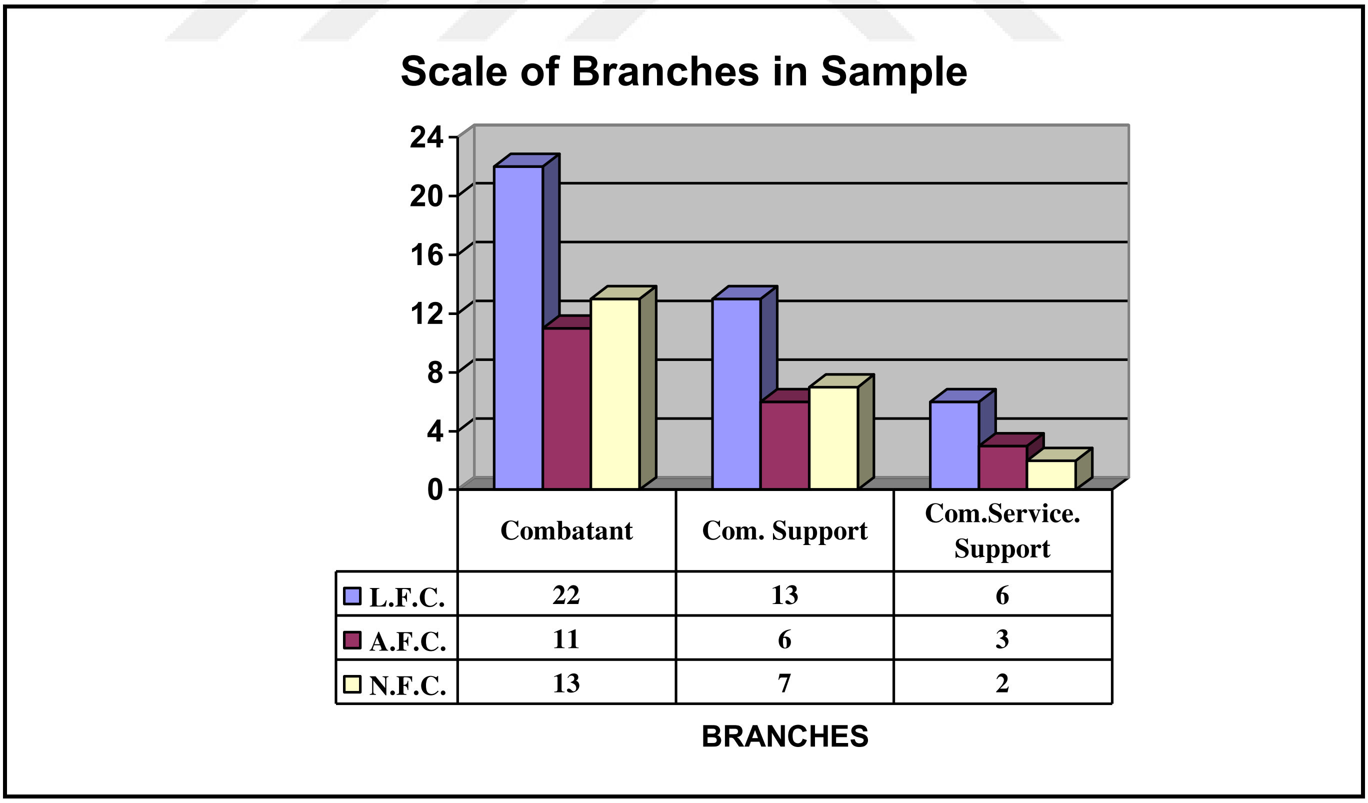

Figure 6.5- Scale of Branches in Sample

6.3 REVIEW of RELATED LITERATURE

The variables of the initial research model were extracted from the methodology of Learning Methodology Working Group (LMWG). This methodology was given in Appendix C. There are twenty five questions and one core concept question to define the expectations of Turkish Armed Forces trainers about how to apply simulations for an effective learning.

6.3.1 Core Concepts and Their Definitions Related to the Research

Core concept is making an effective training environment with simulations. Question 17 was asked to define this objective. Question 17 implies that simulations must provide a high reality of battlefield conditions so that must provide an effective training as if in the real battlefield conditions. Q22 was prepared as a reverse question for the dependent variable.

6.3.2 Factors or External Variables Affecting the Core Concept and Their Definitions In The Research

There are ten variables in the model:

1. **Interaction**: This variable shortly explains providing meaningful interaction between trainees and the learning environment.

2. **Repetition**: This variable can be summarized as providing repetition of training events.

3. **Varying**: The aim in this variable is varying exercise conditions on successive training events

4. **Matching**: The effective learning may not be successful by varying the exercise conditions so that the exercise must be structured with opportunities for trainees by including future concepts to provide realistic conditions.

5. **Collecting data**: The methods of collecting data should not influence the behaviors of the trainees and should not cause deviation from expected performance.

6. **Performance metrics on trainee outcomes and process**: The validated performance metrics provide information for both the performance of underlying tasks and overall performance and helps trainees to evaluate themselves.

7. **Adjusting exercises**: From this variable it can be simply understood that the exercise conditions must suit the trainee skill

8. **Meaningful exercise condition**: The realism in trainee interactions depending on the accuracy of the simulation model and realism in the scenario matching the trainee mission is included in this variable.

9. **Timely and relevant feedback:** Feedback tells the trainee about his overall performance and helps him to adjust appropriately for other tasks.

10. **After action review:** The trainer and operator's facilitation after the exercise to help the trainee understand his reflection and take relationship to the outcome of the situation is defined with this variable.

6.4 INITIAL RESEARCH MODEL

Initial research model is depicted in Figure 6.4:

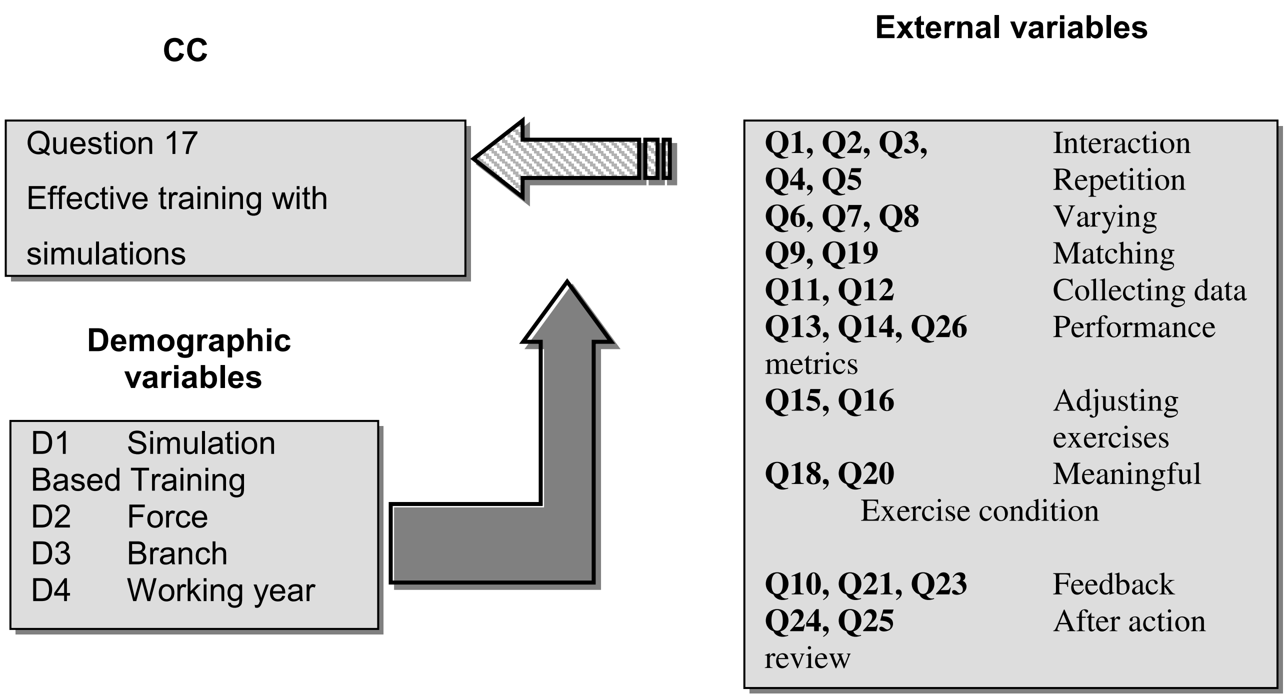

Figure 6.6- Initial Research Model

6.5 METHODOLOGY and RESEARCH FINDINGS

The data obtained through the questioanaire was analyzed using SPSS (Statistic for Social Sciences) for windows. SPSS is a package program designed to be used in statistical calculations. It can generate frequencies, descriptive statistics such as the standard deviation, correlation, factor analysis, reliability analysis, the ANOVA, Chi Square analysis, multiple regression and for drawing the tables and graphs. The followings are the statistical methods used in this research for analyzing the data :

6.5.1 Factor Analysis

Factor is used to identify underlying constructs or factors that explain the correlations among a set of variables

Factor analysis is often used to summarize a large number of variables with a smaller number of derived variables, called factors. For example, factor analysis can be used to explain the correlations in a battery of tests on the basis of factors that measure overall intelligence and mathematical and verbal skills. Or it can be used to determine the dimensions on which consumers rates coffees. These might be heartiness, body, and freshness.

Factor analysis is a data reduction technique. However, unlike cluster analysis, factor analysis builds a model from data. The technique finds underlying factors, also called "latent variables" and provides models for these factors based on variables in the data. For example, suppose you have a market research survey, which asks the importance of 9 product attributes. Suppose also that you find three underlying factors. The variables that “load” highly on these factors give you some information about what these factors might be. For example, if three attributes such as technical support, customer service and availability of training courses all load highly on one factor, we might call this factor "service". This technique can be very helpful in finding important underlying characteristics which might not themselves be observed, but which might be found as manifestations of variables that are observed.

Another good application of factor analysis is for grouping together products based on a similarity of buying patterns. By using factor analysis we might locate opportunities for cross-selling and bundling. In this example, factor analysis tells us we have four distinct groups of products. The technique then produces a table similar to the one shown in this picture. The table lists all products and then shows you which factor (or group) each product belongs to. An inspection of the factors in this picture suggests that these factors make conceptual sense. With these product groupings you can now design packages of products, or attempt to cross sell products to customer in each group who may not be currently enrolled in the other products in the product group.

The descriptive methods use Principal Component Analysis. Principal component analysis has three stages:

1- The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy tests whether the partial correlations among variables are small. KMO must be greater than 0.5

2- Bartlett's test of sphericity tests whether the correlation matrix is an identity matrix, which would indicate that the factor model is inappropriate. Significance of Bartlett's test must be smaller than 0.05.

3- Construction of table for the compositions and significances of the factors extracted.

In the research 25 questions entered Factor analysis. The results were depicted in Table 6.1. The overall results were given in **Appendix D.**

Table 6.1- Factor Analysis Results

```
- - - - - - - - - - - F A C T O R   A N A L Y S I S   - - - - - - - - - -
-


Analysis number 1   Replacement of missing values with the mean
                Mean      Std Dev   Cases   Label
Q1           5,07229     1,17684      83
Q10          5,24096      ,74228      83
Q11          4,83133     1,04554      83
Q12          4,90361      ,98296      83
Q13          5,14458      ,92568      83
Q14          5,16867      ,85282      83
Q15          4,91566     1,11754      83
Q16          4,84337     1,30180      83
Q18          5,32530      ,87106      83
Q19          5,33735      ,78518      83
```

Q2	5,26506	,78218	83
Q20	5,49398	,68740	83
Q21	5,19277	,83312	83
Q22	5,37349	,79189	83
Q23	4,92771	,99735	83
Q24	5,20482	,85196	83
Q25	5,04819	,92266	83
Q26	5,19277	,78799	83
Q3	5,45783	,78556	83
Q4	5,27711	,84555	83
Q5	4,40964	1,27868	83
Q6	5,31325	,89617	83
Q7	5,36145	,78985	83
Q8	5,15663	,90368	83
Q9	5,33735	,81566	83

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = ,81069
Bartlett Test of Sphericity = 1440,0283, Significance = ,00000

As it was depicted in table, KMO has a greater value than **0.50.** It means that the correlations among the variables are high and the factors extracted from test are meaningful and homogeneous. When Bartlett Test was analyzed, Significance value of the test is lower than **0.05.** So that correlation matrix can be used appropriately to construct the table of compositions and significances of factors extracted. The below table depicts the compositions, significance and labels of factor variables:

Table 6.2- Table of Compositions and Significance of Factors Extracted

Percentage of Explained variation	38,8	8,0	7,3	5,6	4,7	4,2	**68,6** TOTAL
Factor Labels	Factor 1	Factor 2	Factor3	Factor 4	Factor 5	Factor 6	
	Timely and relevant feedback with validated performance metrics	Interactive simulation learning environment	Trainer and operator facilitation for high performance	Varying the exercise conditions for successful training	Adjusting exercise conditions according to trainee skills	Applying future battlefield concepts with enough repetitions.	

Labels of Factor Variables:

Factor 1- Timely and relevant feedback with validated performance metrics

1- Q10: The rate of feedback repetitions in simulation based training.
2- Q14: Applying validated process performance metrics for successful feedback.
3- Q1: Interaction between trainees and learning environment
4- Q13: Applying validated outcome performance metrics for successful feedback.
5- Q21: Timely relevant feedback applications.
6- Q26: Adjusting trainee with validated performance metrics and feedback for tasks.

Factor 2- Meaningful and Interactive simulation learning environment

1- Q20: Meaningful exercise conditions and realistic scenarios matching with the training objectives.
2- Q3: Performing important missions in simulation environment.
3- Q2: The interaction between trainee and learning environment
4- Q4: High performance by repetition of training events.
5- Q6: Design of scenarios according to the trainee skills.

Factor 3- Trainer and operator facilitation for high performance

1- Q11: Collecting data about the trainees
2- Q25: Trainer and operator guidance after overall simulation training
3- Q18: Applying the exercises according to the standards by the help of trainers and operators.
4- Q24: Trainer and operator facilitation for adaptation in the beginning of exercises.
5- Q12: Objective performance evaluation.

Factor 4- Varying the exercise conditions for successful training

1- Q7: Varying the scenarios according to the training missions.
2- Q8: Varying the scenarios according to the trainee skills especially for team and joint training
3- Q9: Using easy and realistic design opportunities to make an effective learning
4- Q23: Including the deficiencies of training objectives in feedback environment.

Factor 5- Adjusting exercise conditions according to trainee skills

1- Q15: The ability to change training strategy for unnecessary missions or tasks at the time.
2- Q16: Exercise conditions with varied training strategies according to the trainee skills.

Factor 6- Applying future battlefield concepts with enough repetitions

1- Q5: Determining the reactions of trainees with enough repetitions.
2- Q19: Applying future battlefield concepts for effective learning.

6.5.2 Reliability Analysis

Reliability Analysis performs item analysis on additive scales, calculating a number of commonly used measures of scale reliability such as Cronbach's alpha. Cronbach's alpha is reliability coefficient that shows how well the items in a group are positively correlated to one another. Cronbach's alpha value must be greater than 0.70**.** If the items are standardized (have a standard deviation of 1), the reliability coefficient is based on the average correlation of items within a test. If the items are not standardized, it is based on the average covariance among items. Negative values for alpha occur when the average interitem correlation is negative, which violates the reliability model.

When you have a scale, which is obtained by summing responses to individual items, you want to know how closely the items are related to each other. For example, if you are developing a scale which measures the physical capabilities of the elderly by seeing how well they perform a variety of tasks of daily living, you want to know if all of the tasks are related to the composite score. You can look at the correlations between individual items and the rest of the scale. Or you can split the test into two parts and compute the correlation between them. You can also compute reliability coefficients that measure how strongly the items on a scale are related to each other. All of these statistics are available in the Reliability Analysis procedure.

In the research the reliability of factors was analyzed. Factors 1,2,3,4 are the reliable factors according to this analysis. Factors 5 and 6's significance are lower than the acceptable level so that they entered the regression analysis not as a factor but as an independent variables which has relation with core concept. Table 6.3 depicts the results of the reliability analysis of Factor 1:

Table 6.3- Reliability Analysis of Factor 1

R E L I A B I L I T Y   A N A L Y S I S   - S C A L E   (A L P H A)

		Mean	Std Dev	Cases
1.	Q10	5,2410	,7423	83,0
2.	Q14	5,1687	,8528	83,0
3.	Q1	5,0723	1,1768	83,0
4.	Q13	5,1446	,9257	83,0
5.	Q21	5,1928	,8331	83,0
6.	Q26	5,1928	,7880	83,0

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	31,0120	17,7681	4,2152	6

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q10	25,7711	12,8616	,8181	,8336
Q14	25,8434	12,4020	,7723	,8360
Q1	25,9398	11,7646	,5721	,8834
Q13	25,8675	12,5554	,6640	,8539
Q21	25,8193	12,7840	,7201	,8451
Q26	25,8193	13,5401	,6220	,8610

Reliability Coefficients
N of Cases = 83,0 N of Items = 6
Alpha = ,8735

As it was depicted in table Cronbach's alpha value is higher than 0.70 and it can be said that there is a high consistency between the variables of the factor. As an addition, it can also be seen from the table that when Q1 was extracted from the factor the reliability will be higher but it is not a necessity of methodology. Consequently the variables of the factors are consistent and Factor 1 can be used for the modified research model. Table 6.4 depicts the reliability analysis of Factor 2:

Table 6.4- Reliability Analysis of Factor 2

R E L I A B I L I T Y   A N A L Y S I S   - S C A L E   (A L P H A)

		Mean	Std Dev	Cases
1.	Q20	5,4940	,6874	83,0
2.	Q3	5,4578	,7856	83,0
3.	Q2	5,2651	,7822	83,0
4.	Q6	5,3133	,8962	83,0
5.	Q4	5,2771	,8456	83,0
6.	Q22	5,3735	,7919	83,0

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	32,1807	13,0767	3,6162	6

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q20	26,6867	9,4373	,7498	,8031
Q3	26,7229	8,9589	,7444	,7994

Q2	26,9157	9,2977	,6640	,8151
Q6	26,8675	9,2871	,5468	,8404
Q4	26,9036	9,6491	,5164	,8443
Q22	26,8072	9,5234	,5987	,8274

Reliability Coefficients
N of Cases = 83,0 N of Items = 6
Alpha = ,8470

The Alpha coefficient has a greater value than 0.70. Factor 2 also has a high consistency and can be used as a factor of the modified research model. Table 6.5 depicts the reliability analysis results of Factor 3:

Table 6.5- Reliability Analysis of Factor 3

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

		Mean	Std Dev	Cases
1.	Q11	4,8313	1,0455	83,0
2.	Q25	5,0482	,9227	83,0
3.	Q18	5,3253	,8711	83,0
4.	Q24	5,2048	,8520	83,0
5.	Q12	4,9036	,9830	83,0

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	25,3133	12,9495	3,5985	5

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q11	20,4819	8,4234	,5656	,8107
Q25	20,2651	8,1484	,7498	,7534
Q18	19,9880	9,2316	,5591	,8081
Q24	20,1084	8,7808	,6819	,7761
Q12	20,4096	8,6594	,5746	,8053

Reliability Coefficients
N of Cases = 83,0 N of Items = 5
Alpha = ,8257

Factor 3 provides reliability with the high value of Alpha coefficient and it can be used in modified research model as a factor.

Table 6.6- Factor 4 Reliability Analysis

```
R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)
                            Mean        Std Dev       Cases
  1.     Q8               5,1566          ,9037        83,0
  2.     Q7               5,3614          ,7898        83,0
  3.     Q9               5,3373          ,8157        83,0
  4.     Q23              4,9277          ,9974        83,0
                                                    N of

Statistics for       Mean   Variance    Std Dev  Variables
      SCALE       20,7831     7,0743     2,6598          4
Item-total Statistics
               Scale          Scale      Corrected
               Mean         Variance       Item-           Alpha
              if Item        if Item       Total          if Item
              Deleted        Deleted    Correlation       Deleted
Q8            15,6265         3,8222        ,6893           ,6037
Q7            15,4217         4,4420        ,6033           ,6637
Q9            15,4458         4,3720        ,5972           ,6645
Q23           15,8554         4,6130        ,3423           ,8153

Reliability Coefficients
N of Cases =     83,0                     N of Items =  4
Alpha =    ,7490
```

According to Table 6.6 above Factor 4 also has enough consistency to be used in the modified research model.

Table 6.7- Factor 5 Reliability analysis

```
R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)
                            Mean        Std Dev       Cases
  1.     Q15              4,9157         1,1175        83,0
  2.     Q16              4,8434         1,3018        83,0
                                                    N of
Statistics for       Mean   Variance    Std Dev  Variables
      SCALE        9,7590     4,1607     2,0398          2
Item-total Statistics
               Scale          Scale      Corrected
               Mean         Variance       Item-           Alpha
              if Item        if Item       Total          if Item
              Deleted        Deleted    Correlation       Deleted
Q15            4,8434         1,6947        ,4183           .
Q16            4,9157         1,2489        ,4183           .

Reliability Coefficients
N of Cases =     83,0                     N of Items =  2
Alpha =    ,5851
```

Table 6.7 shows that Factor 5 has not enough consistency among its variables. So that, this factor cannot be used as a factor in both modified model and in regression analysis. The variables will be used independently to understand the relation with core concept in regression analysis. If the number of variables were more than two, there would be a chance of increasing the reliability by extracting the variable, which enables Alpha when deleted.

Table 6.8- Factor 6 Reliability Analysis

```
R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)
                            Mean        Std Dev       Cases
  1.     Q19              5,3373          ,7852        83,0
  2.     Q5               4,4096         1,2787        83,0
                                                  N of


Statistics for       Mean   Variance    Std Dev  Variables
      SCALE        9,7470     2,8498     1,6881          2
Item-total Statistics
               Scale          Scale      Corrected
               Mean         Variance       Item-             Alpha
              if Item        if Item       Total            if Item
              Deleted        Deleted    Correlation         Deleted
Q19            4,4096         1,6350        ,2980              .
Q5             5,3373          ,6165        ,2980              .

Reliability Coefficients
N of Cases =     83,0                    N of Items =  2
Alpha =    ,4199
```

Factor 6 also does not provide reliability and it cannot be used as a factor in the both modified model and regression analysis. So that, the variables of the factor must be used separately to determine the relation with dependent variable.

6.5.3 Modified Research Model

The reliability analysis of the factors indicates that the factors are capable of independently measuring the effective training with simulations. Figure 6.5 below depicts the modified model with the factors that have internal consistency. In our model the variables Q15, Q16 (which entered the reliability analysis as if variables of Factor 5) and Q5, Q19 (which entered the reliability analysis as if variables of Factor 6) do not represent a factor because they have low internal consistency. So that the variable which will represent the factor will be determined through Multiple Regression analysis in the next stage. Cronbach's alpha values of factors 1, 2,3, 4 are greater than 70 % so that these factors are capable of independently measuring the same concept. There is an acceptable high consistency for factors 1,2,3,4 and it will be important for determining the explanatory power of model during the next stage analysis.

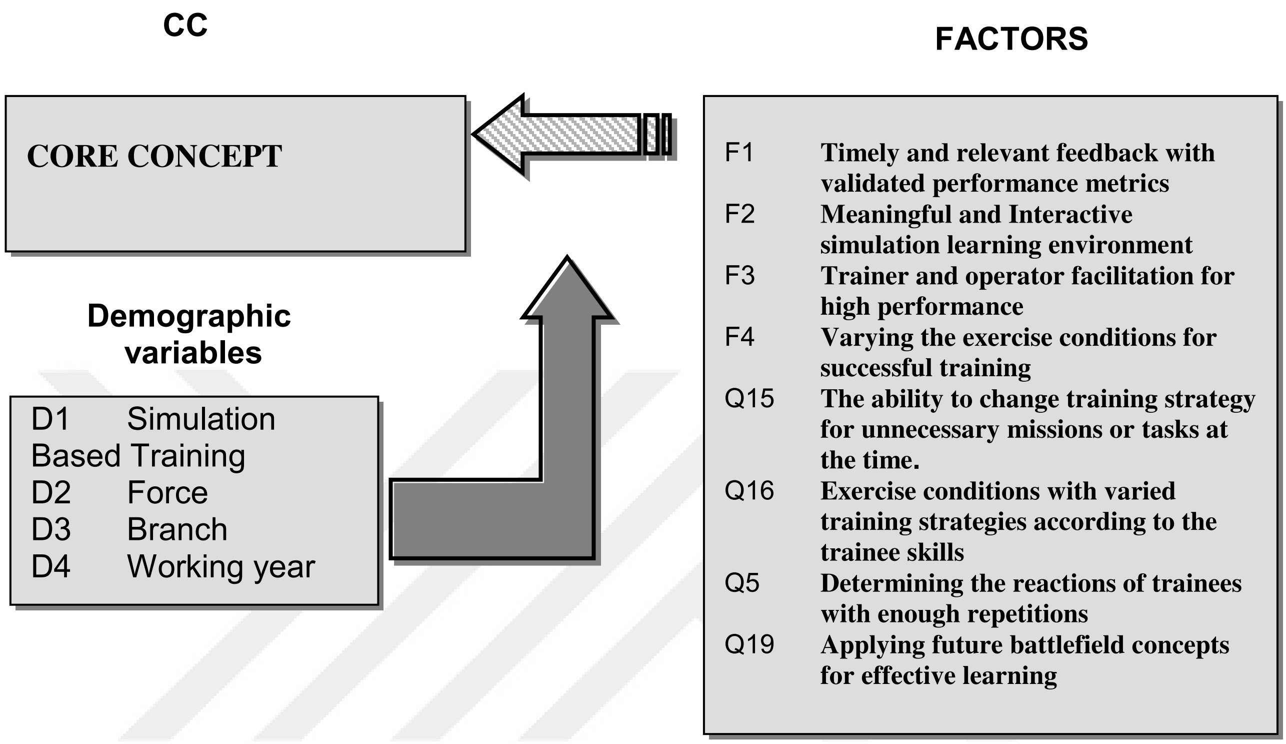

Figure 6.7- Modified Research Model

6.5.4 Multiple regression and correlation analysis:

Multiple regression analysis is used for measuring the relation between dependent variable and independent variables in a model. Regression analysis has two objectives. First is defining the characteristics of relation between the variables. Second is making a prediction from the model, which was constructed as a result of relation among the variables. There are 5 stages in multiple regression analysis:

6.5.4.1 Linearity

Linearity is used to examine the relationship between a dependent variable and a set of independent variables. For example you can try to predict a salesperson's totally yearly sales (the dependent variable) from independent variables such as age, education, years of experience, and sales territory. Or you can try to predict a student's score on the Graduate

Records Exam based on undergraduate GPA, IQ score and major. The relation between the dependent and independent variables must be at least **0.70** according to linearity but it can be tolerated. Table 6.9 depicts the findings in the research:

Table 6.9- Findings About the Linearity of The Modified Model

```
* * * *  M U L T I P L E   R E G R E S S I O N   * * * *
Correlation, 1-tailed Sig, N of Cases:
```

	Q17	F1	F2	F3	F4	Q15	Q16	Q5	Q19
Q17	1,000	**,437**	***,730***	**,510**	**,514**	**,257**	**,401**	**,196**	**,521**
	,	,000	,000	,000	,000	,010	,000	,038	,000
	83	83	83	83	83	83	83	83	83

In the model only F2 provides linearity, the other factors do not provide linearity. But linearity can be tolerated because the investigator may accept all of the factors as if important although they have a low linearity at the first stage of regression analysis and may think to extract the factors during the other stages of regression analysis. But in our model there are two special cases to explain. At the end of the reliability analysis, Factor 5 and Factor 6 did not provide reliability and the variables of these factors entered regression analysis independently. In first stage of regression analysis, the external variable that will represent the Factor 5, 6 will be determined through the linearity values. The variable, which has lower linearity in the unreliable factors, will be extracted. According to table above the variable Q15 has a lower value than Q16 in Factor 5 and will be extracted; Q16 will represent the Factor 5. In Factor 6 Q5 has a lower value and is extracted from the analysis, Q19 will represent factor.

6.5.4.2 Multicollinearity

Collinearity (or multicollinearity) is the undesirable situation where one of the independent variables is a linear function of other independent variables. The regression equation has no unique solution if there is perfect collinearity. Estimates of regression coefficients become unstable as the degree of collinearity increases. Multicollinearity means higher relation between independent variables. The relation between independent variables must be smaller than **0.70** and can not be tolerated. Table 6.10 depicts the multicollinearity analysis of the model:

Table 6.10- Multicollinearity Analysis

* * * * M U L T I P L E   R E G R E S S I O N   * * * *
Correlation, 1-tailed Sig, N of Cases:

	Q17	F1	F2	F3	F4	Q16	Q19
Q17	1,000	,437	,730	,510	,514	,401	,521
	,	,000	,000	,000	,000	,000	,000
	83	83	83	83	83	83	83
F1	,437	1,000	**,564**	**,629**	**,686**	**,420**	**,404**
	,000	,	,000	,000	,000	,000	,000
	83	83	83	83	83	83	83
F2	,730	,564	1,000	**,568**	**,567**	**,400**	**,485**
	,000	,000	,	,000	,000	,000	,000
	83	83	83	83	83	83	83
F3	,510	,629	,568	1,000	**,579**	**,349**	**,454**
	,000	,000	,000	,	,000	,001	,000
	83	83	83	83	83	83	83
F4	,514	,686	,567	,579	1,000	**,385**	**,357**
	,000	,000	,000	,000	,	,000	,000
	83	83	83	83	83	83	83
Q16	,401	,420	,400	,349	,385	1,000	**,315**
	,000	,000	,000	,001	,000	,	,002
	83	83	83	83	83	83	83
Q19	,521	,404	,485	,454	,357	,315	1,000
	,000	,000	,000	,000	,000	,002	,
	83	83	83	83	83	83	83

According to the table the relation among the variables are lower than 0.70 and there is no multicollinearity between any two independent variables.

6.5.4.3 Significance of Model (F test, Adjusted Multiple R Square)

The third step of the multiple regression analysis is significance of model. This designates the significance of the regression. From the regression results, as seen in Table 6.11, it is found that F = 18,54288 and Signif F = ,0000. Since the Signif F is lower than 0,05, the Pearson Correlation Matrix is significant which indicates that the model is valid.

Table 6.11- Significance of the Model

* * * * M U L T I P L E   R E G R E S S I O N   * * * *
Equation Number 1   Dependent Variable..   Q17
Descriptive Statistics are printed on Page   22
Block Number 1. Method: Enter
F1 F2 F3 F4 Q16 Q19

```
Variable(s) Entered on Step Number
   1..    Q19
   2..    Q16
   3..    F4
   4..    F3
   5..    F2
   6..    F1
Multiple R           ,77081
R Square             ,59414
Adjusted R Square    ,56210
Standard Error       ,52403
Analysis of Variance
                    DF      Sum of Squares      Mean Square
Regression           6            30,55175          5,09196
Residual            76            20,86994           ,27460
F =      18,54288       Signif F =  ,0000
```

Adjusted R Square = 0,56210 is greater than 0,50 which stands for high explanatory power of the factors in the model. As the result of the Regression Analysis the core concept has been significantly explained by five factors at the level of 56,210 %.

6.5.4.4 Autocorrelation Analysis

The fourth stage of the regression analysis is Autocorrelation analysis. This test is also called as Durbin-Watson test and shows the relation between independent variables. Durbin-Watson test is a test for serially correlated (or autocorrelated) residuals. One of the assumptions of regression analysis is that the residuals for consecutive observations are uncorrelated. If this is true, the expected value of the Durbin-Watson statistic is 2. Values close to 0 indicate positive autocorrelation, a common problem in time-series data. Values close to 4 indicate negative autocorrelation. Table 6.12 depicts the Durbin-Watson test results.

Table 6.12- Durbin- Watson Test Results

```
* * * *   M U L T I P L E   R E G R E S S I O N   * * * *
Equation Number 1    Dependent Variable..   Q17
Residuals Statistics:
              Min       Max      Mean  Std Dev   N
*PRED      3,7087   6,1204   5,3735    ,6104  83
*RESID    -1,9070   1,1184    ,0000    ,5045  83
*ZPRED    -2,7275   1,2236    ,0000   1,0000  83
*ZRESID   -3,6392   2,1342    ,0000    ,9627  83
Total Cases =       83
Durbin-Watson Test =   2,02699
```

Durbin-Watson Test = 2,02699

Total cases: 83 Number of independent: 6

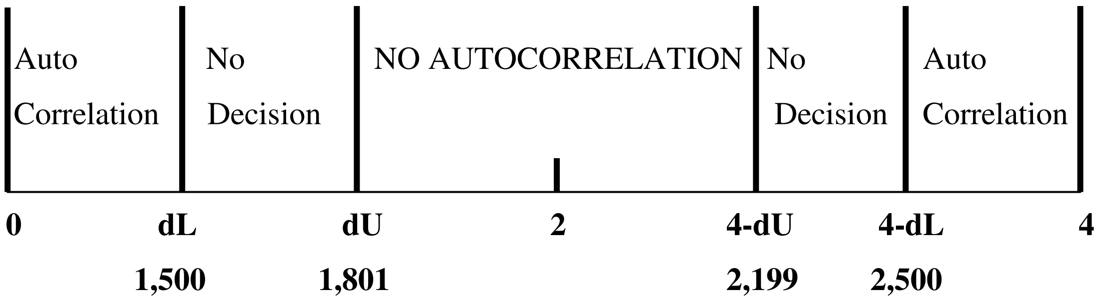

Figure 6.8- Durbin-Watson Statistics.

The Durbin- Watson test value is different from 2 or 4 so that by using Durbin- Watson statistics at 5 percent significance points of dL and dU as shown in Figure 6.6 above page. When our model's Durbin-Watson test value was analyzed the result is in No Autocorrelation zone so that there is no need for autocorrelations between the independent variables and this is a desired situation for explanation of the model.

6.5.4.5 Beta Coefficient Test- t Test

The fifth step of the multiple regression analysis is Beta Coefficient Test. It indicates the significance of linear equation. The Table 6.13 specifies that the Beta coefficient of F2 is the greatest value among others. This situation suggests that the variable F2 has the greatest contribution to the explanatory power among the other variables.

Table 6.13- Significance of Contribution of Variables

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
F1	-,026949	,021115	-,143451	-1,276	,2057
F2	,120147	,022147	,548652	5,425	,0000
F3	,018264	,022715	,082994	,804	,4239
F4	,043985	,031955	,147735	1,376	,1727
Q16	,057905	,050687	,095190	1,142	,2569
Q19	,193695	,087753	,192054	2,207	,0303
(Constant)	-,347918	,577531		-,602	,5487

End Block Number 1 All requested variables entered.

6.5.5 Analysis of variance (ONE WAY OF ANOVA)

One-Way ANOVA is used to test that several independent groups come from populations with the same mean. For example, you can test that three weight loss programs result in the same average weight loss, or that the average amount of money spent on groceries is the same for regular viewers of four different channels. To see which groups are significantly different from each other you can use the multiple comparison procedures available in this procedure. There are three stages in analysis of variance:

Levene Test is the first step and tests homogeneity of variance. For each case, it computes the absolute difference between the value for that case and its cell mean and then performs a 1-way ANOVA on these differences. Levene test is desired to be insignificant to accept the Ho hypothesis and greater than 0.05. If Levene test is significant it will mean that our variance is heterogeneous and applying variance analysis is impossible.

F-test or F-Prob value (Significance value of the test) is the second step of variance analysis. If F-Prob value is lower than 0.05 it means that dependent variable makes differences with the sub-categories of the demographic variable. But F-test cannot define which sub-categories create the differences.

Multiple comparison analysis is the third step of variance analysis. This analysis defines which subcategory of the demographic variable makes the differences. Scheffé test is used in SPSS method for multiple comparison analysis. Scheffé test performs simultaneous joint pairwise comparisons for all possible pairwise combinations of means. Uses the F sampling distribution.

In the research there are four demographic variables. The variables and their labels in parentheses are as follows:

1- Attendance to simulation based training (SBT)
2- Participant's Force (Force)
3- Participant's military branch (Branch)
4- Working year (Wor.Year)

To begin the analysis the hypothesis are as follows:

Ho: ***There is no difference between the demographic variables and dependent variable (core concept)***

H1: ***The demographic variables and dependent variable will vary significantly.***

Table 6.14 depicts the variance analysis of first demographic variable:

Table 6.14- Analysis of Variance for Demographic Variable SBT
(Attendance to Simulation Based Training)

```
                        - - - - -  O N E W A Y  - - - - -
      Variable  Q17
   By Variable  SBT
                                 Analysis of Variance
                                 Sum of         Mean               F      F
        Source          D.F.    Squares        Squares          Ratio  Prob.
Between Groups             1        ,5154          ,5154         ,8201  ,3678
Within Groups             81      50,9063          ,6285
Total                     82      51,4217


Levene Test for Homogeneity of Variances
    Statistic    df1    df2        2-tail Sig.
      2,3751      1     81            ,127
```

Levene Test for Homogeneity of Variance is 0,127, which is greater than 0,05. This situation means that the data are homogenous. Since the Levene Test result is insignificant, it suggests that we can apply the next step, F-Prob test. For the significance of the F-Prob test, its value must be less than 0,05. The result of the F-Prob test is 0,3678, which is greater than 0,05. The third step cannot be applied because of insignificance of the F test. As a result of this test, H_0 hypothesis is accepted.

Table 6.15- Analysis of Variance for Demographic Variable Force

```
                   - - - - -  O N E W A Y  - - - - -
      Variable  Q17
   By Variable  FORCE
                                 Analysis of Variance
                                 Sum of         Mean               F      F
        Source          D.F.    Squares        Squares          Ratio  Prob.
Between Groups             2        ,3068          ,1534         ,2401  ,7871
Within Groups             80      51,1149          ,6389
Total                     82      51,4217

                                Standard   Standard
Levene Test for Homogeneity of Variances
    Statistic    df1    df2        2-tail Sig.
      1,5239      2     80            ,224

      Variable  Q17
   By Variable  FORCE
Multiple Range Tests:  Scheffe test with significance level ,05
```
- No two groups are significantly different at the ,050 level

As depicted in above Table 6.15 Levene Test for Homogeneity of Variance is 0,224, which is greater than 0,05. This situation means that the data are homogenous. Since the Levene Test result is insignificant, it suggests that we can apply the next step, F-Prob test. For the significance of the F-Prob test, its value must be less than 0,05. The result of the F-Prob test is 0,7871, which is greater than 0,05. The third step cannot be applied because of insignificance of the F test. As a result of this test, H_0 hypothesis is accepted.

Table 6.16- Analysis of Variance for Demographic Variable Branch

```
                        - - - - -  O N E W A Y  - - - - -
      Variable  Q17
   By Variable  BRANCH
                                  Analysis of Variance
                                  Sum of         Mean             F      F
        Source          D.F.     Squares       Squares          Ratio  Prob.
Between Groups            2        ,4937          ,2469          ,3878  ,6798
Within Groups            80      50,9279          ,6366
Total                    82      51,4217

Levene Test for Homogeneity of Variances
    Statistic    df1    df2       2-tail Sig.
       ,6416      2     80           ,529

18 Feb 02 SPSS for MS WINDOWS Release 6.0
Page 5


       Variable  Q17
   By Variable  BRANCH
Multiple Range Tests:  Scheffe test with significance level ,05
- No two groups are significantly different at the  ,050 level
```

As seen in Table 6.16 the Levene Test result is insignificant and the result of the F-Prob test is also insignificant. The third step cannot be applied because of insignificance of the F test. As a result of this test, H_0 hypothesis is accepted.

The fourth demographic variable (Working year) is in interval scale. To apply the analysis of variance it must be transformed to nominal scale. The transformation was made through SPSS Transformation menu (Calculating median and recoding the variable according to the median). The variable WOR.YEAR was named as NEW.W.Y. after the transformation. Table 6.17 below depicts the results of the analysis of variance for fourth demographic variable. According to analysis, Levene Test result is insignificant and the result of the F-Prob test is also insignificant. The third step cannot be applied because of insignificance of the F test. As a result of this test, H_0 hypothesis is accepted.

Table 6.17- Analysis of Variance for Demographic Variable NEW.W.Y.

```
- - - - -  O N E W A Y  - - - - -
      Variable  Q17
   By Variable  NEW.W.Y
                                  Analysis of Variance
                                  Sum of         Mean              F      F
        Source           D.F.    Squares       Squares          Ratio  Prob.
Between Groups             1         ,0316         ,0316         ,0499  ,8239
Within Groups             81       51,3901         ,6344
Total                     82       51,4217

                                 Standard   Standard
Levene Test for Homogeneity of Variances
    Statistic    df1    df2       2-tail Sig.
       ,0262      1     81          ,872
No range tests performed with fewer than three non-empty groups.
```

6.5.6 CHI- SQUARE ANALYSIS

Chi -Square analysis is used to determine the degree of the relationship between the core concept and the demographic variables by means of subcategories. The methodology determining this relationship is called as ‘Test of Independence’. This analysis is also used for the detection of data whether it fits a definite dispersion or not. We call this test as ‘Goodness of Fit Test’. If the result of the analysis is significant, then we can say that there is a relationship between two variables. There are some coefficients used in this analysis according to the type of scales. For example, we use Kendall Tau and Spearman Rho for ordinal scales, Pearson for interval scales, and Phi coefficient and Cramer’s V coefficient for nominal scales.

In the research first demographic variable (SBT) is a nominal scale type variable so that Phi coefficient and Cramer’s V coefficient were used. The value of Phi coefficient and Cramer’s V coefficient must be lower than 0.05 to determine a relation. The dependent variable is an ordinal scale variable so that it has been transformed into nominal but the variable has a median value of 6 and to determine the degree of the relationship between the core concept by means of subcategories is impossible. The analysis result was given in Table 6.18 below:

Table 6.18- Phi coefficient and Cramer's V Coefficient

```
CCC  by  SBT
                    SBT          Page 1 of 1
            Count  |
                   |
                   |                    Row
                   |    1,00|    2,00| Total
CCC        --------+--------+--------+
             1,00  |    62  |    21  |    83
                   |        |        | 100,0
                   +--------+--------+
            Column      62       21       83
             Total    74,7     25,3    100,0
>Warning # 10307
>Statistics cannot be computed when the number of non-empty rows or
columns
>is one.
Number of Missing Observations:  0
```

The demographic variables Force and Branch are in ordinal scale so that Kendall Tau and Spearman Rho test are used to determine the degree of the relationship between the core concept by means of subcategories of variables. The significance value of the tests must be lower than 0.05. Table 6.19 depicts the results:

Table 6.19- Kendall and Spearman Correlation Coefficients

```
- - -  - K E N D A L L   C O R R E L A T I O N   C O E F F I C I E N T S
BRANCH          ,0800
             N(   83)
             Sig ,428

FORCE          -,0257     -,0482
             N(   83)   N(   83)
             Sig ,796   Sig ,631
                  Q17     BRANCH
(Coefficient / (Cases) / 2-tailed Significance)
" . " is printed if a coefficient cannot be computed
18 Feb 02 SPSS for MS WINDOWS Release 6.0
Page 12
- - -  S P E A R M A N   C O R R E L A T I O N   C O E F F I C I E N T S
BRANCH          ,0870
             N(   83)
             Sig ,434

FORCE          -,0288     -,0531
             N(   83)   N(   83)
             Sig ,796   Sig ,633
                  Q17     BRANCH
(Coefficient / (Cases) / 2-tailed Significance)
" . " is printed if a coefficient cannot be computed
```

According to the above table analysis are insignificant and it means that there is not a relation between the core concept and demographic variables Force and Branch by means of subcategories.

The fourth variable Wor.Year is in interval scale so that Pearson test is used to determine the relation with core concept. The value of Pearson coefficient must be lower than 0.05 and it implies a meaningful relation.

Table 6.20- Pearson test results for Demographic Variable WOR.YEAR.

```
-  Correlation Coefficients  - -
              Q17         WOR.YEAR
Q17          1,0000      -,0329
            (    83)    (    83)
            P= ,        P= ,384

WOR.YEAR     -,0329      1,0000
            (    83)    (    83)
            P= ,384     P= ,

(Coefficient / (Cases) / 1-tailed Significance)
" . " is printed if a coefficient cannot be computed
```

According to the above table, Pearson coefficient is greater than 0.05 and it means that there is not a relation between the core concept and demographic variable WOR.YEAR by means of subcategories.

6.6 FINALIZED RESEARCH MODEL

According to Chi- Square analysis there is no relation between core concept (Effective training with simulations) and demographic variables by means of subcategories. As a result, in the research the core concept (Effective training with simulations) will be explained by the factors 1,2,3,4 and independent variables Q16 (which is the representative of factor 5 after the regression analysis), Q19 (which is the representative of factor 6 after regression analysis).

