YAŞAR UNIVERSITY

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SETUP TIME REDUCTION

A CASE STUDY IMPLEMENTATION

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This study titled "*Setup time reduction. A case study implementation*" and presented as MSc Thesis by Ş.Aram SITKI has been evaluated in compliance with the relevant provisions of Y.U Graduate Education and Training Regulation and Y.U Institute of Science Education and Training Direction and jury members written below have decided for the defense of this thesis and it has been declared by consensus / majority of votes that the candidate has succeeded in thesis defense examination dated ….....

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ABSTRACT

SETUP TIME REDUCTION

A CASE STUDY IMPLEMENTATION

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This thesis deals with reducing the machine setup time. Applications were performed at NEKA Kalıp Company located in Manisa Organized Industrial Region, where I have been working since 2010. There has been made a bottleneck analysis of the stages of the machine setup times, which play a very important role in the iron sheet metal processing. That bottleneck analysis was poured on a fishbone diagram, which deals with five fundamental problems. The study of the machine setup time is followed by an overview of the merits of modifications to be made using such simulation programs as AutoCAD, Solid Works and Arena. Finally, observations are made on the practical benefits of the results obtained from the use of those simulation programs.

Keywords: Mold setup times, mold change in single time processes, mold modification, simulation

ÖZET

ÜRETİM SÜRELERİNİN DÜŞÜRÜLMESİ

ÖRNEK ÇALIŞMA

SITKI, Ş.Aram

Danışman: Yrd.Doç.Dr Evrim URSAVAŞ

Temmuz 2012, 35 sayfa

Bu tezde makine hazırlık sürelerinin düşürülmesi çalışması yapılmıştır. 2010 yılından bu yana çalışmakta olduğum, Manisa organize sanayi bölgesinde bulunan NEKA kalıp firmasında uygulamalar yapılmıştır. Sac metal işlemede önemli bir yer tutan, makina hazırlık sürelerinin aşamalarında dar boğazlar saptanmıştır. Bu dar boğazları balık kılçığı diyagramında grafiğe döküp beş temel sorunu ele alınmıştır. Zaman etütleri yapıldıktan sonra AutoCAD, Solid Works, Arena gibi benzetim programlarının yardımıyla yapılacak olan değişikliklerin yararları gözlenmiştir. benzetim programlarından alınan sonuçların, uygulama aşamasında da yararları gözlenmiştir.

Anahtar kelimeler: Kalıp bağlama süreleri, tekli sürelerde kalıp değişimi, kalıp değiştirme, benzetim

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1 INTRODUCTION

I have started my thesis to apply what I have learnt from IMIS program in the real life and to solve some problems in the company. I started to study about decreasing the change duration of molds, one of the biggest problems in the company, by harmonizing my knowledge from the IMIS program. The aim of the thesis is to shorten the long durations of mold change and decrease the related loss.

Shortly after I started working in NEKA Company, I explained the significant role of engineering in the business life, firstly from top executives to the suppliers. The company has increased its working load by 43% percent and decreased its working force by 21 workers compared to the period before I started working here; however, with our current working force, 49 workers, we successfully carry out the operations. I started to work on demand forecasting to reproduce the materials, which are considered as junk due to the wrong production strategies or occupying storage.

The firm was established in 1992 to produce metal dies and machine parts in a 45m^2 area in Manisa. NEKA, which has moved its enterprise to its own office (previously 200m^2, 300m^2 in 1994, 900m^2 in 1997) continues its task without any concession of its philosophy of continual progression, by its know-how and experience keeps its quality and customer satisfaction at maximum, now operating in its own factory (12000m^2, of which 6800m^2 is roofed) with technological investments and educational activities.

The firm has 15 to 500 ton hydraulic and eccentric presses on the production area. Company operates 7/24 with three shifts in a day. Each shift has its own foreman, which includes warehouse workers, maintenance team, and quality control and machine workers.

The firm has over 250 press molds and 325 different kinds of end-items. Products are separated to three different group as Cover parts (see ***Figure 1***), Progressive parts (see ***Figure 2***) and Top panel parts. Cover parts usually has three different operations, progressive parts has only one operation, top panel parts has three to eight operations.

Figure 1: Cover parts

Figure 2: Progressive Parts

Monthly product sales quantities are given on **A*ppendix 1.*** Firm has one production line. This includes one coil opener; three 250-ton eccentric press and robotic transfer unit (see ***Figure 3***). With that production line, transfer time is constant; one worker can operate those three machines.