Figure 6.7 below depicts the finalized model of the research:

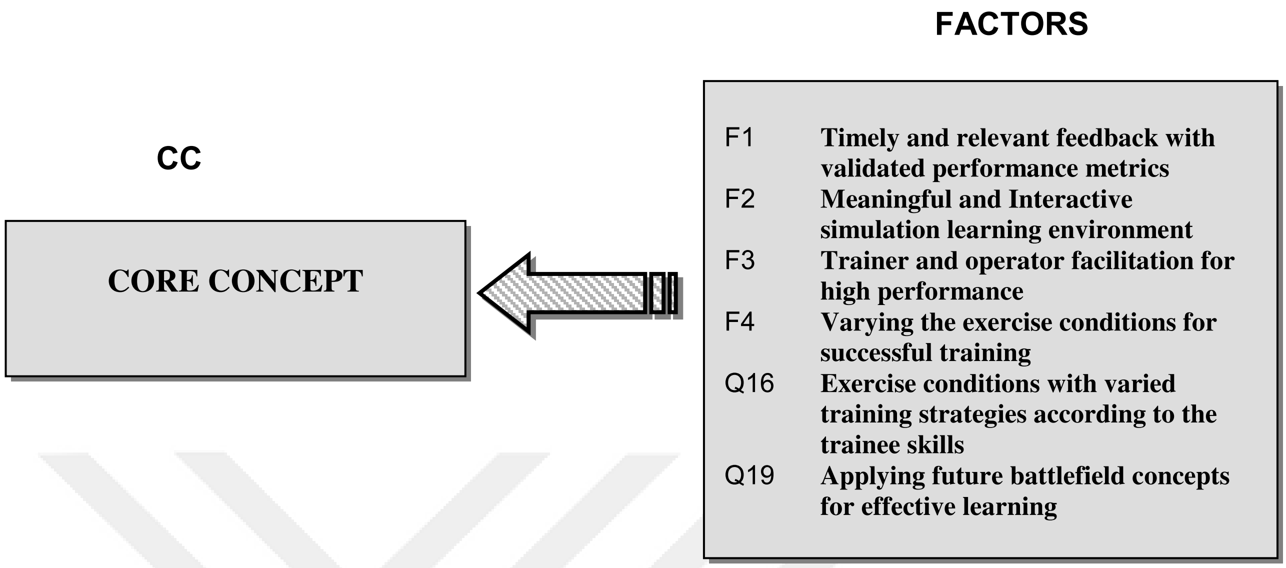

Figure 6.9- Finalized Research Model

7. CONCLUSIONS and RECCOMENDATIONS

7.1 CONCLUSIONS

Although, the effectiveness of modeling & simulation for cost effectiveness, safety, environmental protection is accepted in the science communities there are still discussions about the effectiveness of simulation in learning. It is more important for the contemporary Armed Forces to prepare his soldiers to battlefield environment. Learning can be analyzed from two points of view: First is the trainees’ willingness and capabilities for learning. Second is the systems’ capabilities and their response to trainees for effective training. My research was constructed for defining the expectations and priorities about how to apply simulation based training for effective learning from the view point of trainers in Turkish Armed Forces.

According to my research outcomes meaningful and interactive simulation learning environment has the highest explanatory power for effective training with simulations. The stages to achieve the meaningful and interactive simulation learning environment should be listed as follows(See Figure 7.1):

1- Meaningful exercise conditions and realistic scenarios matching with the training objectives: Effective training begins with a clear understanding of trainees and training requirements expressed in terms of missions, tasks. To provide effective learning realism is very important and realism can be achieved in two ways. First way is providing the accuracy of simulation models and its fidelity to real world. The designing efforts to construct an accurate model must include the force characteristics (also including enemy, allied and neutral forces), synthetic natural environments and civil environments with standardized databases and repositories to be able to apply transformation within the varying simulation models. Second is realism in scenarios. Realism in scenarios means that the scenarios should directly match with training objectives so that trainees must feel that they should apply their best performance to improve themselves.

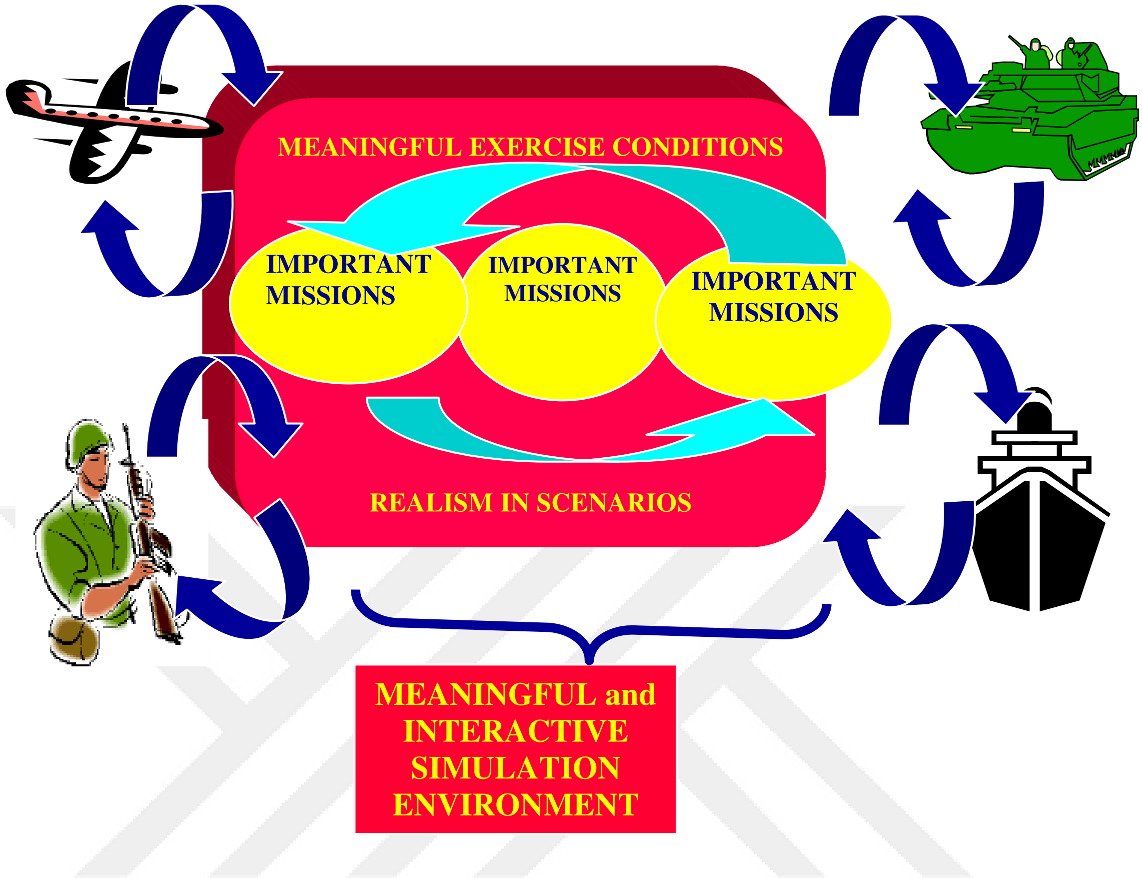

Figure 7.1- Meaningful and Interactive Simulation Environment

2- Performing important missions in simulation environment: Stage two defines the ability to achieve the second step of the first stage. The critical missions and competencies must be defined as trigger events to load the scenarios at the beginning of simulation based training, so that training will be structured in a disciplined mode. The scenarios must be applied continuously to understand the specific learning objectives.

3- Interaction between trainees and learning environment: Interaction is the reactions of trainee for the tasks, which will be performed in simulation environment and the feedback that will back to trainee to evaluate himself. So that simulation environment must allow the individual trainee or teams or groups that the trainee himself can choose the missions or tasks to perform according to his duty. If it is applied so the system also provides the most meaningful feedback for trainees and learning can be achieved successfully.

4- High performance by repetition of training events: Repetition is very important for learning and it provides transferring knowledge to long term memory. But the important factor is the number of repetition for effective learning. The repetition frequencies must be enough to understand the competencies of situation. If the number of repetition is few, the reactions of trainees in simulation environment cannot be detected truly so that the right reaction of trainees cannot be transferred as a feedback.

Applying the future battlefield concepts for effective learning should be taught as important criteria for effective training with simulations. Also in the finalized research model it has the second highest explanatory power. Figure 7.2 summarizes the process:

Figure 7.2- Applying New Battlefield Concepts

It is directly related with matching the training needs with missions of future. It is also a principle for action learning. Action learning is used to examine a complex/difficult task, to move to people to act to change it, and to return the results to the organization for review and learning. The other characteristic of action learning is that people are more willing and able to learn what they have helped create. So that by introducing the new concepts to the trainees in simulation environment creative approaches to solve the problems will be made and as a result learning will occur more voluntarily and more effective.

The third criteria for making effective learning with simulations should be varying the exercise conditions for successful training according to my research. The steps for achieving this criterion are as follows(See Figure 7.3):

Figure 7.3- Varying The Exercises

1- Varying the scenarios according to the training missions: The more scenarios for missions mean better understanding about the conditions and competencies of missions and tasks.

2- Varying the scenarios according to the trainee skills especially for team and joint training: Although varying the scenarios according to the missions, tasks seems to be solution for effective learning, the skills of the trainees must not be ignored. If the difficulty level of the scenarios does not fit the skill of trainee especially for team studies in simulation environment, the training becomes only the repetition of familiarized missions and no new knowledge transfer to the long term memory can be provided. So that while increasing the difficulty levels of scenarios to vary exercise conditions the skills of trainees in teams, groups must be taught and the skill of the trainees must be determined at the beginning of simulation based training so that the teams or groups should be constructed according to their skill levels.

3- Including the deficiencies of training objectives in feedback environment: This step is a solution for the above problem about how to vary the scenarios. The deficiencies defines not only the missing missions, tasks but also includes the missions, tasks, learning objectives to exit because they need not to be applied to achieve the competencies of current or future conditions. In feedback environment this criteria should be taught as an important factor to achieve effective learning.

4- Using easy and realistic design opportunities to make an effective learning: This is also important about varying the exercise conditions. The trainees must behave as themselves and could apply their performance to achieve the higher competencies and standards of missions in an easy way. Complex designs and complex scenarios affect the trainee and decrease his performance and using the complex scenarios to vary the exercise conditions becomes meaningless.

The fourth requirement for effective training with simulation is timely and relevant feedback with validated performance metrics. According to research the steps of this requirement are as follows (See Figure 7.4):

1- Applying validated process performance metrics for successful feedback: The process performance metrics should be used in two ways. First is for the evaluation of overall simulation model second is for the performance of trainee. The evaluation of simulation model should begin before system exists and continues during the system development. This evaluation starts with estimating the training needs and the design is assessed and training content is defined. These activities can be made through analytical and judgment based surveys.

The process performance evaluation of trainee aims to measure the reaction, learning, collective performance during the underlying tasks. The computer outputs, interview with trainees group discussions can be applied for the evaluation. The standards, which are defined to achieve the mission in mission task lists, can be used as metrics. As a result of this evaluation the results will turn back to both trainee and simulation system. The trainee will adjust himself to achieve his deficiencies and this will provide the simulation system to redefine the designs and training contents and make a better acceptance of users.

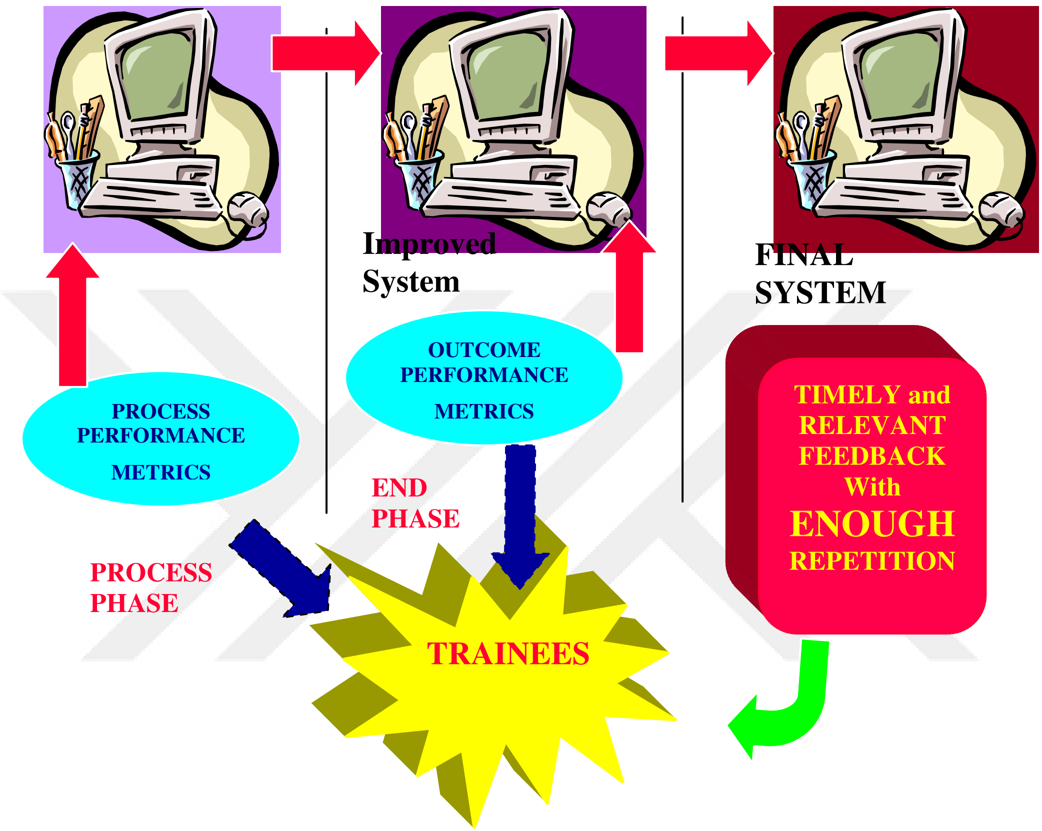

Figure 7.4- Feedback Environment

2- Applying validated outcome performance metrics for successful feedback: Using validated performance metrics which depends on the standards to achieve the mission, task to evaluate the overall performance of the trainee is very important for determining how well learning occurred. This is also an input for the evaluation of overall performance of simulation system. It provides to determine the difference between the situation and environment presented to trainee and how well it was understood by the trainee. As a result the trainee can determine his deficiencies and according to these deficiencies, repetitions can be applied. For the overall system, the training effectiveness of the simulation system is determined according to the outcomes of trainee performance and modifications are made to increase the acceptance of system by users.

3- The rate of feedback repetitions in simulation based training: The repetitions should not include only the deficiencies but mostly should be made on critical competencies of missions. Learning is directly related with how much repetition should be made to transfer the knowledge into long term memory so that the repetition rates must be adjusted by analyzing the objective performance outcomes. It is important to define the difference between the training event repetition and feedback repetition. Feedback repetition must be applied after an accurate performance measurement that shows the real reactions and behaviors of trainees. The more and inaccurate repetitions cause decrease in the performance of the trainees.

4- Timely relevant feedback applications: Feedback applications should include: What happened, why it happened and what trainee could have done to improve the outcome. Feedback must be based on both process performance results and outcome results. Feedback must be a chance for the trainee to remember the exercise in the point of objective external observers.

In a simulation environment the participants are trainers, operators and trainees. High performance from simulation based training can be provided by collective study of those participants. For providing high performance the abilities of trainees should be determined at the beginning of training. But an important factor is that the trainee always needs to be lead for high performance. So that trainer and operator facilitation should be applied as an important criterion for effective learning. The steps should include the followings (See Figure 7.5):

1- Collecting data about trainees and simulation environment: Data collection methods (such as interviews, discussions, questionnaires) should not influence trainees so that trainees should be able perform as themselves.

2- Trainer and operator facilitation for adaptation in the beginning of exercises: Trainers must provide information about the missions and tasks at the beginning of the scenarios. That is very important to be able to apply the important missions and competencies in simulation environment. The operators must provide guidance about how to use simulation system. So that the problems which will occur as a result of misusage and which cause delays, performance decreases should be prevent at the beginning of the training.

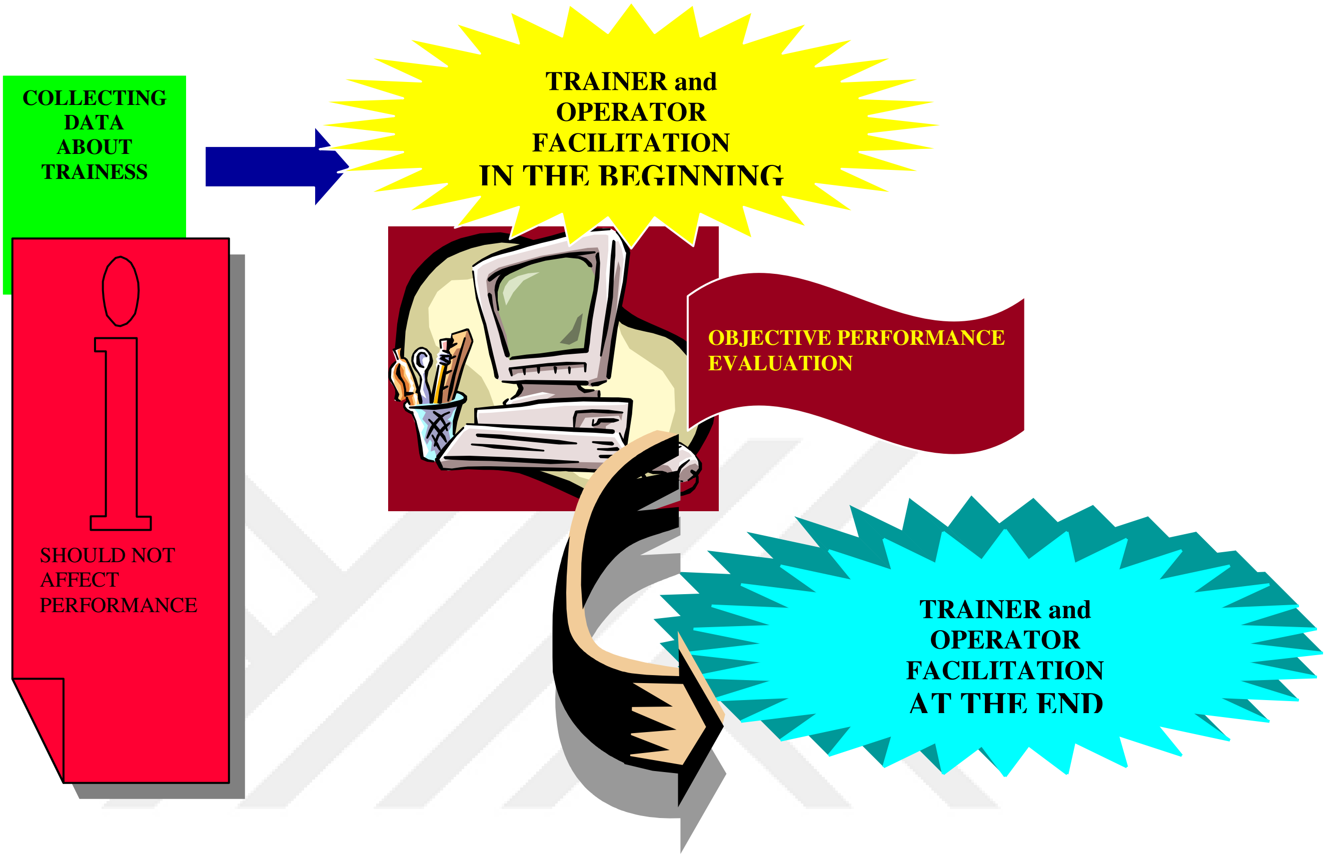

Figure 7.5- Trainer and Operator Facilitation

3- Objective performance evaluation: That should be applied for both a successful feedback and to make believe the trainee that the outcomes depict the real results. So that the standards of simulated training missions, tasks must be same with the real cases.

4- Trainer and operator guidance after overall simulation training: The guidance after overall simulation training is a chance for trainee to adjust himself to new missions and to determine the deficiencies of himself. The trainer and operator must prepare reports about the reactions, behaviors of the trainees and difficulty levels of the scenarios according to the trainees. To make an effective learning they should not give the solutions to the trainee to improve his deficiencies.

The last requirement for an effective training with simulations is varied training strategies. However, exiting unnecessary missions, repetitions or applying timely and relevant feedbacks provides learning, it is important which one of those must be applied to which trainee or teams. So that not only with one training strategy but applying the varied strategies according to the situations will provide a better understanding and effective learning.

7.2 RECCOMENDATIONS for FURTHER RESEARCH

A further research may be prepared in Turkish Armed Forces modeling &simulation centers with experimental observations and surveys. So that, to determine the current conditions of simulation based training environment and make some changes according to the findings of this study may be possible and as a result, a new study can be constructed for measuring the real effectiveness of learning with simulation based training. Also this study may be improved by comparing the real experimentation and simulated experimentation results. So that, for the various training tasks the best training methods can be assessed.

As a second further research , a concept based study may be conducted to adapt the Joint Simulation System for Turkish Armed Forces. This research may also be expanded for clarifying the joint tasks of Turkish Armed Forces including multinational operations, operations other than war and development scenarios may be conducted to achieve those tasks.

APPENDIX A. MEASURES OF EFFECTIVENESS

A.1. INTRODUCTION

This study which was prepared by the Institute for Defense Analyses (IDA) under the task order of Defense Modeling and Simulation Office to describe the Task Force's efforts and findings, which conducted its collection effort during the period of March to September of 1995 about quantified impacts for M&S applications in acquisition, training, and analysis, is a well documentation to show the benefits of using simulation for Armed Forces. So that it was given as an appendix to familiarize the Turkish science community and contemporary Armed Forces modeling &simulation units in the Task Force's methodology to show the benefits of modeling & simulation applications.

A.1.1 Problem Statement

DMSO has articulated a need for assessing the effect of M&S on the full range of DoD activities. The effect is difficult to quantify for several reasons: acceptable effectiveness metrics are lacking, supporting data are difficult to unearth, and in some cases it is not possible to identify a baseline from which to measure.

One member of the Task Force[1] examined 30 programs to determine how users of M&S measured their success. Those programs are listed and summarized in the Attachment after the exposition of findings. A second member of the Task Force presented a complementary discussion, contained in Appendix B, showing alternative methods of calculating cost effectiveness and a range of effectiveness measures and cost components.

To measure the effect of the many M&S applications in the DoD, we must first state our objectives in quantifiable terms. Only then can we assess our progress toward reaching those objectives. The metrics described here are nominated for comment, and will move us toward measuring the effects of M&S.

A.1.2 Technical Areas, Functional Areas, and DoD M&S Objectives

M&S capabilities fall into one of two broad areas. The Technical Areas deals with mechanisms that make the M&S application work, while the Functional Areas considers how

[1] Mr. Matt Aylward of MITRE, Quantico, VA.

the M&S application will be used. The two broad areas, their subareas, and the DoD M&S objectives are discussed in the following list, along with a short description of the M&S objectives.

- Technical Areas. As mentioned above, this area deals with the inner workings of the M&S tool. The particular topics in this area are as follow:

Architecture: The high-level system and software design of the M&S tool.

Computer Generated Forces (CGF): The representation of constructive simulations.

Environmental Representation: How the real world is portrayed in the synthetic environment; the effects of weather, terrain, obscurants, and their interaction with the exercise entities.

Information/Database: Methods for M&S tools to store or access information; data modeling.

Interoperability: How various M&S tools interface and operate together.

Networking: How information is shared among physically remote M&S tools.

Verification, Validation & Accreditation (VV&A): the process of giving M&S tools an official stamp of approval.

Instrumentation: Details of the infrastructure needed to incorporate live entities into the synthetic environment; the hardware and software that allows real personnel and platforms to send their state variables between M&S tools, typically through electronic messages.

- Functional Areas. M&S tools are used in the following ways:

Analysis: To conduct experiments where useful information can be extracted.

Training: To enhance military readiness through training, mission planning, and mission rehearsal.

Acquisition (research and development): To allow virtual prototyping, enhance brainstorming, and expand the number of design options that can be considered.

Acquisition (test and evaluation): To accomplish both Developmental Testing (DT) and Operational Testing (OT). Breadboards and brassboards, combined with stimulation from M&S tools, enhance the quality of DT and OT results.

Acquisition (production and logistics): To support design, manufacturing, process analysis, and support planning.

- Master Plan Objectives.

The *Department of Defense Modeling and Simulation Master Plan* [DMSO 1995] lists objectives that M&S tools should achieve. The relevant objectives—framework, environmental representation, systems representation, and human behavior representation—are closely related to the preceding sections on Technical and Functional Areas. Accordingly, a separate discussion of each M&S application area is unnecessary.

A.2 OBSERVATIONS FROM 30 CASE STUDIES

A.2.1 The Search for Metrics

To capture the benefits of any investment, there must be agreement upon objective standards to measure the performance of a particular investment. This appendix contains a proposed set, with quantitative and qualitative metrics. The projects listed in this appendix were selected to demonstrate the breadth of M&S benefits enjoyed by DoD. A discussion of the candidate quantitative and qualitative metrics follows.

A.2.2 Quantitative Metrics: Technical Areas

- Architecture: Decisions about programming architecture have far reaching consequences. Not only are current and future M&S tools affected, legacy systems will also feel some effect. The metric in this area, *Percent of Legacy Migration*, reflects this effect. An underlying Measure of Performance (MOP) to this metric may be the amount of effort (measured in staff-years or dollars) required to migrate a legacy system to the proposed architecture.

- Computer Generated Forces (CGF): Modular Semi-Automated Forces (ModSAF) is the current DIS-compatible software for generating personnel- and vehicle-level entities. M&S tools featuring highly detailed constructive simulation of combat at the lowest level rely on this software. War games also use CGF but usually at a higher level of aggregation. Following the same rationale developed for Architecture, the candidate metric is *Percentage of Software Reused*.

- Environmental Representation: The candidate metric, *Stimulations*, reflects the role of the environment in the real world. Military personnel constantly adjust their plans according to the current or future environment conditions, sorties are canceled or diverted due to obscurants over the primary target, or offensive operations are delayed because the main supply route is a sea of mud. This metric can be measured in many ways. For example, how many environmental effects can the M&S application portray? How many variables does the application use to describe the water column near the landing beach? So, within the metric of *Stimulation*, a number of MOPs can be developed for a given M&S application.

- Human-Systems Interface: There are quantitatively rigorous techniques for measuring how well a M&S application approximates the real system; accordingly, the candidate metric is *User Acceptance*.

- Information/Database: Ready access to information, especially information stored in databases, is critical to reducing the overhead of M&S tools. As future tools will rely on information archived in databases of various designs, database design decisions should consider migrating legacy databases. Possible metrics include *Level of Effort Required for Collaboration* and *Reuse*, measured in staff-years and cost avoidance, perhaps arising from the reuse of an existing database.

- Networking: The links connecting the various sites involved in a DIS exercise are vital for exercise success. When choosing among various network designs, the analysis should identify the least expensive choice that ensures a successful DIS exercise. Therefore, possible metrics are *Cost per Megabit per second* and *Latency*.

- Verification, Validation, and Accreditation (VV&A): If there is a suitable M&S application in existence, and this application has undergone a formal VV&A process, then a particular project has no reason to create a new application. Developing a rigorous VV&A procedure, particularly one that is not onerous to the owners of M&S tools, would enhance software reuse; accordingly, a candidate metric is *Cost Avoidance*, arising from such reuse.

- Instrumentation: When conducting instrumented exercises, the Services can completely forgo live fire or use the position reporting capability to have positive location information on each player. In either case, the risk of fratricide or erroneous fire mission approval by the Fire Support Coordination Center is greatly diminished. Consequently, a candidate metric is *Risk Reduction*.

A.2.3 Quantitative Metrics: Functional Areas

- Analysis: Current evaluations of military operations rely heavily on anecdotal information; if analysts had a mechanism to capture what really happened, the resulting conclusions could have a much smaller confidence interval. An assessment of how various proposed M&S tools allow the analyst to better understand a process, and perhaps conduct the analysis from "ground truth," would be of obvious interest. One candidate metric for this assessment is *Net Utility*.

- Training: By far the functional area to benefit the most from M&S tools, training also has the most easily defined metrics. Examples include *Cost Savings*, *Cost Avoidance*, and *Risk Reduction*; for example, it is hard to have a fatal mishap in an F/A-18 simulator.

- Acquisition (research and development): Candidate metrics include *Cost Savings*, due to avoidance of premature fabrication, and *Number of Options Considered*. The second metric for research and development (R&D) and production and logistics (P&L) captures the same idea: Study a wide range of options for the proposed system in virtual reality before making the first bend in metal.

- Acquisition (test and evaluation): A number of case studies show that using M&S tools to prepare for DT and OT is advantageous. M&S allows for better designed tests, aids in training the test force, and identifies areas of deficient data collection. In some cases, such as testing software upgrades for the F-14, M&S is the only way to conduct DT, due to the risks involved. Use of *Cost Avoidance* as a metric is well supported by these case studies.

- Acquisition (production and logistics): Candidate metrics include *Cost Savings* and *Number of Options Considered*. The former accrues when production lines and consumption rates can be simulated, allowing problem identification and correction before the system is fielded. The latter is appropriate when application of M&S allows planners to explore a wide range of production options in detail, at a minimal cost, when compared to exploring the options with real-world equipment.

A.2.4 Qualitative Metrics: Technical Areas

- Computer Generated Forces (CGF): The more realistic the portrayal by the CGF, the better the training; therefore, a candidate metric is *Training Quality*, as evaluated by the training audience.

- Environmental Representation: One candidate metric is *Immersion*, a measure of how "real" the environment feels to the trainee.

- Human-Systems Interface: How well the M&S application matches the feel of the simulated system is critical to positive training transfer. For this reason, a candidate metric is *Ease of Use*, as evaluated by the trainee or instructor.

- Interoperability: Ideally, all Service models would interoperate readily, thus ensuring that the conclusions of a study sponsored by one Service would be acceptable to all Services. For example, the Office of the Secretary of Defense (OSD) can choose among a number of combat simulations to evaluate Service roles and missions; the selected simulation should neither over- nor understate the relative value of any one Service. A candidate metric, *Level Playing Field*, embodies this idea of a neutral evaluation tool.

- Networking: If the M&S application is distributed, the network can either degrade or enhance the sensory experience of the participants. The quality of sensory stimulation, the feeling of *Immersion* experience by players, is a candidate metric.

- Verification, Validation, and Accreditation (VV&A): The candidate metric is *Enhanced Decision Support*. Here, the implicit assumption is extended one step further: A model that has completed a formal VV&A process produces results that are "more valid" than results from a non-VV&A process. "More valid" results will lead to better quality decisions.

- Instrumentation: With many M&S tools executing over current command, control, communications, computer, and intelligence (C4I) systems, it is desirable for these two disciplines to merge. A candidate metric is *Merger of C4I with M&S*. This metric estimates how closely a particular M&S application approaches this goal.

A.2.5 Qualitative Metrics: Functional Areas

- Analysis: As discussed in the quantitative section, much analysis of military operations is based on anecdotal data. Merging live, virtual, and constructive simulations with C4I systems would give analysts much better quality data with which to work. For these reasons the metric, *Data Quality*, is offered.

- Training: The candidate metrics are *Readiness* and *Unique Training*. *Readiness* is enhanced because the lower cost of training with M&S tools increases the quantity and quality of training opportunities. *Unique Training* is possible with M&S because only electrons are in danger of getting killed. This metric speaks to the ability of M&S to present trainees with situations not seen in the real world outside of combat.

- Acquisition (research and development): The candidate metrics are *Brainstorming* and *Unique Capability*. *Brainstorming* refers to the ability of M&S to let program managers explore a much wider array of options before settling on one approach. In other cases, the *Unique Capability* of M&S cannot be reproduced in the real world.

- Acquisition (test and evaluation): Possible metrics include *Developmental Test Planning*, *Operational Test Planning*, *Development of Measures of Performance (MOP),* and *Development of Measures of Effectiveness (MOE).* These metrics assess how well an M&S tool assists the test and evaluation community in all of the foregoing tasks.

ANNEX A TO APPENDIX A

Projects Examined for Measures of Effectiveness

1. Indoor Simulated Marksmanship Trainer (ISMT): A stand-alone M&S application, ISMT is used for training Marines in all aspects of small arms fire, as well as training small units in tactical engagements. Analysis indicates that use of the ISMT for a portion of annual weapons requalification could save significant amounts of money as a result of ammunition offset [Fish 1995a].

2. Deployable Forward Observer - Modular Universal Laser Equipment (DFO-MULE): A stand-alone M&S application, DFO-MULE is a training device for forward observers (artillery and mortar) and forward air controllers. It complies with current DIS standards. The DFO-MULE is being used in the Multi-Service Distributed Testbed. A MITRE analysis indicated that use of the DFO-MULE for required forward observer training could save significant amounts of money as a result of ammunition offset [Fish 1995c]. Assuming a 10% offset in live fire tasks, savings in ammunition expenditures could recover the acquisition costs before the end of the second year.

3. Emerald Light: A Marine Corps proof-of-concept demonstration, Emerald Light will instrument a training range at the Marine Corps Air Ground Combat Center (MCAGCC) at 29 Palms, CA. Ultimately, the MCAGCC and the National Training Center (NTC) at Fort Irwin, CA, will be linked. This will allow the conduct of Joint exercises at both sites. During the exercise, participants will share a synthetic battlespace over the Defense Simulation Internet (DSI).

4. Synthetic Theater of War - Europe (STOW-E): A Defense Advanced Research Projects Agency (DARPA) funded effort, STOW-E allowed the Army to link live, virtual, and constructive simulations to conduct a large-scale training event embedded within ATLANTIC RESOLVE. Comparable in breadth to REFORGER (Return of Forces to Germany), ATLANTIC RESOLVE cost on the order of $37 million less to conduct than REFORGER.

5. LeatherNet: A DARPA-funded project developed in concert with STOW-97, LeatherNet seeks to create a credible Marine Corps CGF at the level of the individual rifleman.

6. Turret Layout: Not really a project as much as a study, the Turret Layout effort compared the use of M&S to prototype construction for developing modifications to the Abrams tank. The M&S application allowed more options to be considered, at a lower cost, in less time, while involving the user community; the benefits were clear cut and convincing.

7. Advanced Medium Range Air to Air Missile (AMRAAM): During the development of this system, investments in M&S tools allowed engineers to fly a complete mission profile in a virtual environment. The amount and quality of data made available from this investment far exceeded the telemetry from a real flight. Also, given the cost of each flight and the number of flights required, actual flight testing was prohibitively expensive. Only M&S could satisfy the need for performance data at an acceptable cost.

8. AIM-9X: The AIM-9X missile is an implementation of advanced medium range air-to-air missile technology. See discussion of the AMRAAM (*7*).

9. F-14 Software Test: The F-14, like most modern aircraft, relies on computers to execute its mission. Changes to its software are made continuously, yet each change could potentially result in non-desirable flight performance such as crashes. For this reason, each change in software must be rigorously tested before the plane is flown. This testing must be conducted on the ground, with all flight control systems receiving accurate input stimulation. Only M&S tools can provide this input. In the absence of simulation, upgrades to the F-14 software would not be possible.

10. Advanced Amphibious Assault Vehicle (AAAV): While this program is moving forward under the conventional acquisition paradigm, it is concurrently looking at ways to use M&S tools to change the process. One example is the participation of the two automotive test rigs participating in the Virtual Proving Ground. In this project, data collected from real vehicles on the test track at Aberdeen Proving Grounds are compared to data produced by computer simulations. Successful completion of the Virtual Proving Ground project will give designers the ability to consider many design options without bending any metal.

11. Boeing 777: During the development of this aircraft, the Boeing Corporation re-invented itself: this is the world's first paper-less airplane. Boeing's corporate information system architecture allowed for extensive use of CAD, CAE, and CAM (computer-aided design, engineering, and manufacturing). Production of the aircraft was greatly simplified, as only a minuscule amount of time was lost to poorly fitting parts. In turn, this reduced the costs of production by reducing labor overtime charges and scrap rework.

12. New SSN Prototype: Employing simulation (see Boeing 777, (*11*)) for the follow-on to the SSN-21 (Sea Wolf class), General Dynamics has already experienced cost avoidance on the order of tens of millions of dollars. Proposed changes to the weapon systems consoles, sensor suites, or engineering plant can be completely explored in a virtual environment before any metal is bent. Compared to previous construction methods, large costs are avoided. This is an example of how the corporate information system architecture can have a significant effect on the bottom line.

13. B-2 Mockup: In a vein similar to Boeing and General Dynamics, Northrop designed its CISA to gather information throughout the company. As a result, the mockup of the B-2 was so close to the design resident in the CISA that future mockups may be eliminated entirely.

14. SEEK IGLOO: An Air Force project to deploy warning radar, SEEK IGLOO's concept of employment called for manned installations. A MITRE simulation determined that the radar was much more reliable than assumed. This led to a different concept of employment, unmanned radar installations of smaller size. Large savings from cost avoidance were realized.

15. F-16 Operational Test (OT) Scenario Development: By using simulators, the OT project officer was able to realize a number of benefits. First, the test team was fully trained in the scenario for the OT, increasing the efficiency of the test. Second, the test crews were able to show the project officer what performance measures were truly important, leading to a modification of the test scenario. In this way, simulation led to a higher quality OT.

16. Forward Area Air Defense System/Air Defense, Anti-Tank System (FAADS/ ADATS) Measure of Performance (MOP): Since neither of these systems exist, the project officer was stymied in attempts to develop appropriate MOPs. The use of simulation allowed the project officer to clarify the concept of employment and develop worthwhile MOPs.

17. Non Line of Sight (NLOS) Operational Test: The NLOS is a new type of anti-tank weapon that allows for precision attack of armored vehicles by a gunner in full defilade. Facing problems similar to the FAADS/ADATS (*16*), the project officer turned to simulation. Again, the existence of sophisticated M&S tools led to high quality OT of a future system.

18. Virtual Proving Ground: This is an effort between the Army's Aberdeen Proving Grounds, Aberdeen, MD, and the University of Iowa. It is an attempt to create a synthetic environment for testing vehicles. The goal is to allow engineers to fully explore system design (e.g., of the HMMWV) before any metal is bent.

19. Joint Warfare Concept Analysis - Operations Research (JWCA-OR): JWCA-OR is an effort to improve the quality of Joint analysis. For this work, it is essential that all Services are represented, as JWCA-OR supports force structure decisions, aids in developing Joint doctrine, and guides force allocation to the warfighting commands. Currently, Service representation largely involves legacy systems.

20. Joint Warrior Interoperability Demonstration (JWID): JWID is a series of demonstrations sponsored by the Chairman, Joint Chiefs of Staff. They are primarily concerned with C4I; future demonstrations will see further integration of M&S with C4I.

21. Standard Interchange Format (SIF): Developed by the Institute for Simulation and Training (IST), Orlando, FL, SIF allows existing databases to interface with M&S tools. The use of SIF generates savings for each project by reducing the number of years normally required to develop a custom interface.

22. B-52 Data Study: Undertaken by the Strategic Air Command (SAC) during Operation Desert Shield/Desert Storm, this effort collected a wide array of operational data from the bomber force. This data is potentially very useful for a number of different M&S functional uses.

23. Jedi Knights: A colloquialism that refers to a group of Army officers who provided operations research support to the Commander in Chief, U.S. Central Command (CINCCENT), in theater. Drawn from the Command and General Staff College, the members of this group were experts in the TACWAR model. Prior to the start of Operation Desert Storm, the Jedi Knights ran TACWAR manually and compared the results to the computer results from the same scenario. They judged the TACWAR output credible and proceeded to use TACWAR for operational support. The Jedi Knights are an example of the effort and benefits associated with VV&A of simulations.

24. Desert Storm Operations Research: CINCCENT, as well as subordinate commanders, made extensive use of operations research personnel as plans for Operation Desert Storm were developed or executed. Analytic support was provided from the United States, as well as from Operation Research (OR) cells in theater. Plans were developed, analyzed, and modified in a greatly truncated cycle. Without sophisticated M&S tools, the OR cells would have been unable to respond to the needs of the operational commanders. The benefit of simulation was especially evident in planning and conducting the air campaign.

25. Joint Surveillance Target Acquisition Radar Terminal Emulation (JSTAR TE): Originally intended as an adjunct to the JSTAR program, the JSTAR TE allowed the JSTAR to reach operational capability in time for Desert Storm, six years ahead of schedule. This was a great success, both for the war effort as well as for the program.

26. Defense Information Systems Agency (DISA): DISA is responsible for developing the communication links necessary to connect the far flung activities of the DoD. In this task, DISA has used a number of M&S tools to consider various alternative methods of linking the DoD nodes. There are several documented instances of cost avoidance that are the direct result of using M&S.

27. Simulation Utility Management System (SUMS): SUMS is an Air Force effort to develop an M&S tool to assess the effects of changing manpower policies and programs. It also allows personnel planners to consider various scenarios regarding the nature of the civilian labor pool.

28. Virtual Medicine: This project is still in the basic research phase, but it offers tantalizing benefits. Battlefield surgeons could operate without subjecting the wounded to the trauma of transportation to a field hospital. This multiplies the effectiveness of each surgeon, while reducing demands on the transportation system and eliminating a lucrative rear area target, the large field hospital.

ANNEX B TO APPENDIX A: METHODS OF ANALYSIS

One member of the Task Force gathered examples of data and cost-effectiveness analysis with which she was familiar.[2] Through three case studies, she depicted alternative methods of calculating cost effectiveness using the same data. Subsequently, she generalized her observations and discussed a range of effectiveness measures and cost components, contained in this appendix.

B.1 ALTERNATIVE CALCULATIONS FOR THREE CASE STUDIES

The separate case studies were chosen because of the availability of data to the author and their ability to demonstrate the various methods of analysis. The data come from, or have been examined by, personnel associated with the relevant programs. Four different methods of calculating cost effectiveness are shown, each providing a different result.

- The first and most common method calculates cost savings or avoidance, and is usually based on the assumption that live and simulated events are completely interchangeable.
- The second method is break-even analysis that determines how many live events must be replaced by simulated events to recover capital investment and operating costs in a given period of time.
- The third method is based on the assumption that finding errors early in the acquisition process is less costly to repair than finding them later in the process.
- The final method of comparing alternative events is to compare their costs and their effectiveness separately. While it is the most general method, it is also difficult to implement due to the inability to adequately measure the effectiveness of an event. This final method would allow comparison of an alternative M&S-supported event with a baseline event where the alternative was more costly but provided better training, for example. Military experts could then decide whether

[2] Ms. Michelle Bailey of Naval Air Warfare Center, Weapons Division (NAWCWD), China Lake, CA.

the training increment or decrement was worth the additional, or conversely, lower cost.

B.1.1 AMRAAM Hardware in the Loop

The AMRAAM Hardware-in-the-Loop (HIL) facility at Point Mugu, CA, is employed in the ongoing evaluation of missile guidance and control system performance. The facility includes a flight simulator table, anechoic chamber, target simulators, special interface hardware, and an instrumented missile. The facility can be used for additional applications, but only its use for testing the AMRAAM is considered here. Its primary cost components are shown in Table A.1.

Table A.1- AMRAAM HIL Costs

BRAC Replacement Cost[3]	$23.7 M
Yearly Operating Cost	$930K ($1M)
Number of Tests per Year	8,400

Using the assumption that all firings are live, we calculate an extremely favorable cost savings, as shown in Table A.2. While 8,400 *simulated* firings per year are possible, a program simply could not afford 8,400 *live* firings. Even so, several M&S cost savings we have gathered have been calculated using this type of assumption.

Table A.2- AMRAAM Example Savings Calculations

Cost Savings Method (assumes all live firings)	
Cost per firing	$40K
Cost of missile	+ $250K
Total cost per firing	$290K
Number of tests	× 8,400
Total savings	$2,436M
Could a program do 8,400 firings, let alone in one year?	

[3] Base Realignment and Closure (BRAC) replacement costs represent the cost to replace a facility and not the cost of original development and maintenance. This metric is used here because it is a certified figure with a definite meaning applied uniformly across the country.

For this case, break-even analysis may be more meaningful. An example is shown in Table A.3. In this case, recovery of BRAC replacement costs occurs in 10 years, assuming that 12 firings per year are simulated, a far more reasonable assumption. Further, assuming 3 or 4 firings per year beyond the 10-year break-even point will recoup facility operations and maintenance costs. The conclusion, then, is that 12 firings per year will recoup the capital investment in 10 years, and the other 8,388 simulated firings are value added, i.e., contribute more effectiveness. It must be remembered that an AMRAAM missile costs considerably more during its development and early production. Consolidation of the earlier missile costs with later production costs would shorten the payback time.

Table A.3- AMRAAM Example Break-Even Calculations

Time to Break-Even Method
• Number of firings required for break-even in 10 years at 12 firings per year (23.7 + 10 × (operating costs)/(cost per firing)) = \$34M / \$290K = 117 firings in 10 years
• Number of firings saved per year to maintain cost effectiveness (\$1M / \$290K = 3.45 firings per year)

A third alternative method of calculating the cost effectiveness of this type of facility is to record the number of errors found during HIL testing that would have caused a firing failure. Live firings are an expensive way of finding errors. We do not have the data required to conduct this type of analysis. However, we can approach it using the F/A-18 WSSF data, discussed in the next section.

B.1.2 F/A-18 Weapons Software Support Facility (WSSF)

The F/A-18 Weapons Software Support Facility (WSSF) at China Lake, CA, is used for integration, checkout, and verification and validation (V&V) of avionics software with actual avionics hardware operating as a total aircraft system. The WSSF is actually several facilities containing avionics hardware, simulations of flight dynamics, weapons simulations, and operator consoles. Table A.4. shows the WSSF cost factors used in the following example calculations.

Table A.4- F/A-18 WSSF Cost Factors

BRAC Replacement Cost	$54 M
Yearly Operating Cost	$6 to 8 M
Number of Test Hours per Year	over 6,000
Lab Costs per Hour (F/A-18)	$930
Lab Costs per Hour (other aircraft)	$1550
Ground Costs per Hour	$100
Flight Costs per Hour	$2,800

The WSSF is also used by weapons programs for integration and checkout of their aircraft interfaces. In addition, it has been used to supply simulated aircraft for other tests. The cost savings being computed (Tables A.5 and 6) are just the savings for the F/A-18, not for all programs using the facility. It is important to note that the cost per flight used here is the actual figure charged to the project. The true fully amortized cost of keeping an F/A-18 in the air and flight ready is probably much higher. The topic here is methodology.

Table A.5- F/A-18 WSSF A/B Software Upgrade

Cost Component	Hours Expended	% Errors Found
Lab Hours	1,084	73%
Ground Hours	81	2%
Flight Hours	195	11%
Other Methods[4]	?	14%

Table A.6- F/A-18 WSSF C/D Software Upgrade

Cost Component	Hours Expended	% Errors Found
Lab Hours	4,957	61%
Ground Hours	440	4%
Flight Hours	966	13%
Other Methods	?	22%

[4] Includes code reviews and other paper-based checks.

The more errors that can be found in the early stages of development using WSSF, the cheaper the overall program will be without even considering safety issues. Ground tests are relatively cheap, but they can only be used for simple power checks. They are included here so that total errors add up to 100%. Table A.7 depicts example savings calculations.

Table A.7- WSSF Example Savings Calculations

Cost Savings Method (assumes use of flight hours for all lab debug)		
Cost of flight hours (A/B)	1,084 hrs × $2,800/hr	$3M
Cost of flight hours (C/D)	4,957 hrs × $2,800/hr	+ $14M
Total cost of flight hours		$17M
Annual operating costs		- 7M
Savings per year		$10M
However, there are not enough local planes to fly 6,000 hours in one year.		

The break-even viewpoint, based on replacement and operating costs (Table A.8), yields a more reasonable number of flight hours, but even that is difficult for one test facility to bear. If each lab hour equated to a flight hour, we would need more than one facility testing the software, or we would need more F/A-18s dedicated to software integration and test. The WSSF actually has several labs which may be used in parallel.

Table A.8- WSSF Example Break-Even Calculations

Time to Break-Even Method	
Replacement costs	$54M
Maintenance costs ($7M per year)	+ $70M
Total costs	$124M
Cost per flight	$2,880
Have to save 4,400 flights per year for 10 years ($124M/$2,880 = 4,428)	

The real value added of the WSSF is that an aircraft as complex as the F/A-18 is not possible without this type of test facility. We could not fly enough to test it. There is a danger in just looking at cost savings as the measure of whether or not we invest in M&S. As we demand more from our warfighting systems—safer, more accurate, more environmentally friendly, more stealthy, longer range, etc.—we will have to demand more from our test and training systems.

B.1.3 Kernel Blitz

Kernel Blitz was a fleet training exercise (FLEETEX) that included live ships, submarines, aircraft, and land troops. The simulation portion augmented the fleet with additional synthetic ships, submarines, aircraft, and weapons. The simulation center used several existing computer facilities (including both coasts) and existing communications capability to link to platforms. A purpose of the exercise was to show that the use of simulated assets could add realism and complexity to training exercises. The costs of these simulated assets are depicted in Table A.9.

Table A.9- Kernel Blitz

Cost of Assets Simulated	
Ships and submarines	
(23 platforms × 2 days × $100K/day)	$4.6M
Aircraft	
(27 platforms × 4 hrs × $3K/hr)	+$0.3M
Weapons	
(23 weapons × $500K/weapon)	+$11.5M
Costs	
BFTT Enhancements	–$350K
Total Savings	$16M

The Battle Force Tactical Trainer (BFTT) existed prior to Kernel Blitz but was enhanced for this exercise. During Kernel Blitz, 33 real ships and submarines were used. The simulated assets significantly increased that number. The commanders at sea quickly forgot who was real and who was not. The fleet commands will have to answer the question of whether they would ever put 55 ships and subs into a training exercise.

The $500K per weapon may seem high to some, but it is the value used by the BFTT office (the AMRAAM is running about $250K per copy).[5] Regardless of what we think about the full cost of all the simulated assets, the $350K modification costs are impressively low (they

[5] There may likely be different cost factors included in the $500K and $250K values.

represent only those costs charged to Kernel Blitz via BFTT). If we counted only the use of two ships for two days ($400K), the Navy would recoup its investment.

A study by the Center for Naval Analyses (CNA) [Neuberger and Shea 1995] states that "At this point, simulation should be viewed as enriching training and increasing readiness rather than reducing costs." The CNA analysis also specified much greater costs. However, the purpose of this discussion is not to determine the cost effectiveness of Kernel Blitz, but to demonstrate possible analytic methods.

B.2 IS COST SAVINGS THE BEST MEASURE OF M&S EFFECTIVENESS?

There are four basic categories of effectiveness measures obtained from applying modeling and simulation—*doing it better*, *doing it faster*, *doing it cheaper*, *doing it at all*. By "doing it better," we mean that the quality of the product or the quality of the processes employed is improved through the application of M&S. This is sometimes hard to measure in terms of dollar savings. *What value do we put on safer processes? We know how to determine the cost of a disaster, but what about the cost of near misses?* Is there a savings from reducing the number of near misses? We can usually obtain dollar savings for more accurate testing, earlier discovery of problems, and repeatability of testing, although there will be some subjectivity in the figures.

Simulations make it possible to conduct training events or test events that would not be possible or affordable if conducted live. *Is it reasonable to compare the cost of a simulated event to the cost of a live event that never would have occurred?* Better would be to compare the costs and effects of two realistic but different live and simulated events. However, we often lack the appropriate effectiveness measures.

Sometimes, it just would not be possible to conduct a specific test, or train for a specific situation, without simulation. For instance, in testing seekers, there are neither enough test points nor space to hook up test equipment to obtain all the information needed about the behavior of the hardware. By using a simulation, we have access to all parameters. For aircraft, we want them to be able to withstand a certain amount of G-loading, but *to actually test that would mean risking the loss of an aircraft at the edge of its envelope*—so we simulate the effects of Gs through application of M&S.

When classifying the effectiveness of M&S, much depends upon its application. Is it a wargame or an engineering simulation? Identifying effectiveness measures for the different M&S applications would make it easier for users to keep track of the effects of M&S. For instance, wargames may save money by identifying shortfalls of existing weapons by pointing out tactical solutions vice acquisition solutions, or by identifying a set of equally effective solutions from which the least expensive can be chosen. Engineering simulations save money by enabling faster design. *But what is the value added by increasing the number of alternatives considered through simulation?*

B.3 CANDIDATE MEASURES OF EFFECTIVENESS

Table A.10 lists candidate measures of effectiveness (MOEs) and how they may be derived or calculated. The application space is mission planning.

Table A.10- Mission Planning

	Candidate MOE	Determination of MOE
Do It Faster	Actual time savings of commanders doing the strategy, per mission	Review mission planning times
	Value added of "quick reaction" capability: shorten war, avoid casualties	Wargame with and without M&S capability
Do It Better	Value added of additional (on-line) information to mission planners	Review costs of mistakes, wargaming
	Value added of considering additional strategies	Wargame with and without M&S capability
	Value added of considering multiple enemy reactions to strategy	Review costs of unexpected reactions
Do It Cheaper	Cost savings of using new methods	Review cost of current equipment and compare to projected costs
Do It At All	Value added of retargeting mission en route	Number of "wasted" missions
	Value added of more detailed planning	Operator assessment of mistakes caused by ambiguity
	Value added of automatic recording or of review of strategies, scenarios and lessons learned	Evaluate mission planning training methods

Table A.11 lists candidate MOEs for M&S tools that support analysis in support of Research, Development, Test and Evaluation (RDT&E). Examples of this type of analysis includes cost estimation, technical effectiveness evaluation, and cost and operational effectiveness analysis (COEA).

Table A.11- RDT&E, Analysis

	Candidate MOE	Determination of MOE
Do It Faster	Better adherence to schedule	Review daily program expenditures
	Use of virtual prototyping	Look at turn-around time for physical models
Do It Better	Value of adding more detailed analysis	Review number of design, software, planning changes
	Value added of considering more alternatives	Review pre-planned product improvement, cost reduction, packaging efforts
	Value added of making better decisions	Estimate of unknown unknowns, number of backup plans used for risk mitigation
Do It Cheaper	Cost savings of using new methods	Review cost of current equipment purchase, use, and maintenance and compare to projected costs
Do It At All	Value added of "executable requirements"	Costs of erroneous requirements: suits, redesigns, ambiguities
	Value added of operators of virtual prototyping	Costs of failing operational evaluation

Table A.12 lists candidate MOEs for M&S tools employed in the design phase of RDT&E. Examples include trade-off studies, engineering simulations, parametric optimization, maintenance planning, logistics planning, and production planning.

Table A.13 offers seven MOEs for M&S tools used in test and evaluation.

Table A.14 lists seven candidate MOEs for M&S application to training and how those MOEs might be determined.

And finally, Table A.15 lists candidate MOEs for M&S tools in support of military operations.

Table A.12- RDT&E, Design Phase

	Candidate MOE	Determination of MOE
Do It Faster	Reduction of design iterations	Compare to similar efforts
	Automatic design documentation	Compare to manual methods
Do It Better	Incorporation of maintenance, logistics, and production considerations	Estimates of reduced life cycle costs from what simulations pointed out
Do It Cheaper	Use of virtual prototyping	Cost of physical models
Do It At All	Evaluation of designs under more situations	Estimated costs of design failure under those situations

Table A.13- Test and Evaluation

	Candidate MOE	Determination of MOE
Do It Faster	Better adherence to schedule	Daily cost of ranges, program slips
	Better use of flight test time	Percent of test time wasted
Do It Better	Value added of "monte carlo-ing" test conditions	Percent of operational requirements not physically tested but inferred from testing
	Value added of rehearsing test	Percent of tests wasted
	Earlier identification of problems	Look at cost and spending curves for phase of project, look at cost of engineering change proposals by phase
Do It Cheaper	Use of virtual prototyping	Cost of physical models
Do It At All	Evaluation of designs under more situations	Estimated costs of design failure under those situations

Table A.14- Training

	Candidate MOE	Determination of MOE
Do It Faster	Cost savings for fewer training days	Review average number of days for specific training
	Value added of training en route	Percent delay in deployment due to training
Do It Better	Value added of exposing trainees to more situations	Review of operator errors
	Total assessment of trainee progress	Evaluation of individualized training to graduate some individuals early
Do It Cheaper	Cost savings of using new methods	Review cost of current methods and equipment
Do It At All	Individual remedial training	Review number of "flunked" trainees
	Virtual reality training in hazardous situations	Review casualties, accidents due to operator error

.

Table A.15- Support to Military Operations

	Candidate MOE	Determination of MOE
Do It Faster	Logistics routing	Time saved with better method
Do It Better	Weapons mix studies, both platform and individual	Enhancement of capabilities from tailored mixes
Do It Cheaper	Reduction of personnel required to do analysis	Amount of analysis based upon simulation
Do It At All	Decision aids	Benefits of faster, better decisions

B.4 IDENTIFICATION OF EXPENDITURES

The previous sections identified several MOEs for M&S. This section takes a closer look at the costs. Ideally, cost estimation would be the responsibility of each program manager when determining whether to pursue M&S versus other options. Too often we examine only the costs of building the simulation (or enhancing an existing one) and forget about the cost of V&V, training, operation, and maintenance.

An additional shortcoming in assessing the cost effectiveness of M&S is that the cost of failure is rarely captured. With the large up-front costs associated with some M&S tools, a considerable amount of money can be spent before determining that the tool simply will not work. Unfortunately, these lessons learned rarely get publicized, so we "learn" the same lessons repeatedly.

The costs of an M&S tool are less dependent upon its application domain and more dependent upon its physical implementation. If a simulation is entirely software, its costs can be identified in the same fashion as any other software system. The same is true of hardware-in-the-loop and live simulations.

The greatest difficulty in acquiring data is getting the right data and understanding its meaning and limits. It is imperative that the M&S community decide what data it needs and provide guidelines to program managers on how to record that data. It does not have to be difficult if people know from the beginning what is needed.

The second problem is making sure the data are used correctly. Good data used against the provider will not engender more good data. This is a political problem and hence more difficult to solve than the first.

Table A.16 summarizes the identification of expenditures.

Table A.16- Identification of Expenditures

	Area of Cost Saving or Avoidance	**Determination of MOE**
Build	The simulation is a product, just like a weapon system	Treat like an acquisition program, important to do a feasibility study
	Costs of "productizing" M&S; making it usable by several people	May be applicable if using a legacy simulation
	Integration of simulation with other simulations or hardware	May have to pay to modify interface software or equipment

Prove	VV&A	Probably 50% of acquisition costs, simulations are software intensive
	Operator acceptance—do the users and customers believe the results?	Need operator involvement from start, increasing acquisition costs
	Validation testing	Actual hardware tests to validate the models may include live ordnance firings—number and type need to be determined during program planning
Use	Training of users	Recurring cost—users will change
	Training of facilitators—people who train the users and run the simulation	Recurring cost but at a slower pace than training of users
	Computer time	Lease or ownership costs
	Equipment storage, access to space	May be leased
	Scheduling time	Delay to program because simulation facility was not available exactly when needed
	Setup costs	Simulation may be scenario dependent or user tailored
	Duplication of equipment	Users may choose to purchase their own systems—they also need to duplicate facilitator costs and maintenance costs

Feed	Population of databases	Dependent upon scenario, access to, and cost of data
	Equipment maintenance contracts	Recurring costs
	Configuration management	Recurring costs
	Depreciation of equipment	Sometimes applicable
	Lease of communications lines	Recurring costs
	Update of databases	Scenario dependent
	Software support activity	Make modifications, upgrade, fix
	Revalidation	Each time a change is made
	Maintenance of libraries	Baselines and distributing releases
	Point of contact for questions	Necessary if system at multiple sites

LIST OF REFERENCES

[Angier et al. 1993]
B. N. Angier, E. A. Alluisi, and S. A. Horowitz. *Simulators and Enhanced Training*. IDA Paper P-2672. Institute for Defense Analyses, Alexandria, VA, 1992.

[ARI 1995a]
Army Research Institute for the Behavioral and Social Sciences. "ARI Support of Tactical Engagement Simulation." *ARI Newsletter* 5 (1) (1995): 1-15.

[ARI 1995b]
Army Research Institute for the Behavioral and Social Sciences. "Simulator Training Research Advanced Testbed for Aviation (STRATA)." *ARI Newsletter* 5(2) (1995): 7-12.

[Army Science Board 1989]
Army Science Board. *Close Combat (Heavy) Training Strategy for the 1990s*. U.S. Department of Defense, Washington, DC, March 1989.

[Bailey and Hodak 1994]
S. S. Bailey and G. W. Hodak. *Live Fire Versus Simulation: A Review of the Literature*. NAWCTSD-SR-94-002. Naval Air Warfare Center, Training Systems Division (NAWCWD), Orlando, FL, 1994.

[Bell and Crane 1992]
H. H. Bell and P. M. Crane. *Training Utility of Multiship Air Combat Simulation*. USAF Armstrong Laboratory, Mesa, AZ, 1992.

[Berg et al. 1993b]
R. M. Berg, A. M. Adedeji, and C. Trenholm. *Simulation Offset to Live Fire Training Study: Assessment of Marine Corps Live Fire Training Support*. CIM-238. Center for Naval Analyses, Alexandria, VA, 1993.

[Bessemer 1991]
D. W. Bessemer. *Transfer of SIMNET Training in the Armor Officer Basic Course*. ARI TR 920. USA Research Institute Field Unit—Ft. Knox, Ft. Knox, KY, 1991.

[Boldovici et al. 1985]
J. A. Boldovici, D. W. Bessemer, and D. F. Haggard. *Review of the M1 Unit-Conduct of Fire Trainer (*UCOFT*) Validation and Verification Test Report.* ARI Research Note 85-56. USA Research Institute Field Unit—Ft. Knox, Ft. Knox, KY, 1985.

[Brewer and Shubik 1979]
G. D. Brewer and M. Shubik. *The War Game: A Critique of Military Problem Solving.* Harvard University Press, Cambridge, MA, 1979.

[Brown et al. 1988]
R. E. Brown, R. G. Pishel, and L. D. Southard. *Simulation Networking*. TRAC-WSMR-TEA-8-99. USA TRADOC Analysis Command, White Sands Missile Range, NM, 1988.

[Bryant et al. 1992]
J. A. Bryant, N. L. Lewis, M. Stapp, A. A. Zamarripa, J. Cox, J. Wilhelm, and M. Walker. *JANUS(A) Brigade/Battalion Simulation Cost and Training Effectiveness Analysis*. TRAC-WSMR-CTEA-92-006. USA TRADOC Analysis Command, White Sands Missile Range, NM, 1992.

[Burnside 1990]
B. L. Burnside. *Assessing the Capabilities of Training Simulations: A Method and Simulation Network (SIMNET) Application*. ARI Research Report 1565. USA Research Institute for the Behavioral and Social Sciences, Alexandria, VA, 1990.

[Case 1991]
F. T. Case. *Analysis of Air Operations During Desert Shield/Desert Storm*. AFSAA Report No. 28467; DTIC AD-B161 849. Air Force Studies and Analysis Agency, Department of the Air Force, Washington, DC, November 1991.

[Crane and Berger 1993]
P. M. Crane and S. C. Berger. *Multiplayer Simulator Based Training for Air Combat.* USAF Armstrong Laboratory, Williams AFB, AZ, 1993.

[Defense Science Board 1988]
Defense Science Board. *Report of the Defense Science Board Task Force on Computer Applications to Training and Wargaming.* Office of the Under Secretary of Defense for Acquisition, Washington, DC, 1988.

[Deitchman 1988]
S. J. Deitchman. *Preliminary Exploration of the Use of a Warfare Simulation Model to Examine the Military Value of Training*. IDA Paper P-2094. Institute for Defense Analyses, Alexandria, VA, 1988.

[Department of the Army 1993]
Department of the Army. *Simulations and Their Relationship to OPTEMPO/Training Ammunition.* Unpublished memorandum. USA, Washington, DC, 1993.

[DMSO 1995]
Defense Modeling and Simulation Office. *Modeling and Simulation (M&S) Master Plan.* Office of the Under Secretary of Defense (Acquisition and Technology), Washington, DC, January 1995.

[Eisley et al. 1990]
M. E. Eisley, J. D. Hagman, R. L. Ashworth, and M. P. Viner. *Training Effectiveness Evaluation of the Squad Engagement Training System (SETS).* RR 1562. USA Research Institute for the Behavioral and Social Sciences, Alexandria, VA, 1990.

[Fish 1995a]
D. Fish. *Return on Investment Calculations for Indoor Simulation Marksmanship Trainer (ISMT).* Memorandum to M&S Benefits Task Force. Marine Corps Modeling and Simulation Management Office (MCMSMO), Quantico, VA, 1995.

[Fish 1995c]
D. Fish. *Return on Investment Calculations for Deployable Forward Observer-Modular Universal Laser Equipment (DFO-MULE).* Memorandum to M&S Benefits Task Force. Marine Corps Modeling and Simulation Management Office (MCMSMO), Quantico, VA, 1995.

[GAO 1993]
General Accounting Office. *Army Training: Commanders Lack Guidance and Training for Effective Use of Simulations.* GAO, Washington, DC, 1993.

[GAO 1991]
General Accounting Office. *Army Training: Computer Simulations Can Improve Command Training in Large-Scale Exercises*. GAO, Washington, DC, 1991.

[Hammond et al. 1995]
M. H. Hammond, B. Brykczynski, E. A. Feustel, A. N. Joglekar, J. J. Loughran. *Review of Defense Modeling and Simulation Office Projects and Activities for Fiscal Years 1992-1994.* IDA Paper P-3062. Institute for Defense Analyses, Alexandria, VA, 1995.

[Hawley and Christ, in press]
J. K. Hawley and R. E. Christ. *Assessing the Value Added of New Training Technologies.* USA Research Institute for the Behavioral and Social Sciences, Alexandria, VA, in press.

[Horowitz et al. 1992]
S. Horowitz, C. Hammon, P. Lurie, P. Brooks, and A. Rolfe. *The Cost-Effectiveness of Flying Hours and Simulators.* Briefing. Institute for Defense Analyses, Alexandria, VA, 1992.

[Houck et al. 1991]
M. R. Houck, G. S. Thomas, and H. H. Bell. *Training Evaluation of the F-15 Advanced Air Combat Simulation*. AL-TP-1991-0047. USAF Armstrong Laboratory, Williams AFB, AZ, 1991.

[Hughes et al. 1988]
C. R. Hughes, W. G. Butler, B. S. Sterling, and A. W. Berglund. *M1 Unit Conduct of Fire Trainer: Post Fielding Training Effectiveness Analysis.* USA TRAC-WSMR TEA 16087. USA TRADOC Systems Analysis Activity, White Sands Missile Range, NM, 1988.

[JCS 1993]
Joint Chiefs of Staff. *The Catalog of Wargaming and Military Simulation Models*. 12th edition. U.S. Department of Defense, Washington, DC, 1993.

[Jolly and Ward 1995]
A. C. Jolly and R. C. Ward. *Cost Saving/Avoidance Benefits of Hardware-in-the-Loop Simulation and Distributed Interactive Simulation at RD&E Center, US Army Missile Command.* Research, Development, and Engineering Center, USA Missile Command, Redstone Arsenal, AL, 1995.

[Kraemer and Bessemer 1987]
R. E. Kraemer and D. W. Bessemer. *U.S. Tank Platoon Training for the 1987 Canadian Army Trophy (CAT) Competition Using a Simulation Networking (SIMNET) System.* Research Report 1457. USA Research Institute for the Behavioral and Social Sciences, Ft. Knox, KY, 1987.

[Morrison et al. 1991a]
J. E. Morrison, E. H. Drucker, and D. A. Campshure. *Devices and Aids for Training M1 Tank Gunnery in the Army National Guard: A Review of Military Documents and the Research Literature.* ARI Research Report 1586. USA Research Institute for the Behavioral and Social Sciences, Alexandria, VA, 1991.

[Morrison et al. 1991b]
J. E. Morrison, D. A. Campshure, and E. L. Doyle. *A Device/Aid-Based Strategy for Training M1 Tank Gunnery in the Army National Guard.* ARI Research Report 1587. USA Research Institute for the Behavioral and Social Sciences, Alexandria, VA, 1991.

[Neuberger and Shea 1995]
Thomas K. Neuberger and Dennis P. Shea. Applying Synthetic Environments to Operational Training: A Perspective from Kernel Blitz 95. CNA CAB 95-58. Center for Naval Analyses, Alexandria, VA, September 1995.

[Noble and Johnson 1991]
J. L. Noble and D. R. Johnson. *Close Combat Tactical Trainer (CCTT) Cost and Training Effectiveness Analysis*. TRAC-WSMR-CTEA-91-018. USA TRADOC Analysis Command, White Sands Missile Range, NM, 1991.

[Operational Research and Analysis Establishment 1990]
Operational Research and Analysis Establishment. *Comparison of Conventional and Simulator Enhanced Tank Gunnery Training Methods*. Project Report 523. Operational Research and Analysis Establishment, Ottawa, Canada, 1990.

[Orlansky 1993]
J. Orlansky. *The Battle of 73 Easting and Ways to Future Victories*. NATO Panel 8 Meeting on Training Strategies for Networked Simulation and Gaming, NATO, November 1993.

[Orlansky et al. 1994]
J. Orlansky, C. J. Dahlman, C. P. Hammon, J. Metzko, H. L. Taylor, and C. Youngblut. *The Value of Simulation for Training*. IDA Paper P-2982. Institute for Defense Analyses, Alexandria, VA, 1994.

[Orlansky and String 1977]
J. Orlansky and J. String. *Cost-Effectiveness of Flight Simulators for Military Training. Volume I: Use and Effectiveness of Flight Simulators.* IDA Paper P-1275. Institute for Defense Analyses, Alexandria, VA, 1977.

[Orlansky et al. 1984]
J. Orlansky, M. I. Knapp, and J. String. *Operating Costs of Aircraft and Flight Simulators.* IDA Paper P-1733. Institute for Defense Analyses, Alexandria, VA, 1984.

[Orlansky and String 1981]
J. Orlansky and J. String. *Cost-Effectiveness of Maintenance Simulators for Military Training.* IDA Paper P-1568. Institute for Defense Analyses, Alexandria, VA, 1981.

[OTA 1994]
Office of Technology Assessment. *Virtual Reality and Technologies for Combat Simulation*. U.S. Congress, Washington, DC, 1994.

[Schendel et al. 1984]
J. D. Schendel, F. H. Heller, D. L. Finley, and J. K. Hawley. *Use of Weaponeer Marksmanship Trainer in Predicting M16A1 Rifle Qualification Performance*. RR 1370. USA Research Institute for the Behavioral and Social Sciences, Ft. Benning, GA, 1984.

[Schwab and Gound 1986]
J. R. Schwab and D. Gound. *Concept Evaluation of Simulation Networking (SIMNET).* TR 86-CEP345. USA Armor and Engineer Board, Ft. Knox, KY, 1986.

[Simpson et al. 1995]
H. Simpson, W. D. West, and D. Gleisner. *The Use of Simulation in Military Training: Value, Investment, and Potential.* DMDC TR 95-007. Defense Manpower Data Center, Monterey, CA, 1995.

[Swinsick 1995]
S. R. Swinsick. *Longbow Apache FCR RMAP Model Benefits*. RFI response. McDonnell Douglas Helicopter Systems, Mesa, AZ, 1995.

[TECOM 1995]
USA Test and Evaluation Command (TECOM). "Virtual Proving Grounds (VPG) Modeling and Simulation Success Stories." Unpublished manuscript. TECOM, Aberdeen, MD, August 1995.

[TILV 1995]
DoD FY95 Master Plan for Target Interaction, Lethality and Vulnerability (TILV) Science and Technology (S&T) Programs. Volume I: Classical Ballistic Threats. U.S. Department of Defense, Washington, DC, May 4, 1995.

[Turnage and Bliss 1990]
J. J. Turnage and J. P. Bliss. *An Analysis of Skill Transfer for Tank Gunnery Performance Using TOPGUN, VIGS, and ICOFT Trainers*. ARI Technical Report 916. USA Research Institute for the Behavioral and Social Sciences, Alexandria, VA, 1990.

[Wilhoite 1993]
B. K. Wilhoite. "Bytes vs. Bullets: Crew-Served Weapons Simulation Based Training." *Proceedings of the 15th Interservice/Industry Training Systems and Education Conference,* Orlando, FL, December 1993, 475-480.

[Winsch et al.1994]
B. J. Winsch, N. K. Atwood, A. R. Sawyer, K. A. Quinkert, C. K. Heiden, P. G. Smith, and B. Schwartz. *Innovative Training Concepts for Use in Distributed Interactive Simulation Environments.* ARI Research Product 94-16. USA Research Institute for the Behavioral and Social Sciences, Alexandria, VA, 1994.

ABBREVIATIONS AND ACRONYMS

AAAV	Advanced Amphibious Assault Vehicle
ACR	Aerial Cable Range; Armored Cavalry Regiment
ADS	Advanced Distribution Simulation
AIAG	Automotive Industry Action Group
AEDC	Arnold Engineering Development Center (U.S. Air Force)
AFB	Air Force Base
AFSAA	Air Force Studies and Analyses Agency
AGS	Armored Gun System
ALSP	Aggregate Level Simulation Protocol
AMRAAM	Advanced Medium Range Air to Air Missile
AP	Agile Provider
ARI	Army Research Institute for the Behavioral and Social Sciences
ARNG	Army National Guard
ARTEP	Army Training and Evaluation Program
ATC	Aberdeen (MD) Test Center
ATCSS	Army Tactical Command and Control System
BBS	Brigade/Battalion Battle Simulation
BCST	Battle Command Staff Training
BFTT	Battle Force Tactical Training
BKEP	Boosted Kinetic Energy Penetrator
BRAC	Base Realignment and Closure
C3	Command, Control, and Communications
C3ISIM	Command, Control, Communications, and Intelligence Simulation
C4I	Command, Control, Communications, Computers, and Intelligence
CAD	Computer-Assisted Design
CAE	Computer-Assisted Engineering
CAM	Computer-Assisted Manufacturing
CAS	Close Air Support
CASE	Combined Arms Synthetic Experiment
CAT	Canadian Army Trophy
CAX	Computer-Aided Exercise
CCTT	Close Combat Tactical Trainer
CD-ROM	Compact Disk - Read Only Memory
CFE	Conventional Forces in Europe
CGF	Computer Generated Forces
CGSC	Command and General Staff College (U.S. Army)
CINCCENT	Central Command
CJCS	Chair, Joint Chiefs of Staff
CMTC	Combat Maneuver Training Center
COEA	Cost and Operational Effectiveness Analysis
COFT	Conduct of Fire Trainer
CREWS	Covert Remote Electronic Warfare Simulator

CSTS	Combat Simulation Test System
CTEA	Cost and Training Effectiveness Analysis
CTC	Combat Training Center
DARPA	Defense Advanced Research Projects Agency
DFO-MULE	Deployable Forward Observer - Modular Universal Laser Equipment
DIRSP	Dynamic Infrared Scene Projector
DIS	Distributed Interactive Simulation
DISA	Defense Information Systems Agency
DMDC	Defense Manpower Data Center
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
DSARC	Defense Systems Acquisition Review Council
DSB	Defense Science Board
DSI	Defense Simulation Internet
DT	Developmental Test
EADSIM	Extended Air Defense Simulation
ECM	Electronic Countermeasures
EIGHT	Environmental Issues Guide for Heuristic Testing
EMD	Engineering and Manufacturing Development
EPG	Electronic Proving Ground
EPLRS	Enhanced Position Location Reporting System
FAADS/ADATS	Forward Area Air Defense System/Air Defense, Anti-Tank System
FDT&E	Force Development Test and Experimentation
FFRDC	Federally Funded Research and Development Center
FIS	Firing Impulse Simulator
FLEETEX	Fleet Training Exercise
FOG	Fiber Optics Guidance
G	Gravity (force)
GAO	General Accounting Office
GM	General Motors
GUARDFIST	Guard Unit Armory Device Full-Crew Interactive Simulation Trainer
HAWK	Homing-All-The-Way Killer (missile)
CIWS	Close in Weapon System
HMMWV	High-Mobility Multi-Purpose Wheeled Vehicle (Hummer)
HWIL	Hardware in the Loop
ICOFT	Institutional Conduct of Fire Trainer
IDA	Institute for Defense Analyses
IMEX	Information Management Exercise
IOT&E	Initial Operational Test and Evaluation
IPPD	Integrated Product and Process Development
IRIAM	Integrated Radar and Infrared Analysis Modeling
ISAS	Intelligence Shelter Attack Submunition
ISMT	Indoor Simulated Marksmanship Trainer
IST	Institute for Simulation Technology
ITE	Integrated Test and Evaluation

ITS	Interface Test Set
JCS	Joint Chiefs of Staff
JPSD	Joint Precision Strike Demonstration
JSTARS TE	Joint Surveillance Target Acquisition Radar Terminal Emulation
JTC	Joint Training Confederation
JTIDS	Joint Tactical Information Distribution System
JWCA-OR	Joint Warfare Concept Analysis - Operations Research
JWID	Joint Warrior Interoperability Demonstration
K	Thousand
KEP	Kinetic Energy Penetrator
LAMPS	Light Airborne Multipurpose System
LAV	Light Armored Vehicle
LCS	Liquid Crystal Display
LDWSS	Laser Designator Weapon System Simulation
LMTTU	Light Airborne Multipurpose System (LAMPS) I/III Mobile Team Trainer Unit
L/V	Lethality and Vulnerability
M	Million
M&S	Modeling and Simulation
MACS	Multipurpose Arcade Combat Simulator
MATT	Multi-Mission Advanced Tactical Terminal
MAWS	Missile Approach Warning System
MBST	Marine Battle Skill Training
MCAGCC	Marine Corps Air Ground Combat Center
MCMSMO	Marine Corps Modeling and Simulation Management Office
MDT2	Multi-Service Distributed Training Testbed
MILES	Multiple Integrated Laser Engagement System
ModSAF	Modular Semi-Automated Forces
MOE	Measure of Effectiveness
MOP	Measure of Performance
MORS	Military Operations Research Society
MOS	Military Occupational Specialty qualifications
MRTFB	Major Range and Test Facility Base
MSBTF	Modeling and Simulation Benefits Task Force
MSE	Mobile Subscriber Equipment
MTP	Mission Training Plan
MTS	Moving Target Simulator
MULTIRAD	Multiship Research and Development program
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NAWCWD	Naval Air Warfare Center, Weapons Division
NLOS	Non Line of Sight
NSC	National Simulation Center
NTC	National Training Center
O&M	Operations and Maintenance

OEM	Original Equipment Manufacturer
OPTEMPO	Operating Tempo
OR	Operations Research
OSD	Office of the Secretary of Defense
OT	Operational Test
OT&E	Operational Test and Evaluation
PAC-3	Patriot Advanced Capability - 3
PC	Personal Computer
P&L	Production and Logistics
PGTS	Precision Gunnery Training System
R&D	Research and Development
RAVIR	Radar Video Recorder
RC	Reserve Component
RDEC	Research, Development and Engineering Center (U.S. Army)
RDT&E	Research, Development, Test and Evaluation
REFORGER	Return of Forces to Germany
RFI	Request for Information
RFTOP	Rooftop Transmitter Device
ROI	Return on Investment
RTTC	Redstone (AL) Technical Test Center
RSAS	RAND Strategy Assessment System
RSL	Received Signal Level
SAC	Strategic Air Command
SADARM	Sense and Destroy Armor Simulation
SAM3	Software Acquisition Management Maturity Model
SARDS	Situational and Reality Display System
SAW	Squad Automatic Weapon
SDF	Sensor Data Fusion
SETS	Squad Engagement Training System
SIF	Standard Interchange Format
SIM2	Simulator/Simulation-Based Training Program Analysis
SIMNET	Simulator Networking
SM	Standard Missile
SMART	Simulation and Modeling Anchored by Real Testing
SOP	Standard Operating Procedure
STAF	Simulation/Test Acceptance Facility
STOW-E	Synthetic Theater of War - Europe
STRATA	Simulator Training Research Advanced Testbed for Aviation
STRICOM	Simulation, Training, and Instrumentation Command
STX	Situational Training Exercise
SUMS	Simulation Utility Management System
TAC-DM	Tactical Decision Making
TACDEW	Tactical Advanced Combat Direction and Electronic Warfare
TACSIM	Tactical Simulation
TACWAR	Tactical Warfare

TAMIP	Target Acquisition Model Improvement Program
TECOM	Test and Evaluation Command (U.S. Army)
TES	Tactical Engagement Simulation
TIS	Test Item Stimulators
TILV	Target Interaction, Lethality and Vulnerability
TIS	Test Item Simulator
TOW	Tube Launched, Optically Tracked, Wire Guided
TQM	Total Quality Management
TRUE	Training Requirements Utility Evaluation
TTP	Tactics, Techniques, and Procedures
TWGSS	Tank Weapons Gunnery Simulation System
UCOFT	Unit Conduct of Fire Trainer
UE	Unified Endeavor
USA	United States Army
USACOM	United States Atlantic Command
USAF	United States Air Force
USAMICOM	United States Army Missile Command
USMC	United States Marine Corps
USMCR	United States Marine Corps Reserve
USMTF	United States Message Text Format
V/V	Verification and Validation
VR	Virtual Reality
VTF	Vibration Test Facility
VTR	Virtual Test Range
VV&A	Verification, Validation, and Accreditation
WAAM	Wide-Area Anti-Armor Munition
WSMR	White Sands Missile Range
WSSF	Weapons Software Support Facility
YPG	Yuma (AZ) Proving Grounds

APPENDIX B.

JOINT SIMULATION SYSTEM (JSIMS) SCENARIOS

Modeling and Simulation Scenarios have historically provided training context -- the conditions, assumptions, political, strategic, military, and operational factors that combine to form the dynamic setting in which military users train during an exercise

Scenarios are developed as part of the Joint Exercise Life Cycle. Exercise planners, control group members, technical control and database development personnel, response cell members, and opposition forces assist in scenario development and employ it as the central context and script for logical preparation and management of the exercise on behalf of the training audience.

Players are the military forces that will perform the training tasks vary with each exercise and scenario A typical training audience consists of the JTF commander and his staff and component commanders with their staffs. Under the JSIMS architecture, component commanders and their staffs are expected to participate as distributed participants operating from home stations. The players use their normal operating procedures, C4I, and applicable real world or exercise developed OPLANs.

Response Cells. Response cell personnel provide the interface between the simulation and the training audience for the flow of JSIMS gaming data and automated reporting outputs, role player inputs, and scripted events. To the extent possible, this information is presented to the training audience through normal component and service information and decision making channels via real world C4I connectivity. Response cell members are normally drawn from component commands participating in the exercise. They simulate the activities of echelons below the lowest level of component play and role play units represented. The training audience is expected to be located at distributed sites and use real world C4I systems to interface with JSIMS.

During exercise planning, the assigned OPFOR team will develop scenario specific events, role player scripting, data collection requirements, force structure, and tailored databases to be integrated into the exercise. It is envisioned that JSIMS will enable the OPFOR, as coordinated with the Joint Exercise Control Group (JECG), to provide thinking, fighting, interactive opposition or stress elements that realistically emulate threats in terms of doctrine, tactics, techniques, and procedures that will sustain realism and challenge the training audience. The objective of the OPFOR team is to provide sustained realistic training support. This objective is carried through active participation in exercise planning and design, through execution of the scenario based OPFOR Campaign Plan during the exercise event. The OPFOR requires a higher level of automation to control simulation units than is required by the player forces. For a major theater war scenario, the OPFOR is expected to consist of approximately 50 simulation operators and controllers and will normally be collocated with the main body of the JECG.

B.1. Conceptual Development Scenarios

JSIMS will replicate joint and service interactions in an operational setting that embraces a "real world" combat or nontraditional mission environment. This will be accomplished through the development of the JSIMS conceptual model of the mission space (JCMMS). This conceptual model will evolve from an operational scenario setting designed to represent selected entities, actions, and interactions as they exist in a potential operational warfighting or nontraditional operational situation.

The application of development scenarios is intended to provide the JSIMS development community with a sample context within which user requirements can be met -- broad background and events that drive user training interactions, functions, and processes, regardless of geographic location or level of warfare. Specific locations and levels are used to accommodate finite regional and functional CINC training requirements, traceability, and environmental fidelity. In these scenarios JSIMS will need to support simulation of the transportation, reception, staging, onward movement, and integration of ground forces in a joint synthetic battlespace that realistically represents the environment that would exist on real world operational displays and C4I systems.

B.1.1. Operational Representations

The scenario setting will establish the conditions that are expected to exist in a dynamic environment. Within this mission setting, activities will be selected to address user training objectives. The scenario provides the operational context upon which the eventual exercise planners and military users tailor, compose, and efficiently build a wide range of complex training exercises.

B.1.1.1. Linkage to UJTL, JMETL, JUCL and SSS

Scenario representation for development purposes is a method to tie objects and their functionality to the design objectives of the simulation. Those objectives, in the case of JSIMS, are training objectives and they are clearly defined in the Universal Joint Task List (UJTL) and the CINCs' Joint Mission Essential Task Lists (JMETLs). For JSIMS development, mission essential tasks are prioritized in the JSIMS Universal Capabilities List (JUCL) and further broken down into the System/Subsystem Specification (SSS) in terms that are meaningful to developers.

To assist development of the desired functionality simultaneously with the preparation of the SSS object specifications, what is needed is an understandable depiction of useful interactions that could be traced to the original requirements. Developers need the SSS to describe the attributes and interactions of the objects, and they need a scenario to understand how the interactions relate in a real world situation. Although it will be transparent to code developers, the scenario should be traceable to actual training objectives as described in selected JMETs derived from the UJTL.

B.1.2. Role in Verification, Validation and Accreditation

Development scenarios can be divided into small functional units or "Use Cases." Each use case is traceable to the UJTL item(s) it supports. Functional traces from the scenario use case to the training objective(s) defined by the UJTL (threads) can be cataloged for future use in Verification, Validation, and Accreditation (VV&A). Developers will seek to ensure functionality defined by the elements in the SSS applied through the use cases is accurately implemented. During validation this implementation will be certified to have met the training objectives derived from the UJTL.

B.1.2.1. Validation Utility -- Improved Exercise Design

Scenario based development offers the added utility of ensuring a final JSIMS scenario design that can be validated to meet requirements based training objectives by assembling previously tested use cases into operational scenarios to be used during actual exercises. Training objectives will already be validated during development, and threads will be identified for the use cases.

B.1.3. Scenario Tools -- Vignette Building Blocks

Scenario development efforts for an exercise can concentrate on composing a scenario to meet specific user requirements, rather than trying to ensure training objectives are contained within the execution of a new scenario design. While the use cases devised during JSIMS development may not account for every training objective that can be derived from the UJTL, they will provide a robust set of scenario elements for future use. As new training requirements emerge, exercise scenario developers will need to design additional use cases to complete operational scenarios using methods similar to those described above.

These CONOPS scenarios are intended to support both the users and the development community and to provide a starting point for the creation of a repository of event vignettes. The events will be matrixed to user training requirements as expressed in the Universal Joint Task List. At the lowest level, JSIMS vignettes are expected to form stand alone, high fidelity training segments spanning the warfare domains and military functions. When combined and aggregated, they can become traceable building blocks designed to support tailorable, composable, and efficient automated exercise design, planning, and preparation.

B.2. Development Scenarios - Initial Focus

The initial JSIMS development scenarios include: (1) training a joint force commander and staff in a major theater war as addressed in the national military strategy, e.g., a scenario developed to replicate a joint training environment supporting a major theater war (MTW) in Southwest Asia (SWA); (2) a joint military operation other than war (MOOTW) training event; and (3) a joint academic training seminar.

The initial scenarios and development effort are intended to facilitate creating a repository of information and building blocks suitable for expansion into other scenarios and mission locations. Additional scenarios and locations will be developed as needed.

B.2.1. Southwest Asia Major Theater War

The SWA-MTW context is consistent with the Defense Planning Guidance Illustrative Scenarios for Planning and with guidance to consider the ongoing work in the Joint Warfare System (JWARS) force analysis simulation model.

B.2.1.1. Focus and Sufficiency

The specific area and context for the initial JSIMS Development Scenario -- the Southwest Asia major theater war (MTW) and training objectives across strategic theater and operational levels of war -- were selected both to focus the initial development and for breadth and sufficiency of the notional training environment.

Also in regard to sufficiency, the development scenario context stresses the five phases of military operations. It offers opportunities to create smaller subsets to facilitate developer (as well as exercise planner) build efforts and subsequent integration into the JSIMS model. The setting replicates a challenging training environment.

B.2.1.2. A CINC/JTF Mission

The initial development scenario is intended to be representative of the level of scenario for use as a basis for creating a training environment designed to train a joint force commander, his staff, and the component commanders and their staffs in the processes and functions involved in the planning and prosecution of a major theater war (MTW).

This context would generate activity and communications with most of the US joint combatant commands, their service components, CONUS based training and force providers, and joint supporting commands. These organizations have expressed their JSIMS user requirements in the JUCL and the ORD. This scenario places the user organization requirements into a relational setting.

The MTW mission setting is predicated on an international mandate, and involves multiple sides and factions - replicated as coalition forces, assets, and basing support from around the world, and has an opponent with internal political factions, realistic military capabilities, and regional threat potential. These aspects of the context are intended to support development of robust training simulation capabilities.

B.2.1.3. Build Toward the IOC Event

The initial development scenario is intended provide developers and users the context of a notional MTW setting sufficient to build toward the eventual IOC event - a JTF training exercise supported by JSIMS. The IOC exercise is expected to be designed to facilitate training audience achievement of maximum training value in an environment in which resolution of ground forces may be aggregated at the battalion level or higher. High interest company level and special operations force activities will need to be replicated, as well. Air, space, and maritime forces are expected to be represented as individual platforms.

B.2.2. Follow-on MOOTW Development Scenario

The JSIMS MOOTW capabilities development effort is viewed as a progression of refinements through JSIMS FOC.

The MOOTW scenario can be used for training the same joint force commander and staff that constitutes the training audience for the MTW described above, or it can be adapted to support training of a separate joint force commander and staff, as well as service specific training. Decisions on training audience, exercise goals, and training objectives should drive further scenario development and exercise design. Higher levels of behavior complexity and resolution will be required to portray MOOTW.