Figure 3: Assembly line

The company works with Vestel, Ariston and E.C.A, which works on orders. Ariston has several specifications for demand. First is related to deadline and quantity; the company has to send orders on time and given quantity, otherwise company faces serious consequences such as, time and money punishment. If the firm could not send product to Ariston on time and defined quantity, several production lines of Ariston stop. Result of the stopping production line is very bad and cost is very high.

2 PROBLEM DEFINITION

Ariston Company has 7 big refrigerator production and assembly lines. 90% of the produced material is sent to the Ariston Company in Italy, and the rest is introduced into the domestic markets. According to the agreement between NEKA and Ariston, if the supplier fails to supply the ordered material in ordered amount and within the defined time, the supplier has to cover the loss of the company. For instance, when we cannot send the ordered upper panel, the production line using that panel has to stop, and we have to pay the related bill. Ariston Company finds the amount of production that could have been produced in the stop time based on the end product (refrigerator) by multiplying the amount of production with the selling price. The bill covers from workers' wages to the electricity consumption when Ariston cannot produce and it costs more than TL 15.000 for a 10 minute stop. When we consider that the produced material has at least 3 operations and an average mold exchange lasts 30 minutes, the shortest stop costs more than TL 100.000 to our company. An example of a punishment bill can be found on ***Appendix 1.***

Decreasing the mold exchange duration is the first step of JIT (just in time), a production philosophy. The long change durations, the biggest problem of every production company, cause loss in working force and thus decrease the production capacity. This significant problem constitutes a giant problem in big companies such as Ariston and Vestel. Decreasing the machinery preparation duration, which is also the aim of my thesis, derives a great profit. In order to solve this problem, we prepared fish bone diagrams and searched for the reasons of long changes and dealt with 5 main problems.

Without searching the reasons behind the long durations of mold exchanges, the possible stops are tried to be prevented by holding extra stock in the company. The disregard of storage cost means additional expense between % 9.1 - % 13.2 on the actual cost per unit

of the product. Holding extra stock causes the decrease of usage area, the unnecessary use of limited packaging material such as parcel, pack, etc., inability to find these materials when necessary and stops the production occasionally. Shortening the mold exchange duration as far as possible will play an important role in preventing unrequired working force loss and increasing the efficiency of engineering vehicle.

The company has limited machinery and worker capacity. 90 workers and 46 working machines are not enough to produce over 250 different types of products. Each day approximately 67 different types of product are shipped to the Ariston, Vestel and E.C.A. Their storage conditions and working machines are defined on the product tree. Every week almost 150 mold-die parts are being changed. Some exchange of die can take almost 3-4 hours. In this tight production plans, that amount of die exchange causes big problems such as customer satisfactions. As it can be seen ***Table 1*** over 2.500.000 piece produces every month.

Product diversity		
Final refences per month		
Pieces sold per month	2.541.225	
Types of macines and Molds	Qt. Machines	Molds
<100 Tons	30	178
101 < <200 Tons	7	55
> 201 Tons	9	14

Table 1: Product diversity

Long exchange time causes holding semi manufacturing parts (see ***Figure 4***) and finished goods. Holding inventory is unnecessary and waste of money. It requires boxes, pallets and storage area. Those expenses increased unit costs.

Figure 4: Semi manufacturing parts storage area

3 BACKGROUND INFORMATION

We will give a brief introduction about the topic. Single minute exchange of dies is the method to reduce setup times.Every production line has one or several bottlenecks. Some of them are about transporting to semi-manufactured material slow working workers, machine breakdowns, and long changeover times. In case of a long change over times occurs and it was increasing the overall production lot size will be increased. If a changeover takes too much time, it increases the overall cost of production. According to today's marketing conditions factories, firms or companies cannot survive under these conditions. By reducing changeover times, companies achieve many advantages from reduced costs per unit, inventory costs, and lead times of process, lot sizes and setup errors. Most importantly, companies gain their actual capacity.

The SMED (Single Minute Exchange of Die) methodology developed by Shingo (1985) was developed in order to reduce and simplify the setup time during changeover. SMED, which also a Japanese process-based innovation makes it possible to respond to fluctuations in a demand and results in lead time reductions, while also eliminating wastefulness during changeover and diminishing lost sizes (Shingo, 1985; Womack and Jones, 1998)

During its origins in Japan, SMED was adopted for Toyota. Toyota needed additional space to store its manufactured cars. Because Japan is a small series of island, real estate is expensive. Because Toyota had to store their cars in high-priced lots, the company's profits were less than other manufacturers.

Toyota could do nothing about the costs of land but an engineer named Mr. Shingo decided that if the changeover costs could be reduced, the company would realize higher profits. Normally, the volume of product the machines could produce before they were changed offset the cost of changeover on production machines. Therefore, the cost of changeover was low. However, the costs for lot storage were exceeding what the company was saving.

It took several years but Toyota managed to come up with a system that minimized the tools and steps used in the manufacturing process. In addition, by maximizing their existing components so that more cars shared the same components, the company managed to cut back on costs and to speed up changeover time.

According to Shingo (1985), the main benefits of the SMED application are as follows;

Direct

- ✓ Setup Time reduction
- ✓ Reduction of time spent with fine tuning
- ✓ Fewer errors during changeovers
- ✓ Product quality improvements
- ✓ Increase safety

Indirect

- ✓ Inventory reduction
- ✓ Increase of production flexibility
- ✓ Rationalization of tools

4 ANALYSIS

4.1 CURRENT SITUATION

After the production plan defined die exchange process has begins. If the product is being changed then before the processing of the new product following acts should be taken; removing previous raw material, insert new material, take out old die, insert new die, prepare new die for setup, calibrate and adjust parameters. After these processes machine and die are ready to production. The detailed steps taken during the process for metal and plastic products are separately given below;

Exchanging metal mold operations;

1- Stop machine and open die
2- Remove top die part
3- Remove bottom die part
4- Loading to forklift
5- Dropping old die to shelf
6- Taking new die to machine
7- Insert new die to machine
8- Adjust disk level
9- Attach fixing bolts
10- Open mandrel
11- Wrap old coil
12- Removing fixing bolts from coil opener
13- Removing old coil
14- Insert new coil
15- Attach fixing bolts to coil opener

Exchanging plastic injection mold operations;

1- Stop machine and open machine cover
2- Silicone delivery to die
3- Remove water and oil hoses
4- Remove mold clamping bars
5- Loading old mold to forklift
6- Loading old mold to shelf
7- Taking new die from shelf
8- Insert new die from shelf
9- Attaching fixing bolts
10- Waiting to reach defined heat
11- Remove safety bars
12- Reset and open machine

Mold exchange time show differences from machine to machine, mold to mold. Generally exchanging mold of the progressive parts easier than cover and top panel mold. We separate three different groups of molds, so that we can optimize and reduce setup times. In ***Table 2*** plastic injection dies exchange times are given.

plastic injection dies exchange times			
Tasks	**min time (sec)**	**max time (sec)**	**Percentage**
Stop machine and open machine cover	62	238	5,09%
silicone delivery to die	12	35	0,98%
remove water and oil hoses	45	78	3,69%
remove mold clamping bars	99	241	8,12%
loading old mold to forklift	193	296	15,83%
loading old mold to shelf	61	93	5,00%
taking new die from shelf	73	115	5,99%
insert new die to machine	160	281	13,13%
attach fixing bolts	80	146	6,56%
waiting for defined heat	245	338	20,10%
remove safety bars	111	175	9,11%
reset and open machine	78	83	6,40%

Table 2: Plastic injection die exchange

In ***Table 3*** metal die exchange times are given.

metal die exchange times			
Tasks	**min time (sec)**	**max time (sec)**	**Percentage**
Stop machine and open die	37	105	2,68%
remove top die part	78	289	5,65%
remove bottom die part	63	182	4,56%
loading to forklift	45	59	3,26%
dropping old die to shelf	128	348	9,27%
taking new die from shelf	95	148	6,88%
insert new die to machine	168	356	12,17%
adjust disk level	37	59	2,68%
attach fixing bolts	93	142	6,73%
open mandrel	32	51	2,32%
wrap old coil	120	180	8,69%
removing fixing bolts from coil opener	87	143	6,30%
removing old coil	164	186	11,88%
insert new coil	150	204	10,86%
attach fixing bolts to coil opener	84	138	6,08%

Table 3: Metal Die Exchange

As it can be seen on the ***Appendix 3*** some of the parts are more important the rest of part in term of cost and quantity. ABC analysis shows us if we can reduce the setup times of group, overall mold exchange times can dramatically reduce and inventory levels may decrease.