B.2.2.1. Forces and Level of Refinement.

Many of the forces in the JSIMS MOOTW development scenario will be created and initially simulated to the aggregate level of resolution achieved during the JSIMS conceptual development effort on the MTW scenario described above. For MOOTW, these initial model efforts also need to include Special Operations Forces and other specialized units and organizations within Services.

B.2.2.2. Unique Capabilities

To reflect user requirements and unique considerations and complexities encountered in the conduct of MOOTW missions, the initial JSIMS development efforts for the support of MOOTW exercises should continue to be refined and additional capabilities addressed. JSIMS MOOTW simulation will need to replicate non-lethal weapon applications and effects, as well as other military force activities not involving hostile actions. Higher levels of complexity and resolution will be necessary to portray MOOTW activities. Typical of these are non-combatant evacuation operations (NEO), refugee interdiction and humanitarian assistance operations, psychological operations (PSYOPS), and civil affairs operations.

B.2.2.3. Environmental Conditions

Environmental conditions will also need to be considered in the development of JSIMS MOOTW training support capabilities. Urban features such as road and power grids, blueprints for key terrorist targets such as embassies, telecommunications sites, airports, and sewers or underground tunnel access points are samples of non-traditional operational environment considerations that impact MOOTW operations. This modeling effort, perhaps down to individual entity level actors, will be essential to staging accurate rehearsal and training events for high profile and sensitive missions such as hostage rescue and non-combatant evacuation operations.

B.2.2.4. MOOTW in JSIMS Events - Progressive Automation

Because of the unique nature and smaller force entities normally involved in MOOTW operations, a moderate level of HITL intervention is expected to be required in IOC MOOTW exercise events. As greater resolution is effected with follow-on versions, HITL intervention is expected to diminish substantially.

B.2.3. Academic Seminar Scenario

The application of JSIMS during an academic seminar will focus on a training audience such as a class at the National Defense University, Armed Forces Staff College or the Service War Colleges. The JSIMS user will consist of the academic staff and planners, and their student bodies.

B.2.3.1. Environmental Conditions

The initial academic seminar scenario might be described in the context of a fast breaking international disaster response. Examples of candidate scenarios include an earthquake, hurricane/typhoon, or breach of a nuclear power plant. Other candidate scenarios could be based on international crises in which national headquarters level military and other agency staffs would be involved in development of responses to politico-military developments associated with the crises. Such scenarios might run at accelerated game speeds to facilitate academic training while maintaining realistic operational conditions. Such training environments will require a high degree of automation and behavioral modeling to avoid significant levels of role player activities.

B.2.3.2. Forces and Level of Refinement

Some assets and capabilities developed for the MTW and/or MOOTW scenarios above could be used to react to a disaster requirement. Additional capabilities would include field hospitals, water purification systems and specialists, engineering units, security forces, civil-military operations specialists to deal specifically with a massive refugee problem, media and public affairs specialists.

B.2.3.3. Unique Capabilities

Academic training events would require a higher level of automation to replicate a broader range of military force levels and activities, as well as other U.S. Government, foreign government, nongovernmental organizations, and private voluntary organizations than might be required or emphasized in scenarios developed for operational training audiences.

The ability of JSIMS to return to a specific point in simulation time in the joint synthetic battlespace (JSB) is expected to facilitate comparative analysis of alternative courses of action, which will make it extremely useful in supporting academic seminar types of training events.

B.2.4. Academic Seminar Events.

Academic seminar training sessions using JSIMS tools could be developed as precursors to operational exercises and as stand alone events. Examples include crafting operations plans, crisis action planning, standing up a joint task force, TPFDD development, or other JOPES processes. The scenario for precursor academic seminar training could be the same as that developed above for the operational training exercise such as the joint force commander in an MTW or the MOOTW training audience, or it could be an entirely different scenario. In any case, the academic seminar should be designed with a clear understanding of training objectives to be achieved in the course of the event.

B.3. JSIMS Scenarios at FOC

As sequential versions of JSIMS are fielded after IOC, scenarios similar to those developed for JSIMS applications at IOC can and should be developed. These events will achieve increasingly refined levels of resolution and be able to accommodate more diverse training objectives at a finer level of detail based on greater JSIMS capabilities as iterative versions of software are developed and fielded. Additionally, scenarios should be developed to reflect changes in national military strategy and the associated command and control structures.

B.3.1. Expanded Capabilities

At FOC, JSIMS is expected to be able to replicate activities that have generally been provided by role playing and scripting (manual intervention) events supported by legacy models. Examples of areas in which such off-line support is typically provided are logistics, intelligence, Nuclear-Biological-Chemical (NBC) warfare effects, theater missile defense (TMD), weapons of mass destruction (WMD), engineering, communications, inter/intra-theater transportation, medical, and information operations. JSIMS will need to represent higher and lower echelons of command, and U.S., allied, coalition, neutral and opposing forces, as well as accommodate and represent training with U.S. Government agencies, nongovernmental organizations (NGOs), private voluntary organizations (PVOs), and international organizations.

B.3.2. FOC Expectations

As JSIMS version 2.0 is introduced at FOC in 2003, capabilities of the system will have matured to provide the full range of training and other uses described in section 5.0 and the paragraph above. While the three scenario types discussed for application throughout introduction of the sequential versions of JSIMS will still be applicable, other scenario types and designs will evolve to take advantage of the JSIMS system capabilities, as well as in response to world political-military developments.

JSIMS will be designed to provide an operationally realistic and composable simulation environment primarily focused to provide military training at the joint task force (JTF) operational level. The operational level framework provides consistent context and definition for the development and maturation sequence of the simulation. In addition to this central theme, JSIMS will develop tools to address the interplay of tactical warfare, tailored functional resources, military operations other than war (MOOTW), national and international interfaces and operational level situations. As the JSIMS synthetic battlespace matures, it will be sufficiently robust to accommodate virtually any scenario requirements conceivable as this CONOPS is developed.

At IOC, JSIMS will selectively include capabilities at the tactical level of operations to represent small-units and individual platforms appropriate for joint operations and specialized missions. At FOC it will have the capabilities to represent strategic national and strategic theater level activities for the realistic replication of political and international factors impacting the mission assigned to the training audience.

The model will support both deliberate and crisis action planning for an operational situation. Integrated exercise design tools will facilitate construction of training events that capture the full spectrum of operations, from prehostilities or nontraditional emergency situations, as well as the more familiar phases of conflict -- deployment, employment, sustainment, and redeployment. JSIMS will provide automated methods to support scenario development, data selection, event execution, and analysis of training results (during and post execution).

B.4. JSIMS Operational Scenario Design

The "warfare and operational art" aspect of JSIMS will be instituted through the application of warfighting skills and nontraditional military engagement skills responding to events and implications within an operational scenario. The scenario is a "big picture" description of a military problem or situation that provides context for training. This setting provides both the overarching context and finite events traced to the Universal Joint Task List and CINC Mission Essential Tasks and training programs. The scenario structure can be likened to a binder containing exercise design elements.

The design binder contains tailored background material; summaries of geography, history, culture, religion, military and political information of a given region. The planner selects a region and turns to the section containing current information to continue developing the exercise context. Examples of notional current events include government agendas and actions, military and terrorist threats, ethnic and religious conflicts, and man-made or natural disasters. The binder also provides a set of short descriptive events to build toward specific training requirements. A range of examples include generic events designed to set the exercise stage for a noncombatant evacuation operation, establishment of a civil military operations center, or requirement for tracking weapons of mass destruction.

JSIMS exercise design tools and user friendly build methodology are intended to assist exercise planners to efficiently research, plan, and refine specific training events appropriate to drive joint and Service specific training requirements. The resulting JSIMS exercise design will provide a robust and challenging mission environment for the training audience.

B.5. JSIMS Operational Scenario Structure

Section 6.1 discussed the JSIMS conceptual scenario in terms of providing context which incorporates the use cases contained in the JUCL. These use cases, with their system and subsystem specifications, form a consistent framework to conceptualize the mission space used in the software development process.

B.5.1. User Templates

The developer's efforts and clear understanding of user requirements and scenario structure are key to providing the user "operational scenario design tools" addressed in paragraph 6.3. Within the overarching scenario, use cases and vignettes encompass balanced partitions of military operational requirements. They may be linked with other use cases and vignettes. Systems and operational activities, and subsystems and events divide the scenario based partitions into sequentially smaller portions, each level providing greater detail and functionality designed to serve developer and user. The two reference systems and communities are linked and mutually supportive within the scenario context. When combined, vignettes, activities, and events comprise the training templates within the JSIMS operational scenario structure.

These components are traced to functional user training requirements and conditions in the Universal Joint Task List. Individual training events contain the various entity and behavioral threads, and form the first level of military user tools. Activities combine the events into higher order groupings, such as course of action development. Vignettes are partitions analogous to stages of a military operation. Continuing with the example, COA development is an activity within the planning vignette of the overarching scenario.

A vignette is a subset of a scenario that is generally militarily balanced and focused in time. Vignettes enable focused training of functional processes and tasks as they interrelate. A vignette may emphasize training requirements in one or more functional activities related to selected Joint Mission Essential Tasks, while the events establish and comprise finite conditions per the Universal Joint Task List. The scenario is provided as a backdrop to play out the operational concept.

The vignettes will relate to the way in which military campaigns and operations are executed. Thus, the most common exercise design scenario will structure vignettes and activities to correspond to the functions conducted during stages of a campaign or operation as specified in the corresponding plan or order. Conditions and training opportunities (events) within functional activities are linked to other functional activities represented in the scenario/vignette subset. For example, strategic lift events within the pre-hostilities deployment vignette are matrixed to force allocation events. Tailored events within this example might include mobilization of reserve civil affairs assets and personnel in anticipation of a later training requirement for the exercise of a civil military operations center (CMOC).

During exercise execution, the training audience level user will conduct initial planning and preparation based on their evaluation of the JSIMS scenario environment and history. The planning and building block event tools appropriate for use by the exercise planner and scenario design community will be transparent to this level user. Instead, the JSIMS functionality will provide a robust, seamless and realistic contextual flow through the exercise. The training audience will interpret and establish their own set of operational conditions to transition from one operational stage to another within this initial context but, as in real world military operations, the preplanned transitions and conditions are not static. JSIMS exercise design scenario tools are available to compose and tailor adhoc developments during the flow of the exercise training.

The exercise design scenario and family of tailorable JSIMS vignettes can provide the backdrop and progressive conditions against which the exercise training audience commander could execute his plans. JSIMS events can also afford opportunities for exploitation and decision making; these may be presented by the "enemy", by environmental factors such as natural disasters, or as unforeseen situations.

B.6. Partitions by Stage of Operations

Dividing a scenario into operational stages can assist planners in thinking through an entire operation and in defining requirements. It also assists in sequentially supporting and achieving major objectives within realistic timelines and resource constraints.

The JSIMS exercise design scenario will address the following major joint operational stages: (1) Prehostilities/Predeployment, (2) Lodgment, (3) Combat/Mission Execution and Stabilization, (4) Follow-through, and (5) Posthostilities/Mission Closure and Redeployment.

These major stage partitions of the scenario based mission take into account the expected flow of actions and decisions from beginning to end. The user may choose to begin or focus on a particular partition stage and rely on JSIMS to provide the base and linkage to preceding stages. An example might consist of an exercise focused on execution or rehearsal of a combat mission, using automated deployment events and lodgment data from JSIMS to provide sufficient STARTEX information to update the background scenario context.

B.6.1. Prehostilities/Predeployment Stage

Vignettes and activities will include deterrence actions (flexible deterrent options, FDOs) and actions to set the terms for employment and enhance friendly and limit enemy freedom of action. During this stage forces will be tailored for deployment. C4I and logistics requirements of the force will be developed based on the commander's concept of operations. This stage will also identify critical timelines required to deploy the force.

B.6.2. Lodgment Stage

Vignettes and activities provide for the movement and buildup of a decisive and appropriate military force in the operational area. In lodgment operations before hostilities and to support nontraditional military engagement, deployment will normally include movements to host nation air or sea ports. In operations conducted before and during combat, initial deployment may require forcible entry, followed by the occupation and expansion of the lodgment area.

B.6.3. Decisive Combat/Mission Execution and Stabilization Phase

Decisive combat or nontraditional engagement and stabilization phase vignette activities focus initially on a rapid buildup of joint force capabilities. The appropriate sequencing of forces into the operational area can contribute to the stabilization of the situation. The resulting stabilization could serve as a deterrent. If deterrence fails, deployment of forces will permit JTF commanders (CJTFs) to build up full dimensional capabilities rapidly, and to conduct decisive action as early as possible. This decisive action is focused to build an operational capability to achieve NCA and CINC objectives.

B.6.4. Follow-through Phase

Vignettes and specific activities will be focused on synchronizing the joint force events to bring the military operations to a successful conclusion. Part of the effort is devoted to ensure that the threat or human stress element in a nontraditional mission do not undo the gains of the preceding phase. The essence of this phase is ensuring that the results achieved in the earlier phase are maintained. In this phase joint forces may conduct operations in support of other governmental agencies in operations other than war (MOOTW) to assist in meeting war termination objectives, and in the conduct of designated nontraditional missions such as disaster response and humanitarian relief.

B.6.5. Posthostilities/Mission Closure and Redeployment Phase

The vignettes and activities will center on setting the stage to conclude the military role in the situation. In this phase the CJTF will ascertain posthostilities requirements and identify who should accomplish the final conflict or mission termination actions. Once the national military objectives are reached this phase will focus on redeploying the joint force from the operational area as the military mission has been accomplished and the forces are no longer needed in the objective area.

The initial JSIMS development scenario is a JTF level operation designed to execute a MTW mission. It currently focuses on those aspects of a military situation needed to provide a framework and context for the JSIMS Conceptual Model of the Mission Space (JCMMS). This Scenario provides an operational foundation that will permit development of the object oriented threads needed for software development and form the baseline to support Verification, Validation, and Accreditation traceability to user requirements.

The Scenario is a living document that will be expanded and altered as necessary to meet JSIMS software development requirements as the program evolves. The Scenario will support JSIMS users and developers with the ability to link thread development to mission tasks and trace them to military operational training requirements.

ANNEX A TO APPENDIX B

A.1. Background

During the design and planning of a simulation-supported event, planners develop the framework for a relevant training experience tailored to the training audience. Development of tools embedded in JSIMS, such as the scenario and supporting database information contained in the common Modeling and Simulation Resource Repository (M&SRR), combined with current assets such as the Joint Exercise Management Package, will facilitate exercise planning team efforts to compose and tailor efficiently the JSIMS event to the specific and detailed training needs of the exercise sponsor.

The JSIMS development build scenario is a notional example of the type of complex international setting the JSIMS user community will be able to develop. For the purposes of JSIMS development, the scenario is not intended to represent a crisis that is expected to play out on the world scene. It is for program development purposes only and any similarity to a real world situation is coincidental.

A.2. Political-Military and Geographic Setting - Focused and Sufficient

The Southwest Asia region was selected as the geographic area for this notional initial JSIMS development build scenario. This scenario provides a realistic situation, events, notional forces, and a physical environment that will support developer actions in a sufficiently broad but focused context.

The mission would draw forces from many US war fighting commands, supporting commands, and each of the Services. Order of battle data for US and notional coalition forces is provided at Annex B, as is notional threat order of battle data.

The setting provides the challenge of representing multiple sides (coalitions and combined operations as well as government agencies, international and private organizations, and non- governmental organizations). The scenario script can be expanded to encompass multiple factions within the opposing force side. It can also represent the operational problems posed by non- combatant civilians, hostages, as well as refugee populations and displaced persons.

The development build scenario is designed to provide an international situation that has national security implications requiring the application of military skills and forces across and within the JSIMS domains. The Defense Planning Guidance Illustrative Scenarios for Planning and the tenets of Joint Vision 2010 were reviewed during this effort. In an effort to attain cost and time savings in design efforts, the JSIMS build scenario was developed with similar characteristics to the Joint Warfare System (JWARS) scenario.

A.3. Development Scenario

Although the development build scenario is not explicitly linked to an actual world situation or event, it is deliberately created at the unclassified level and provides a setting that is plausible, realistic, and reflects the actual work and resulting products of the exercise design and planning process.

A.3.1. Middle East MTW Training Audience

The structure of the notional CINC/JTF level training audience is displayed at Figure B.1.

JSIMS Middle East MTW Scenario - CINC and JTF Training Audience		
JTF Component	**Provider**	**Response Cell Location**
Joint Task Force (JTF)	CINCCENT and Staff	Centralized Location, possibly USACOM's JTASC facility, Suffolk, Virginia
Navy Forces (NAVFOR) NAVCENT, Commander, 5th Fleet and Staff	Commander, Carrier Group (COMCARGRU) 8 and Staff	Rear Headquarters, MacDill, Air Force Base, Tampa, Florida and or Camp Blanding, Florida
Air Forces (AFFOR)	Commanding General, 9th Air Force and Staff	Shaw Air Force Base, Sumter, South Carolina
Marine Forces (MARFOR)	Commanding General, III Marine Expeditionary Force (MEF) and Staff	Okinawa, Japan and Det Rear, Camp LeJeune, North Carolina
Army Forces (ARFOR)	Commanding General, 18th Airborne Corps and Staff	Fort Bragg, Fayetteville, North Carolina

Figure B.1 -- CINC and JTF Training Audience

A.3.2. Middle East MTW Training Audience - Organizational Relationships

The organizational relationships of the training audience are displayed at Figure B.2.

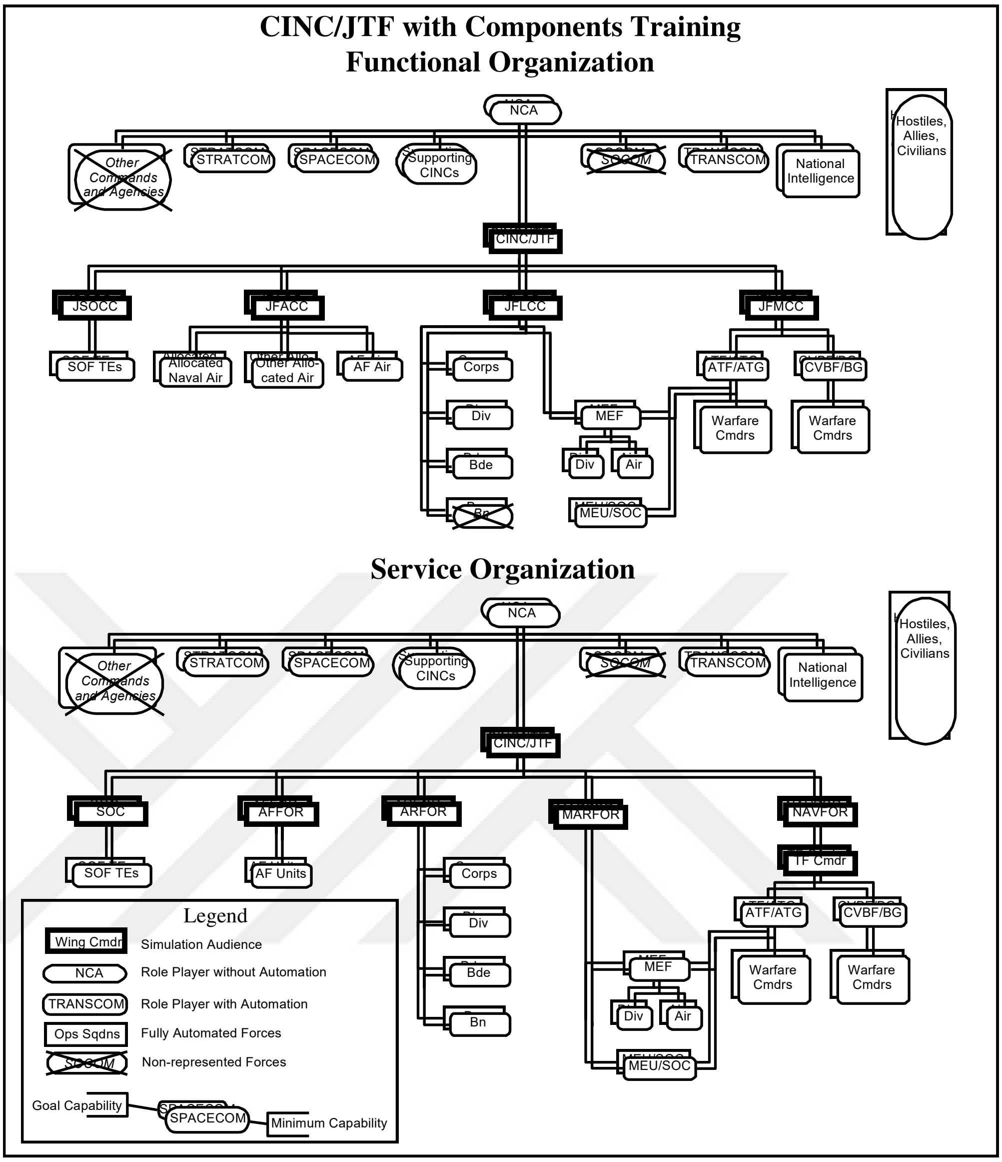

Figure B.2 -- CINC/JTF Functional and Service Organization

A.4. JSIMS Training Objectives for Initial Development

As sequential versions of JSIMS are fielded after IOC, training objectives will be developed as described in chapter three. For this initial development, however, the following training objectives have been developed as a notional representation of what is required for an exercise training objective for the training audience.

Joint tasks (essential and supporting) are developed from the Universal Joint Task List (UJTL) and once conditions (taken from the scenario) and standards (delineated by the exercise director, CINC or JTF commander) are added, this becomes a training objective for this particular exercise. The development scenario does not attempt to replicate the information normally derived from various reference CINC and component documents normally used in the development of training objectives. However, it demonstrates the linkages that occur during the exercise design process.

The initial JSIMS event will be conducted within the context of the scenario as described in this Annex, for which it is appropriate to use training objectives as listed below. Each of these training tasks refers to common conditions which are listed later in this section. Some of these training tasks will not pertain to all of the training audience, rather a specific component, board, cell, center, or section of the staff.

References on how to perform each of these tasks are listed in the UJTL and are from current joint and service publications. In applying the UJTL to the requirements-based joint training process, a number of basic terms apply which are shown in figure B.3.

Term	Definition
Mission	The task, together with the purpose, that clearly indicates the action to be taken and the reason therefor.
Essential	Absolutely necessary; indispensable; critical.
Task	A discrete event or action, not specific to a single unit, weapon system, or individual that enables a mission or function to be accomplished.
Condition	A variable of the operational environment or situation in which a unit, system, or individual is expected to operate that may affect performance.
Standard	The minimum acceptable proficiency required in the performance of a particular task under a specified set of conditions. Standards are established by a joint force commander.
Joint Mission Essential Task (JMET)	A task selected by a joint force commander from the Universal Joint Task List (UJTL) deemed essential to mission accomplishment.
Joint Mission Essential Task List (JMETL)	A list of joint tasks considered essential to the accomplishment of assigned or anticipated missions. A JMETL includes associated conditions and standards and may identify command-linked and supporting tasks.
Supporting Task	Specific activities that contribute to the accomplishment of a joint mission essential task. Supporting tasks are accomplished at the same command level or by subordinate elements of a joint force (i.e., joint staff, functional components, etc.).

Figure B.3 -- UJTL Definition of Terms

The essential tasks below are in bold and the supporting task in each case is in italics. The task conditions key is located in A.4.1.

ST 1.1.1 - Process Requests for Forces to be deployed. Validate and coordinate movement requests with supporting agencies to determine resources and assets available. Prepare movement orders. Conditions: (15-25) Standards: (a) Movement requests processed in sufficient time to support the campaign plan, (b) Movement orders prepared and issued in accordance with JTF SOP.

ST 1.1.3 - Conduct Intratheater Deployment of Forces. Coordinate and prioritize movement of US and Multinational forces within theater. Determine phasing requirements in accordance with assets available. Prepare deployment orders in accordance with JTF SOP. Conditions (3,4,15-17, 19-25). Standards: (a) Uninterrupted movement conducted in support of campaign plan. (b) Multinational and coalition movement assets and shortfalls identified and resolved in a timely manner. (c) Deployment orders prepared and issued in accordance with JTF SOP.

ST 1.1.4 - Provide Command and Control of Deploying Units. Insure that the required information and format of deployment orders are correct. Maintain requirements that implement and monitor command and control instructions as listed in deployment orders. Conditions; (3, 6-14). Standard: Control of forces during phasing is maintained at all times.

ST 2.2 - Collect Theater Strategic Information. Insure collection assets provide timely information to maintain a current target list. Assess significant battle damage of enemy targets. Conditions: (1-5, 11, 14, 20-22, 25). Standards: (a) Collection requirements on targets processed in a timely manner. Disseminate a BDA assessment within 12-36 hours of collection.

ST 2.4 - Produce Theater Strategic Intelligence and Prepare Intelligence Products. Maintain enemy situation and order of battle. Respond to requests for targeting and BDA information. Respond to requests for intelligence for planning purposes. Conditions: (1, 2, 11, 14, 25). Standards: (a) Enemy order of battle maintained in a timely manner. Target and BDA information requests processed in a timely manner. (c) Intelligence information requests processed in a timely manner.

ST 2.5 - Disseminate and Integrate theater Strategic Intelligence. Respond to requests for strategic intelligence products. Provide follow-on intelligence support to theater strategic planners and decision makers. Conditions: (1-4, 6-14, 20). Standards: (a) Provide prompt and comprehensive transmission, in peace and war, of theater-produced intelligence products. (b) Provide intelligence inputs in response to queries based upon furnished intelligence products or the evolution of events.

ST 4.2.2 - Provide Health Services. Provide health service support in preparing theater forces for joint operations and theater level campaigns. Manage the theater joint blood program. Coordinate patient evacuation from the AOR. Monitor and adjust preventive medicine plan. Conditions: (1, 6-13, 17-19, 21, 22). Standards: (a) Ensure coordination occurs between the theater joint blood program office and the armed services blood program office. (b) Ensure that a theater and joint patient movement requirements centers are formed and operated in accordance with JP 4-02. (c) Ensure sufficient medical capabilities exist to support campaign plan.

ST 4.2.3 - Reconstitute Theater Forces. Take extraordinary actions to restore combat-attrited units in the theater to desired level of combat effectiveness. Coordinate CONUS/theater personnel replacement systems with service components. Conditions: (1-14, 23-26). Standards: (a) Ensure no significant shortage of personnel that effects the ability of the components to accomplish their mission. (b) Ensure that planning forces to counter the emergence of a global threat has occurred.

ST 4.3 - Distribute Supplies/Services for Theater Campaign and COMMZ. Establish a Joint Movement Center to coordinate all means of transportation to support campaign plan. Provide supplies and services for theater forces. Implement theater/joint operations area transportation policy. Conditions: (3, 4, 22, 24). Standards: (a) Courses of action for logistics movement developed and analyzed as required. (b) Recommendations provided to JFC to meet projected shortfalls in intratheater lift capability as required. (c) Movement of equipment, supplies, and personnel meets CINC's timeliness for execution of campaign plan.

ST 8.1.3 - Develop Headquarters or Organizations for Coalitions. Validate the F2C2 staff functions and interaction with the battle staff in support of the campaign plan. Educate and familiarize the battle staff with the F2C2 mission. Validate augmentee manning in support of the campaign plan. Validate F2C2 overall manning in support of the campaign plan. Conditions: (3, 4, 6-15). Standards: (a) F2C2 staff provides continuous support for the maneuver and sustainment of coalition forces. (b) CINC's battle staff manifests a complete appreciation for the mission of the F2C2 by staffing and coordinating 90% of coalition issues with the F2C2 staff. No later than the completion of the second exercise stage, 95% of all staff procedures are standardized. 90% of augmentee and overall F2C2 manning are present or accounted for during the exercise.

OP 1.1 - Conduct Operational Movement. Formulate request for strategic deployment to the theater of operations/JOA. Conduct theater of operations/JOA reception, staging, onward movement, and integration. Conditions: (1-14, 21-24). Standards: (a) Deployment request should be consistent with joint force command's campaign plan. (b) The staff should ensure centers are established to receive and process equipment and personnel in a timely manner in accordance with JTF SOP. (c) US and coalition forces unimpeded by host nation reception services.

OP 1.2 - Conduct Operational Maneuver. Transition joint forces to and from tactical battle formations. Concentrate forces in theater of operations/JOA. Plan and execute show of force. Plan and execute demonstration to draw attention and forces of an adversary from the area of major operations. Conditions: (1-4, 6-15, 20, 23-25). Standards: (a) Determine when, where, and for what purpose major forces will be employed, consider commitment to or withdraw from battle, the arrangement of battles, and major operations to achieve operational relationships, policies, procedures, and options for C2 of joint air operations through designation of a JFACC or the use of the JFC staff. (b) Use available assets to provide the minimum level of sustainment to deployed forces. (c) During amphibious operations, exploit the element of surprise and capitalize on enemy weaknesses by projecting combat power at the most advantageous location and time. (d) Provide guidance for the organization, command and control, and mission selection pertaining to SOF.

OP 2.2 - Collect Operational Information. Collect information on operational situation to include significant enemy information on force strength, vulnerabilities and locations.

Provide surveillance and reconnaissance support to combatant commanders and national level agencies. Conditions: (1, 2, 11-14, 16, 18, 20, 25). Standards: (a) Employ joint force organic intelligence resources to obtain general military intelligence (GMI) in support of the joint force commander's decision making process and operational requirements. (b) Develop and maintain intelligence databases capable of meeting operational intelligence requirements. (c) Ensure that positive ID is maintained on friendly forces.

OP 2.4 - Produce Operational Intelligence and Prepare Intelligence Products. Evaluate, integrate, analyze, and interpret operational information for credibility, reliability, applicability, and accuracy. Determine enemy's operational capabilities, courses of action and intentions. Provide indications and warning for theater of operations/JOA. Conditions: (1, 2, 11-14, 16, 18, 20, 25). Standards: (a) Provide tailored all-source intelligence analysis support to joint operations in such a way as to ensure the correlation of new data with the existing database and the continuous assessment of the effectiveness of the collection strategy to meet evolving intelligence needs. (b) Assist is identifying and determining operational objectives by providing the joint force commander with a clear, comprehensive understanding of the adversary's intent, objectives and centers of gravity. (c) Further support to operational requirements is provided through the development and maintenance of a tailored GMI database.

OP 3.1 - Conduct Joint Force Targeting. Establish joint force targeting guidance to include prioritizing targets. Assign joint/multinational operational firepower to operational targets consistent with joint force command's guidance. Evaluate and choose operational targets for attack to achieve optimum effect on enemy decisive points and centers of gravity. Publish tasking orders for employment of air assets and other means. Determine the overall effectiveness of joint and multinational forces employment in operational objectives. Conditions: (3, 4, 6-14, 20, 24-25). Standards: (a) Select targets and match the appropriate response to them taking account of operational requirements and capabilities. (b) Comply with international law, the law of war, international agreements and conventions, and NCA approved ROE. (c) All components involved in targeting, should establish procedures and mechanisms to manage the targeting function. (d) Transmit a daily air tasking order that maximizes the use of all firepower assets. (e) JFCs establish broad planning objectives and guidance for attack of enemy strategic and operational centers of gravity and interdiction of enemy forces. (f) Set priorities, provide targeting guidance, and determine the weight of effort to be provided to various operations. (g) When established, the JTCB operates at the macro level and ensures targeting nominations are consistent with the JFC establish broad planning guidance. (h) Develop an unconstrained prioritized list of potential targets which reflects relative importance of targets to the enemy's ability to wage war. (i) Consider target system characteristics, target linkage, and interdependence. (j) Identify key target systems that are relevant to objectives and guidance and suitable for disruption, degradation, neutralization, or destruction. (k) Identify critical nodes, prepare preliminary documentation, validate the target, identify recommended aim points for attack, and develop a potential prioritized target list. (l) Analyze what is known about the damage inflicted on the adversary to determine what physical attrition the adversary has suffered; what effect the efforts have on the adversary's plans or capabilities; and what, if any, changes or additional actions are required to meet campaign objectives. (m) The CA effort should be a joint program supported at all levels.

OP 3.2 - Attack Operational Targets. Attack operational land and sea targets with available joint and multinational operational firepower. Engage operational land, sea, and air targets with nonlethal joint and multinational means designed to degrade, impair, disrupt, or delay the performance of enemy operational forces, tasks and facilities. Conditions: (3, 5, 9, 11, 14, 20, 24, 25). Standards: (a) Employ all available joint and multinational firepower to delay, disrupt, destroy or degrade enemy operational forces or critical tasks and facilities to effect the enemy's will to fight. (b) Employ EW to control the electromagnetic spectrum or to attack enemy systems; include optical, infrared, and directed-energy means. (c) Employ offensive information warfare activities. (d) Consider use of SOF when non-lethal means are insufficient and conventional means are not feasible. (e)Degrade, impair, disrupt, or delay performance of enemy operational forces, tasks, and facilities. (f) Synchronize interdiction and maneuver, as complementary operations, to assist commanders in optimizing leverage at the operational level. (g) Synchronize and integrate close air support with surface fires; achieve the desired effect without suspending the use of any of the supporting arms or unnecessarily delaying the scheme of maneuver, and protect aircraft from the effects of friendly surface fire.

OP 5.1 - Acquire and Communicate Operational Level Information and Maintain Status. Send and receive operationally significant information and data from one echelon of command to another by any means. Direct, establish or control the means used in sending or receiving operational information of any kind. Determine the critical information that the commander requires to understand the flow of operations and to make timely and informed decisions. Maintain operational information and force status. Monitor the strategic situation. Conditions: (1-5, 9, 11, 14-16, 18-22, 24-25). Standards: (a) Combatant command planners develop peacetime assessments that ease transition to crisis or war as well as to post-conflict. (b) Peacetime intelligence and logistic assessments are essential for force projection operations and rapid transition to combat operations. (c) When directed by the NCA to conduct military operations, the combatant commander refines peacetime strategies and modify existing plans or develop campaign plans as appropriate. (d) The result, expressed in terms of military objectives, military concepts, and resources, provides guidance for a broad range of activities. (e) Modern intelligence collection systems accumulate vast amounts of information. (f) To be useful, the information must be relevant, accurate, analyzed, formatted, and disseminated in a timely manner to the appropriate user. (g) The information must be appropriately classified and sanitized to the degree necessary to allow dissemination to the appropriate user level. (h) The commander specifies the critical information needed to support a decision-making process to retain the initiative. (i) The information may be derived from one or more of three broad information categories of friendly, enemy , and environmental. (j) This includes identification, management, and promulgation of critical information requirements to the joint force staff and components.

OP 5.2 - Assess Operational Situation. Evaluate information received through reports or the personal observations of the commander on the general situation in the theater of operation and conduct of the campaign or major operation. In particular, this activity includes deciding whether different actions are required from those that would result from the most recent orders issued. This includes evaluating operational requirements of subordinate task forces and components. Conditions: (1-5, 14-15, 18, 20-22, 24-25). Standards: (a) The nature, scope and tempo of military operations continually changes, requiring the commander to make new decisions and take new actions in response to these changes. (b)

Although the scope and details will vary with the level and function of the command, the purpose is constant: analyze the situation and need for action; determine the course of action best suited for mission accomplishment; and carry out that course of action, with adjustments as necessary, while continuing to assess the unfolding situation. (c) Combatant commanders' plans provide strategic direction: assign missions, tasks, forces, and resources; designate objectives; provide authoritative direction; promulgate rules of engagement(approved by the NCA); establish constraints and restraints; and define polices and concepts to be integrated into subordinate or supporting plans. (d) Branches are options built into the basic plan. Such branches may include shifting priorities, changing unit organization and command relationships, or changing the very nature of the joint operation itself. (f) Branches add flexibility to plans by anticipating situations that could alter the basic plan. Such situations could be a result of enemy action, availability of friendly capabilities or resources, or even a change in the weather or season within the operational area.

OP 5.3 - Prepare Plans and Orders. Make detailed plans, staff estimates, and decisions for implementing the theater combatant commander's theater strategy, associated sequels, and anticipated campaigns or major operations. Plans and orders address, among other things, centers of gravity, branches, sequels, culminating points, and phasing. Planning includes organizing an effective staff, structuring and organizing the force, considering multinational capabilities/ limitations, and cross-leveling or balancing Service component, joint, and national C^4 means. Conditions: (3, 4, 6-14, 20-24). Standards: (a) Synchronize operations by establishing command relationships among subordinate commands, describe the concept of the operations, assign tasks and objectives, and task-organize assigned forces. (b) Campaign planning can be started prior to or during deliberate planning, but is not completed until crisis action planning. (c) Prepare OPORDs under joint procedures during crisis planning. (d) Plans should address specific missions and tasks for subordinate joint or multinational task forces, Service and functional components and supporting commands and agencies. (e) Plans should specify main effort(s) and supporting and supported relationships by phase. (f) Planning also should address rules of engagement for force employment. (g)This activity includes determining solutions to operational level needs

OP 5.4 - Command Subordinate Operational Forces. Promulgate the interrelated responsibilities between commanders, as well as the authority of commanders in the chain of command. Clear delineation of responsibility among commanders up, down, and laterally ensures unity of command which is a foundation for trust, coordination, and the teamwork necessary for unified military action. All commanders must understand their mission, their contribution to achievement of the commander's concept and intent, and their relationship to attainment of a higher or supported commanders operational objectives. This facilitates maximum decentralized conduct of campaigns and major operations utilizing either detailed or mission-type plans and orders as the situation and time permit. Arrange land, air, sea, and space operational forces in time, space, and purpose to produce maximum relative combat power at the decisive point. This activity includes the vertical and the horizontal integration of tasks in time and space to maximize combat output. Synchronization ensures all elements of the operational force, including supported agencies' and nations' forces, are efficiently and safely employed to maximize their combined effects beyond the sum of their individual capabilities. This includes synchronizing support to a supported command. Synchronization permits the friendly commander to get inside the enemy commander's decision cycle. Conditions: (3-14, 22-24). Standards: (a) Organize and employ commands and forces as the combatant commander considers necessary to accomplish the assigned mission. (b) COCOM is the authority to perform those function of command over assigned forces including assigning tasks designating objectives, providing authoritative direction, joint training, and logistics necessary to meet mission requirements. (c) Generate decisive joint combat power through the integration of all US military capabilities and with other nations and organizations as required. (d) Synchronizing interdiction and maneuver provides a dynamic concept available to the joint force. (e) The synergy achieved by integrating and synchronizing interdiction and maneuver assists commanders in optimizing leverage at the operational level.

OP 5.5 - Organize a Joint Force Headquarters. Organize a headquarters for the command and control of designated and organized joint and multinational forces under the duly authorized, single, joint force commander. Conditions: (1-15, 20-25). Standards: (a) The first principle in joint force organization is that JFCs organize forces to accomplish the mission based on the JFC's vision and concept of operations. (b) Key considerations are unity of effort, centralized planning, and decentralized execution. (c) Joint force organizations need to consider interoperability with multinational forces. (d) Simplicity and clarity of expression are critical.

OP 5.7 Coordinate and Integrate Joint/Multinational and Interagency Support. Coordinate with elements of the joint force, allies/coalition partners, and other government agencies to ensure cooperation and mutual support, a consistent effort, and a mutual understanding of the joint force commander's priorities, support requirements, concept and intent, and objectives. Conditions: (3-5, 15-17, 19-26). Standards: (a) Ensure the joint force commanders priorities, support requirements, concept, interest, and objectives are clearly understood and that US, allied, and friendly nations act in concert as a single and seamless force to generate decisive joint combat power. (b) Coordinate coalition support activities to provide the combined force commander the means to acquire coalition force status and capabilities.

OP 6.1 - Provide Operational Aerospace and Missile Defense. Protect operational forces from air attack by direct defense and by destroying the enemy's air attack capacity in the air. This will include the use of aircraft, interceptor missiles, air defense artillery, and weapons not used primarily in an air defense role. Provide joint and multinational operational aerospace defense. Provide airspace control. Conditions: (3, 4, 11, 14, 18, 20, 21, 25, 26). Standards: (a) Disseminate TMD voice warning consistent with available and capable organizations and equipment, direct receipt of voice warning is preferred. (b) JFC TMD cell must maintain theater-wide TMD situational awareness 90% of the time by multiple means. (c) Recommend improvements on theater TMD policy and guidance to the JFC TMD cell. (d) The JFC TMD cell delivers recommendations in a timely manner to the theater JTCB for discussion and decision.

A.4.1. Scenario Task Conditions

Common Conditions that pertain to the above training tasks are listed below. The numbers against these conditions cross reference to the numbers in parenthesis after each task. The conditions are initial starting points and become dynamic once the exercise starts.

1. JTF will conduct operations in an arid, austere environment, with severe climatic conditions, creating harsh conditions under which military personnel and equipment will operate. (Note: Based on UJTL conditions C 1.3.1 (arid), C 1.3.1.3.1 (hot), C 1.3.1.3.5 (very low), and C 1.3.2 (low).)

2. Three maritime choke points (Strait of Hormuz, Bab El Mandeb, and Suez Canal) coupled with the confining characteristics of the Red Sea and Persian Gulf may impact the CINC/JTF's ability to rapidly respond to the crisis. (Note: Based on UJTL conditions C 1.1.3.4 (extensive) C 1.2.1.7 (confined), C 2.5.1.4 (contested), and C 2.7.3 (partial).)
3. CINCCENT will conduct operations integrating multinational commands and forces to accomplish coalition objectives. (Note: Based on UJTL conditions C 2.1.1.2 (partial), C 2.1.1.4 (multinational), C 2.1.1.7 (limited), C 2.2.6 (some), and C 2.3.1.2 (partial).)
4. CINCCENT will provide critical support to nations in the AOR in terms of security assistance, forward presence of military forces, and will deploy/employ military forces rapidly to the region to maintain regional peace and stability. (Note: Based on UJTL conditions C 2.1.1.3 (overt), C 2.1.1.4 (multinational), C 2.1.5.1 (short), C 2.3.1 (multinational), C 2.5.1.2 (minimal), and C 2.5.3.1 (limited).)
5. CINCCENT will conduct operations supported by secure yet long intertheater lines of communication (LOCs) from the Continental United States (CONUS) to the AOR. (Note: Based on UJTL conditions C 2.1.4.5 (long), C 2.5.1 (good), C 2.5.1.3 (secure), C 2.5.2.1 (robust), C 2.5.2.2 (limited) and C 2.5.2.3 (little or no).)
6. Staff officers have required knowledge and skills necessary to perform in a staff section/board/center/cell. (Note: Based on UJTL conditions C 2.2.4 (high), C 2.2.4.5 (normal), and C 2.3.1.3 (moderate).)
7. Section/boards/centers/cells are properly equipped to perform their tasks. (Note: Based on UJTL conditions C 2.2.5.1 (abundant), C 2.2.5.2 (abundant), and C 2.2.6 (high).)
8. Sections/boards/centers/cells are properly formed (organized). (Note: Based on UJTL conditions C 2.2.7 (moderate), C 2.3.1.3 (moderate) and C 2.4.3 (mature).)
9. Headquarters support functions are in place. (Note: Based on UJTL conditions C 2.5.4 (robust) and C 2.8.1 (adequate).)
10. Coordination procedures are established and understood by all members of a staff's section/board/cell/centers. (Note: Based on UJTL conditions C 2.3.1.2 (partial), C 2.3.1.3 (moderate), C 2.3.1.4 (partial) and C2.3.1.6 (continuous).
11. All guidance/directives/orders/intelligence summaries that would be available are available to the appropriate section/board/center/cell. (Note: Based on UJTL conditions C 2.3.2.1 (mission orders), C 2.3.1.8 (unrestricted) and C 2.2.5.2 (abundant).
12. All required section/board/center/cell training has been completed. (Note: Based on UJTL conditions C 2.3.1.3 (high) and C 2.2.4 (high).
13. All sections/boards/centers/cells have knowledge of own force capabilities and limitations. (Note: Based on UJTL conditions C 2.2.5 (abundant) and C 2.3.1.3 (high).
14. All sections/boards/centers/cells have knowledge of enemy capabilities and limitations as appropriate. (Note: Based on UJTL conditions C 2.4.2 (abundant) and C 2.4.5 (moderate).
15. DOD media pool is deployed and dissolved. (Note: Based on UJTL condition C 3.1.1.5.
16. Joint Information Bureau is established and operational. (Note: Based on UJTL conditions C 2.2.3 (adequate), C 2.2.4 (high), C 2.2.5.2 (abundant), and C 2.3.1.8 (unrestricted).

17. Army Reserve Civil Affairs personnel have been notified of call-up and active duty Civil Affairs liaison personnel have been deployed to establish the scope of requirements for a Civil Military Operations Center. (Note: Based on UJTL condition C 2.1.1 (clear), C 2.1.1.3 (overt), C 2.1.1.5 (cooperative), C 2.1.1.6 (major)and C 3.1.3.3.1 (partial).