Flow of the system must be observed and analyze. To do this we measure all distances to machines to mold shelf, workers movements and places of the tool car. We also did time studies to measure the dimension of operations. To deeply analyze the reasons behind long duration of mold exchange we followed a fish bone diagram approach. The diagram can be seen in ***Figure 5.*** To define those terms fish-bone diagram will be helpful. ABC analysis done for the purpose is shown on ***Appendix 3.***

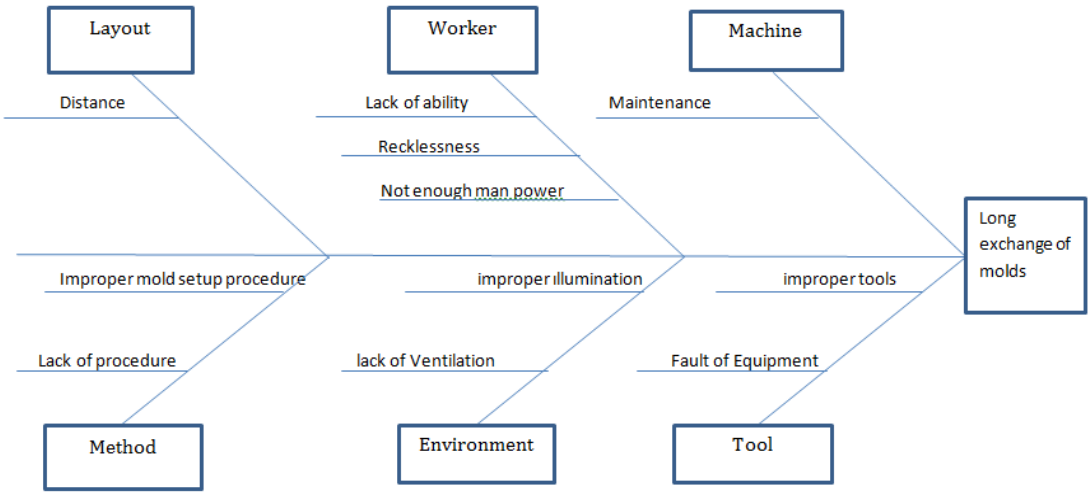

Figure 5: Fish Bone Diagram

The next step here is to observe the main problems caused by the long durations of mold change in the fish bone diagram. Betterments under the main categories of place change, machinery and equipment will be much more beneficial to the general process of the system.

4.2 TECHNICAL IMPROVEMENTS

In this section, main causes to problem will be explored in detail.

4.2.1 LAYOUT

Predisposing of the distance of bad-ordered mangles between the operations and to the mold shelf and finding the optimum points play the key role in decreasing the durations of mold fixing. Operator takes the mold to be connected from the mold shelf (see ***Figure 6***) and brings it near to the machinery in the production route. Decreasing the loss time spent in going to and returning from the mold shelf affects the set up time. A newly prepared layout change the distance of machineries to the mold setup shelf and tries to minimize the way the operator takes.

Figure 6: Mold shelf

To design the layout, we analyzed product routes. First of all we draw current layout in AutoCAD and we measure distances between mold shelf and machines. The product for the 10 A group item in the ABC are shown in the ***Table 4***. The table shows product routes, number of operations and machine.

Inventory code	Definition	No of opr	opr1	opr2	opr3	opr4	opr5
13407893305	FZ SEPET RAYI KAPI MONT.ELEMANI UST SAG DX	2	EP-150-1	EP-160-1			
13407893405	FZ SEPET RAYI KAPI MONT.ELEMANI UST SOL SX	2					
	Distance to Mold shelf (cm)		49.027	34.767			
13403324102	ON UST KUSAK	2	EP-45-1	EP-160-1			
	Distance to Mold shelf (cm)		55.817	34.767			
13406480500	ORTA KUSAK	2	EP-45-1	HP-200-2			
	Distance to Mold shelf (cm)		55.817	27.682			
13409771600	ALT KUSAK B.SIZ RA 24/23	2	EP-80-1	HP-80-2			
	Distance to Mold shelf (cm)		52.439	41.168			
21013680602	O/KUSAK GRB.B-SIZ CB50 FS	3	EP-80-1	HP-300-2	EP-15-4		
	Distance to Mold shelf (cm)		52.439	10.551	32.056		
13406041801	ORTA KUSAK	4	GYT-2	EP-60-1	EP-150-1	EP-200-1	
	Distance to Mold shelf (cm)		0	29.803	55.817	32.986	
13407886902	4D DIKEY KUSAK	3	EP-30-1	EP-150-1	HP-200-2		
	Distance to Mold shelf (cm)		28.444	55.817	27.682		
13408779603	CABINET TOP (DKP)	3	EP-250-1	EP-250-2	EP-250-3		
	Distance to Mold shelf (cm)		63.019	64.278	65.483		
13408497900	KOMRESOR SASESI	5	EP-80-1	HP-200-2	EP-250-1	EP-250-2	EP-250-3
	Distance to Mold shelf (cm)		52.439	27.682	63.019	64.278	65.483