18. Respective environmental and combat service support specialty units have been notified of pending deployment. Critical assets include water purification and transportation units, oil spill and environmental decontamination specialists, and chemical detection and decontamination units. (Note: Based on UJTL condition C 2.1.1 (clear), C 2.1.1.3 (overt), C 2.1.1.5 (cooperative), C 2.1.1.6 (major), C 2.2.1 (strong), C 2.5.1.1 (full), C 2.5.2.3 (limited), C 2.8.3 (sufficient), and C 2.8.5 (extensive)..

19. Chaplains and social services personnel have been notified and have begun appropriate personnel sensitivity and cultural awareness training programs. (Note: Based on UJTL conditions C 2.2.3 (adequate), C 2.2.4 (partial), C 2.2.4.4 (good), and C 2.2.4.5 (normal).

20. Information warfare and electronic warfare specialists have begun aggressive protection and COMSEC programs, as well as evaluation of potential Iranian C4I weakness for exploitation. (Note: Based on UJTL conditions C 2.3.1.8 (restricted) and C 2.4.5 (strong).

21. Communications with host nation and a clear mandate has been published for the operation, included the desired end state and duration of the mission. The mandate may be based on international sanctions, or by invitation of the coalition partner nations. (Note: Based on UJTL conditions C 2.1.1 (clear), C 2.1.1.2 (strong), and C 2.1.1.3 (overt).

22. Contact with US government on scene authorities (such as US consular officials and Ambassadors) have been established, to include gathering information for any potential Department of State Non Combatant Evacuation Operation (to include numbers and locations of American Citizens, special category employees, and personnel likely to be compromised by their close association with US persons or employment.). (Note: Based on UJTL conditions C 2.1.1.5 (cooperative), C 3.1.1.3 (strong) and C 3.1.2.1 (active).

23. Appropriate Status of Forces Agreements with host nations and Rules of Engagement for the coalition forces have been established. (Note: Based on UJTL conditions C 2.1.1.4 (multinational) and C 2.1.1.5 (cooperative).

24. Coordination for special mission and supporting CINC assets has been accomplished, for example, SPACECOM counter-TBM capabilities for tracking the potential SCUD-B threat. (Note: Based on UJTL conditions C 2.2.2 (multiple), C 2.2.5 (abundant) and C 2.7.3 (full).

25. Force protection, security, and law enforcement procedures have been established. (Note: Based on UJTL condition C 2.7.1 (high).

A.5. World Situation

The international political, social, and economic environments are under pressure, with access to energy resources playing an increasingly volatile role in evolutionary and, at times, revolutionary power struggles. These struggles are sustained primarily by economic dissatisfaction.

In the Middle East, radical fundamentalist religious groups have continued the pattern of fanning social and economic agendas to gain power and popular political support.

Oppressive regimes, rising population burdens, and failing resources contribute to the failure of many governments to meet the needs of their people. These human needs have gained recognition with the advance of the information age and the international exposure that highlights the deep economic rift between the "haves" and "have-nots."

As a result of these factors, tensions are running high around the world. The United States has strategic concerns in many of the key hot spots -- in Asia with China and Taiwan, in the Middle East Arab-Israeli contentious zones, and in South Asia with Pakistan and India. Of immediate concern is growing instability in Iran and the Persian Gulf region. The potential threat to the flow of oil from the area, in particular through the Strait of Hormuz, is a vital interest throughout the world.

A.5.1. The Iranian and Gulf Crisis

A.5.1.1. Background

Since the Persian Gulf conflict of Desert Storm, Iran has been fraught with turbulence, both internal and external. The Iranian people have become disillusioned after nearly 20 years of Islamic Fundamentalist rule. The Mullahs and the Fundamentalist controlled Government relied upon the China paradigm to engineer rapid economic growth. This plan focused on building a strong popular base of support, initially capitalizing on promises of improving the standard of living for the burgeoning underclass.

A.5.1.2. Sociological/Economic Factors

The initial success of the first generation economic plan also diminished political and religious opposition. With internal popularity high, the government opted to defer social benefit programs; instead, it applied economic resources to strengthen its military position in the region. The armed forces have purchased sophisticated military equipment from Russia, and they have made arms purchases from China.

Iran’s rapid economic growth model has faltered with the reentry of Iraq into the world oil market. The resulting competition has led to increased tensions between the two countries. The competition in the oil market provides a pressure release point to reduce internal political and religious demands by focusing on a long standing external threat.

A.5.1.3. Demographics of Resistance

In Iran the economy remains soft, living standards continue to decline and it is becoming more difficult for the present regime to control internal dissent by non-lethal means. Complicating this volatile situation, the Iranian youth population continues to grow at a very high rate. This sector of the population is troublesome to the regime as it is under employed and susceptible to criminal and anti-regime political activity.

A.5.1.4. Regime Agenda - Retain Power

Human intelligence reporting has revealed that the Iranian Islamic Consultative (Majlis) urged the President to deal with the internal crisis by adopting a very hard line domestically. The President has taken dual action – internally, through a revitalization of Fundamentalist interpretation of the Faith by purging creeping Western influence, and externally, by asserting Iranian power in the region. The combination of the actions is intended to divert public attention away from the nation's economic stagnation.

Internal Control. Reflecting the internal crackdown and surge of anti-western sentiment, European and Japanese energy firms operating in Iran have become increasingly uncertain of their continued freedom of operation and long term access to energy resources. Investment sponsors underwriting the advanced oil extraction technology expressed concern over rumors of impending nationalization by the Iranian Government. Iranian officials have denied any intent to seize foreign assets, but local Mullahs have begun harassing foreign workers and their families. Workers have encountered restrictions on local travel and movement of equipment. Family members have faced harsh enforcement of Islamic Law. Iranian shop keepers and suppliers have begun refusing service to foreigners, noting they will be fined for such contacts.

External Threats. The Iranian Government's initial external actions consisted of military reinforcement of the key islands in the southern Persian Gulf. This effort was explained to the Iranian public in a televised address. The strident Islamic Fundamentalist rhetoric enjoined the Iranian people to link arms in a shield against the threat of Iraq, the American infidels, and their lackeys in the Middle East. The President declared that endless Iranian efforts to resolve the dispute over the sovereignty of Abu Muse and the Greater and Lessor Tunb Islands have fallen on deaf ears. He expounded on the need for military strength to guarantee the safety of Iranian citizens on the islands. Tacitly, the Iranian island reinforcement was probably intended to remind the Gulf Arabs of Iran's presence.

A.5.1.5. Regional Military Action

The status quo in the region, centered on the agreements between Gulf Cooperation Council states and the western allies had effectively reduced Iran's regional influence, and served to stabilize oil prices at a level below that considered essential to sustain the Iranian economic paradigm. The Iranian Government determined a visible threat to oil resource access would best serve its interests and give the regime renewed regional voice. The Government controlled media has focused on the elite capabilities, unit training, and reinforcement activity on the islands.

Combat engineers have improved preexisting berms, water holding tanks, defensive fighting positions, airfield facilities, and bunkers. Troop strength has been increased and coastal artillery sites have been manned. Because of this action, the UAE protested to the United Nations. However, the protest has elicited very little reaction from the international community. This perceived lack of international interest encouraged the Iranian leadership to broaden their military activities in the southern Gulf.

A.5.1.6. International Shipping Provocations

Recently the Iranian Foreign Minister announced that Iran would begin to enforce the provisions of its 1993 Maritime Law, which provides that the waters between islands not more than 24 miles apart are Iranian internal waters. Passage of vessels through these waters would require Iranian permission. Specifically, the Foreign Minister's proclamation stated that any merchant shipping transiting within Iran's so-called "internal sea" will be boarded and expected to pay a 5% tariff on the cargo. Additionally, Iran stated that no foreign warships would be permitted to enter or transit through the "internal sea," and any attempts to do so would be met with force.

In the northern Gulf, the Iranians have reinforced the contested area of the Shatt al Arab territory. This resurgence of territorial claims was also heralded with Fundamentalist rhetoric. The Mullahs announced a Jihad and Allah's Call to avenge the dead of the eight year Iran-Iraq conflict. This direct challenge to the Iraqi Government has further heightened tensions in the Gulf region. Iraq is countering the Iranian action by moving their forces into the Shatt al Arab area. This movement has flamed the concerns of Saudi Arabia and Kuwait in particular. Overall, the region is primed with dissent, heightening the concerns of all the countries in the Persian Gulf area and the world community.

A.6. Scenario Events

The foregoing JSIMS scenario provides a general picture of the political, economic, and military situation in Iran. This situation is deteriorating to the extent initial pre-hostilities force deterrent options (FDOs) can be expected to be initiated by the National Command Authority. These initial FDOs will not be intrusive or provocative from a military perspective. The JSIMS scenario includes a sequence of events that evolve to trigger progressively more aggressive political decisions and military actions by the United States, its allies, and potential coalition states.

A.6.1. Escalation - Stages One Through Four

A.6.1.1. Stage One.

The Iranian Government continues issuing strong political and military escalation rhetoric simultaneously with efforts to revitalize nationalist fervor.

External Situation

Persian Gulf. The Iranian Media has actively broadcast coverage of the military buildup on the two Tunbs, Abu Musa, and Sirri islands. Iranian military forces continue to strengthen their defensive positions on the islands. The UAE has expressed grave concern regarding Iranian intentions in the Persian Gulf.

Iran-Iraq Border. Iranian military posturing on the Iraqi border continues, and the pace of the force build-up has increased. Two army divisions located at Bakhtaran have moved to defensive positions to the west and along the border. Special forces teams from the 23d Special Forces Division have reportedly made reconnaissance forays over the border into Iraq to coordinate with the Kurds in the northern region of Iraq.

Internal Situation

In spite of the Regime's efforts to control and divert public opinion, political and economic turmoil are growing.

Resistance. Regional political and economic differences are beginning to surface in intellectual and political resistance forums. Common citizens are voicing economic concerns as unemployment increases. The willingness of the population to express opposition is greater in northern Iran, as highlighted by a recent general strike in the city of Tabriz. People in this region are calling for greater regional political autonomy and economic choices.

Military Reliability. Reports of internal military disagreements and leadership purges are coming to the attention of the Iranian public as the Iraq-Iran border is being reinforced. Army personnel in particular recall the bitter carnage endured during the previous eight year war with Iraq. The belated efforts of the regime to portray the historic claims and conflict with Iraq as a Holy cause and declaration of its victims as Martyrs have been unable to erase the negative legacy.

A.6.1.2. Stage Two

Political, military, and terrorist activities accelerate.

Political. Official proclamations indicate a shipping tax will be levied and strictly enforced. The Government issued a demarche to the UAE demanding an immediate oil price increase. The rambling demarche further demanded refusal of passage to all U.S. flagged ships into the Gulf States ports and facilities and threatened any UAE asset found communicating or cooperating with a U.S. Navy ship in the Gulf.

Outward signs of organized political dissent in northern Iran are gaining momentum. The city of Tabriz is becoming the focal point for a rival political faction of government. The local leadership has taken control of local media and is aggressively demanding self rule status. There is intense friction in negotiations and contact with the current national regime.

World opinion is beginning to take on a negative shape toward the aggressive activities of Iran. The United Nations is coming under increasing pressure to react to the belligerent tone and escalating level of Iran's political and military actions in the Persian Gulf region.

The Government of Egypt has made extraordinary diplomatic efforts to defuse the volatile situation and has offered to facilitate a review and possible negotiations on the Iranian issues and claims. The Iranian Government has spurned the Egyptian efforts and denounced the Egyptian Government as a western puppet and traitor to Islam.

Military. The Iranian Government continues its belligerent military actions on the islands adjacent to the Strait of Hormuz. Patrol boats from the Iranian coast have been making provocative runs on shipping moving through the Strait of Hormuz. Reports of Iranian military abuses of UAE citizens on the island of Abu Musa are beginning to surface.

Terrorist. A terrorist group claimed to have placed a bomb in a hotel frequented by American oil business persons in Abu Dhabi, UAE. American and European citizens were among the casualties. Investigation into the incident revealed the group had trained in Iran and maintained links to the Iranian fundamentalist advisors. In addition, several high level members of the group were noted to have received Iranian travel permissions and financial support. The Iranian Government responded to these allegations by decrying them as yet another Western conspiracy and part of an international effort to discredit legitimate Iranian businesses in an effort to hold oil prices down.

A.6.1.3. Stage Three

Military. Iran has established the long threatened tariff on merchant shipping passing through the Gulf of Hormuz. Merchant ships have been boarded and the crews forced to pay the tax before proceeding. Three ships that did not respond to radio and semaphore warning were fired upon, forced to stop, and subsequently boarded. Crews have reported being searched, having their personal property and papers seized, and enduring aggressive responses to any form of resistance. Ships' crews unable or lacking means to render payment have been forced to remain anchored under guard, without resupply, until their parent companies were forthcoming with electronic transfer payment. Several flag line carriers and tanker companies have registered international protests over the contract delays and blackmail nature of the Iranian Navy's enforcement actions.

Coastal defense batteries have been activated all along the Iranian coast. Unannounced live fire exercises against towed targets have been conducted, often in close proximity to passing merchant shipping. Iran conducted a test firing of a SCUD B missile. The missile was launched from a mobile firing position near Teheran. The dummy warhead impacted in the Gulf of Oman. The firing was not announced, nor was a "Notice to Mariners or Airmen" provided by the Iranian Navy or the Government.

A.6.1.4. Stage Four

The situation portends activation of a combined United States, allied, and coalition military response at the major theater war (MTW) level.

Military. The Iranian Army has deployed its Theater Ballistic Missile Force from garrison locations to tactical hide sites. These positions are in the vicinity of prepared launch sites. Chemical warheads are also suspected of having been pre-staged near the SCUD firing positions. Iran's military is at the highest state of alert. National mobilization efforts are underway. Mining preparations are being observed in the Strait of Hormuz area. Submarines have been reported as deployed from known pier locations at Bandar Abbas and Bandar Beheshti.

International Incidents.

An American flagged tanker was fired upon, boarded, and the crew taken hostage. The ship was subsequently set on fire and is expected to be scuttled inside the Iranian 12 mile limit north of Jazereh-ye Forur Island in the ingress shipping lane.

An Egyptian flagged commercial cargo ship transiting off Abu Mase radioed a distress call and described hull damage indicating the ship had struck a mine. The crew was taken into custody by Iranian patrol forces and transported to the Island. The damaged ship was scuttled after supplies and some of its cargo were removed.

Political. The United States issued a formal international protest of the Iranian attack on the oil tanker and demanded the immediate release of the ship's crew. The Iranian Government responded by moving the hostages to the mainland and announcing preparations to try the American captain as a spy. The state controlled Iranian media broadcast images of cryptologic equipment and communications suites ostensibly described as being seized from the tanker.

The Egyptian Government issued an immediate protest and demand for the release of the ship's crew.

Iranian radio announced obtaining proof of the Egyptian Government 's secretly cooperating with the United States to betray the faithful by placing American spies among the ship's crew.

Iran has withdrawn its Ambassador to the United Nations for emergency consultations. Government security forces have surrounded the Japanese Embassy and demanded oil royalty payments in lieu of unpaid shipping taxes. The Swiss Ambassador has reported that requests for the departure of Japanese Embassy sponsored dependents have been rebuffed.

Economic. Lloyds of London has declared the Strait of Hormuz a high risk area and tripled its insurance rates on commercial shipping bound through the Persian Gulf. Speculation on the international oil market has generated crude oil price increases. Japan and Indonesia have reported spot shortages of refined petroleum products.

Environmental. The sinking of the U.S. oil tanker threatens to release a swath of crude oil into the Gulf. Regional concern for the protection of desalinization facilities is paramount. Fresh water supplies in the region are estimated marginal. Loss of water production would exacerbate immediate health concerns and further destabilize the regional situation.

A.7. Operational Situation

A.7.1. Background

In response to this hypothetical scenario environment, planning guidance in the Joint Strategic Capabilities Plan (JSCP) will have directed the Commander-in-Chief, US Central Command (CINCCENT) to prepare operational plans for the Persian Gulf region. Because of the political, economic, and military volatility of the Persian Gulf region and because of its strategic importance, a fully developed operational plan would be ready for implementation. These war plans are developed within the context of the Joint Operations Planning and Execution System (JOPES) "deliberate" planning process in response to specific guidance in the JSCP. Fully developed plans include a Time Phased Force Deployment Data (TPFDD) file and corresponding supporting CINCs' plans.

In this hypothetical operational situation the plan would be assigned an exercise reference name under the existing OPLAN. The plan would be updated continually as events occur to maintain the plan in a "ready to execute" status awaiting a National Command Authority (NCA) execute decision. The plan concept includes five distinct stages: (1) prehostilities; (2) lodgment; (3) decisive combat and stabilization; (4) follow-through; and (5) posthostilities and redeployment. These stages support activities that constitute the five phases of war – mobilization, deployment, employment, sustainment, and redeployment.

CINC Campaign Plan: A Persian Gulf major theater war (MTW) campaign plan would exist for the region to link national strategic security objectives to the operational level joint task force (JTF) planning requirement. As a minimum this plan would include: (1) theater objectives; (2) CINC's mission statement; (3) concept of operations; (4) command and control arrangements; and (5) force allocation. In general this campaign plan embodies the combatant commander's strategic vision of the arrangement of related operations to accomplish theater objectives and the assigned mission. The following represents a skeleton campaign plan that would set the operational stage for a CINCCENT established joint task force (JTF) to conduct this MTW operation.

A.7.2. Theater Objectives

Theater objectives for this scenario follow:

- Assure access to strategic resources. In coordination with allies and friendly nations in the region, ensure continued, unimpeded access to the petroleum reserves in the Gulf area. In particular, prevent hostile forces from gaining control or threatening closure of the Strait of Hormuz.

- Ensure external security for friendly regional states. Foster programs to improve the defense capabilities of friendly nations in the region. Encourage the development of political and economic activities within, and cooperative security arrangements among, friendly nations in order to enhance regional stability. When directed, provide direct U.S. military assistance to deter attacks on or defend friendly nations from external threats.

- Develop plans to provide direct U.S. military assistance to deter attacks on friendly countries and, in the event that deterrence fails, defend them from external attack. These plans should address various levels of U.S. involvement, from logistics support only; to support of friendly regional forces by air, naval, and SOF forces; to employment of major U.S. ground, naval, and air forces.

- Ensure the security of the Strait of Hormuz from control or interdiction by hostile powers.

- Conduct routine naval operations to ensure the freedom of navigation through international waterways in the region and develop plans to respond to attempts by hostile powers to curtail or stop freedom of navigation in vital international waterways.

- Countering weapon proliferation, including active and passive actions and plans to counter effectively the military and political intimidation and war fighting activities of adversaries who possess weapons of mass destruction and missile delivery systems.

A.7.3. Mission Statement

When directed conduct military operations in the Persian Gulf operational area to prevent hostile forces from gaining and maintaining control of the international waterways in the Gulf region to insure continued free passage to and from the area, and to counter military intimidation and war fighting against allies and friendly nations. Should deterrence fail, conduct land, sea, and aerospace operations to counter the aggression and reestablish friendly force control and long term stability in the region.

A.7.4. Concept of Operations

The CINC Campaign Plan concept of operations would be segmented into the five stages as identified above. Representative strategic national, strategic theater, and operational level activities supporting these stages follows:

Stage 1 - Prehostilities: Actions in this stage include "adaptive planning" generated flexible deterrent options (FDOs) that focus on deterrent measures. These measures include political, economic, diplomatic, and military efforts to stabilize the situation in the region. USCENTCOM generated military FDOs include: (1) Increase readiness of in-place forces; (2) Upgrade the in-place force alert status; (3) Increase strategic and operational reconnaissance and intelligence collection efforts (including SOF missions); (4) Direct show of force by ordering deployment of the Army prepositioned sets (APS) and maritime prepositioning ships (MPS); deploying a CVBG to the region along with the deployed ARG/MEU, and an "advance force" JTF HQ element aboard a Navy command ship (LCC); moving Air Force tactical fighter squadrons and air command and control assets to bed-down positions in the region; bolstering command, control and communications in the area; and, upgrading the region's logistic posture. Corresponding activities at the U.S. national level include initiating actions to form an international coalition to confront this hostile activity under United Nation sponsorship.

Stage 2 - Lodgment: Military actions in this stage include reestablishing the "rights of innocent passage" through the waterways in the Gulf; establishing lodgment areas in the region to support follow-on deployment of a decisive combat force; and a corresponding logistics support buildup in the event deterrence fails. If necessary, forcible entry operations will be conducted to establish lodgments for initial defensive and subsequent offensive operations and force expansion. This stage will also include increased reconnaissance and intelligence collection efforts and expansion of command and control facilities in the theater of operations. Pre-hostilities lodgment activities will include peacetime deployment to host nation air and sea ports in the event pre-hostility deterrent activities are warranted based on hostile force reactions to deterrent measures implemented in the first stage. In-theater forces will focus on defensive measures to secure lodgment areas and on providing operational security for the forces deployed in the region, to permit lodgment activities to proceed as planned to support the buildup effort.

Stage 3 - Decisive Force and Stabilization: The initial focus of this stage will be on a rapid buildup of joint forces' offensive combat capability. Force flow will be established to expand the offensive capability to a point were decisive combat operations can be initiated to defeat the enemy forces and reestablish stability in the Persian Gulf region. Once the buildup has been completed, joint forces will transition from a defensive posture and, when feasible, conduct combat operations in the land, air, and maritime areas of operation (AOs). Decisive action will focus on winning, as directed by the NCA, by controlling the enemy territory and population and by destroying the enemy's ability and will to continue the war.

Stage 4 - Follow-through: This stage will involve a synchronized theater-wide effort to bring military operations developed in the above stages to a successful conclusion. Activities include actions to ensure the political objectives are achieved and sustained. The main thrust of this effort will be to assure that the military and/or political threat will not resurface. This will be done by addressing long term requirements to secure an enduring stability in the Gulf region. Theater forces will be prepared to conduct peacekeeping operations and transition to operations in support of other governmental agencies or UN directed activities. The emphasis will be on war termination objectives as established by the NCA. Forces will conduct military operations that will not conflict with the long-term solution to the problems that initially generated the crisis.

Stage 5 - Post-hostilities and Redeployment: This stage will evolve from military combat operations and transition to operations associated with peacekeeping. U.S. forces will initially focus on preparing to reduce the scope of military involvement in the region. These forces can expect to transition from controlling the war effort to a role of providing support as in the context of a "supporting" command to a non-military organization. As military requirements for operational forces are reduced they will be phased out of the theater of operations. Redeployment will be phased to correspond with the operational situation. Combat arms beyond security forces will be redeployed first. Support forces can be expected to remain until region stabilization efforts are assumed by non-military agencies. At this point in the stage, total redeployment will be directed, concluding the CINC's mission.

A.7.5. Command and Control

Command relationships would be specified in the CINC plan. This plan would designate a joint task force (JTF) commander to provide command and control over the joint operational effort. Command authority would be specified for the JTF commander and, in this case, operational control (OPCON) would be delegated to the JTF commander. Command relationships for dealing with coalition and allied forces would also be detailed. The basis for the notional command and control relationships is as identified in the JTF organizational structure included at Figure A.4.2.

Control measures would be specified to establish bounds for the JTF in executing the mission tasks assigned. A key bounding measure is provided in the form of designated operational areas. These areas as designated for the CINC plan follow:

- Theater of War -- Persian Gulf Region including the countries of Iran, Iraq, Saudi Arabia, Qatar, United Arab Emirates, Oman, and Kuwait.

- Joint Operations Area (JOA) -- The area within the theater designated by the CINC in which the JTF will conduct military operations. The JOA includes land, sea, and airspace. This area includes the western area of Iran, eastern Persian Gulf area of Saudi Arabia, Kuwait, Oman, United Arab Emirates, the Persian Gulf, Gulf of Oman, and the sea approaches from the Arabian Sea.

- Joint Special Operations Area (JSOA) – The land, sea, and airspace assigned to Special Operations Forces for operations by SOF units. The stage one JSOA includes the general area of the Hormozgan and the Zagos Mountains region of Iraq.

- Joint Rear Area (JRA) -- The area wherein the JTF facilitates the protection and operation of bases, installations, and forces that support combat operations in theater. Initial JRA is in Dhahran, Saudi Arabia and Diego Garcia, B.I.O.T. Other JRAs will be designated as the operation progresses through the various stages of the operation throughout the world. Areas where stage 2 lodgments are established can be anticipated for planning purposes to become JRAs as the operation progresses.

- Area of Operations (AO) – Land, air, and sea area where land and naval forces operate within the JOA. They will not include the entire JOA, but include areas needed to control land, sea and air operations as the war effort progresses through the designated stages.

- Area of Interest -- Area within the theater in which the JTF commander has a general interest as activities in the area may impact on his operation. Of primary interest is the area in and from which the enemy can affect current or future operations.

A.7.6 Force Allocation

The CINC plan would allocate planning forces to conduct the operation. These forces would hypothetically be as designated in the JSCP for a Major Theater War (MTW) in the Persian Gulf Theater of Operations. These forces would identify the resources the JTF commander can expect to have available to conduct the operation if and when authorized for execution. A notional force allocation for this operation is included at Annex B.

A.8. Military Operations Other Than War (MOOTW)

The MOOTW scenario envisioned is a humanitarian relief mission subset of the major theater war scenario. It will focus on the exercise of a joint training audience nearing the conclusion of an assigned relief mission. Activities will center on preparation for closure, e.g., transition of the on-scene situation to civilian authority and military withdrawal operations.

A.8.1. Background

During the course of the MTW it comes to the attention of the international community that a minority ethnic faction in the JOA has been subjected to increasing physical and economic abuse by Iranian military forces, with the tacit approval of the Iranian Government. Members of the faction experience increasing difficulty in finding work, and many are discharged from positions they have held for several years. Methodical eviction of faction families from their homes begins, and rumors of summary executions start to circulate, some appearing in the international press. Historical religious and cultural variances from the Iranian majority provide the Iranian media with justification for the sanctions imposed by the military, but the Iranian media facade is not lost on the international press or the world community.

During the follow-through stage of the MTW, the JTF commander is alerted to prepare to provide security and support efforts by nongovernmental organizations (NGOs) and private voluntary organizations (PVOs) that have initiated relief activities on behalf of faction members. Subsequently, the JTF commander is directed to execute that mission, resulting in detachment of security and support forces to the area of interest to perform necessary security and support functions associated with the humanitarian relief operation.

A.8.2. Factors Affecting Mission Execution

- The relief operation is conducted amidst ongoing international negotiations to establish standards for the autonomy of the minority group, as a subset of a peace agreement.
- The signature of a peace accord includes provision of immediate elections in the minority dominated area of interest.
- International representatives note the need to conduct election training and monitoring in the contested area to ensure minority access and confidence in the electoral process. Elements of election results include decisions on self rule, autonomy, or continued minority representation within the ruling government.
- Successful elections and repatriation of minority displaced persons to their homes are essential conditions to the conclusion of the humanitarian mission (and larger MTW).

A.8.3. MOOTW Development Scenario Summary

Determination of the training audience will assist refinement of the MOOTW scenario and preparation of organizational relationships for replication in the JSIMS build. Unlike the standing OPLAN ready for execution and under continuing updates, MOOTW mission requirements often develop without existing plans or guidelines. The potential for use of JSIMS to quickly replicate real world circumstances - build and rehearse or study various alternative courses of action could provide the users a unique and valuable tool for assessing and responding to high pressure situations.

A.9. Academic Seminar Training Scenario

Currently envisioned as a classroom training session for a school house audience or for an operational commander and staff, the academic seminar is the ideal forum for presentation and JSIMS facilitation of non traditional military missions. Such an event might include study of lessons learned in Somalia and Bosnia, followed by a JSIMS supported United Nations mandated mission. JSIMS training support would include replication of the United Nations entities and decisions relevant to the example scenario.

ANNEX B JSIMS DEVELOPMENT SCENARIO FORCE

B.1. General

The following is a notional presentation of the forces allocated to CINCCENT for planning purposes. The forces presented would be designated in the Joint Strategic Capabilities Plan (JSCP). In a hypothetical environment the forces listed below will eventually be assigned to a JTF for operations in the JOA. Forces will be phased into the operation to support the operational concept. The following is a breakout of the forces expected to be deployed into the theater to meet operational requirements. N day is the the day that active duty units are notified for deployment/redeployment. C days are the days that active duty units deploy. M day is the day that reserve/air national guard units deploy.

Attachment (1) to Annex B: U.S. Forces

B.A1.1. In Place Forces - Major Theater War - Persian Gulf

The following forces can be expected to be in theater at the time the OPLAN is ordered executed by the NCA.

Army Forces

Unit	Available Date	Location	Source	Component	Remarks
APS 4a	Available	Kuwait	CENTCOM		Brigade Set
APS 4b	Available	Qatar	CENTCOM		Brigade Set

Air Forces

Unit	Available Date	Location	Source	Component	Remarks
Composite Wing	Available	Saudi Arabia	CENTCOM	Active	1 Sqdrn F-15s 2 Sqdrns F-16s

Naval Forces

Unit	Available Date	Location	Source	Component	Remarks
5th FLT SAG	Available	Arabian Sea	CENTCOM		Note 1
Peleliu ARG	Available	Arabian Sea	CENTCOM		Note 2, 15th MEU embarked
MCM-1 Ardent and Dexterous	Available	Home ported, Bahrain	CENTCOM		Rotational crews, operate with 5th Flt
VP DET	Available	Masirah	CENTCOM		3 P-3C ,EP-3

Note: 1. Valley Forge SAG

Designation	Name	Capability
CG-50	Valley Forge	2 SH-60 Lamps III
DD-968	Arthur W. Radford	2 SH-60 Lamps III
DD-969	Peterson	2 SH-60 Lamps III
DDG-72	Mahan	2 SH-60 Lamps III
MHC-53	Oriole	Mine Hunter
MHC-55	Pelican	Mine Hunter
MCM-8	Scout	Mine Countermeasures
MCS-12	Inchon	8 MH-53's Embarked

Designation	Name	Capability
T-AO 202	Yukon	Oiler

Note 2. PELELIU Amphibious Ready Group (ARG)

Designation	Name
LHA-5	Peleliu
LPD-9	Denver
LSD-39	Mount Vernon
LSD-45	Comstock

15 th MEU embarked on PELELIU ARG

Designation	Capability
Battalion Landing Team 2/1	1 Infantry Bn, 12 AAV, 6 LAV, 6 M198
VMA-214	Six Harriers
HML/A	3 UH- I N & 4 AH- 1W
HMM- 164	12 CH-46, 4 CH-53
MSSG-15	

Coast Guard Forces:

Units	Location	Available Date	Remarks
Coast Guard Port Security	Bahrain and UAE	Available	4 16 ft and 2 110 ft boats

B.A1.2. Allocated for Planning - Persian Gulf Region

CINC/CENTCOM Staff:

Parent Unit	Sub-Unit	Location	Available	Component	Remarks
CENTCOM	HQ staff	CONUS	N+2, C+5	Active	

Army Forces:

Parent Unit	Sub-Unit	Location	Available	Component	Remarks
3rd Army	HQ 3d Army	CONUS	N+1, C+7	Active	
	HQ III Corps	Fort Sill, OK	N+2, C+30	Active	
	1st Mech Div	Germany	N+2, C+30	Active	1 Bde (Ft. Riley, KS)
	4th Mech Div	Fort Hood, TX	N+4, C+45	Active	
	1st Cav Div	Fort Hood, TX	N+4, C+45	Active	
	3rd Armd Cav Rgt	Fort Carson, CO	N+4, C+45	Active	
	6th Cav Bde	Fort Hood, TX	N+4, C+45	Active	
	III Corps Arty	Fort Sill, OK	N+4, C+45	Active	
	504th MI Bde	Fort Hood, TX	N+4, C+45	Active	
	89th MP Bde	Fort Hood, TX	N+4, C+45	Active	
	31st AD Bde	Fort Hood, TX	N+4, C+45	Active	
	13th CosCom	Fort Hood, TX	N+4, C+30	Active	
	155th Cav Bde	Tupelo MS	N+2, C+30	Active	
	MD Bde		N+2, C+90	Reserve Comp	FORSCOM
	Engr Bde		N+2, C+90	Reserve Comp	FORSCOM
	XVIII ABN Corps	Fort Bragg	C+4	Active	
	Corps HQ	Fort Polk	C+4	Active	
	2 ND Lt. Armd	Fort Bragg	C+10	Active	

Parent Unit	Sub-Unit	Location	Available	Component	Remarks
	Cav Rgt				
	1st CosCom	Fort Bragg	C+2	Active	
	525th Med Bde	Fort Bragg	C+2	Active	
	44th Med Bde	Fort Bragg	C+2	Active	
	18th Avn Bde	Fort Bragg	C+2	Active	
	35th Signal Bde	Fort Bragg	C+2	Active	
	16th MP Bde	Fort Bragg	C+2	Active	
	20th Engineer Bde	Fort Bragg	C+2	Active	
	108th AD Bde	Fort Bliss	C+2	Active	
	XVII ABN Corps Arty	Fort Bragg	C+2	Active	
	82nd Air Defense Bde	Fort Bragg	C+2	Active	
	101st Air Assault Div	Fort Campbell	N+2, C+45	Active	
	3rd Mech Div	Fort Stewart	N+2, C+45	Active	
	10th Inf Div	Fort Drum	N+2, C+45	Active	

Air Forces:

Unit	Location	Available	Component	Remarks
HQ 9th AF	CONUS	C+4	Active	
ASOCC	CONUS	C+4	Active	Air Sector Operations Center
Composite Wing	CONUS	C+4	Active	1 Squadron F-15s/ 2 Squadrons F-16s
Fighter Wing	CONUS	C+4	Active	1 Squadron F-15s
AWACS Wing	CONUS	C+4	Active	16 AWACS
Fighter Wing	CONUS	C+10	Active	4 Squadrons A-10s
Fighter Wing	CONUS	C+4	Active	2 Squadrons F-15
Fighter Wing	CONUS	C+4	Active	3 Squadrons F-16
Fighter Wing	CONUS	C+6	Active	4 Squadrons F-15E
Fighter Wing	CONUS	M+30	Air National Guard	3 Squadrons F-15E
Bomb Wing	CONUS	C+4	Active	16 B-ls
Bomb Wing	CONUS	C+14	Active	16 B-ls
Bomb Wing	CONUS	C+4	Active	12 B-52s
Bomb Wing	CONUS	C+14	Active	12 B-52s
Stealth Wing	CONUS	C+4	Active	36 F-117s
Fighter Wing	United Kingdom	C+4	Active	54 F- 15s
Fighter Wing	Italy	C+4	Active	1 Squadron F- 16s
Fighter Wing	CONUS	M+30	Air National Guard	7 Squadrons F-16s
Fighter Wing	CONUS	M+30	Air Force Reserve	2 Squadrons F-16s
JSTARS Det	CONUS	C+4	Active	3 E-8 A/C
Det 11th Recon	CONUS	C+4	Active	4 Predator UAV
Det Surveillance	CONUS	C+4	Active	3 RC-135s; 2 U-2s
AMC Squad	CONUS	C+4	Active	10 KC-10
Refuel Squads	CONUS	C+4	Active	24 KC-135
AMC Squad	CONUS	C+4	Active	12 C-17
Airlift Squads	CONUS	C+4	Active	16 C-130

Navy Forces:

Parent Unit	Sub-Units	Location	Available Date	Remarks
5th Fleet TF 50		Bahrain		
TG 50.1	Task Force 50	Indian Ocean	N+3	Embarked Blue Ridge LCC-19
TG-50.2	Nimitz CVBG	Indian Ocean	N+2	Note 1
TG-50.3	Truman CVBG	Atlantic Ocean	N+20	Note 2
TG-50.4	Bataan ARG	Mediterranean Sea	N+7	With Truman TG/26MEU, Note 3
TG-50.5	Kearsarge ARG	Mediterranean Sea	N+7	In Work-up, Note 3
TG-50.6	Guam ARG	Norfolk	N+20	Ready ARG, Note 3
TG-50.7	MPSRON	Diego Garcia	N+6	Preposition Force
TG-50.8	ATF	Pacific Ocean	N+14	PhibGru-3
TG-50.9	MPSRON-3	Guam	N+10	Preposition Force

Note 1: Nimitz Carrier Battle Group (CVBG)

Designation/Name	Designation/Name	Designation/Name
CVN-68 Nimitz	CG-59 Princeton	CG-73 Port Royal
DDG-62 Fitzgerald	DDG-69 Milius	FFG-57 Reuben James
SSN-717 Olympia	SSN-752 Pasadena	AOE-10
PC-4 Monsoon (SOF support)	PC-5 Typhoon (SOF support)	CVW-9 (74 A/C: 14 F-14, 36 F/A-18, 4 EA-6B, 4 E-2C, 8 S3B, 4 SH-60F, 2 HH-60H, 2 ES-3A)

Note 2: Truman Carrier Battle Group (CVBG) will have similar size units and aircraft embarked to that described in the Nimitz Battle Group. One aircraft carrier with 74 aircraft, two cruisers, two guided missile destroyers, one guided missile frigate, two attack submarines, and an oiler.

Note 3: Bataan Amphibious Ready Group (ARG), Kearsarge Amphibious Ready Group (ARG) and Guam Amphibious Ready Group (ARG) will each have units and embarked MEU similar to that described in paragraph B.a.1 above.

Coast Guard Forces:

Parent Unit	Units	Location	Available Date	Remarks
TG-55.3	WHEC 715	Atlantic Ocean	N+20	CGC Hamilton
TG-55.4	WHEC 716	Mediterranean Sea	N+7	CGC Dallas
TG-55.2	WHEC 721	Indian Ocean	N+2	CGC Gallatin
TG-120	WMEC 911/901	Caribbean Sea	N+30	CGC Forward & Bear

Marine Corps Forces:

Parent Unit	Sub-Units	Location	Available Date	Remarks
I MEF		CONUS	C+2	Camp Pendleton,CA
CE	HQ I MEF	CONUS	C+2	Command Element
	9th Comm Bn (-)	CONUS	C+2	
	1st Radio Bn (-)	CONUS	C+2	
	1st ANGLCO (-)	CONUS	C+2	
GCE	H&S Bn (-) 1st MARDIV	CONUS	C+2	

Parent Unit	Sub-Units	Location	Available Date	Remarks
	1st MarRegt	CONUS	C+2	
	5th MarRegt	CONUS	M+10	
	7th MarRegt	CONUS	C+2	MPS Fly in Echelon
	11 th MarRegt	CONUS	C+2	4 Arty Bns: 18x I 55tow
	3rd AAV Bn	CONUS	C+2	4 Cos: 208 AAVs
	1st LARBn	CONUS	C+2	4 Cos: 106 LAVs
	1st Tk Bn	CONUS	C+2	4 Cos: 58 M-ls
	1st Cbt Eng Bn	CONUS	C+2	4 Cbt CO's + I Eng Spt CO
	8th Tk Bn	CONUS	C+2	4 Cos 58 M-1s
	4th AAV	CONUS	C+2	2 Cos 102 AAVs
FSSG	HQ 1st FSSG	CONUS	C+2	
	H&S Bn	CONUS	C+2	
	7th Engr Spt Bn	CONUS	C+2	
	1st Supply Bn	CONUS	C+2	
	1st Maint Bn	CONUS	C+2	
	7th MT Bn	CONUS	C+2	
	1st Landing Spt Bn	CONUS	C+2	
	1st Med Bn	CONUS	C+2	
	1st Dental Co	CONUS	C+2	
ACE	3rd MAW	CONUS	C+2	Cherry Point NC
	Marine Air Control Group 38	CONUS	C+2	36 IHAWKS, 60 Avengers, 30 Stingers
	MAG-13	CONUS	C+2	60 AV-8B, 10 RPV
	MAG-16 & 39	CONUS	C+2	72 CH-46s 48 CH-53s
	MAG-11	CONUS	C+2	72 F/A-18C/Ds, 12 KC-130s, 6 EA-6B
	MAG-39	CONUS	C+2	54 AH-1W 27 UH-1N
	MWSG-2	CONUS	C+2	Logistic/ Maintenance
II MEF	II MEF (Forward) CE	LeJeune	C+2	Amphibious MEF (FWD), Camp LeJeune, NC
	HQ CO	CONUS	C+2	Camp Lejeune NC
	Det 2nd SRIG	CONUS	C+2	Camp Lejeune NC
	Det 8th Com Bn	CONUS	C+2	Camp Lejeune NC
	Det 2nd Radio Bn		C+2	
	Det, Intel Co		C+2	
	Det 2nd Force RECON	CONUS	C+2	Camp Lejeune NC
	Det 2nd ANGLICO	CONUS	C+2	Camp Lejeune NC
GCE	RLT-8		C+2	3 Infantry Bns, 1 Artillery Bn 18 M198s 2nd AAV Bn (-) 102 AAVs Tk Co 14 M-1s LAR Co 25 LAVs

Parent Unit	Sub-Units	Location	Available Date	Remarks
ACE	MAG-26		C+2	Cbt Eng Co 16 CH-53s 36 CH-46s 18 AH-1W, 9 UH-1N 12 AV-8B
CSSE	CSSG-5		C+2	Det, 8th Eng Bn Det, 2nd Maint Bn Det, 2nd Supply Bn Det, 2nd Med Bn Det, 8th Motor Transportation Bn Det, 2nd Landing Support Bn

Special Operations Forces (SOF):

Parent Unit	Sub-Units	Location	Available Date	Remarks
SOCOM	HQ SOCCENT	CONUS	N+2, C+7	
Army SOF:	5th Special Forces Group (SFG)	CONUS	N+4, C+14	3 Battalions
	19th SFG	CONUS	M+30	National Guard
	4th Psychological Operations Group (POG) (-)	CONUS	HQ element N+7, C+21	Task organized, BN (-)
	96th Civil Affairs Battalion (CA BN) (-)	CONUS	LNOs N+7, C+14 Reserves M+60	Task organized
	160th Special Operations Air Regiment (SOAR) (-)	CONUS	N+7 to 14	MH-60/MH-47E
	75Tth Ranger Regiment	CONUS	N+4, C+14	1 Battalion
Air Force SOF: 16th Special Operations Wing (SOW)		CONUS	N+4, C+7	HQ functions
	21st Special Tactics Squadron (STS)	CONUS	N+4, C+7	
	20th Special Operations Squadron (SOS)	CONUS	N+4, C+7	MH-53J
	55th SOS	CONUS	N+4, C+7	MH-60G
	4th SOS	CONUS	N+4, C+7	AC-130U
	16th SOS	CONUS	N+4, C+7	AC-130H
	8th SOS	CONUS	N+4, C+7	MC-130E
	9th SOS	CONUS	N+4, C+7	MC-130P
	15th SOS		N+4, C+7	MC-130H
Navy SOF : Navy Special		CONUS	N+4, C+7	HQ Element

Parent Unit	Sub-Units	Location	Available Date	Remarks
Warfare Group (NSWGRP) 1				
	SEAL Team 1	CONUS	N+4, C+7	Task organized
	SEAL Team 3	CONUS	N+4, C+7	Task organized
	SEAL Team 5	CONUS	N+4, C+7	Task organized
	Special Dive Vehicle (SDV) Team 1	CONUS	N+14, C+21	
	Navy Special Boat Squadron (NAVSPECBOATRON) 1	CONUS	N+14, C+21	Task organized
	Special Boat Unit (SBU) 12	CONUS	N+14, C+21	Task organized (PC/MK-V/RHIB)
	Det MRC 5 Unit	CONUS	N+7 to 14, C+14 to 21	

Attachment (2) to Annex B: Combined/Coalition Forces

B.A2.1. SAUDI ARABIA

B.A2.1.1. Saudi Land Forces

Ground Forces	Number	Remarks
Armored Brigades	3	M-1 Abrams and M60s mix
Airborne Brigades	1	
Infantry Brigades	5	
Artillery Battalions	8	
Anti-Tank Weapons	1,029	(TOW and Dragon)
Air Defense Systems		
I-HAWK	8 batteries	
Patriot	2 batteries	
Helicopters		
AH-64	72	
Major Equipment:		
Tanks	600	
Armored Personnel Carriers	1,000	(M-113, LAV and IFV)

B.A2.1.2. Saudi Air Forces:

Aircraft Type	Number	Remarks
Fighter, Interceptor, Ground Attack		
F-15C/D	98	
Mirage 2000	48	
F- 15E	48	
F- 16C	36	
Reconnaissance		
RF-5	24	
E-3	3	
Transport		
KC- 130	7	
KC-10	4	
UH-60	16	

B.A2.1.3. Saudi Navy Forces:

Ship Type	Number	Remarks
Missile Patrol Craft	11	
Frigates	8	
Mine Countermeasures	7	
Patrol	29	
Helicopters		
AS-365N	21	
Helicopters		
AS-332B/F	12	

B.A2.2. KUWAIT

B.A2.2.1. Kuwaiti Land Forces:

Ground Forces	Number	Remarks
Armored Brigades	2	M-1 Abrams
Mechanized Brigades	1	
Infantry Brigades		
Major Equipment		
Tanks	373	
Armored Personnel Carriers	389	M- 1 13, IFV TOW, BNT-AT-3
Surface-to-Surface Missiles	18	MLRS
Anti-Tank Weapons	938	TOW/Dragon
Air Defense Systems		
Patriot	1 battalion	
Ground Forces	**Number**	**Remarks**
Rapier, Roland	10 launchers	
Avenger PAADS	18 launchers	
Helicopters		
AH- 1	24	

B.A2.2.2. Kuwaiti Air Forces:

Aircraft Type	Number	Remarks
Fighter, Interceptor, Ground Attack		
F/A-18C	40	
Helicopter, Transport Misc.		
AH-64, SA-342	23	
SA-330, AS332	11	
UH-60S	16	
L-100	3	
DC-9	1	

B.A2.3. EGYPT:

B.A2.3.1. Egyptian Land Forces:

Ground Forces	Number	Remarks
Armored Brigades	2	M-1 Abrams
Infantry Brigades	3	

B.A2.3.2. Egyptian Air Forces:

Aircraft Type	Number	Remarks
F/A-16	40	2 Squadrons

B.A2.4. GULF STATES (BAHRAIN, QATAR, UAE, OMAN)

Forces are displayed in combined aggregate unless otherwise noted.