Table 4: Product route

For instance; for the third product in the table specifications are as follows:

Inventory code : 13403324102

Definition : ON UST KUSAK

Number of operations : 2 operations

Used machine 1 : EP_45-1 (eccentric press machine 45 tones 1st machine)

Used machine 2 : EP_160-1 (eccentric press machine 160 tones 1st machine)

Distance to mold shelf : EP_45-1 to mold shelf is 49.027 cm

Distance to mold shelf : EP_160-1 to mold shelf is 34.767 cm

For 10 A-group items, we change mold shelf location to reduce distance travel by forklift. If traveled distances reduce also exchanging time will reduce. ***Table 5*** shows us the distance machine from the mold shelf. Distance between EP-150-1 machine and mold shelf is 49.027 meters. By changing initial position of mold shelf is costly. Better than changing position of machines.

Inventory code	Definition	No of opr	opr1	opr2	opr3	opr4	opr5
13407893305	FZ SEPET RAYI KAPI MONT.ELEMANI UST SAG DX	2	EP-150-1	EP-160-1			
13407893405	FZ SEPET RAYI KAPI MONT.ELEMANI UST SOL SX	2					
	Distance to Mold shelf (cm)		65.165	7.708			
13403324102	ON UST KUSAK	2	EP-45-1	EP-160-1			
	Distance to Mold shelf (cm)		71.767	7.708			
13406480500	ORTA KUSAK	2	EP-45-1	HP-200-2			
	Distance to Mold shelf (cm)		71.767	5.874			
13409771600	ALT KUSAK B.SIZ RA 24/23	2	EP-80-1	HP-80-2			
	Distance to Mold shelf (cm)		68.152	26.754			
21013680602	O/KUSAK GRB.B-SIZ CB50 FS	3	EP-80-1	HP-300-2	EP-15-4		
	Distance to Mold shelf (cm)		68.152	20.270	11.489		
13406041801	ORTA KUSAK	4	GYT-2	EP-60-1	EP-150-1	EP-200-1	
	Distance to Mold shelf (cm)		0	3.724	65.165	6.143	
13407886902	4D DIKEY KUSAK	3	EP-30-1	EP-150-1	HP-200-2		
	Distance to Mold shelf (cm)		4.570	65.165	5.874		
13408779603	CABINET TOP (DKP)	3	EP-250-1	EP-250-2	EP-250-3		
	Distance to Mold shelf (cm)		50.118	51.359	53.114		
13408497900	KOMRESOR SASESI	5	EP-80-1	HP-200-2	EP-250-1	EP-250-2	EP-250-3
	Distance to Mold shelf (cm)		68.152	5.874	50.118	51.359	53.114

Table 5: New mold shelf position

After mold shelf position change, some of the machines distance increase. However, for a product following the product route total distance reduces almost by 16% with new lay out. The old and new layout is shown in next page. CASE-I total distance 1.142.760 Meters CASE-II 958.655 meters. Reducing total distance save almost three minutes per exchange.

4.2.2 MACHINE

Machinery choice depends according to the press force, mold dimensions and sheet thickness. The reason why a mold has different set up durations when connected to different machineries is because of different equipment being used.

Figure 7: Mold insert

In the above photo (see ***Figure 7***), you can see an item connected to a 150 ton eccentric press. Its annual production item can be up to 150.000. Two fixing equipment are used to anchor mold to the machinery. This connection equipment is placed to the stud sockets in the press below body. Studs are chosen according to the dimension of the mold to be connected and automatic mold anchoring equipment produced for each press machine the following improvements decrease the mold setup durations considerably.