B.A2.4.1. Gulf States Land Forces:

Ground Forces	Number	Remarks
Armored Brigades	2	Various Older Models
Armored Regiments	2	
Artillery Brigades	2	
Artillery Regiments	4	
Field Artillery Regiments	1	
Infantry Brigades	3	
Infantry Regiments	9	
Mechanized Infantry Battalions	4	
Mechanized Infantry Brigades	1	
Tank Battalions	1	
Major Equipment:		
Tanks	354	
Armored Personnel Carriers	826	
Surface-to-Surface Missile Launchers		
Scud-B	6	
Anti-Tank Weapons	420	
Air Defense	158	
Helicopters	154	

B.A2.4.2. Gulf States Air Forces:

Fighter, Interceptor/Ground Attack	Number
Country	
Bahrain	24
Fighter, Interceptor/Ground Attack	**Number**
Qatar	12
UAE	34
Oman	27
Reconnaissance	8
Transport	48

B.A2.4.3. Gulf States Navy:

Ship Type	Number	
Missile Patrol Craft	19	
Frigates	2	
Patrol	50	
Corvettes	4	
Mine Countermeasures	14	7 Oman, 7 UAE

Attachment (3) to Annex B: Opposing Forces Order of Battle

B.A3.1. IRAN

B.A3.1.1. Land Forces:

Unit	Location	Remarks
58th Infantry Div	Tabriz	
40th Infantry Div	Tehran	
55th Parachute Div	Tehran	
23rd Special Forces Div	Tehran	
18th Armored Div	Qazvin	
77th Infantry Div	Mashed	
88th Armored Div	Bakhtaran	
64th Infantry Div	Bakhtaran	
28th Mechanized Div	Ahvaz	
84th Mechanized Div	Shiraz	
30th Infantry Div	Bandar Abbas	
451st Mechanized Brigade	Bandar Abbas	
478th Mechanized Brigade	Chah Bagar	
81st Armored Division	Zahedan	

B.A3.1.2. Air Forces:

Aircraft Type/Unit	Location	Number	Remarks
F-4E Squadron	Bandar Abbas	10 A/C	
MIG-29 Squadron	Bandar Abbas	10 A/C	
F- I 4A Squadron	Bandar Bushehr	10 A/C	
F-4E Squadron	Bandar Bushehr	10 A/C	
SU-27 Squadron	Bandar Bushehr	10 A/C	
F-5E/F Squadron	Shiraz	10 A/C	
SU-22 Squadron	Shiraz	10 A/C	
SU-27 Squadron	Shiraz	10 A/C	
P-3 Surveillance Sqdrn	Shiraz	3 A/C	
C-130 Transport Sqdrn	Shiraz	25 A/C	
SU-24 Group	Shiraz	30 A/C	
F-7 Squadron	Ahvaz	18 A/C	
F-6 Squadron	Ahvaz	16 A/C	
F-4E Squadron	Mehrabad (Tehran)	10 A/C	
RF-4E Recon Squadron	Mehrabad	10 A/C	
F-5E/F Group	Mehrabad	20 A/C	
MIG-29 Squadron	Mehrabad	20 A/C	
SU-25 Squadron	Mehrabad	20 A/C	
SU-24 Squadron	Mehrabad	10 A/C	
F-4E Squadron	Hamadan	10 A/C	
RF-4E Recon Squadron	Hamadan	5 A/C	
SU-22 Squadron	Hamadan	10 A/C	
F-5E/F Group	Tabriz	20 A/C	

Aircraft Type/Unit	Location	Number	Remarks
MIG-29 Squadron	Tabriz	15 A/C	
MIG-23 Squadron	Tabriz	10 A/C	
F-5E\F Squadron	Dezful	10 A/C	
SU-24 Squadron	Dezful	10 A/C	
F- I Mirage Squadron	Dezful	12 A/C	
F-14A Squadron	Esfahan	10 A/C	
SU-22 Squadron	Esfahan	10 A/C	
F- I Mirage Squadron	Zahedan	12 A/C	
SU-22 Squadron	Zahedan	10 A/C	

B.A3.1.3. Navy Forces:

Ship Type/Unit	Location	Remarks
Squadron Tareq Submarines	Bandar Abbas	3 Kilo Class Submarines
Squadron SSM Submarines	Bandar Abbas	3 Iranian Design
Yugo Submarines	Bandar Abbas	6 SSMs
Damavand Destroyer	Bandar Bushehr	1 ship
Alvand Frigates	Bandar Abbas	3 ships
Bayandor FSs	Bandar Abbas	2 ships
Houdongs	Bandar Bushehr	25 patrol craft
Kaman PGFs	Bandar Bushehr	10 craft
Chaho	Bandar Bushehr	3 craft
Kaivan Patrol Craft	Bandar Bushehr	3 craft
Parvin Patrol Craft	Bandar Bushehr	3 craft
Small Patrol Craft	Coastal Ports Throughout	213 craft
BH7 Hovercraft	Bandar Bushehr	4 craft
Landing Ships/Craft	Bandar Bushehr	24 assorted
Mine Countermeasures	Bandar Bushehr	2 ships

B.A3.1.4. Iranian Missile Forces:

Type	Launchers	Missiles	Range
SCUD B	24-36	300	320km
SCUD C	24-36	250	600km
NO DONG I	18-24	100	1300km
CSS - 2 SILKWORM	12	50	30nm

APPENDIX C- JSIMS LEARNING METHODOLOGY

This appendix is a study of Learning Methodology Working Group (LMWG) which was chartered by Office of the Chief of Naval Operations (OPNAV) to assure that the Joint Simulation System (JSIMS) provides an effective learning environment for its users. This study is given as an appendix at the end of the thesis to familiarize the Turkish modeling& simulation designers and developers with Learning Methodologies of JSIMS.

C.1- BASIC GUIDELINES FOR BUILDING AN EFFECTIVE LEARNING ENVIRONMENT

This appendix is intended to familiarize readers with how people learn in terms of ten basic principles derived from learning theory. These guidelines are relevant both to system designers/developers and to the trainers who use simulators to deliver training. The learning theory underlying these principles is elaborated in Annex C. Theory must be interpreted to derive the concrete guidelines needed for practical design/development. The authors of this guide have attempted to make this translation as transparent as possible. Figure C-1 is an attempt to provide concrete guidance. The checklist summarizes what is necessary to make simulation-based training systems such as JSIMS effective for training. Practically, it will be difficult to satisfy all of these requirements in all situations. However, designers, developers, and trainers should strive to satisfy them as fully as possible inasmuch as they govern the potential training effectiveness of the training system.

- Provide meaningful interaction between trainees and the learning environment
- Provide repetition of training events
- Vary exercise conditions on successive training events
- Match exercise conditions to learning objectives
- Collect data non-intrusively
- Collect validated performance metrics on team outcomes and processes
- Adjust exercise conditions to match trainee skills
- Provide meaningful exercise conditions
- Provide timely and relevant feedback to trainees
- Conduct After Action Review

Figure C.1 Basic Guidelines for Building an Effective Learning Environment

Each of the guidelines is described in greater details in the sections that follow.

C.1.1 Provide Meaningful Interaction between Trainees and the Learning Environment

For learning to occur, actions performed by trainees must influence the situation in the learning environment. "Interaction" implies a two-way relationship. Trainees influence the situation through their behavior, and they in turn get feedback from the environment based on their actions. The core function of a simulation-based training system is to provide this interaction. The term "meaningful" implies that the environment's reactions to trainee actions must be realistic and related to the learning objectives. For example, if a training program is to instill a particular competency, trainees must be able to discern and reflect upon the tangible effects of acquiring or not acquiring that competency.

C.1.2 Provide Repetition of Training Events

Repetition is essential for learning to take place. Repetition causes knowledge to transfer to and encode in long-term memory. Training must provide sufficient opportunities for trainees to experience the effects of its actions upon the situation's outcome. One of the advantages of a simulation-based exercise is the ability to repeat events. Implicit in this requirement is the need for successive training events to be appropriately timed. Repeat events frequently enough to permit trainees to reflect upon the situation; do not de-couple cause and effect by too-infrequent practice.

C.1.3 Vary Exercise Conditions on Successive Training Events

As noted, effective learning happens when trainees experience a sequence of training events. Repeating identical events is not generally an effective strategy, for a number of reasons. First, trainee skills change with each succeeding event. For this reason, the trainer/facilitator may, for example, increase the difficulty level for a succeeding scenario. Variation is particularly important when training highly cognitive skills, such as decision-making. Another reason to vary exercise conditions is to reflect changes in the composition of trainees. If a novice replaces an expert on the team, for example, the difficulty of the training event sequence may need to be adjusted. If new combinations of individuals or teams are aggregated into a higher level organization for a particular event, the exercise conditions should reflect the fact that the organization has not trained together.

C.1.4 Match Exercise Conditions to Learning Objectives

To ensure that the desired behaviors are reinforced, it is necessary to relate the exercise conditions to the learning objectives. If the exercise is not structured with opportunities for trainees to act in the desired way and to experience the consequences of its actions, learning will not occur effectively. If trainees do not view the conditions as realistic, the training may not be perceived as meaningful, which again works against effective learning. On the surface, this element and the previous one (the ability to vary exercise conditions) may seem redundant. However, given the ability to vary conditions, it is a jump in complexity to recognize and understand the relationships between learning objectives and exercise conditions. Those relationships comprise the essential ingredient in this element of the learning environment.

C.1.5 Collect Data Non-Intrusively

Assure that the methods of data collection do not influence the behavior of trainees. Data collection should not cause deviation from expected performance or affect trainee behavior.

C.1.6 Collect Validated Performance Metrics on Team Outcomes and Processes

Trainee performance should be measured using specific metrics related to learning objectives. The data collected will later enable feedback to trainees to support reflective learning and thereby improve performance. Collect data related to both (1) outcomes (i.e., was the right decision made?) and (2) processes (i.e., was the decision made right?). Outcome measures provide important information regarding overall performance. Process measures provide information on the underlying tasks, sequences of behaviors, and team dynamics that achieved the given outcome. Excellent examples of these metrics are described in Bibliography in works authored by Cannon-Bowers, Dwyer, Fowlkes, Oser, and Salas.

C.1.7 Adjust Exercise Conditions to Match the Trainee Skills

Adjust exercise conditions to suit trainees. There are a number of different factors to consider. One of these is difficulty. That is, the higher the skill level, the greater should be the difficulty of the exercise. Other factors are also important. Trainees will almost always consist of more than one individual, and this means that skills may develop at different rates for different participants. Certain skills may require more repetitions to mastery than others may, even if the level of difficulty is the same. It may be necessary to change the training strategy with advancing skill level, from a highly structured and controlled environment to one that is less so. Trainee skills comprise a complex set of variables. Exercise conditions must be appropriately varied to train effectively on this complex set.

C.1.8 Provide Meaningful Exercise Conditions

Trainees must perceive the exercise as meaningful to learn from it. In simulation terms, they must regard the scenario as being realistic. There is a difference between (1) realism in trainee interactions with the environment and (2) realism in the scenario. Realism in interactions depends mainly on the accuracy of the simulation models its fidelity to the real world. The designers and developers build this type of realism into the system. Realism in the scenario depends upon how accurately the scenario is written by its author and conducted by the trainer/facilitator. Learning will not occur if the scenario is perceived as unrealistic, even if all the object models are realistic. The closer the scenario matches the trainee mission, the better, and the more lasting the learning will be. The trainer/facilitator needs to consider the expected operational use of the competencies to be trained, and to structure trainee experience opportunities as closely as possible to the expected operational context

C.1.9 Provide Timely and Relevant Feedback to Trainees

Feedback during training tells trainees how well they are performing. It must be timely so that it is associated with the behavior it reflects. It must be relevant so that it helps trainees to adjust behavior appropriately. The requirement for “timeliness” is fairly straightforward and easy to measure. Achieving “relevance” is more difficult. In training involving teams and cognitive skills, it is often difficult to make the connection between actions and their effects. The effects may not be obvious, may be delayed in time, or there may be cumulative effects that are difficult to associate directly.

C1.10 Conduct After Action Review

Effective learning requires that trainees have sufficient opportunities to experience the environment, act upon it, and understand and reflect upon actions taken and the relationships to the outcome of the situation. The role of the trainer/facilitator after the exercise is to facilitate the processes of understanding and reflection. The process of facilitation is quite different from the traditional, pedagogic process of delivering feedback to trainees. Learning is enhanced when trainees can self-discover the relationships between actions and outcomes. The contribution of the facilitator is to help the process through guidance, team facilitation techniques, and the furnishing of external reference data (for example, ground truth data). Metrics used must assist this process by providing meaningful information in a systematic and structured manner.

C.2- BUILDING AND EVALUATING THE LEARNING ENVIRONMENT

As mentioned in the prefatory guidance, the present chapter is probably the most important one in this guide. It provides background and design tools to help you build an effective training system. Please read with care. The concepts presented in this chapter are based mainly on the work of research conducted at the Naval Air Warfare Center Training Systems Division in Orlando, Florida. For more in-depth information on the subjects covered in this chapter, refer to Bibliography. Key contributors to this body of work (listed alphabetically) are Cannon-Bowers, Dwyer, Fowlkes, Oser, and Salas. (The LMWG POC for questions relating to this work is Randy Oser; see Appendix A)

C.2.1 Modeling the Learning Environment

C.2.1.1 Model

Creating an effective learning environment requires an understanding of human learning and use of an accepted learning model. One learning model is shown in Figure C.2. This model is based on the concept that the most effective way to develop task and team skills is to provide opportunities for trainees to practice those skills within a contextual environment coupled with effective feedback. One method of feedback is post-reflective dialogue. Post-reflective dialogue is defined as an after-action review process wherein trainees (1) reflect (relive) what occurred during the execution phase, (2) explicitly challenge perceptions of what happened, and (3), through honest dialogue, change individual and collective perception. In the model, the contextual environment (Synthetic Battle Space) is based on the task, learning objectives, and trainee skill level. Trainees are immersed in the contextual environment where outcomes are dependent on trainee behaviors.

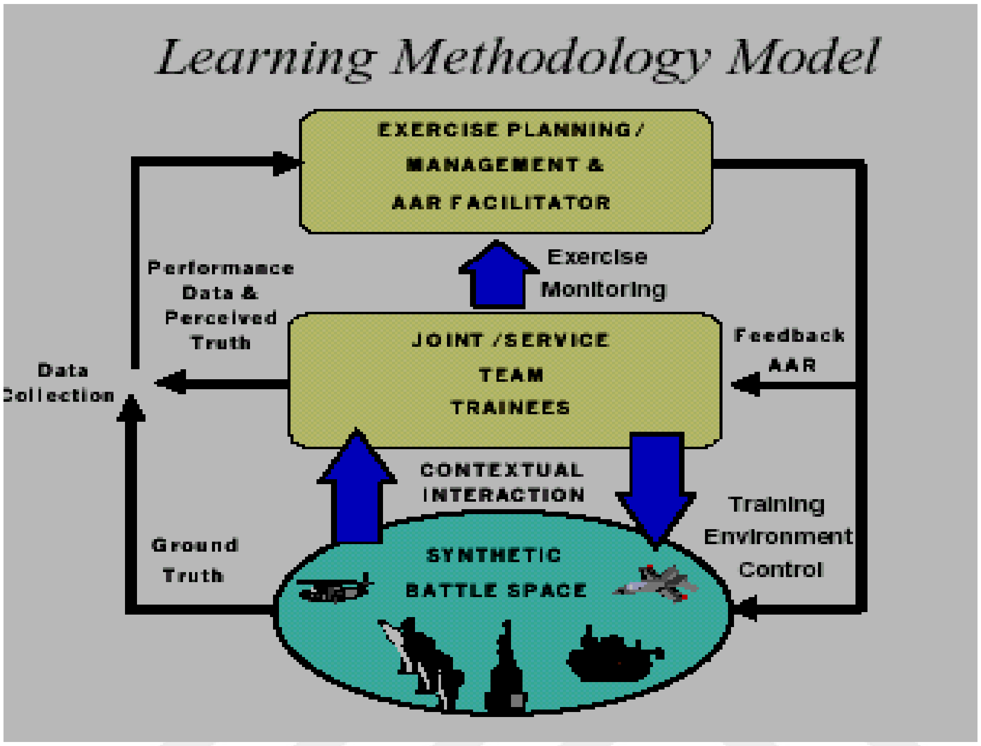

Figure C.2. A Conceptual Learning Model

C.2.1.2 Ground Truth, Perceived Truth, and Performance Data

As trainees interact with the environment, data are collected, merged, and stored. Data collected includes ground truth, perceived truth, and performance data. Ground truth is the situation and the environment presented to trainees. Perceived truth is what trainee sense through interactions with the environment (for example, a C4I display). Performance data are information on task outcomes and team processes including data collected automatically and data collected by observers.

C.2.1.3 After-Action Review

Ideally, during an exercise, trainee performance is monitored, and the complexity of the environment adjusted as appropriate based on skill level or outcomes. After conduct of the interactive exercise, a facilitated, learner-centered After Action Review session is conducted. In this session, trainees (supported by relevant feedback products) re-create what happened during the demonstration period and challenge the results of actions taken. It is during this phase that perceived truth is aligned with ground truth and “discovery learning” takes place. By completing cycles around this model, trainees continue to build proficiency in both task and team skills, which have a direct impact on combat readiness. The team asks the three basic questions:

- What happened?
- What should have happened?
- What do we want to do about it?

C.2.1.4 Systematic Training and Feedback

Effective learning environments employ systematic, deliberate approaches to ensure skill acquisition and retention by trainees. Certain disciplines need to govern the application of the model to real training situations. For example, efficient learning requires the presence of specific, pre-planned opportunities for participants to demonstrate and receive feedback in targeted competencies (knowledge and the skill to collectively use that knowledge). The introduction of these opportunities must be transparent to maintain realistic trainee performance. Uncontrolled free play, without established learning opportunities and associated feedback, risks wasted resources and failure to achieve objectives. At the same time, scenarios must not be so constrained that the trainee loses interest. A well-designed scenario provides a free play backdrop interlaced with structured unexpected learning objectives.

C.2.1.5 Data Collection

Learning environments must employ a systematic, coordinated data collection scheme to provide effective feedback on targeted tasks and competencies. The method used for data collection must be non-intrusive. This learning model supports the types of disciplines required to ensure an effective learning environment, but it does not guarantee that those disciplines will actually govern training. The training system must be designed to support a systematic and disciplined approach to structuring an effective learning environment.

C.2.2 Modeling Learning Processes

C.2.2.1 Model

Creating an effective learning environment requires an understanding of human learning processes within the simulation environment. One such model is shown in Figure C.3. This model reflects the shared conceptual model of the learning environment, and actual experience with simulation based training systems within the military services. Note that the model divides this process into three parts--planning, execution, and assessment--and that each part consists of several objects, events, or sub-processes that interact and influence one another in predictable ways.

The value of the LM process model is that it expresses LM requirements in terms of a tangible process consistent with military training environments. This is a crucial step in the translation from theory to practice. Components of the LM process model are described below. Each component description includes a checklist of specific LM requirements for simulation-based training expressed in terms of the components and their interactions. The lists are included to provide insights into LM requirements and to indicate which software components might be affected by invoking these requirements. Note that the checklists are not intended as a specification for JSIMS or any other specific system but are simply an expression of requirements that support LM concepts.

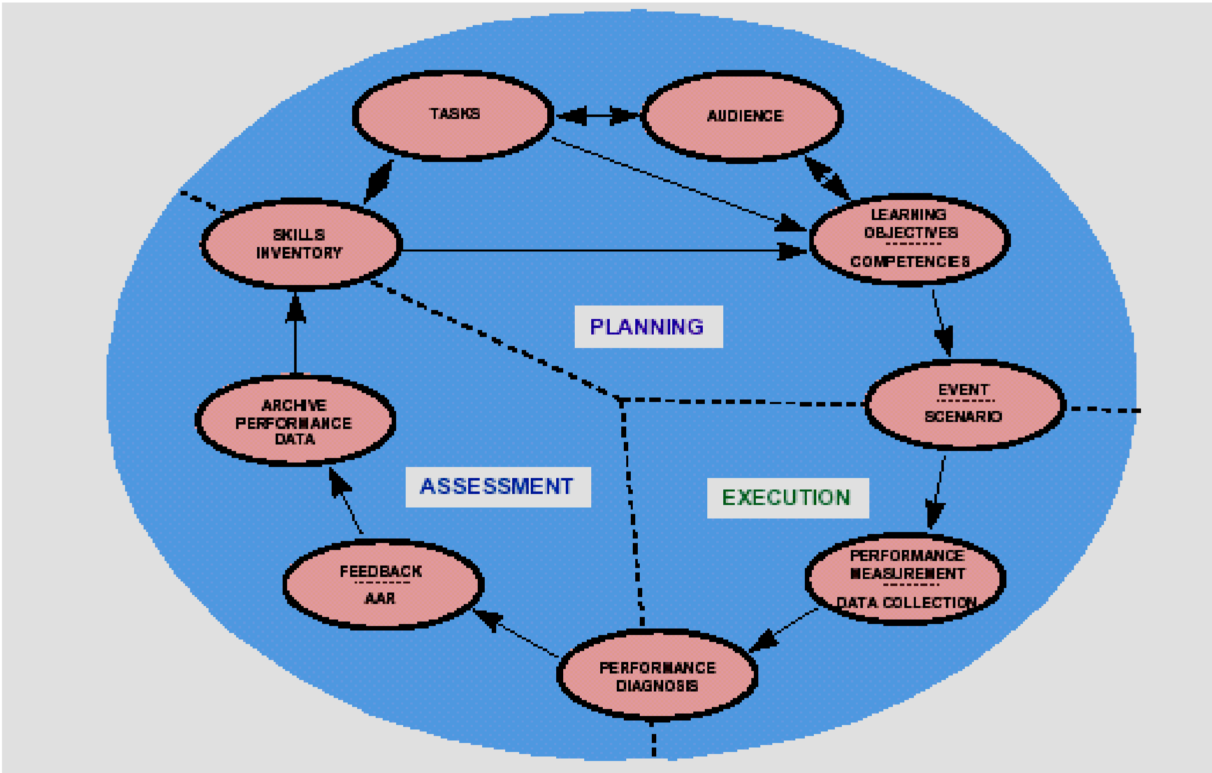

Figure C.3. LM Process Model

C.2.2.2 General Requirements

Some general requirements apply to all the tasks or capabilities in a simulation throughout planning, execution, and assessment phases. These requirements address a mixture of efficiency and effectiveness issues. The requirements that fall into this category are shown in Figure C.4

- Shorten clock time or calendar time to perform a function.
- Reduce labor hours to perform a function.
- Reduce skill level requirement to perform a function.
- Reduce the incidence of errors.
- Generate recommendations in support of decisions and selections.
- Maintain schedule of planned events.
- Report scheduled events by member of training audience, organization, task, mission, date, or location.
- Report potential conflicts in scheduling of training audience or training location.

Figure C.4 General Requirements

C.2.2.3 Planning: Trainees and Tasks

Effective training begins with a clear understanding of trainees and training requirements, expressed in terms of mission-essential tasks. One source of task definitions is the Universal Joint Task List (UJTL). The UJTL provides a detailed listing of tasks, conditions, and standards that comprise the missions of a joint military force. There are other useful sources as well, including National Military Strategy, Assigned Missions, Commander's Intent, Joint Doctrine, Joint Tactics, Techniques, and Procedures (JTTP) and service component tactical task lists. The definition of trainees and the required tasks comprise the independent variable of the training event. Requirements relating to trainees and tasks are shown in Figure C.5

TRAINEES

- Allow trainees to be an individual, an organization, or a collection of individuals and organizations.

TASKS

- Accept task definitions from authoritative sources. *[The system should accept task definitions from existing sources without requiring re-formatting or re-keying.]*
- Allow the trainer/facilitator to modify task definitions.
- Link tasks to performance standards.
- Relate new tasks to skills and standards. *[The user should be able to create a new task definition that is automatically linked to the existing skills inventory and performance standards, based on the new task's relationship to an existing task.]*
- Represent tasks at different levels of aggregation. *[The system should automatically link a given task with the same or higher level tasks at higher organizational echelons.]*
- Allow missions to be defined in terms of tasks. *[The trainer/facilitator should have the option of specifying training requirements in terms of missions, as well as individual tasks.]*
- Allow requirements to be defined in terms of either tasks or missions.
- Suggest and allow editing of task lists for a specified mission and training audience.
- For specified mission and set of actors, provide a skill assessment. *[Skill assessment is the delta between proficiency required for the mission and skills presently held by trainees.]*

Figure C.5 Requirements Relating to Trainees and Tasks

C.2.2.4 Planning: Skills Inventory and Learning Objectives/Competencies

Based upon the trainees and targeted tasks, appropriate learning objectives are identified. These learning objectives represent the "deltas" between the existing skills, as represented in the skill inventory, and the mission-related task requirements. Part of the discipline of an effective learning environment is the establishment of Measures of Effectiveness (MOEs) and Measures of Performance (MOPs) for each learning objective. MOEs are process measures; they emphasize those actions taken to reach a performance end state. MOPs are outcome measures; they focus on the End State achieved. MOEs provide data to answer "Was the decision made right?", while MOPs provide data to answer "Was the right decision made?" Selected MOEs determine specific data to be collected and the associated feedback products. The data collection infrastructure and tools should generate trends during the exercise, diagnostic performance feedback, external reference products, and assess how well learning objectives were achieved. Data collection across multiple events for a specific learning objective enables one to assess how well an individual or team performed on similar objectives over a range of conditions.

Requirements relating to learning objectives are shown in Figure C.6

- Report the skills inventory for the specified training audience as it relates to the specified mission or task set.
- Recommend learning objectives based on mission or task requirements, trainees, and skills inventory.

Figure C.6 Requirements Relating to Learning Objectives

C.2.2.5 Planning: Event/Scenario

Once the learning objectives are identified, it is necessary to select or create "trigger events" for each learning objective and incorporate these into a scenario. This process reflects the guiding principle that the training must be structured in a disciplined fashion, with a continuously applied understanding of the specific learning objectives. The trigger events create specific opportunities for trainees to practice critical tasks and competencies in a contextual environment, and to experience the consequences of their actions. Typically, a number of events are created for each learning objective that vary in difficulty and occur at different points in an exercise. This not only provides opportunities to reinforce behavior, but also increases confidence in the results.

Once task requirements, learning objectives, trigger events, MOPs, MOEs, and data collection strategies are known, they are amalgamated into a coherent scenario related as closely as possible to the expected mission or operational use of the training being undertaken. Scenarios must permit the trainees to interact in realistic situations that will facilitate transfer of learning from the training environment to the operational situation. Scenarios can use a wide range of constructive, virtual, synthetic, and live resources. Regardless of the specific resources used to create the training environment, the scenario must support the learning objectives, enable the required events to be presented to the participants, and facilitate the collection of data for feedback on the established MOPs, MOEs and other relevant facts and data. Requirements relating to Events/Scenarios are shown in Figure C.7. Note that these requirements also apply to the next topic.

- Recommend a sequence of training events leading to achievement of required competencies.
- Sequentially aggregate up to highest specified echelon. *[The sequence of training events may progress logically up through higher levels of aggregation.]*
- Incorporate repetition as required. *[Consider trainee's learning capability in setting the number and timing of repetitions.]*
- Incorporate variation as required. *[This includes variation for randomness, for increasing difficulty, changing skill mixes within the training audience, and progression from more to less structure training situations based on level of expertise.]*
- Set exit criteria for each training phase. *[Not all learning objectives need to be met in order to advance to a subsequent phase.]*
- Recommend training system configuration.
- Allow prompted editing of training system configuration. *[Prompts should suggest potential conflicts between training system configuration and the intended training audience, scenario, and/or data collection strategy.]*
- Recommend and allow editing of the trainer/facilitator staffing and organization to support a specified event.
- Recommend sequence of event preparation steps.
- Recommend building blocks (vignettes) for constructing each training event. *[Vignettes would be linked to specific learning objectives, and they would incorporate trigger events.]*
- Relate the mission requirements to a geographical area. *[It should be possible to define location-specific missions, or to overlay a selected mission on a specified location.]*
- Relate the entity mix (live vs. simulated entities) to the specified learning objectives. *[A particular scenario may be executed with different mixes of live and simulated entities, depending upon who is being trained.]*
- Build a coherent scenario from selected vignettes.
- Develop coherent sequences of scenarios. *[Avoid overlapping benefits and duplication of effort, thereby optimizing use of simulation resources.]*
- Relate each scenario to organization echelon. *[Link the same or similar scenarios used at different levels of aggregation]*.
- Adjust model fidelity to fit the learning objectives, scenario, and trainees.
- Recommend and allow editing of the scenario initial conditions.

Figure C.7 Requirements Relating to Events/Scenarios

C.2.2.6 Execution: Event/Scenario

After the scenario is generated and tested, it is used to create the synthetic battle space environment for trainees. This represents the transition from Planning to Execution. Exercise management and control of exercise flow are critical aspects of this process. Training participants must be permitted to make their own decisions and to handle the presented situation consistently with doctrine. At the same time, exercise managers must ensure that opportunities are presented which are aligned with the exercise objectives. Critical features of exercise management include: tracking the occurrence of events and collecting data during those events, ensuring contingency plans are in place to maintain exercise continuity if there is a failure or anomaly, and monitoring scenario scripts to ensure the exercise unfolds in a way that meets exercise objectives (adjusting if necessary).

C.2.2.7 Execution: Performance Measurement/Data Collection

As trainees perform within the simulated environment, data are collected to support feedback. An important aspect of this function is the fusion of data, from multiple sources, associated with a particular event and associated trainee actions. When an event occurs, relevant ground truth, perceived truth, and performance data must be collected and correlated. The resulting information can be documented, analyzed, and packaged to provide critical feedback. Requirements relating to Performance Measurement/Data Collection are shown in Figure C. 8 .

- Set forth performance measurement (data collection) requirements for each scenario.
- Relate performance measurement (PM) requirements to learning objectives for specified phase of training.
- Relate PM requirements to exit criteria for specified phase of training.
- Relate PM requirements to organization echelon. *[Different data will be collected at different levels of team aggregation.]*
- Ensure scenario events and PM requirements are consistent. *[Highlight potential conflicts between the scenario and apparent PM requirements.]*
- Relate MOPs and MOEs to learning objectives.
- Relate MOPs and MOEs to mission tasks.
- Relate MOPs and MOEs to overall mission effectiveness.

Figure C.8 Requirements Relating to Performance Measurement/Data Collection

C.2.2.8 Execution: Performance Diagnosis

Performance diagnosis begins in the Execution Phase. Near-real-time assessments permit the trainer/facilitator to monitor performance and ensure that learning objectives are being met. If appropriate, various components of the situation can be adjusted as to difficulty, or new events can be created to target specific skills. If appropriate, a training event can be truncated if it becomes evident that continuation of the event would not be productive. Requirements relating to performance diagnosis are shown in Figure C.9.

C.2.2.9 Assessment: Feedback/AAR

Through facilitated team dialogue and use of feedback products, trainees can determine (1) what happened, (2) why it happened, and (3) what they could have done to improve the outcome. Feedback products enhance the ability of the team to relive the exercise and provide external reference information that supports non-threatening changes in both individual and team perceptions (learning). The after action review products integrate ground truth data with

perceived data and performance measurements. Feedback elements are based on the MOPs and MOEs, which in turn are linked to the trigger events and learning objectives. This approach provides structure and control to training and ensures internal consistency throughout an exercise. Feedback must be timely and in a form that is relevant to the task at hand. It also must be flexible enough to accommodate varied learning styles.

- Base performance diagnosis on MOPs and MOEs.
- Report the effects of observed MOPs and MOEs on task and mission effectiveness.
- Extrapolate performance trends during the exercise to projected achievement of learning objectives.
- Report if difficulty level appears too high or too low for all or part of the trainees. *[Recommend adjustments to the scenario if appropriate.]*
- Assess and report on learning effectiveness of a given training event or sequence of events. *[Learning effectiveness criteria need to be defined.]*

Figure C.9 Requirements Relating to Performance Diagnosis

Requirements relating to Feedback/AAR are shown in Figure C.10.

- Allow trainer/facilitator to customize AAR products.

Figure C.10 Requirements Relating to Feedback/AAR

C.2.2.10 Assessment: Archive Performance Data

Following the completion of the exercise, appropriate data are stored and archived in a manner that supports the development of lessons learned. Data collected across exercises can facilitate the development of normative databases that would indicate problem areas and may suggest new instructional strategies. Requirements relating to Archive Performance Data are shown in Figure C.11.

- Analyze and report trends across successive events, with regard to specified set of competencies and trainees.
- Allow retrieval, fusion and analysis of archived performance data by selected individual or organization. *[Data should be available for a selected organization, regardless of the level of aggregation of the training event in which that organization participated.]*
- Recommend type, timing, and echelon of a subsequent training event. *[Recommend an adjustment to a planned interval between events, if observed performance so warrants.]*

Figure C.11 Requirements Relating to Archive Performance Data

C.2.2.11 Assessment: Skills Inventory

Archived data includes a skills inventory database. The skills inventory is updated each time an exercise is conducted. Updated skills inventories are then used in the planning of subsequent exercises. The skills inventory thus represents the transition from one cycle to the next in the LM process model and provides the baseline for follow-on exercise planning process.

C.2.3 Evaluating the Learning Environment

The LMWG Process model (Figure 3-2) is essentially a theory about how people learn within large-scale simulations. The model represents the operations of the simulation in terms of planning, execution, and assessment phases and, as such, offers a rough standard against which a new simulation design can be compared. The LMWG developed the process model as a way to define requirements for an effective learning environment. This model can serve as a useful analysis, design, and evaluation tool.

C.2.3.1 Gross Analysis (Count Limbs)

Among other things, the process model identifies (1) phases, (2) functions performed in the simulation and (3) their relationships in time. These factors define a simulation at a very gross level in terms of fundamental evaluation criteria:

- ❑ Are the phases present?
- ❑ Are the functions present?
- ❑ Do the phases/functions follow the sequence in the model?

Analyses to answer these questions can be performed with paper and pencil. (In some cases, one may need to call on subject-matter expert [SME] opinion.) Create checklists. Are all the phases there? The functions? Are they performed in the same sequence as in the model? For negative answers to these questions, determine the reasons why. Are the answers reasonable, or would it be better to tailor the design to the model?

C.2.3.2 Functional Analysis (Fingers and Toes)

Functional analysis focuses on the content of the functions in the system. These factors define a simulator at a somewhat more refined level:

- ❑ How are functions defined?
- ❑ What is sequence of events in each function?
- ❑ How (hardware and software) is function implemented?

Analyses to answer these questions are an extension of those performed above using analytical and possibly SME-based evaluations. For the first two criteria, compare answers for the model and simulation and resolve discrepancies. The third factor (hardware and software) opens new doors. If actual design information is available, some obvious training effectiveness questions offer themselves:

- What design alternatives are being considered?
- Which is the best?
- How can the design be optimized?

How to address these questions depends upon what is available to evaluate and this depends, to a degree, on how far system development has progressed.

C.2.3.3 Requirements Analysis

Based on the process model, the LMWG generated a list of requirements to support an effective learning environment "for a hypothetical simulation based training system." The authors caution that the list is not a "specification of JSIMS or any other specific system, nor is it the result of an engineering analysis of JSIMS requirements. It is an independent expression of those requirements that support the precepts of [learning]." Sets of requirements are presented in the figures for Section C.2.2. These requirements on these checklists are attributes that the LMWG contends are important in the design of a new simulation. As with attempting to apply the process model, a reasonable first step is to review and adapt the requirements to the design task at hand. Once this is done, they can be used directly, to see if all requirements are met, as well as to suggest evaluation topics for further study and analysis.

C.3- EVALUATING THE TRAINING SYSTEM

This chapter addresses the important issue of training effectiveness evaluation. Among other things, it argues that evaluation is important before, during, and after system development. First, it develops a framework for deciding what types of evaluation events to stage throughout development to assure that the training system is effective for training. Second, it lays out some basic evaluation principles. Finally, it describes some of the tools that JSIMS needs to support evaluation.

This chapter is based on Evaluating Large-Scale Training Simulations (Simpson, 1999a,b). Readers seeking a more in-depth coverage of the subjects should refer to the source. (The LMWG POC for questions relating to this work is Henry Simpson; see Appendix A)

C.3.1 Proposed Training Effectiveness Evaluation Framework

C.3.1.1 Rationale: Why Evaluate?

Evaluations are conducted for a number of different reasons; obvious ones are to:

- Satisfy milestone requirements
- Assure that system performance standards are met
- Demonstrate cost and training effectiveness
- Identify and correct developmental deficiencies
- Identify and correct deficiencies in the management and use of training systems
- Monitor competencies to support planning and execution of training events

All of these are sound reasons to evaluate. From a purely training standpoint, however, the focus shifts to reasons 2, 3, and 4: 2 and 3 because they show that the system works well and justifies its cost in some relatively mature end state; 4, because evaluations can help identify system shortcomings that can be corrected during development.

C.3.1.2. Evaluation as Total Quality Management

As we tend to think of evaluations as one-shot events that provide definitive results, the least obvious of these reasons to evaluate is 4. Evaluation conducted for this reason suggests that evaluation (1) is not an event but a process, (2) is a technique for improving the system being evaluated, and (3) may or may not provide definitive results. In other words, evaluation can be thought of as similar to Total Quality Management (TQM), wherein data pertaining to a process are gathered and analyzed, the process is critiqued, and corrective actions are taken to improve the process. Data pertaining to the revised process are gathered, analyzed, and so forth, in an endless cycle.

C.3.1.3. Building an Evaluation Framework

In thinking about evaluation, it is useful to start by asking basic questions; for example., how, what, and when should I evaluate? These three questions take on more specific meanings in the context of an actual evaluation:

- How should I evaluate (What evaluation methods should I use?)
- What should I evaluate (What dependent variables should I measure?)
- When should I evaluate (How should I conduct evaluation events in terms of time?)

C.3.1.3.1 How Should I Evaluate? (Methods).

Many different evaluation methods are available. The Defense Manpower Data Center (DMDC) is currently compiling data on several hundred military training system evaluations. Work to date indicates that evaluations tend to use one of four main methods: experiment, judgment, analysis, or survey. In general terms, here is how the methods are applied:

- **Experiments**: determine effectiveness based on observational data.
- **Judgment-based evaluations**: determine effectiveness based on human judgments.
- **Analytical evaluations**: determine effectiveness based on common analytical techniques and using common analytical strategies.

- **Surveys**: gather data from a sample of a knowledgeable target population and determine effectiveness based on analysis of the collected data.

Each of the methods can, in turn, be performed in several different ways, comprising a set of submethods. Table C.1 summarizes these four methods (left column), the corresponding submethods (middle column), and their relative frequency of usage (right column) as found in 250 representative evaluations in DMDC's data base. Each of these methods and submethods is described in greater detail with concrete examples in Chapter 3 of Simpson (1999a).

Table C.1 Frequency of Usage of Common Evaluation Methods and Submethods

METHOD	SUBMETHODS	PERCENT
Experiment (65% of cases)	True experiment	29
	Transfer	9
	Pre-experiment	10
	Test	6
	Quasi-experiment	5
	Ex post facto	6
Judgment (13% of cases)	Users	6
	SMEs	5
	Analysts	2
Analysis (17% of cases)	Evaluate	10
	Compare	4
	Optimize	2
Survey (6% of cases)		6

Each of the methods can, in turn, be performed in several different ways, comprising a set of submethods. The submethods of Experiment are defined mainly based on distinctions made in Campbell and Stanley (1966). The submethods of Judgment are based on respondent category; i.e., the group whose judgments are considered (Users, SMEs [subject-matter experts], or Analysts). The submethods of Analysis are based on differences in the objectives of analysis (Evaluate, Compare, Optimize). The submethods for these two methods were developed iteratively based on analysis of the various cases of their usage in DMDC's database. The distinctions do correspond to differences in usage rather than mere surface characteristics. The

Survey method has no submethods. The submethods vary in terms of the cost and difficulty of conducting them and in the authority with which they support conclusions based on their outcomes. Based on currently available data, the method most commonly used is experiment (65% of cases). Judgment (13%), Analysis (17%), and Survey (6%) are used in far fewer cases. In practice, different methods are sometimes used in combination, although one of the methods is almost invariably primary. Why do these relative numbers differ? Some possible reasons:

- Acquisition regulations generally encourage experiments.

- Among most evaluators and military decision-makers, experiments have greater face validity than other methods.

- Analysis- and Judgment-based evaluations are generally less difficult and costly than experiments and so tend to be used when experiments are not possible.

Note that, to use experiment, a training system must exist and be functional in some form. (The system does not necessarily have to be actual, complete, or final. In some cases, it may be possible to use a mockup or simulation to represent the system. Enough of the system must be represented to conduct a meaningful experiment.) Judgment can be used in a limited way before a system exists (for example, to estimate training potential of a hypothetical design or the perceived need for a system), but usually requires an existing, functional system. On the other hand, analysis can be performed without an existing, functional training system. Analysis tends to be used in two main cases:

- The system is insufficiently developed to conduct an experiment or gather judgment data.

- Evaluation resources are limited.

C.3.1.3.2 What Should I Evaluate? (Dependent Variables).

Many different dependent variables have been used in evaluating large-scale simulations. To date, no set of variables has gained universal acceptance. Thus, it is necessary to start from basics. Simpson (1999a) derives a set of four key variables:

- Reactions
- Learning
- Collective Performance
- Results

One of the simplest and easiest variables to measure is the reaction of participants to a particular training experience. This is commonly done with a post-training questionnaire, interview, or, more recently, with a videotaped group discussion akin to an after-action review. Within the traditional schoolhouse learning paradigm, it is common to evaluate student learning based on knowledge and performance test scores. These scores, in turn, may be used to evaluate the training system. In simple terms, the higher the scores, the more effective the training system.

Collective performance--training of groups of people to work together as integrated teams or organizations--is a fundamental a part of military training. Thus, an important criterion for collective training is how well do collectives perform in the training system? Definition of evaluation criteria for collective performance is still an immature enterprise, more art than science. However, all training—of individuals or collectives—is built upon tasks. Collective training is intended to provide training on collective tasks. At the Joint level, the Universal Joint Task List (UJTL) contains a comprehensive, hierarchical list of the tasks that can be performed by a joint military force; the conditions under which the tasks are performed; and standards of performance. Comparable Service-specific task lists define the relevant collective tasks at the Service level. These task lists essentially define what tasks the Services and Joint forces are expected to be able to perform. They are the logical tasks to use when building scenarios to evaluate collective training.

The operational testing community usually measures performance capabilities in terms of engagement or battle outcomes. There are analogous variables for training systems; that is, what are the tangible results during training? (exchange ratio, percent losses by force, shots/kill, etc.) One can measure the performance of the system in terms of achieving its overall objectives while trainees use it. For example, does the simulated Tank Company defeat the simulated enemy; or, do the senior commanders participating in a war game win the war? In certain circumstances, one might be able to measure transfer of training from the system to the real world in terms of combat readiness, field exercise performance, or simulated (or actual) combat.

All of these criteria are of interest, but they are not all of equal significance. While it is useful to gather reaction data, they are less important than collective performance, which in turn are less important than tangible results in the training system. And, since the name of the game is to perform well in the post-training world, transfer of training criteria are arguably the most important of all--they may amount to winning or losing a battle.

C.3.1.3.3 When Should I Evaluate? (Timing).

Evaluations are usually considered as one-shot events that answer a question at a particular point in time. This may make sense when evaluating simple things that already exist (for example., an inexpensive training method or medium). It does not make sense when evaluating complex and expensive large-scale training simulations that undergo years of development before becoming operational. For example, early on, evaluations might be conducted to determine whether a prototype design is capable of training on certain tasks. Much later, the total system is put to the test to determine whether it, for example, improves combat readiness.

Table C-2 illustrates the timing of proposed evaluation events for a large-scale training simulation. Evaluation occurs in four phases, represented by the four right-most columns: I.

Prospective, II. Developmental, III. Milestone, and IV. Post-development. Phases II and III may occur concurrently, if there are several successive milestones during a development. They are separated here to simplify discussion. The left-most column indicates what entries appear in the cells: When (timing of events), Purpose (why evaluation event is conducted), and How (the evaluation method employed). Boldovici and Bessemer (1994) seem to have been the first to advocate a multi-level evaluation strategy such as proposed here. Their recommendations were based on their analysis of the shortcomings of prior SIMNET evaluations. They recommended that several methods be used, as and where needed, to include (1) in-device learning experiments, (2) quasi-transfer experiments, (3) correlational research with archived data, (4) efficient experimental designs, (5) quasi-experimental designs, (6) improved methods for documenting training, (7) analytic evaluations.

I. Prospective Evaluation Phase.

Evaluation actually starts before the system exists. Some purposes of evaluation at this phase are:

- Estimate perceived need for and training potential of system
- Define/refine training content
- Assure adequate learning environment

These questions can be addressed using analytical and judgment-based analyses and survey.

II. Developmental Evaluation Phase.

Later, during system development, hardware and software capabilities will be built, in stages, and it will become possible to evaluate these fledgling capabilities. Some purposes of evaluation at this phase are:

- Demonstrate training effectiveness of functioning subsystems
- Assess/refine design

• Estimate user acceptance

These questions can be addressed based on judgment (user, SME) and simple experiment (functionality tests, user in-device learning experiments).

Table C-2. Timing of Hypothetical Evaluation Events for a Large-Scale Training Simulation, Illustrating Purpose and Evaluation Methods by Evaluation Phase

DESCRIP-TION	**EVALUATION**	**PHASE**		
	I. Prospective	**II. Developmental**	**III. Milestone**	**IV. Post-Development**
When	Before system exists	During system development	At major developmental milestones (builds, IOC, FOC)	After system becomes operational
Purpose	• Estimate perceived need for and training potential of system • Assess/refine design • Define/refine training content • Assure adequate learning environment	• Demonstrate training effectiveness of *functioning subsystems* • Assess/refine design • Estimate user acceptance	• Demonstrate training effectiveness of *total system* • Assess/refine design • Determine user acceptance	• Estimate transfer of training • Determine effects of training on readiness, use of resources, & overall performance • Estimate need to modify training system • Determine acceptance by user population
How	• Analysis • Judgment (SMEs) • Survey	• Judgment (user, SME) • Experiment (pre-, test, quasi-)	• Judgment (user, SME) • Experiment (quasi-, true)	• Judgment (user, SME) • Experiment (ex post facto) • Survey

III. Milestone Evaluation Phase.

As development proceeds, certain milestones will be reached during which relatively mature system capabilities are expected to be demonstrated. At these points, and at the end of development, purposes of evaluation are:

• Demonstrate training effectiveness of total system

• Assess/refine design

• Determine user acceptance

These questions can be addressed based on judgment (user, SME) and full-scale experiments. True experiments (involving separate experimental and control groups) are not usually an option when evaluating large-scale simulations, as there is seldom a non-experimental condition to use as a control. If such a control condition is possible, a true experiment can be conducted.

IV. Post-Development Evaluation Phase.

After the system becomes operational, it is possible to accrue data to ask questions that could not be addressed during development. Some purposes of evaluation at this phase are:

• Estimate transfer of training

• Determine effects of training on readiness, use of resources, and overall performance

• Apply (above) information to estimate need to modify training system

These questions can be addressed based on judgment, survey, and ex post facto experiments to estimate effects of training on readiness and transfer to the operational setting.

When is evaluation complete? Proponents of TQM would argue that evaluation is never over, as the system can always undergo further refinement. Furthermore, in this technologically evolving world, equipment and doctrine changes may stress the ability of training systems to keep up. A more realistic answer is that evaluation ends when the body of accumulated evidence persuades decision makers that the system has successfully met its goals in terms of support of combat readiness, training, and cost reduction, and there are no significant changes in mission, doctrine, weapons systems/equipment, organization, and job design.

C.3.2 Evaluation Principles

The evaluation framework is based on the following are the principles:

• Essential first steps; define purpose of evaluation and stakeholders. Gain consensus.

• Evaluation is a process, not an isolated event.

• Evaluators should attempt to influence design and development. (Key: well-formed evaluation plans.)

• Evaluate (1) longitudinally (across time) and (2) vertically (across a family of measures) (This provides more useful decision-making information than point measures.)

• Obtain the best data possible, based on (1) state of development and (2) resources. (The worth of the evaluation is a direct function of the quality of its data.)

• Assure that data are valid and reliable.

• Develop learning curves for the collectives using the training system. (These reflect the rate of learning and can provide an indication of system training effectiveness in the absence of a control group.)

• Measure transfer of training to the job. (These provide an ongoing measure of the validity of training and possible need for change.)

C.3.3 Tools Needed To Support Evaluation

Evaluation events that rely on judgment, analysis, and survey will usually be based on paper and pencil data collection instruments, protocols, etc., and are not expected to generate any special requirements in terms of design.

Experiments conducted during Phases II and III will be based upon a variety of measures

reflecting Reaction, Collective Performance, and Results. Assigned evaluators and/or O/Cs may collect some of these measures. However, to facilitate efficient data collection, it is necessary to provide a semi-automated data collection, storage, retrieval, and display capability. (This may very well tie in to whatever after-action review system is already in place.)

This topic was covered in greater depth in Chapter 3. Tools need to be designed and developed to support these requirements; for example:

- Interface with O/C tools
- On-the-fly data acquisition
- Short, medium, and long-term data storage
- Retrieval and display for evaluation purposes
- Archival storage

The archival storage capability is particularly important in evaluating large-scale simulations because of the need to accumulate and integrate data over the long term to separate effects of training from confounding variables.

BIBLIOGRAPHY

Boldovici, J.A. & Bessemer, D.W. (1994). Training research with distributed interactive simulation: Lessons learned from simulation networking. TR 1006. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (ADA285584)

Campbell, D.T. & Stanley, J.C. (1966). Experimental and quasi-experimental designs for research. Chicago, IL: Rand McNally. (Also published as Campbell, D.T. & Stanley, J.C. (1963). Experimental and quasi-experimental design in teaching. In N.L. Gage (Ed.). Handbook of Research on Teaching. Chicago, IL: Rand-McNally.)

Cannon-Bowers, J.A. & Salas, E. (1997). A framework for developing team performance measures in training. In M.T. Brannick, E. Salas, & C. Prince (Eds.), Team Performance Assessment and Measurement: Theory, Methods and Applications. Hillsdale, NJ: Lawrence Erlbaum.

Department of Defense, Office of the Inspector General (1997). Requirements planning and impact on readiness of training simulators and devices. Report No. 97-138. Arlington, VA: Author.

Dwyer, D.J., Fowlkes, J.E., Oser, R.L., Salas, E., & Lane, N.E. (1997). Team performance measurement in distributed environments: the TARGETs methodology. In M.T. Brannick, E. Salas, & C. Prince (Eds.), Team Performance Assessment and Measurement: Theory, Methods and Applications (pp. 137-153). Hillsdale, NJ: Lawrence Erlbaum.

Dwyer, D. J., Oser, R. L., Salas, E., & Fowlkes, J. E. (1999). Performance measurement in distributed environments: Initial results and implications for training. Military Psychology,11 (2), 189-215.

Fowlkes, J., Dwyer, D.J., Oser, R.L., & Salas, E. (1997). Event-based approach to training. Proceedings of the 19th. I/ITSEC Conference. Albuquerque, NM.

Garlinger, D.K. & Fallesen, J.J. (1988). Review of command group training measurement methods. TR 798. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (ADA201753)

Joint Warfighting Center (1997). Joint Simulation System Concept of Operations Version 1.0 (15 August 1977). Ft. Monroe, VA: Author.

Oser, R. L., Cannon-Bowers, J. A., Dwyer, D. J., & Salas, E. (1997). Establishing a learning environment for JSIMS: Challenges and considerations [CD-ROM]. Proceedings of the 19th Annual Interservice/Industry Training, Simulation, and Education Conference, Orlando, FL, 144-153.

Oser, R. L., Dwyer, D. J., & Fowlkes, J. E. (1995). Team performance in multi-service distributed interactive simulation exercises: Initial results [CD-ROM]. Proceedings of the 17th Interservice/Industry Training Systems and Education Conference, Arlington, VA, 163-171.

Simpson, H. (1999a). Evaluating large-scale training simulations, Volume I: Reference Manual. DMDC TR 99-05. Seaside, CA: Defense Manpower Data Center.

Simpson, H. (1999b). Evaluating large-scale training simulations, Volume II: User's Manual. DMDC TR 99-06. Seaside, CA: Defense Manpower Data Center.

ANNEX A TO APPENDIX C

ACRONYMS

AFAMS	Air Force Agency for Modeling and Simulation
ARI U.S.	Army Research Institute for the Behavioral and Social Sciences
C4I	Command, Control, Communications, Computers and Intelligence
CONOPS	Concept of Operations
DA	Development Agent
DMDC	Defense Manpower Data Center
DoD	Department of Defense
DoDIG	DoD Office of the Inspector General
DSR	Digital Systems Resources
JPO	Joint Project Office
JSIMS	Joint Simulation System
JTTP	Joint Tactics, Techniques, and Procedures
JWFC	Joint Warfighting Center
LM	Learning Methodology
LMWG	Learning Methodology Working Group
MOE	Measure of Effectiveness
MOP	Measure of Performance
NATSIM	National Simulation System
NAVSEA	Naval Sea Systems Command
NAVSEA PMS 430	NAVSEA Performance Monitoring, Training, and Assessment Program Office

NAWC	Naval Air Warfare Center
NAWC-TSD	Naval Air Warfare Center Training System Division
NSC	National Simulation Center
NSWC	Naval Surface Warfare Center
O/C	Observer/Controller
OPNAV	Office of the Chief of Naval Operations
POC	Point of Contact
SIMNET	Simulator Network
SME	Subject-Matter Expert
SPAWAR	Space and Warfare Command
TQM	Total Quality Management
UJTL	Universal Joint Task List

ANNEX B TO APPENDIX C

LEARNING THEORIES

This appendix provides a brief overview of three theories of human learning: Behaviorism, Cognitivism, and Constructivism. The appendix also includes a section on learning within an organization and a glossary of terms. The material is covered at a fairly basic, non-academic level. The intent is to provide the reader with an understanding of some of the theory underlying the concepts presented in this guide.

There is no single universally accepted theory of how people learn. Multiple theories continue to evolve. Moreover, there are large individual differences in how people learn in particular situations. Thus, for the foreseeable future, there will undoubtedly be numerous competing theories on learning, as well as numerous variants of those theories to cover specific types of individuals and learning situations. Despite this diversity, the most accepted theories share certain concepts. The following discussion will show this commonality.

B.1 Behaviorism

The main tenet of the behavioralist approach is that environmental factors shape a person's behavior. This approach is concerned with changes in an individual's behavior that occur as a result of learning. Therefore, the behavioralist focuses primarily on the development of skills and abilities, as opposed to knowledge.

Early behavioralists identified two types of conditioning, referred to as respondent and operant conditioning, which can affect an individual's behavioral response. Respondent conditioning is a process whereby a subject is conditioned to respond to a certain stimulus from the environment. A well-known example of this process is Pavlov's dog, which was trained to salivate when a bell was rung. This training was accomplished by repeatedly ringing a bell just prior to the dog's receiving food.

Operant conditioning is a process whereby the subject's behaviors work on the environment, and feedback is used to reinforce desirable behaviors. Such feedback may be artificial, such as a reward, or it may be a direct result of the subject's behavior, such as the acceleration of an automobile when the gas pedal is pressed. As in the case of respondent conditioning, this training is the result of repeatedly providing the reinforcing feedback when the desired response is elicited. It is important that the time lag between the operant response and the feedback be relatively short, so that the subject will correctly pair the behavior with the feedback. This requirement is known as temporal pairing. It should also be noted that feedback might be either positive or negative, depending upon whether the goal is to reinforce or extinguish a particular behavior.

The behavioralist approach has been shown to work for relatively simple skills, but it is not effective when more complex tasks need to be learned. This approach is particularly ineffective when there is a strong cognitive component involved (such as decision making), or when temporal pairing is not feasible.

B.2 Cognitivism

Cognitive theorists are concerned with the changes in an individual's knowledge that result from experience with a stimulus environment. The cognitive approach is based upon the concept of schemata, or mental models, by which individuals organize their perceived environment. During learning, these schematic structures change by the processes of specialization and generalization. Specialization involves the integration of new information and experiences into existing schemata. Generalization is the process of modifying existing schemata or of creating new ones. For these processes to work in a training environment, it is necessary to provide multiple opportunities for the individual to make changes and additions to existing models based on experience with the environment.

Mental models exist in long-term memory. Therefore, in order for training to be effective, learning must transfer from short-term memory to long-term memory. Different theories have arisen as to the means by which this transfer occurs. What is important to realize is that an effective learning environment must facilitate this transfer. An individual's mere recollection of a training event, even in minute detail, does not by itself assure that learning has taken place, because this recollection may involve only short-term memory. A training program must incorporate multiple exposures – and the right kinds of exposures – to the environment and to feedback from it, in order for this transfer to take place. According to the cognitive approach, in order to ensure that changes in knowledge occur, the learning must be "meaningful." That is, there must be perceived consequences for integrating new knowledge or for failing to do so.

B.3 Constructivism

The constructivist approach is based on the belief that learning is a self-assembly process. Constructivists suggest that individuals "construct" their understanding of a topic area through two processes: conflict resolution and reflection. Within the constructivist framework, discovery learning (i.e., free play) is preferred over formally structured training. Discovery learning requires the trainee to determine the best way of learning; learning is not externally determined or controlled. The responsibility of the instructor is to structure the learning environment to ensure that there are sufficient opportunities to discover instances of the desired learning objective.

It is believed that discovery learning increases a trainee's motivation to learn and produces richer knowledge stores. However, because complex behaviors can be selected and orchestrated by the trainee, it is possible that the trainee's own goals may deviate from those of the training exercise itself. The result is the potential for loss of control over the exercise on the part of the instructor. An additional problem associated with the constructivist approach is that it can lead to idiosyncratic learning, for two reasons. First, the course and progress of a training session will be determined by what the trainee already knows. Second, only that knowledge which is personally meaningful to the trainee will be integrated into long-term memory. These potential drawbacks have led to the suggestion that discovery learning may not be appropriate for novices within a domain. However, as the individual moves towards becoming an expert, discovery learning may foster the development of a richer representation of the problem space. In this regard, it should be noted that modern technological advances, such as interactive and multi-media computers, laser discs, and the World Wide Web, can provide trainees with the tools to support discovery learning when it is appropriate.

B.4 Learning within an Organization

Several types of learning within an organization are suggested by the framework offered by Peter Senge and Michael Marquardt:

B.4.1 Adaptive, Anticipatory, and Generative Learning

Adaptive learning is learning from experience and reflection; for example:

action—>outcome—>results data—>reflection

Learning can be single- or double-loop learning. Single-loop focuses on gaining information for stabilizing and maintaining existing systems with the emphasis on error detection and correction. Double-loop, a more in-depth process, involves questioning the system itself for the root cause of the errors OR successes.

Anticipatory learning is the process of gaining knowledge by envisioning and expecting the future.Generative learning is created from reflection, analysis, or creativity.

B.4.2 Deutero Learning

Deutero learning is technically "learning about learning." It occurs when the organization learns from critical reflection on taken-for-granted assumptions. This type of reflection provides an organization the opportunity to discover what they do (or have done) to either facilitate or hinder learning, to invent new strategies to advance learning with the goal of effecting change in the organizational learning practice.

B.4.3 Action Learning/Action Reflection Learning

Action Learning/Action Reflection Learning involves reflecting on real problems using the following formula:

L (learning) = P (existing knowledge) + Q (questioning insight)

Action learning provides a well-tested method of accelerating learning. When used as a systematic process, organizational learning increases so that it can more effectively deal with change and so that its people can learn better and more effectively handle difficult situations. Action learning is used to examine a complex/difficult task, to move people to act to change it, and to return the results to the organization for review and learning; people devote quality time and energy as needed to learn how to learn and think critically. As a result the individuals involved in action learning build the skills to meet team and organizational needs. Some principles of action learning are shown in Figure C-12.

Action learning is intended to induce new thinking by conscious consideration of group content, called "an action learning set." The model is centered on the concept that setting (or environment) and problems to be considered are an important link to group decisions and the depth of the learning experience.

- Reflection upon participation in an experience increases learning
- If too much reliance is on "expert opinion/information" individuals do not seek own/new solutions
- We learn critically when able to question assumptions that drive an action
- Accurate feedback from others and results of problem-solving actions increase learning
- Working on unfamiliar problems in unfamiliar settings provides greatest challenges; potential and high probability are greatest for learning
- Mixed groups, nonhierarchical, often are better able to gain new perspectives
- Action learning is most effective when learners are examining the organizational system as a whole

Figure C.12 Some Principles of Action Learning

These settings and problems can be categorized as either familiar or unfamiliar, but team learning reaches its fullest potential when both setting and problem are unfamiliar. Michael Marquardt, in Building the Learning Organization, identifies specific characteristics for "new learning" said to be applicable in tailoring military training (Figure C-13)

- Learning is performance-based, tied to objectives
- Importance is placed on learning processes (learning how to learn) as much, if not more, than on the content
- As important as coming up with the correct "answers" is the ability to define the learning needs
- Across the organization opportunities are created to develop knowledge, skills, and attitudes
- In part, learning is a product of the activity, context, and culture in which it is developed and used
- People are more willing and able to learn that which they have helped create
- Critical survival skill: the ability to know what one needs to know, and to learn on one's own
- Continuous learning is essential for survival and success
- Learning can be accelerated if facilitators help people think critically
- Learning should both accommodate and challenge different learning style preferences
- Learning is part of work—part of everyone's job description
- Learning involves a cyclical, iterative process of planning, implementing, and reflecting on action

Figure C.13 Characteristics for "New Learning" Said To Be Applicable in Tailoring Military Training

C.5 Glossary

Behavioral psychology: the study of overt human behaviors; emphasis is based on the belief that by studying the relationship between environmental events and behavior would lead to an understanding of why humans do what they do without references to their mental processes. Behaviorists (often called S-R psychologists) view environmental factors in terms of stimuli and resultant behavior in terms of responses.

Cognitive psychology: the study of mental process and of changes in an individual's knowledge that result from experience with a stimulus environment. Cognitivists delve into the internal processes by which an individual deals with the complexity of his environment. They also try to define the resulting cognitive structures that he constructs in his mind: the ways in which he perceives and conceptualizes his physical and social world. An important assumption of cognitive theory is that an individual's behavior is always based on cognition, the act of knowing about the situation in which behavior occurs.

Competency: suitable or sufficient skill or skill level, knowledge, or experience to perform a task. A specific job may require multiple competencies. Or a corporation may have several competencies; i.e. several business bases at which they are equally successfully competitive.

Constructive psychology: Based on the belief that learning is a self-assembly process.

Discovery learning: The learner organizes into final form the material to be learned. Discovery learning is like wrapping your own package, reception learning (or didactic teaching) is like having someone open it for you. Jerome Bruner receives primary credit for encouraging discovery learning, whose advantages are: increment in intellectual potency; emphasis placed on intrinsic rather than extrinsic rewards; students masters the methods of "how" to discover; student is more likely to remember information.

Education: The act or process of imparting or acquiring general knowledge and of developing powers or reasoning and judgment.

Evaluation: While measurement only identifies amount, evaluation lays amounts against criteria so that we may make value judgments about the observed amounts.

Knowledge: Acquaintance with facts and truths or principles and familiarity with a particular subject or branch of learning; gained through study, sight, and/or experience.

Learning: Knowledge acquired by systematic study.

Learning Methodology: A systematic process for creating an efficient and effective learning environment which enables a training audience to develop the competencies necessary to perform their required tasks.

Measurement: The process of using numbers to describe quantity, quality, or frequency according to a set of rules.

Skill: Ability to do something well through, talent, training, or practice; learned performance required to complete a task

Task: A logical and necessary step in the performance of a duty—usually a fairly long and complex procedure.

Task analysis: Identification of the behavioral characteristics of a job requirement.

Test: A systematic procedure for comparing the performance of an individual with a designated standard of performance.

Training: The act of making someone proficient by instruction and practice.

APPENDIX D
RESEARCH MODEL SPSS OUTPUTS

16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 1

- - - - - - - - - - - F A C T O R A N A L Y S I S - - - - - - - - - - -

Analysis number 1 Replacement of missing values with the mean

	Mean	Std Dev	Cases	Label
Q1	5,07229	1,17684	83	
Q10	5,24096	,74228	83	
Q11	4,83133	1,04554	83	
Q12	4,90361	,98296	83	
Q13	5,14458	,92568	83	
Q14	5,16867	,85282	83	
Q15	4,91566	1,11754	83	
Q16	4,84337	1,30180	83	
Q18	5,32530	,87106	83	
Q19	5,33735	,78518	83	
Q2	5,26506	,78218	83	
Q20	5,49398	,68740	83	
Q21	5,19277	,83312	83	
Q22	5,37349	,79189	83	
Q23	4,92771	,99735	83	
Q24	5,20482	,85196	83	
Q25	5,04819	,92266	83	
Q26	5,19277	,78799	83	
Q3	5,45783	,78556	83	
Q4	5,27711	,84555	83	
Q5	4,40964	1,27868	83	
Q6	5,31325	,89617	83	
Q7	5,36145	,78985	83	
Q8	5,15663	,90368	83	
Q9	5,33735	,81566	83	

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = ,81069

Bartlett Test of Sphericity = 1440,0283, Significance = ,00000

Extraction 1 for analysis 1, Principal Components Analysis (PC)

Initial Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
Q1	1,00000	*	1	9,69631	38,8	38,8
Q10	1,00000	*	2	1,99285	8,0	46,8

16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 2

- - - - - - - - - - - F A C T O R A N A L Y S I S - - - - - - - - - - -

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
Q11	1,00000	*	3	1,82933	7,3	54,1
Q12	1,00000	*	4	1,39343	5,6	59,6
Q13	1,00000	*	5	1,18589	4,7	64,4
Q14	1,00000	*	6	1,06055	4,2	68,6
Q15	1,00000	*	7	,96979	3,9	72,5
Q16	1,00000	*	8	,89597	3,6	76,1
Q18	1,00000	*	9	,82599	3,3	79,4
Q19	1,00000	*	10	,69547	2,8	82,2
Q2	1,00000	*	11	,63589	2,5	84,7
Q20	1,00000	*	12	,61514	2,5	87,2
Q21	1,00000	*	13	,56957	2,3	89,5
Q22	1,00000	*	14	,49716	2,0	91,5
Q23	1,00000	*	15	,39397	1,6	93,0
Q24	1,00000	*	16	,32093	1,3	94,3
Q25	1,00000	*	17	,29423	1,2	95,5
Q26	1,00000	*	18	,26866	1,1	96,6

Q3	1,00000	*	19	,21886	,9	97,4
Q4	1,00000	*	20	,18407	,7	98,2
Q5	1,00000	*	21	,16397	,7	98,8
Q6	1,00000	*	22	,11037	,4	99,3
Q7	1,00000	*	23	,09318	,4	99,6
Q8	1,00000	*	24	,07321	,3	99,9
Q9	1,00000	*	25	,01521	,1	100,0

PC extracted 6 factors.

VARIMAX rotation 1 for extraction 1 in analysis 1 - Kaiser Normalization.
VARIMAX converged in 8 iterations.
Rotated Factor Matrix:

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q10	,83944	,20006	,25338	,08965	,16713
Q14	,81726	,20346	,19664	,09774	,23722
Q1	,71240	,15073	,01294	,24882	-,25682
Q13	,63185	,09064	,25706	,29633	,16600
Q21	,58562	,24569	,30830	,44581	,18351
Q26	,55486	,29881	,26357	,20927	-,11641
Q20	,14813	,89026	,22649	,09258	-,01768
Q3	,14535	,86904	,25236	,11389	,02203

16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 3

\- - - - - - - - - - - - F A C T O R A N A L Y S I S - - - - - - - - - - - -

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q2	,23120	,59487	,15835	,24214	,17875
Q6	,14062	,52886	,21346	,20227	,43577
Q4	,28154	,52410	-,08904	,19018	,06128
Q22	,14578	,48985	,22373	,32627	,26569
Q11	,19004	,12876	,73963	-,17675	,25583
Q25	,38143	,09309	,66325	,36952	,08224
Q18	,01170	,25349	,64562	,27429	,05903
Q24	,19775	,23414	,62356	,42519	,18855
Q12	,42994	,16999	,60224	,08702	-,04424
Q8	,17746	,18291	,16026	,78625	,14876
Q7	,35098	,40830	-,09465	,66942	,12608
Q9	,27738	,24271	,41078	,62307	-,08819
Q23	,33968	-,16226	,15487	,42549	,33153
Q15	-,12247	,02670	,16773	,15872	,73211
Q16	,34724	,22368	,05714	,04571	,66126
Q5	-,09617	-,05700	,08262	-,01432	,19815
Q19	,19436	,40861	,28159	,02521	,07607

	Factor 6
Q10	-,02701
Q14	-,02650
Q1	-,06756
Q13	,14047
Q21	,10279
Q26	,33359
Q20	-,01505
Q3	-,05296
Q2	,17017
Q6	-,24069
Q4	,34698
Q22	,35119
Q11	,04146
Q25	,19190

Q18	,19778
Q24	,09095
Q12	,04298
Q8	,00136
Q7	,08253

16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 4

- - - - - - - - - - - - F A C T O R   A N A L Y S I S - - - - - - - - - - - -

	Factor 6
Q9	-,04361
Q23	,38804
Q15	,26413
Q16	,13570
Q5	,77509
Q19	,60504

Factor Transformation Matrix:

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Factor 1	,54684	,48206	,44604	,42381	,22616
Factor 2	-,52626	-,06286	,23135	-,06454	,54452
Factor 3	,44225	-,85553	,16583	,10384	,09352
Factor 4	,10250	,02140	-,81384	,46168	,24265
Factor 5	,46656	,17177	-,24017	-,76745	,18206
Factor 6	-,01578	,04207	,00157	,05753	-,74268

	Factor 6
Factor 1	,19715
Factor 2	,60407
Factor 3	,15954
Factor 4	,23382
Factor 5	,27022
Factor 6	,66565

16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 5

****** Method 1 (space saver) will be used for this analysis ******

16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 6

R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

		Mean	Std Dev	Cases
1.	Q10	5,2410	,7423	83,0
2.	Q14	5,1687	,8528	83,0
3.	Q1	5,0723	1,1768	83,0
4.	Q13	5,1446	,9257	83,0
5.	Q21	5,1928	,8331	83,0
6.	Q26	5,1928	,7880	83,0

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	31,0120	17,7681	4,2152	6

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q10	25,7711	12,8616	,8181	,8336
Q14	25,8434	12,4020	,7723	,8360
Q1	25,9398	11,7646	,5721	,8834
Q13	25,8675	12,5554	,6640	,8539
Q21	25,8193	12,7840	,7201	,8451
Q26	25,8193	13,5401	,6220	,8610

Reliability Coefficients
N of Cases = 83,0 N of Items = 6
Alpha = ,8735

****** Method 1 (space saver) will be used for this analysis ******

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

		Mean	Std Dev	Cases
1.	Q20	5,4940	,6874	83,0
2.	Q3	5,4578	,7856	83,0
3.	Q2	5,2651	,7822	83,0
4.	Q6	5,3133	,8962	83,0
5.	Q4	5,2771	,8456	83,0
6.	Q22	5,3735	,7919	83,0

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	32,1807	13,0767	3,6162	6

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q20	26,6867	9,4373	,7498	,8031
Q3	26,7229	8,9589	,7444	,7994
Q2	26,9157	9,2977	,6640	,8151
Q6	26,8675	9,2871	,5468	,8404
Q4	26,9036	9,6491	,5164	,8443
Q22	26,8072	9,5234	,5987	,8274

Reliability Coefficients
N of Cases = 83,0 N of Items = 6
Alpha = ,8470

****** Method 1 (space saver) will be used for this analysis ******

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

		Mean	Std Dev	Cases
1.	Q11	4,8313	1,0455	83,0
2.	Q25	5,0482	,9227	83,0
3.	Q18	5,3253	,8711	83,0
4.	Q24	5,2048	,8520	83,0
5.	Q12	4,9036	,9830	83,0

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	25,3133	12,9495	3,5985	5

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q11	20,4819	8,4234	,5656	,8107
Q25	20,2651	8,1484	,7498	,7534
Q18	19,9880	9,2316	,5591	,8081
Q24	20,1084	8,7808	,6819	,7761
Q12	20,4096	8,6594	,5746	,8053

Reliability Coefficients
N of Cases = 83,0 N of Items = 5
Alpha = ,8257
16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 11

****** Method 1 (space saver) will be used for this analysis ******

16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 12

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

		Mean	Std Dev	Cases
1.	Q8	5,1566	,9037	83,0
2.	Q7	5,3614	,7898	83,0
3.	Q9	5,3373	,8157	83,0
4.	Q23	4,9277	,9974	83,0

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	20,7831	7,0743	2,6598	4

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q8	15,6265	3,8222	,6893	,6037
Q7	15,4217	4,4420	,6033	,6637
Q9	15,4458	4,3720	,5972	,6645
Q23	15,8554	4,6130	,3423	,8153

Reliability Coefficients
N of Cases = 83,0 N of Items = 4
Alpha = ,7490
16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 13

****** Method 1 (space saver) will be used for this analysis ******
16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 14

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

		Mean	Std Dev	Cases
1.	Q15	4,9157	1,1175	83,0
2.	Q16	4,8434	1,3018	83,0

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	9,7590	4,1607	2,0398	2

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q15	4,8434	1,6947	,4183	.
Q16	4,9157	1,2489	,4183	.

Reliability Coefficients
N of Cases = 83,0 N of Items = 2
Alpha = ,5851
16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 15

****** Method 1 (space saver) will be used for this analysis ******

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

		Mean	Std Dev	Cases
1.	Q19	5,3373	,7852	83,0
2.	Q5	4,4096	1,2787	83,0

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	9,7470	2,8498	1,6881	2

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q19	4,4096	1,6350	,2980	.
Q5	5,3373	,6165	,2980	.

Reliability Coefficients

N of Cases = 83,0 N of Items = 2

Alpha = ,4199

* * * * M U L T I P L E R E G R E S S I O N * * * *

Mean Substituted for Missing Data

	Mean	Std Dev	Cases	Label
Q17	5,373	,792	83	
F1	31,012	4,215	83	
F2	32,181	3,616	83	
F3	25,313	3,599	83	
F4	20,783	2,660	83	
Q15	4,916	1,118	83	
Q16	4,843	1,302	83	
Q5	4,410	1,279	83	
Q19	5,337	,785	83	

N of Cases encountered = 83

Minimum Pairwise N of Cases = 83

* * * * M U L T I P L E R E G R E S S I O N * * * *

Correlation, 1-tailed Sig, N of Cases:

	Q17	F1	F2	F3	F4	Q15	Q16	Q5
Q17	1,000	,437	,730	,510	,514	,257	,401	,196
	,	,000	,000	,000	,000	,010	,000	,038
	83	83	83	83	83	83	83	83
F1	,437	1,000	,564	,629	,686	,080	,420	,017
	,000	,	,000	,000	,000	,235	,000	,439
	83	83	83	83	83	83	83	83
F2	,730	,564	1,000	,568	,567	,212	,400	,081
	,000	,000	,	,000	,000	,027	,000	,232
	83	83	83	83	83	83	83	83
F3	,510	,629	,568	1,000	,579	,270	,349	,155
	,000	,000	,000	,	,000	,007	,001	,081
	83	83	83	83	83	83	83	83
F4	,514	,686	,567	,579	1,000	,310	,385	,127
	,000	,000	,000	,000	,	,002	,000	,127
	83	83	83	83	83	83	83	83
Q15	,257	,080	,212	,270	,310	1,000	,418	,366
	,010	,235	,027	,007	,002	,	,000	,000
	83	83	83	83	83	83	83	83
Q16	,401	,420	,400	,349	,385	,418	1,000	,164
	,000	,000	,000	,001	,000	,000	,	,070
	83	83	83	83	83	83	83	83

```
Q5            ,196     ,017     ,081     ,155     ,127     ,366     ,164    1,000
              ,038     ,439     ,232     ,081     ,127     ,000     ,070     ,
                83       83       83       83       83       83       83       83
Q19           ,521     ,404     ,485     ,454     ,357     ,311     ,315     ,298
              ,000     ,000     ,000     ,000     ,000     ,002     ,002     ,003
                83       83       83       83       83       83       83       83
```

```
16 Feb 02 SPSS for MS WINDOWS Release 6.0                               Page 19
           * * * *   M U L T I P L E   R E G R E S S I O N   * * * *
               Q19
Q17           ,521
              ,000
                83
F1            ,404
              ,000
                83
F2            ,485
              ,000
                83
F3            ,454
              ,000
                83
F4            ,357
              ,000
                83
Q15           ,311
              ,002
                83
Q16           ,315
              ,002
                83
Q5            ,298
              ,003
                83
Q19          1,000
              ,
                83
```

```
16 Feb 02 SPSS for MS WINDOWS Release 6.0                               Page 20
           * * * *   M U L T I P L E   R E G R E S S I O N   * * * *
Equation Number 1    Dependent Variable..   Q17
  Descriptive Statistics are printed on Page   17
Block Number  1.  Method:  Enter
   F1       F2       F3       F4       Q15      Q16      Q5       Q19
Variable(s) Entered on Step Number
   1..    Q19
   2..    Q5
   3..    Q16
   4..    F4
   5..    Q15
   6..    F3
   7..    F2
   8..    F1
Multiple R           ,77339
R Square             ,59813
Adjusted R Square    ,55469
Standard Error       ,52844
Analysis of Variance
                    DF      Sum of Squares      Mean Square
Regression           8            30,75690          3,84461
Residual            74            20,66479           ,27925
```

F = 13,76744 Signif F = ,0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
F1	-,027254	,022901	-,145072	-1,190	,2378
F2	,121253	,022464	,553703	5,398	,0000
F3	,018161	,023219	,082528	,782	,4366
F4	,045340	,033627	,152284	1,348	,1817
Q15	-,029709	,065725	-,041927	-,452	,6526
Q16	,062543	,055307	,102815	1,131	,2618
Q5	,041299	,050670	,066686	,815	,4177
Q19	,181143	,093147	,179609	1,945	,0556
(Constant)	-,391163	,602136		-,650	,5179

End Block Number 1 All requested variables entered.

16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 21

* * * * M U L T I P L E R E G R E S S I O N * * * *

Equation Number 1 Dependent Variable.. Q17

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*PRED	3,6849	6,1575	5,3735	,6124	83
*RESID	-1,8596	1,1409	,0000	,5020	83
*ZPRED	-2,7571	1,2801	,0000	1,0000	83
*ZRESID	-3,5190	2,1590	,0000	,9500	83

Total Cases = 83

Durbin-Watson Test = 2,04698

16 Feb 02 SPSS for MS WINDOWS Release 6.0 Page 22

* * * * M U L T I P L E R E G R E S S I O N * * * *

Mean Substituted for Missing Data

	Mean	Std Dev	Cases	Label
Q17	5,373	,792	83	
F1	31,012	4,215	83	
F2	32,181	3,616	83	
F3	25,313	3,599	83	
F4	20,783	2,660	83	
Q16	4,843	1,302	83	
Q19	5,337	,785	83	

N of Cases encountered = 83

Minimum Pairwise N of Cases = 83

Correlation, 1-tailed Sig, N of Cases:

	Q17	F1	F2	F3	F4	Q16	Q19
Q17	1,000	,437	,730	,510	,514	,401	,521
	,	,000	,000	,000	,000	,000	,000
	83	83	83	83	83	83	83
F1	,437	1,000	,564	,629	,686	,420	,404
	,000	,	,000	,000	,000	,000	,000
	83	83	83	83	83	83	83
F2	,730	,564	1,000	,568	,567	,400	,485
	,000	,000	,	,000	,000	,000	,000
	83	83	83	83	83	83	83
F3	,510	,629	,568	1,000	,579	,349	,454
	,000	,000	,000	,	,000	,001	,000
	83	83	83	83	83	83	83
F4	,514	,686	,567	,579	1,000	,385	,357
	,000	,000	,000	,000	,	,000	,000
	83	83	83	83	83	83	83
Q16	,401	,420	,400	,349	,385	1,000	,315
	,000	,000	,000	,001	,000	,	,002
	83	83	83	83	83	83	83
Q19	,521	,404	,485	,454	,357	,315	1,000
	,000	,000	,000	,000	,000	,002	,
	83	83	83	83	83	83	83

```
16 Feb 02 SPSS for MS WINDOWS Release 6.0                               Page 23
           * * * *   M U L T I P L E   R E G R E S S I O N   * * * *
Equation Number 1    Dependent Variable..   Q17
  Descriptive Statistics are printed on Page   22
Block Number  1.  Method:  Enter
   F1       F2       F3       F4       Q16      Q19
Variable(s) Entered on Step Number
   1..    Q19
   2..    Q16
   3..    F4
   4..    F3
   5..    F2
   6..    F1
Multiple R           ,77081
R Square             ,59414
Adjusted R Square    ,56210
Standard Error       ,52403
Analysis of Variance
                    DF      Sum of Squares      Mean Square
Regression           6            30,55175          5,09196
Residual            76            20,86994           ,27460
F =      18,54288       Signif F =  ,0000
------------------ Variables in the Equation ------------------
Variable              B        SE B       Beta          T  Sig T
F1             -,026949     ,021115   -,143451    -1,276  ,2057
F2              ,120147     ,022147    ,548652     5,425  ,0000
F3              ,018264     ,022715    ,082994      ,804  ,4239
F4              ,043985     ,031955    ,147735     1,376  ,1727
Q16             ,057905     ,050687    ,095190     1,142  ,2569
Q19             ,193695     ,087753    ,192054     2,207  ,0303
(Constant)     -,347918     ,577531                -,602  ,5487
End Block Number   1   All requested variables entered.
16 Feb 02 SPSS for MS WINDOWS Release 6.0                               Page 24
           * * * *   M U L T I P L E   R E G R E S S I O N   * * * *
Equation Number 1    Dependent Variable..   Q17
Residuals Statistics:
              Min       Max     Mean  Std Dev   N
*PRED      3,7087    6,1204   5,3735    ,6104  83
*RESID    -1,9070    1,1184    ,0000    ,5045  83
*ZPRED    -2,7275    1,2236    ,0000   1,0000  83
*ZRESID   -3,6392    2,1342    ,0000    ,9627  83
Total Cases =       83
Durbin-Watson Test =   2,02699
16 Feb 02 SPSS for MS WINDOWS Release 6.0                               Page 25
```

```
                 - - - - -  O N E W A Y  - - - - -
      Variable  Q17
   By Variable  SBT
                                   Analysis of Variance
                                   Sum of        Mean            F       F
        Source            D.F.    Squares       Squares        Ratio   Prob.
Between Groups              1        ,5154         ,5154        ,8201   ,3678
Within Groups              81      50,9063         ,6285
Total                      82      51,4217

                                  Standard   Standard
Group       Count       Mean     Deviation      Error    95 Pct Conf Int for Mean
Grp 1          62      5,4194        ,7585       ,0963      5,2267  TO      5,6120
Grp 2          21      5,2381        ,8891       ,1940      4,8334  TO      5,6428
Total          83      5,3735        ,7919       ,0869      5,2006  TO      5,5464

GROUP        MINIMUM     MAXIMUM
Grp 1         3,0000      6,0000
Grp 2         4,0000      6,0000
TOTAL         3,0000      6,0000

Levene Test for Homogeneity of Variances
    Statistic    df1    df2       2-tail Sig.
      2,3751      1     81          ,127
No range tests performed with fewer than three non-empty groups.
```



```
                 - - - - -  O N E W A Y  - - - - -
      Variable  Q17
   By Variable  FORCE
                                   Analysis of Variance
                                   Sum of        Mean            F       F
        Source            D.F.    Squares       Squares        Ratio   Prob.
Between Groups              2        ,3068         ,1534        ,2401   ,7871
Within Groups              80      51,1149         ,6389
Total                      82      51,4217

                                  Standard   Standard
Group       Count       Mean     Deviation      Error    95 Pct Conf Int for Mean
Grp 1          41      5,4146        ,7062       ,1103      5,1917  TO      5,6376
Grp 2          20      5,4000        ,8208       ,1835      5,0159  TO      5,7841
Grp 3          22      5,2727        ,9351       ,1994      4,8581  TO      5,6873
Total          83      5,3735        ,7919       ,0869      5,2006  TO      5,5464

GROUP        MINIMUM     MAXIMUM
Grp 1         4,0000      6,0000
Grp 2         4,0000      6,0000
Grp 3         3,0000      6,0000
TOTAL         3,0000      6,0000
Levene Test for Homogeneity of Variances
    Statistic    df1    df2       2-tail Sig.
      1,5239      2     80          ,224
```



```
                 - - - - -  O N E W A Y  - - - - -
      Variable  Q17
   By Variable  FORCE
Multiple Range Tests:  Scheffe test with significance level ,05
```

```
The difference between two means is significant if
  MEAN(J)-MEAN(I)  >= ,5652 * RANGE * SQRT(1/N(I) + 1/N(J))
  with the following value(s) for RANGE: 3,53
- No two groups are significantly different at the  ,050 level
```



```
                       - - - - -  O N E W A Y  - - - - -
      Variable  Q17
   By Variable  BRANCH
                                          Analysis of Variance
                                          Sum of         Mean              F       F
        Source              D.F.         Squares        Squares          Ratio   Prob.
Between Groups                2            ,4937          ,2469          ,3878   ,6798
Within Groups                80          50,9279          ,6366
Total                        82          51,4217

                                        Standard   Standard
Group       Count       Mean           Deviation      Error     95 Pct Conf Int for Mean
Grp 1          46     5,3043             ,8398      ,1238       5,0549  TO       5,5537
Grp 2          26     5,4615             ,7060      ,1385       5,1764  TO       5,7467
Grp 3          11     5,4545             ,8202      ,2473       4,9035  TO       6,0056
Total          83     5,3735             ,7919      ,0869       5,2006  TO       5,5464

GROUP        MINIMUM      MAXIMUM
Grp 1         3,0000       6,0000
Grp 2         4,0000       6,0000
Grp 3         4,0000       6,0000
TOTAL         3,0000       6,0000

Levene Test for Homogeneity of Variances
    Statistic    df1    df2        2-tail Sig.
       ,6416      2      80            ,529
```



```
                   - - - - -  O N E W A Y  - - - - -
      Variable  Q17
   By Variable  BRANCH
Multiple Range Tests:  Scheffe test with significance level ,05
The difference between two means is significant if
  MEAN(J)-MEAN(I)  >= ,5642 * RANGE * SQRT(1/N(I) + 1/N(J))
  with the following value(s) for RANGE: 3,53
- No two groups are significantly different at the  ,050 level
```



```
WOR.YEAR
                                                              Valid     Cum
Value Label                    Value  Frequency  Percent   Percent   Percent
                                8,00          7      8,4       8,4       8,4
                                9,00         13     15,7      15,7      24,1
                               10,00         14     16,9      16,9      41,0
                               11,00         11     13,3      13,3      54,2
```

Value	Frequency	Percent	Valid Percent	Cum Percent
12,00	15	18,1	18,1	72,3
13,00	9	10,8	10,8	83,1
14,00	3	3,6	3,6	86,7
15,00	7	8,4	8,4	95,2
16,00	1	1,2	1,2	96,4
17,00	3	3,6	3,6	100,0
Total	83	100,0	100,0	

Median 11,000
Valid cases 83 Missing cases 0

- - - - - O N E W A Y - - - - -

Variable Q17
By Variable NEW.W.Y

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	1	,0316	,0316	,0499	,8239
Within Groups	81	51,3901	,6344		
Total	82	51,4217			

Group	Count	Mean	Standard Deviation	Standard Error	95 Pct Conf Int for Mean		
Grp 1	45	5,3556	,8021	,1196	5,1146	TO	5,5965
Grp 2	38	5,3947	,7898	,1281	5,1351	TO	5,6543
Total	83	5,3735	,7919	,0869	5,2006	TO	5,5464

GROUP	MINIMUM	MAXIMUM
Grp 1	3,0000	6,0000
Grp 2	4,0000	6,0000
TOTAL	3,0000	6,0000

Levene Test for Homogeneity of Variances

Statistic	df1	df2	2-tail Sig.
,0262	1	81	,872

No range tests performed with fewer than three non-empty groups.