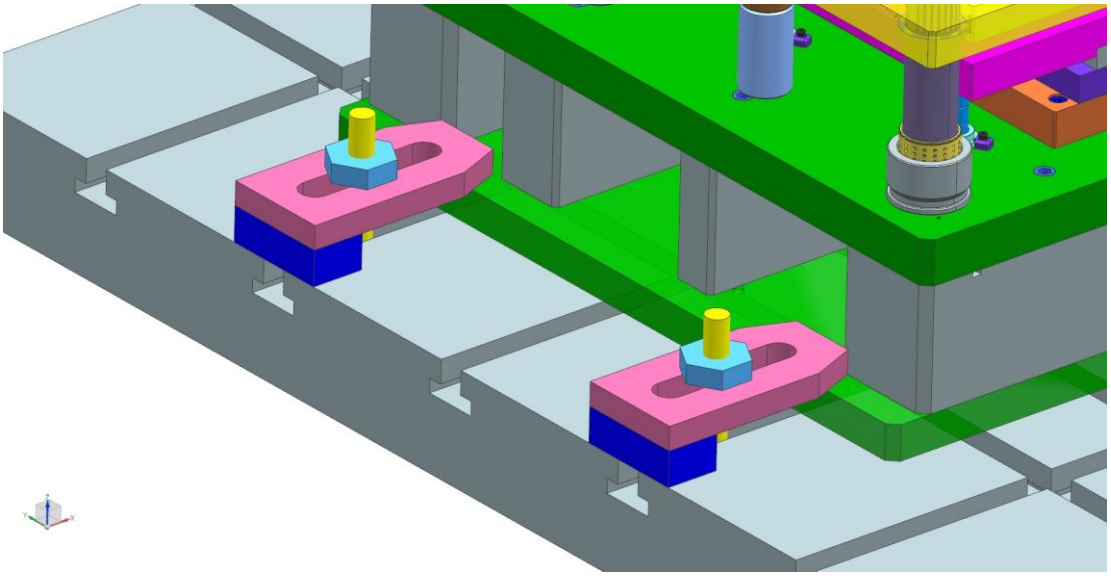

Figure 8: Mold fixing tool

To prevent loss of the nuts, bolts and wrenches, we put the entire equipment in one tool car. Disadvantages of having only one tool car is; if simultaneously two different molds are needed for setup one tool car is insufficient. Arena simulation ***(Appendix 2)*** proves that production department needs at least four tool cars on the production side. Buying three more tool car is not logical decision if we consider the price of one tool car. We make simulations in Arena program to find bottlenecks caused by tool car. We simulated the mold setup process we see on the reports one tool car is not enough. We tried same simulation with two tool cars, result is not sufficient. Simulation starts with three tool car and also three tool cars is insufficient. We decided to start simulation with four tool cars. According to Arena four tool cars is optimum solution. We decide to fix all molds fixing material to press machine. We design hydraulic fixing apparatus which can be seen on ***Figure 9.***