Q17

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
	3,00	1	1,2	1,2	1,2
	4,00	13	15,7	15,7	16,9
	5,00	23	27,7	27,7	44,6
	6,00	46	55,4	55,4	100,0
	Total	83	100,0	100,0	

Median 6,000
Valid cases 83 Missing cases 0

CCC by SBT

```
                SBT          Page 1 of 1
        Count  |
               |
               |                    Row
               |    1,00|    2,00| Total
CCC      --------+--------+--------+
         1,00  |    62  |    21  |    83
               |        |        | 100,0
               +--------+--------+
        Column      62       21       83
         Total    74,7     25,3    100,0
>Warning # 10307
>Statistics cannot be computed when the number of non-empty rows or columns
>is one.
Number of Missing Observations:  0
18 Feb 02 SPSS for MS WINDOWS Release 6.0                              Page 10

18 Feb 02 SPSS for MS WINDOWS Release 6.0                              Page 11


- - -  - K E N D A L L   C O R R E L A T I O N   C O E F F I C I E N T S - - -
BRANCH          ,0800
             N(    83)
             Sig ,428
FORCE          -,0257     -,0482
             N(    83)   N(    83)
             Sig ,796   Sig ,631
                  Q17      BRANCH
(Coefficient / (Cases) / 2-tailed Significance)
" . " is printed if a coefficient cannot be computed
18 Feb 02 SPSS for MS WINDOWS Release 6.0                              Page 12
- - -  S P E A R M A N   C O R R E L A T I O N   C O E F F I C I E N T S - - -
BRANCH          ,0870
             N(    83)
             Sig ,434
FORCE          -,0288     -,0531
             N(    83)   N(    83)
             Sig ,796   Sig ,633
                  Q17      BRANCH
(Coefficient / (Cases) / 2-tailed Significance)
" . " is printed if a coefficient cannot be computed
18 Feb 02 SPSS for MS WINDOWS Release 6.0                              Page 13

                      - -  Correlation Coefficients  - -
             Q17        WOR.YEAR
Q17          1,0000     -,0329
            (   83)    (   83)
            P= ,       P= ,384
WOR.YEAR     -,0329     1,0000
            (   83)    (   83)
            P= ,384    P= ,
(Coefficient / (Cases) / 1-tailed Significance)
" . " is printed if a coefficient cannot be computed
18 Feb 02 SPSS for MS WINDOWS Release 6.0                              Page 14
```

TÜRK SİLAHLI KUVVETLERİNDE EĞİTİM PLANLARINI HAZIRLAYACAK PERSONELİN VE EĞİTİCİLERİN SİMÜLASYON TABANLI EĞİTİMDEN BEKLENTİLERİ ANKETİ

Simülasyonlar ve simülatörler çağdaş orduların eğitiminin temel öğelerini oluştururlar. Gelecekte oluşacak muharebe ortamı; hata payını en düşük seviyelere indirecek kadar dinamik ve gerekli yerlerde inisiyatif kullanımını gerekli kılacaktır. Gelecekte sürekli değişen muharebe koşullarını süratle kavrayıp doğru kararlar verebilen yetenekli ve yeterli seviyede tecrübeli komutanların varlığına daha çok ihtiyaç duyulacaktır. Simulasyon tabanlı eğitimler ise hedeflenen yetenek geliştirme ve tecrübe kazandırma konularında günümüz şartlarında en doğru eğitimleri daha emniyetli ve az maliyetli bir şekilde sunarak daha da yoğun kullanılacaktır.

Bu anket, önemli kaynaklar ayrılarak geliştirilmeye çalışılan simülasyon teknolojilerini eğitimde kullanırken, eğitim planlarını hazırlayanların ve eğiticilerin simülasyon tabanlı eğitimden beklentilerini tespit ederek simülasyon tabanlı eğitimlerde iyi bir öğrenme metodolojisi geliştirmeyi amaçlamaktadır. Soruların altındaki cevap seçeneklerinin sol tarafındaki kutucuklardan size uygun olanı işaretlemeniz anket için yeterli olacaktır.

1- Simülasyon tabanlı eğitim, eğitime katılanların teorik olarak öğrendiklerini hiç bir şeyden etkilenmeden kendi hareket tarzları ile uygulayabilmesini sağlamalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

2- Simülasyon tabanlı eğitim, eğitime katılanların senaryolardaki koşullara gösterdikleri hareket tarzlarının sonuçlarını en iyi şekilde ve karşılıklı olarak hareket tarzının uygulanmasının hemen ardından eğitilenlere yansıtmalı ve bu kitle ile direkt iletişimi sağlamalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

3- Simülasyon tabanlı eğitim, ihtiyaç duyulan eğitim kapsamı ile birebir uygun olmalı, eğitilenlerin eğitim konuları ile ilgili somut ve önemli koşulları uygulayabilmesini sağlamalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

4- Simülasyon tabanlı eğitim, fazla tekrar imkanı sayesinde bilgi beceri birikimini en üst düzeye çıkararak gerçek uygulamalara aktarılmasını sağlamalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

5- Simülasyon tabanlı eğitim, yeterli sayıda tekrarlarla eğitilen kitlenin reaksiyon davranışlarını tespit ederek bunu olumlu şekilde eğitilenlere aktarabilmeli ancak tekrar sayısını çok az tutarak reaksiyon davranışlarını tespit etmek için ikinci bir çabaya müsaade etmemelidir.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

6- Simülasyon tabanlı eğitim, eğitime katılanların yetenek ve kabiliyetlerine göre giderek artan ve zorlaşan senaryolarla dizayn edilmelidir.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

7- Simülasyon tabanlı eğitim, eğitim konularını çeşitli senaryolarla zenginleştirilmiş şekilde uygulanmasını sağlayarak öğrenimi kolaylaştırmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

8- Simülasyon tabanlı eğitim, özellikle müşterek eğitim ve mürettebat eğitimi senaryolarına daha sonradan katılacak personelin tecrübe ve eğitim eksikliğini de göze alacak şekilde senaryoları çeşitlendirerek müşterek seviyeyi yakalamayı sağlamalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

9- Simülasyon tabanlı eğitim uygulamalarının koşulları, öğretim hedeflerini karşılayacak şekilde eğitilenlerin kolaylıkla anlayabileceği bir dizayn ile gerçek koşullardaki ortamı yansıtacak şekilde düzenlenmelidir.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

10- Simülasyon tabanlı eğitimde geri besleme ve tekrarlar personelin iyi yönleri ve hatalarını görmesini sağlamasına rağmen çok az sayıda uygulanarak zaman açısından verimlilik sağlanmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

11- Simülasyon tabanlı eğitime katılanlar hakkında eğitim öncesinde toplanacak bilgi ,eğitilen kitleyi şüpheye düşürmeyecek şekilde ve beklenen performansı düşürmeyecek tarzda toplanmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

12- Simülasyon tabanlı eğitimde performans ölçümü objektif olarak belirlenen ölçüm kriterlerine göre yapılmalı; operatör ve eğiticiler objektifliği sağlamak için gözlem-değerlendirme formları kullanmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

13- Simülasyon tabanlı eğitim uygulamalarının sonunda eğitime katılanların tüm performansını gösteren sonuç çıktıları hazırlanarak eğitilen kitlelere sunulmalı ve eğitime katılanların kendi hatalarını değerlendirmeleri sağlanmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

14- Simülasyon tabanlı eğitimde senaryoların uygulanması esnasında ara değerlendirme çıktıları hazırlanarak eğitilenlere sunulmalı ve eğitime katılanların halihazırdaki durumunu değerlendirerek daha iyi motive olmuş ve eksikliklerini ve iyi yönlerini kavramış bir şekilde senaryolara devam etmesi sağlanmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

15- Simülasyon tabanlı eğitim senaryoları eğitime katılanların seviyelerine göre düzenlenmeli, bazı senaryoları atlayarak (o anda ki koşullarda eğitim ihtiyacı olarak önem arz etmeyen senaryolar) daha gerekli olan ve de zorluk derecesi arttırılmış senaryoları uygulama imkanı sağlanmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

16- Simülasyon tabanlı eğitim müşterek eğitim senaryolarında eğitime katılanların yetenekleri, anlama ve uygulama kapasitelerinin eşit olmayacağını kabul ederek senaryo uygulama koşulları çeşitli seviyelere göre hazırlanmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

17- Simülasyon tabanlı eğitim de kullanılacak olan simülasyon modelleri ve simülatörler gerçek dünya koşullarını en iyi şekilde yansıtarak eğitilenlerin gerçek muharebe ortamında ki gibi motive olmasını sağlayıp, gerçekçi koşullarda ki gibi etkin eğitimini sağlamalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

18- Simülasyon tabanlı eğitim senaryo ve uygulamaları gerçek koşullara göre yazılıp dizayn edilmeli; eğiticiler ve operatörler tarafından gerçek koşullardan, standartlardan sapmadan uygulatılması sağlanmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

19- Simülasyon tabanlı eğitim senaryoları geleceğin muharebe alanının konseptlerini ihtiva edecek şekilde düzenlenmeli ,eğitime katılanların da bu yeni konseptlere adapte olmasını sağlayarak geleceğe yönelik öğrenimi etkin bir şekilde sağlamalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

20- Simülasyon tabanlı eğitim senaryoları ihtiyaç duyulan eğitim kapsamını uygulamaktan çok personelin simülasyon ortamında mekanik ve karar verme kabiliyetini geliştirmeye yönelik bağımsız senaryolar şeklinde hazırlanmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

21- Simülasyon tabanlı eğitimde yapılacak geri beslemeler uygun zaman dilimlerinde eğitilenlere aktarılarak eğitime katılanların performansını arttırmasını sağlamalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

22- Simülasyon tabanlı eğitim gerçek muharebe koşullarını tam olarak yansıtamayacağı için bir eğitim metodu olarak Silahlı Kuvvetlerin eğitiminde kullanmak personelin karar verme kabiliyetlerinin ve mekanik kabiliyetlerini gelişimi, eğitimin maliyet ve verimlilik etkinliği açısından da etkili olmayacaktır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

23- Simülasyon tabanlı eğitimde yapılacak geri beslemeler ve tekrarlar eğitim kapsamı ve konularından sapmaları içine dahil ederek eğitilenlerin eksik kaldığı konulara zamanında müdahale edilerek verimliliğin arttırılması sağlanmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

24- Eğitici ve operatörler simülasyon tabanlı eğitim ortamının kullanılması konusunda eğitim başlangıcında eğitilenlere rehberlik yapıp kolaylık sağlayarak simülasyon ortamına adaptasyonu sağlamalıdırlar.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

25- Eğitici ve operatörler simülasyon tabanlı eğitim ortamında gerçekleştirilen eğitimlerden sonra personele rehberlik yaparak eğitime katılan kitlenin eğitim konuları ile ilgili eksiklik ve avantajlarını daha iyi anlamasını ve sonra ki uygulamalarda daha iyi reaksiyon gösterebilmesini sağlamalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

26- Simülasyon tabanlı eğitimde eğitime katılan kitlelere eğitim esnasında ve sonunda sonuç çıktıları verilerek eğitim uygulaması esnasında ki hareket tarzlarını bir neden-sonuç ilişkisi içinde kendilerinin değerlendirmesi ve hataları ile eksik yönlerini kendilerinin de tespit edebilmesi sağlanmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

27- Simülasyon tabanlı eğitim gerçekçi koşulardaki uygulama zamanını kısaltarak tekrarlara ve diğer faaliyetlere zaman aktarılabilmesine imkan sağlamalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

28- Simülasyon tabanlı eğitim gerçek koşullarda uygulanması zor olan (maliyet, tatbikat alanı yetersizliği, zaman gibi faktörlerden) önemli eğitim konularını icra etmeyi ve eğitimin sürekliliği sağlamayı mümkün kılmalıdır.

☐ **Kesinlikle katılmıyorum**	☐ **Çok az katılıyorum**	☐ **Az katılıyorum**	☐ **Oldukça katılıyorum**	☐ **Çok katılıyorum**	☐ **Kesinlikle katılıyorum**

29- Daha önce Simülasyon tabanlı eğitime katıldınız mı?

☐ Evet ☐ Hayır

30- Mensubu olduğunuz kuvvet?

☐ Kara Kuvvetleri ☐ Hava Kuvvetleri ☐ Deniz Kuvvetleri ☐ Jandarma Genel Kom.

31- Sınıfınız?

☐ Muharebe ☐ Muharebe Destek ☐ Muharebe Hizmet Destek

32- Görev süreniz---

REFERENCES

About SIMNET, Available on site http://www.rtimeinc.com/rtime_web/netscape/rt_about_simnet.html

Adams, R., 1996, "An M & S Primer," Defense News Marketing Supplement, pp9-10

Air University, “Professional Military Education (PME) in 2020”, Available on site http://www.fas.org/spp/military/docops/usaf/2020/app-l.htm

Allen, Thomas B., 1987, **War Games**, McGraw-Hill, New York, pp 28. Cited in: Caffrey Jr., Matthew, 2000,“Toward A History- Based Doctrine for Wargaming”, Aerospace Power Journal, Volume 14 Issue 3, pp 33

Alley, Anthony D., 1994, “ Forecasting Military Technological needs”, edits in **Challenge and Response** by Dr. Karl P.Magyar, Air University Press, pp209-219

Arguello, L. et al., “HLA- Based Distributed Simulation for International Space Station operations, Paper ID: 4c007, Gargarin Cosmonaut Training Center (GCTTC), 141100 Star City Russia, pp 2

Army Vision 2010, Dominant Maneuver, Available on site http://www.army.mil/2010/dominate_maneuver.htm

Army War College, **Army Transformation Wargame 2001,Vigilant Warriors**, Carlisle Barracks, PA, 22-27 April 2001, Available on site http://www.tradoc.army.mil/tpubs/misc/ArmyTransformationBooklet.pdf

Arnold, David H., 1994, “Economic Warfare -Targeting Financial System As centers of Gravity”, edits in **Challenge and Response** by Dr. Karl P. Magyar, Air University Press, Alabama, pp345-362

Aslan, A., 2000, **Ülkelerin Kullandıkları Modelleme ve Simülasyon Sistemleri Nelerdir? Bu Sistemlerden TSK’lerinde Nasıl Yararlanılmaktadır?**, Harp Akademileri Komutanlığı, Yenilevent, İstanbul

Banks J. and Carson J.S., 1984, Discrete-Event System Simulation, Englewood Cliffs, NJ: Prentice-Hall, Inc., Cited in: Surdu, R.J., 2000, **Connecting Simulation to the Mission Operational Environment,** A Dissertation for degree of Doctor of Philosophy, Texas & AM University, May 2000

Bartram S. and Gibson B., 1997, Training **Needs Analysis: A Resource for Identifying Training Needs, Selecting Training Strategies, and Developing Training plans 2nd ed**, Introduction part, Anthony Rowe Ltd., Chippenham, Wiltshire

Bateman III, Robert L., 1998, "Avoiding Information Overload," Military Review, July-August, pp53-54 Cited in: Surdu and Pooch, 2001, “Simulations During Operations.”, Military Review March/April 2001Volume 81 Issue 2, pp 38

Bedingham, K., 1997, “Proving The Effectiveness of Training”, Industrial and Commercial Training, MCB University Press, pp 88-91

Berk, Y., 2000 , “Sanal Ortam Eğitimi”, Hedef 2020 ve Ötesi, Özel sayı, T.C. K.K.K Eğitim ve Doktrin Komutanlığı, Ankara, Sahife 39-41

Berndt, Martin R., 1999, “The USACOM Joint Warfighting Center”, Engineer, April 99,Volume 29, Issue 2, pp 19

Bingham, Price T., 2001, “Transforming Warfare with Effects-Based Joint Operations”, Aerospace Power Journal, Spring 2001 Volume 15 Issue 1, pp 58

Board of Directors, 1996, USAF Long Range Planning, "Future Operating Environments," Briefing Slides 29 February 1996, Slide 33.

Boomer, F.M., "Joint or Combined Doctrine? The Right Choice for Canada" Unpublished paper, Advanced Military Studies Course - AMSC 1, CFC, Toronto, Ont , Available on site http://wps.cfc.dnd.ca/irc/amsc/amsc1/index.html.

Bovenkamp, J., 1999, “Modeling and Simulation: Enabling Better Decisions”, Defense Science and Technology, November 99,pp 1

Browns, 1999 “Simulated Classrooms and Artificial students: The Potential Effects of New Technologies on...”, Journal of Research on Computing in Education, Vol.32 Issue 2, pp 307

Brown, A.M., 1984," The Use Of Training Simulations By Land Forces.”, Unpublished CFCSC essay, Canadian Forces College, p 1 Cited in: Ewing, R.B., 1998, “The Benefits of Using Simulation in Training- Does the Land Force Leadership Understand?”, Ex- New Horizons 1997-1998 Available on site: http://www.cfcsc.dnd.ca/irc/nh/nh9798/0032.html

Bütün ,M.O. , 2000,“2020 için Muharebe Geliştirme” Hedef 2020 ve Ötesi, T.C. K.K.K EDOK Özel sayı , Ankara, Sahife 24

Caffrey Jr., Matthew, 2000,“Toward A History- Based Doctrine for Wargaming”, Aerospace Power Journal, Volume 14 Issue 3, pp 33

Chan, Felix T.S., 1995, “Using Simulation to Predict System Performance: A Case Study of an Electro- Phoretic Deposition Plant, Integrated Manufacturing Systems, Vol. 6 No. 5, pp 27-38

Child, David A., 1997, “Patterns of Simulator Use Within a Military Training Environment”, International Journal of Instructional Media, Volume 24 Issue 1,pp 43

Cohen William S., 1999, **Annual Report to the President and Congress, Chapter 10- Revolution in Military Affairs and Joint Vision 2010**, Available on site http://www.fas.org/man/docs/adr_00/chap10.htm

Cohn J. et al, 2000, "Training-Transfer Guidelines for Virtual Environment (VE)", Interservice/ Industry Training and Simulation Conference November 27-30, 2000, Orlando, FL

Collard, P., 1997, "The COTS Revolution: As Defense Budgets Shrink, Military Planners Turn to Smart, Flexible, Affordable Simulators", Military& Aerospace Electronics, Sep/97 Volume8, Issue 9, pp 33

Command, Control, Communications and Intelligence Assistant Secretary of Defense, 1994, DoD **8320.1-M Data Administration Procedures**, Appendix E- Data Standardization, Washington D.C. 20301-3040, 29 March 1994

Culkin, Rodger T., 1999, **Post Cold Wargaming and The American Military Leadership Challenge**, Air Command and Staff College Air University, Maxwell Air Force Base, Alabama

Cusick John J. and Pipp, Donald C., 1997, "In search of Focused Logistics", JFQ Forum, pp 125-127

Dahman, J., 1998, " High Level Architecture for Simulation", Defense Modeling and Simulation Office, Cited in: Topçu, O., **Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-**, Chapter 1,Middle East Technical University, December 1999, pp 13

Davila, Jeffrey D., 2001, **The Hierarchy and Necessity Principles: A Critical Examination of Jointness**, Unclassified Report Submitted to Naval War College, February 2001, Newport, RI

Davis, Wayne J., 2000, "Simulation-Based Acquisition: An Impetus for Change", Proceedings of the 2000 Winter Simulation Conference eds. J. A. Joines, R. R. Barton, K. Kang, and P. A. Fishwick, pp 1061-1067

Defense Modeling and Simulation Office (DMSO), 1998, DoD Modeling and Simulation (M&S) Glossary DoD 5000.59-M, January 1998, Available on site URL http://www.dmso.mil/public/library/policy/p500059m

Defense Modeling and Simulation Office, "Runtime Infrastructure", Available on site http://www.dmso.mil/index.php? page=70

Defense Modeling and Simulation Office, 1998, "Conceptual Models of Mission Space", Information paper, June 11,1998 Available on site http://www.dmso.mil

Defense Modeling and Simulation Office, 1998, "The Conceptual Model of Mission Space and Data Engineering Toolset", Information Paper, June 11, 1998, Available on site http://www.dmso.mil

Defense Science Board, 1988, Report of the Defense Science Board Task Force on Computer Applications to Training and Wargaming , Government Printing Office, May 1988, Washington, D.C, pp 6

Department of Army Headquarters, **Field Manual 3-0, Chapter 4 –Fundamentals of Full Spectrum Operations**, Available on site http://www.adtdl.army.mil/cgi-bin/atdl.dll/fm/3-0/ch4.htm

Department of the Army, 1998, **Training With Simulations: Handbook for Commanders and Trainers**, Fort Leavenworth: DOD USA, p 39. Cited in: Ewing, R.B., 1998, "The Benefits of Using Simulation in Training- Does the Land Force Leadership Understand?", Ex- New Horizons 1997-1998

Department of The Army Headquarters1996,**Field Manual 100-6 Information Operations**, Washington DC.

Desjardins, B., 1999, "Joint Doctrine for the Canadian Forces: Vital Concern or Hindrance?", Canadian Forces College Papers and Publications: AMSC2 (1999) Papers

Department of Defense, 1998, " Science and Technology", Chapter 17, Arlington, VA, Available on site http://www.dtic.mil/execsec/adr96/chapt_17.html

Department of Defence, 2001, **Technical Reference Model Version 2.0**, 9 April 2001, Available on site: http:// www-trm.itsi.disa.mil

Department of Defense, 1991, "DoD 8320.1-M-1, DoD Data Element Standardization Procedures," January 1993, authorized by DoD Directive 8320.1, September 26, 1991

Dunnigan, James F., 1997, **The Complete Wargames Handbook**, Chapter 5- History of Wargames, Available on site http://www.hyw.com/Books/WargamesHandbook/5-histor.htm

Dynamics Research Corporation, "CMMS Data Dictionary CMMS DD", Available on site http://www.dmso.mil

Dynamics Research Corporation, 1998, **Technical Report: Data Dictionary Requirements Analyses Validation & Verification Plan**, Defense Modeling and Simulation Office, Alexandria, VA 22311

Ewing, R.B., 1998, "The Benefits of Using Simulation in Training- Does the Land Force Leadership Understand?", Ex- New Horizons 1997-1998 Available on site: http://www.cfcsc.dnd.ca/irc/nh/nh9798/0032.html

Ferriter, Edward C., 1995, "Which Way Joint Doctrine?", JFQ Forum Publications, pp 118-119

Frank, Geoffrey A., Helms II, Robert F., and Voor, David J.,2000, "Determining the Right Mix of Live, Virtual and Constructive Training", Interservice/ Industry Training and Simulation Conference November 27-30, 2000, Orlando, FL

Fournier, Ronald F., 1999, "An Architecture for Tailoring Synthetic Natural Environment within the JSIMS Framework.", 1999 FALL Simulation and Interoperability Workshop, 12-17 September 1999, Orlando, FL.

Fullford, D. et al, 1997, "From DIS to HLA", MS&T The International Training Journal 1/97, pp 4

Fullford, D. et al, 1998, "Transitioning Your DIS Simulator to HLA", Mak Technologies, Cambridge, MA, Available on site http:// www.mak.com/tech/dis_to_hla_article.htm

Garamone, J., 2000, "Joint Vision 2020 Emphasizes Full-Spectrum Dominance", Available on site http:// www.defenselink.mil/news/Jun2000/n06022000_20006025.html

Gedik, H., 1995, **Simulation Applications in Project Evaluation, A Master Thesis**, The Institute of Social Sciences of the Middle East Technical University, Ankara

Geyik, Kemal Ç., 1999, **Sistem Benzetimi, İnternet Tabanlı Benzetim ve Bir Modelin Tasarlanması, Master Tezi**, Gazi Üniversitesi Sosyal Bilimler Enstitüsü İşletme Ana Bilim Dalı, Ankara

Glashow, J., 1996, "Regional Powers May Gain Clout," *Defense News*, 11-17 March 1996, pp 36.

Gray, W., "What is Wargaming Part I- History of Wargaming", Available on site http://www.hmgs.org/history.htm

Guetzkow, H., 1971, "Simulations in Consolidation and Utilization of Knowledge about International Relations", in **Cybernetics, Simulation and Conflict Resolution Edited by Knight and et al**, Spartan Books, New York, pp 128

Hamilton, John A., Deal, John.C. and, Murtagh, Jeane L., 1999, **Simulation-Based Requirement Engineering**, Available on site: http:// www.drew-hamilton.com/astc99

Hardt, J. and White, K., 1998, "Distributed Interactive Simulation", EEL 4781 Computer Networks, University of Central Florida, Fall 1998

Hedges P.and Moss D., 1996, "Costing the Effectiveness of Training: Improving Driver Performance", Industrial and Commercial Training, MCB University Press, pp 14-18

Hausrath, Alfred H., 1971, **Venture Simulation in War, Business, and Politics**: McGraw-Hill Book Company, New York, Cited in: Caffrey Jr., Matthew, 2000,"Toward A

History- Based Doctrine for Wargaming", Aerospace Power Journal, Volume 14 Issue 3, pp 33

Hitches, T., 1996, "Lawmakers Call '97 Clinton Plan Unrealistic," *Defense News*, 11-17 March 1996, pp 14.

History of Wargaming, Available on site http://www.aimonline.com/history.htm

Holder L.D and Dessert Roland A., 1996, "Prairie Warrior A Joint and Combined Exercise.", Military Review, July/Aug 96 Volume 76 Issue 4, pp 5

Howard, M., 1973, "Military Science in Age of Peace", War Theory and Campaign Study Department, U.S. Government Printing Office, Alabama, 1996

IDR JH&EL, 1998, "Overview and Data Standardization", Section 4- Data Standardization Process, Presentation Slide Number 3, available on site http://www.w3.org/TR/REC-html40

Jack S. et al, 1997, **Conceptual Model of Mission Space (CMSS) Technical Framework**, Document Number: USD/A&T-DMSO-CMMS-0002, Revision number:0. 2.1, Defense Modeling and Simulation Office, Alexandria, VA 22311, 13 February 1997

Jimenez, Victor J., 1998, "The Joint Simulation System (JSIMS) Modeling and Simulation Resource Repository: An Application of Highly Abstract Language for Objects", 1998 SPRING Simulation and Interoperability Workshop, 9-13 March 1998, Orlando, FL.

Johnston, Scott J., 2001, "Modeling and Strategic Cascading Effects in the Joint Simulation System (JSIMS)", 2001 SPRING Simulation and Interoperability Workshop, 25-30 March 2001, Orlando, FL.

Joint Chief of Staff, 1997, **Concept For Future Operations**, May 1997

Joint Chiefs of Staff, 1998, **The Joint Training System: A Primer for Senior Leaders**

Joint Chiefs of Staff, 2000,**Joint Vision 2020**, US Government Printing Office, Washington DC, June 2000

Joint Chiefs of Staff, 1999, **Joint Training Policy For The Armed Forces Of United States**, CJCSI 3500.01B, 31 December 1999, Washington D.C.

Joint Chiefs of Staff, 1996, Joint **Training Manual for the Armed Forces of United States**, CJCSM 3500.03, 1 June 1996

Joint Chiefs of Staff, 1995, **Joint Pub 1: Joint Warfare of the Armed Forces of the United States**, 10 January 1995

Joint Chiefs of Staff, 1995,**Joint Pub 3-0 Doctrine for Joint Operations**, 1 February 1995

Joint Chiefs of Staff, 2000,**Joint Doctrine for Multinational Operations**, 5 April 2000

Joint Chiefs of Staff, 1997, **Joint Simulation System Operational Requirements Document Version 2.9 (7 November 1997)**, Concept Division Joint Warfighting Center, Fort Monroe, VA 23651-5000

Joint Chiefs of Staff, 1997, **Joint Task Force Headquarters Master Training Guide**, CJCSCM 3500.05, 15 April 1997, Washington D.C. 20318-0400

Joint Warfighting Center, 1997, **Joint Simulation System Concept of Operations Version 1.0**, Joint Warfighting Center Concept Division, Fort Monroe, VA 23651-5000

J.R.W, 1998, "New Protocols Link Simulators Better Than Ever Before.", Military &Aerospace Electronics, Nov 1997 Volume 8 Issue 11, pp 15

JSIMS Learning Methodology Working Group, 1999, **JSIMS Learning Methodology Reference Document: A Guide for System Designers and Developers,** LMWG Reference Guide 99-001, Available on site: URL http://www.jsims.mil/LM/DOCUMENTS/LM_Reference_Document.PDF

Kantarcı, H., 1999, **Simülasyon Modelleri ve Kuyruk (Bekleme Hattı) Sistemleri ile Askeri Alanda Örnek Bir Uygulama, Mastır Tezi**, Gazi Üniversitesi Sosyal Bilimler Enstitüsü İşletme Ana Bilim Dalı, Ankara

Knight, L., 2000, "Joint Simulation System (JSIMS) Program Upgrade", DMSO Industry Days 24 May 00 Briefing, Slide 12 of 13

Knight L., Crabtree G., and Olson S., 2001, "Building the Joint Simulation System (JSIMS)", Army AL &T, September-October 2001,pp 36

Konwin, Crash K., 2001, " Simulation Based Acquisition The Future Way DoD will Do Business", Defense Policy, Acquisition, Research, Test &Evaluation Conference, 26 March 2001, Long Beach, California,

Kornecki, Andrew J. and Vargas, D., 2000, "Simulation-Based Training for Airline Controller Operations", Embry Riddle Aeronautical University, Daytona Beach, FL 32114, pp 2

Kruck, M. et al, 1999, "The Joint Simulation System (JSIMS) Terrain Data Fusion Process Model", 1999 FALL Simulation and Interoperability Workshop, 12-17 September 1999, Orlando, FL.

Kurul, S., "Eğitim-Öğretim Konsepti-2020", Hedef 2020 ve Ötesi, Özel sayı, T.C. K.K.K Eğitim ve Doktrin Komutanlığı , Ankara, Sahife 15-21

Lee, David B., "Advantages of Wargames War Gaming Thinking For The Future", Available on site: http://www.airpower.maxwell.af.mil/airchronicles/apj/3sum90.html

Libicki, M. et al., 1999, **Mind the Gap: Promoting a Transatlantic Revolution in Military Affairs,** National Defense University press, Washington

Maclyntyre, K., 1999, **Analysis in the Utility of Commercial Wargaming Simulation Software for Army Leadership Organization Development**, School of Advanced Military Studies United States Army Command and General Staff College, Fort Leavenworth, Kansas

Magyar and Danapoulos, **Prolonged Wars-A Post Nuclear War Challenge**, Tentative Observations and Conclusions, U.S. Government Printing Office, 1994

McKenzie, F. and Risner, S., 2001, "Joint Simulation System (JSIMS) Approach to C4I System Interoperability", 2001 European Simulation and Interoperability Workshop, 25-27 June 2001, Harrow, Middlesex, UK.

Mingus, S., "Wargaming Miniatures", Available on site http://www.militaryhistoryonline.com/wargaming/mingus/default.htm

MITRE Corporation, 1995, "ALSP Project 1994 Annual Report", Cited in: Topçu, O., **Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-**, Chapter 1,Middle East Technical university, December 1999, pp 13

MITRE Corporation, 1999, "Development of the HLA Part-II", April 1999 Available on site http://www.mitre.org/pubs/showcase/hla/hla_n2.html

Morse Katherine L. and Dillencourt, M., 2000, "Interest Management in Large-Scale Virtual Environments", Presence: Teleoperators & Virtual Environments, February 2000, Volume 9 Issue 1

National Intelligence Council, 2000, **Global Trends 2015: A Dialogue About the Future With Nongovernment Experts**, Available on site http://www.cia.gov/cia/publications/globaltrends2015

National Simulation Center's Spectrum Team, "This is Spectrum", Available on site http://www-leav.army.mil/nsc/famsim/spectrum/intro.htm

National Defense Headquarters, 2000, **Modeling and Simulation: Enabling the Creation of Affordable, Effective 2020 Canadian Forces**, A Discussion Paper Produced by The Symposium Working Group/ A Sub-Committee of Strategic Capability Planning, April 2000, Ottawa, Ontario

The NATO Training Group Working no Individual Training and Education Developments, 1998, "Simulation in Training" Available on site ftp://ftp.xfree86.org/pub/xfree86/4.0/binaries

Nazar, R., 1998, **Küçük Birlik Muharebe Modelleme Simülasyonu, Yüksek Lisans Tezi**, Gazi Üniversitesi Fen Bilimleri Enstitüsü, Ankara

Norford, P.F., 1993,"Maintaining The Edge - The Need To Enhance Combat Readiness In The Royal Australian Air Force.", Unpublished CFCSC essay, Canadian Forces College, p 5. Cited in: Ewing, R.B., 1998, "The Benefits of Using Simulation in Training- Does the Land Force Leadership Understand?", Ex- New Horizons 1997-1998 Available on site: http://www.cfcsc.dnd.ca/irc/nh/nh9798/0032.html

O'Brien, P., "Options for Space Representation in Joint Simulation System (JSIMS)", Air Force Space Command Representation, Slide number 16, Available on site: http://ax.losangeles.af.mil/axl/jsims.ppt

Onyx™ at Bosnia – Mission Rehearsal, " Creating the Virtual Attack.", Available on site: http://www europe.sgi.com/products/remanufactured/onyx/onyx_bosnia.html

Oswalt, I., 1993, "Current Applications, Trends, and Organizations in U.S. Military Modeling and Simulation.", Simulation &Gaming Volume 24 Issue 2,pp 153

Park, Heon G., 1996, **The Development of A Scenario Translator for Distributed Simulations**, Chapter 2, Department of The Air Force Air University, Air Force Institute of Technology, Ohio, December 1996

Patrick, Stephen B., 1977, **Wargame Design**, Simulations Publications, Inc., New York, pp 4. , Cited in: Caffrey Jr., Matthew, 2000,"Toward A History- Based Doctrine for Wargaming", Aerospace Power Journal, Volume 14 Issue 3, pp 33

Perkinson, P.et al, 2001, "A Comprehensive Management Capability for the Joint Simulation System (JSIMS)", 2001 FALL Simulation and Interoperability Workshop, 9-14 September 2001, Orlando, FL.

Perla, Peter P.,1994 , "Future Directions for Wargaming" Joint Forces Quarterly 5, Sum 94, pp 83.

Pidd, M., 1990, **Computer Simulation in Management Science**, 2nd Ed., John Wiley &Sons Ltd., New York

Pullen, J.M, Myjack M. and Bouwens, C., 1998, "Limitations of Internet Protocol Suite for Distributed Interactive Simulation in_the Large Multicast Environment", University of Kansas, Kansas, Available on site: http://hegel.ittc.ukans.edu/topics/internet/internet-drafts/draft-t/draft-ieft-lsma-limitations-02.txt

Quillin ,Tim W., 1999, **Force Protection in Support and Stability Operations**, School of Advanced Military Studies, United States Army and General Staff College, Fort Leavenworth, Kansas,

Raisler, R. B. and Lampton D. R., 1995, ". Simulator sickness in tank driver trainers.", Army Institute for the Behavioral and Social Sciences, Orlando, FL, Available on site http://www.stricom.army.mil/PRODUCTS/TDT/simsick.html

ReliaSoft Corporation, 2001, “Exploring Reliability Analysis Using Simulation”, Reliability Edge Home, Quarter 1, 2001: Volume 2 Issue 1

Reimer, Dennis. J., 1996-1997, “Dominant Maneuver and Precision Engagement”, JFQ Forum, Winter 1996-1997, pp13-16 Available on site http://www.dtic.mil/doctrine/jel/jfq_pubs/domin.pdf

Renner, M., 2000, “Alternative Futures In War and Conflict”, Naval Warfare College Review, Vol. LIII No.3

Rickard, J., “Focused Logistics”, Military History Encyclopedia on the Web, Available on site http://www.rickard.karoo.net/conceptslong3.html

Roger, A. Beaumont, 1993, **Joint Military Operations: A Short Story**, Westport, Connecticut: Greenwood Press, p 187.

Riede, C., 1998, “DIS Implementations”, University of Karlsruhe, Germany, Available on site http://www.akaflieg.uni.karlsruhe.de/~chr/eec_vs_gats/eec_vs_gats.html

Risner, S. et al, 1998, “Conceptual Modeling in Joint Simulation System”, 1998 FALL Simulation and Interoperability Workshop, 14-18 September 1998, Orlando, FL.

RTI and HLA Tool Developers and Users Forum, 25 July 2001, “Joint Simulation System”, Slide 7of 9

Salsbury, T. and Diamond, R., 1998, “Performance Validation and Energy Analysis of HVAC Systems Using Simulation”, Indoor Environment Department, Berkeley, California, pp 2

Scott, William B., 2 November 1998, "'Title-10' Games Shape Policies," Aviation Week & Space Technology, pp 61-62 Cited in: Caffrey Jr., Matthew, 2000,“Toward A History-Based Doctrine for Wargaming”, Aerospace Power Journal, Volume 14 Issue 3, pp 33

Shtrichman et al, 2001, “Using Simulation To Increase Efficiency in an Army Recruitment Office”, Interfaces 31: 4 July- August 2001, pp 61-70

Smith, E., 1998, “Distributed Interactive Simulation”, IST, Orlando, FL, Available on site http://www.ist.ucf.edu/labsproj/projects/dis.htm

Smith, Roger D., 1999, “Military Simulation: Techniques & Technology”, Information & Security. Volume 3, 1999, ISSN 1311-1493.

SIMTEC, Inc., 1998, **Air Force Distributed Mission Analysis**, Prepared for Aeronautical Systems Center Training Systems Program Office, SIMTEC Inc., March 9,1998, Manassas, VA 20109

Stein George J., **Information Attack: Information Warfare In 2025**, Chapter 3-Confused visions, Available on site http://www.au.af.mil/au/2025/volume3/chap03/v3c3-3.htm

Stanford, T. and Snead, C., 2000, MS 101 Introduction to Modeling and Simulation Presentation, Available on site http://www.dmso.mil

Surdu, John R., 2000, **Connecting Simulation to the Mission Operational Environment, A Dissertation for degree of Doctor of Philosophy**, Texas & AM University, May 2000,

Surdu, J. R. and Pooch, U. W. "A Methodology for Applying Simulation Technologies in the Mission Operational Environment," in Proc. IEEE Information Technology Conference, Syracuse, NY, 1-3 September 1998, pp. 45-48

Surdu, J. R., G. D. Haines, and U. W. Pooch, "OpSim: a Purpose-built Distributed Simulation for the Mission Operational Environment," in Proc. International Conference on Web-Based Modeling and Simulation, San Francisco, CA, 17-20January 1999, pp. 69-74

Surdu, J. R. and U. W. Pooch, "Connecting the Operational Environment to Simulation," in Proc. Advanced Simulation Technology Conference: Military, Government, and Aerospace Simulation, San Diego, CA, 11-14 April 1999, pp. 94-99

Surdu, J. R., D. Ragsdale, B. Cox, J. Yen, and U. Pooch, "Implementing Entities in Simulation as Intelligent Agents," in Proc. Military, Government, and Aerospace 1998, Boston, MA, 5-9 April 1998, pp. 90-95

Surdu J.R. and Pooch, U.W., 2001, "Simulations During Operations.", Military Review March/April 2001Volume 81 Issue 2, pp 38

Swezey Robert W. and Owens, Jerry M., 1998, "Task and training requirements analysis methodology (TTRAM): An analytic methodology for...", Ergonomics, Nov 98, Volume 41 Issue 11, pp 1678

Tarrant, T., 24 Mar 97, "1RCR FY 97/98 Budgeted Activities", 1st Battalion, The Royal Canadian Regiment: 7000-1(A/DCO), p A-1 Cited in: Ewing, R.B., 1998, "The Benefits of Using Simulation in Training- Does the Land Force Leadership Understand?", Ex- New Horizons 1997-1998 Available on site: http://www.cfcsc.dnd.ca/irc/nh/nh9798/0032.html

Tınaz , E., 2000, "Eğitim-Öğretim Konsepti-2020", Hedef 2020 ve Ötesi, Özel sayı, T.C. K.K.K Eğitim ve Doktrin Komutanlığı , Ankara, pp35-38

Toffler, Alvin and Heidi, 1993, **War and Anti-War**, Part II, 1st ed., Little, Brown & Company (Canada) Limited, Printed in U.S.A

Topçu, O., 1999, **Naval Surface Tactical Maneuvering Simulation System (NSTMSS)-Master Thesis-**, Chapter 1,Middle East Technical university, December 1999, Ankara

U.S. Army, 1998, **FM 101-5: Staff Organization and Operations**, Headquarters, Department of the Army, Washington, DC.

U.S. Army, 1991, ST 100-9: **Techniques and Procedures for Tactical Decisionmaking**, U.S. Army Command and General Staff College, Fort Leavenworth, KS.

The 2001 US Army Modernization Plan, Military Technology Volume XXV Issue 10-2001,pp10-25

The US Army Training Support Center, 1999, Proceedings of the Second Training Effectiveness Symposium, Hampton, VA.

United States Army Posture Statement FY01, Chapter 2, The Army Vision, Available at http://www.army.mil/aps/aps_ch2_3.htm

U.S. Department of Defense, 1998, "Draft Standard for Modeling & Simulation High Level Architecture- Rules version 1.3", IEEE P1516/D1, April 98

U.S. Department of Defense, 1998, "Draft Standard for Modeling & Simulation High Level Architecture-Federate Interface Specification", IEEEP1516.1, February 98

U.S. Department of Defense, 1998, "Draft Standard for Modeling & Simulation High Level Architecture-Object Model Template", IEEE P1516.2, February 98

U.S. Department of Defense, 1997, "High Level Architecture Run Time Infrastructure Programmer's Guide", Version 1.0, 15 May 1997

United States Joint Forces Command Joint Warfighting Center, "What is ALSP?", Available on site: http://alsp.ie.org/alsp/questions/What%20is/index.html

USSSPACECOM, 1998, USSPACECOM Vision 2020, Available on site http://www.spacecom.af.mil/usspace/LRP/ch02.htm

Valle, T., 1998, "Security Features of The Joint Simulation System (JSIMS) Design", 1998 SPRING Simulation and Interoperability Workshop, 9-13 March 1998, Orlando, FL.

Vlahos, M., 1986, "Wargaming, the Enforcer of Strategic Realism: 1919-1942," Naval War College Review , Volume 39, No. 2 ,March-April 1986, pp19

"War Games," 1961, Military Review Volume 41, No. 6 ,June 1961,pp 68 Cited in: Lee, David B. "Advantages of Wargames War Gaming Thinking For The Future", Available on site: http://www.airpower.maxwell.af.mil/airchronicles/apj/3sum90.html

Weatherly, Richard M. et al., 1996, "Advanced Distributed Simulation Through the Aggregate Level Simulation Protocol", Proceedings of the 29th International Conference on System Sciences, Vol. 1, Wailea, Hawaii, 3-6 January 1996, pp. 407-415

Westra, D.P. et al, 1986, "Simulator design and instructional features for carrier landing: a field transfer study (NAVTRASYSCEN 85-C- 0044-2).", Naval Training Systems Center, FL: Naval Air Systems Command. (No. AD A169962) Cited in: Cohn J. et al, 2000, "Training-Transfer Guidelines for Virtual Environment (VE)", Interservice/ Industry Training and Simulation Conference November 27-30, 2000, Orlando, FL

Wilkerson, Lawrence B., 1997, "What Exactly Is Jointness?", JFQ Publications, Summer 1997

Wilkinson ,Jeffery G. et al, 1999, **Structured Simulation-Based Training Program for a Digitized Force: Approach, Design and Functional Requirements Volume 1,Research Report 1737**, U.S. Army Research Institute for Behavioral and Social Sciences, Alexandria, Virginia 22333-5600

Wilson, A., 1968, The Bomb and the Computer , Delacorte Press, New York ,pp 3 Cited in: Lee, David B. "Advantages of Wargames War Gaming Thinking For The Future", Available on site: http://www.airpower.maxwell.af.mil/airchronicles/apj/3sum90.html

Wilson ,Annette L. and Weatherly, Richard M., 1994, "New traffic reduction and management tools for ALSP confederations". 1994 Elecsim Internet Conference., Available on site: http://alsp.ie.org/alsp.

Worley , R. et al, 1996, **The Utility of Modeling and Simulation in the Department of Defense: Initial Data Collection**, IDA Paper D-1825, Institute for Defense Analysis, Alexandria, Virginia

Young, Don C., 1999, **USAWC Strategy Research Project : Enhancing Engineer Jointness and Future Joint Engineer C2 for Global Engagement**, US Army War College, Carlisle Barracks, Pennsylvania

Young, John P., **History and Bibliography of War Gaming**, Department of the Army, Washington, D.C 1957, pp 2-6. Cited in: Caffrey Jr., Matthew, 2000,"Toward A History-Based Doctrine for Wargaming", Aerospace Power Journal, Volume 14 Issue 3, pp 33

Yürekli A., 1996, "Simülasyon ve Simülatörler", Bilgi Teknolojileri Sempozyumu TEDEB-96, 10-11 Temmuz 1996, Eğitim Doktrin Komutanlığı, Ankara, Sahife 28

Zimmerman, P. and Turrel, C., 2001, "High Level Architecture", RTI and Tools User/Developer Forum, 25-26 July,2001, Available on site http:// www.dmso.mil

ÖZGEÇMİŞ

Tuğrul OĞUZHAN

Kişisel Bilgiler:

Doğum Tarihi	: 10.07.1975
Doğum Yeri	: Domaniç/Kütahya
Medeni Durumu	: Bekar

Eğitim:

Lise	1988-1992	Maltepe Askeri Lisesi
Lisans	1992-1996	Kara Harp Okulu Sistem Mühendisliği
Yüksek Lisans	2000-2002	Yeditepe Üniversitesi Sosyal Bilimler Enstitüsü

Çalıştığı Birlikler

1997- 2000	8nci Mekanize Tugayı 2nci Tnk. Tb. TEKİRDAĞ
2001-	Devam ediyor.