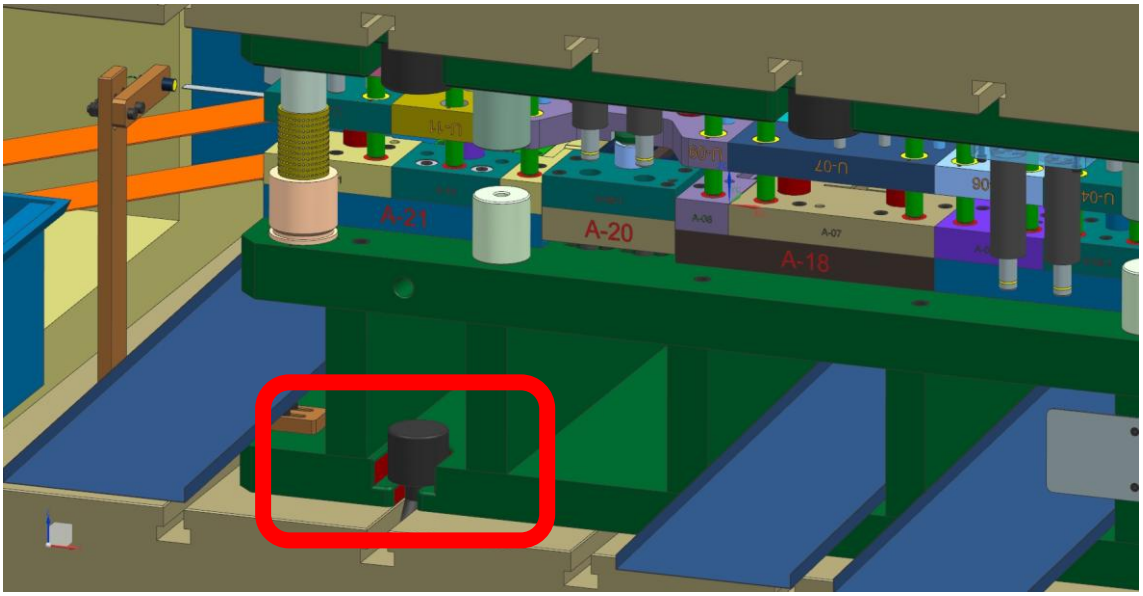

Figure 9: Mold fixing apparatus

In ***Figure 10*** real life application of mold fixing equipment can be seen

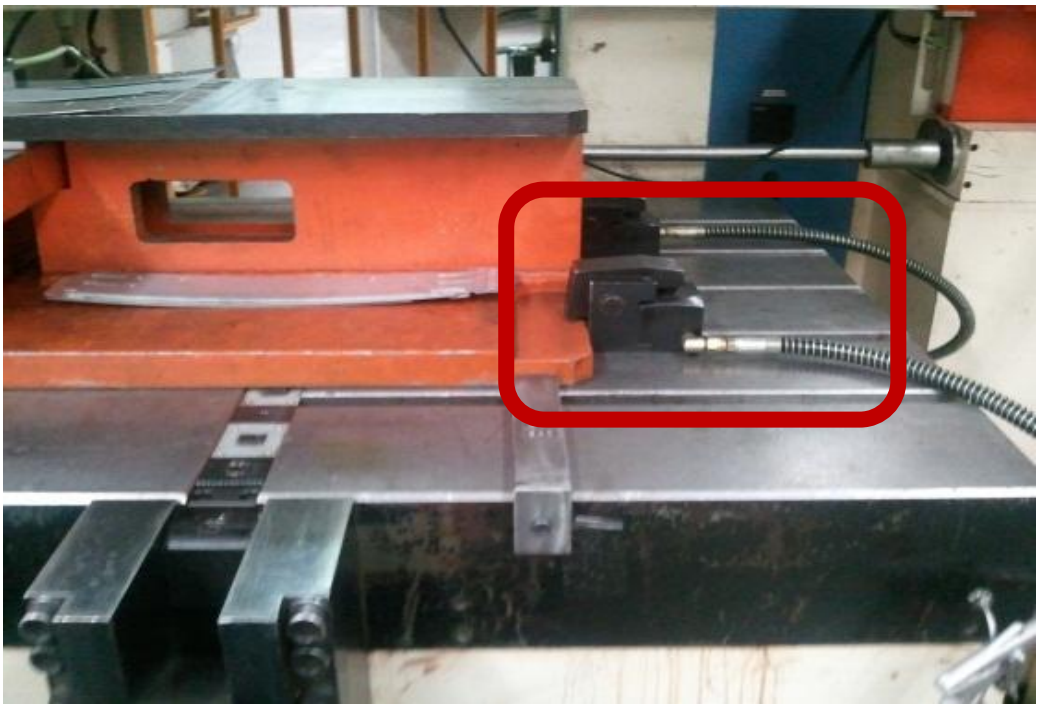

Figure 10: Hydraulic fixing tool

Designing new mold fixing bold reduces setup times over 24% per exchange. Initial mold fixing equipment can be seen at ***Figure 9***. ***Figure 10*** is shown in new mold fixing tool.

4.2.3 TOOL

The insufficient and bad-placed equipment causes operators to search for the monkey wrench, nuts, studs, etc. for larger durations. In addition, the loss of these nuts, studs, etc. means longer mold change durations.

MODIFICATION 1

In the first place, we gathered all the mold setup equipment on a wheeled vehicle. According to the analysis of the simulation model and time studies we see that, two mold fixing equipment vehicles (see ***Figure 11***) are insufficient. The model prepared in arena can be seen in ***Appendix 2.*** Placing the Mold setup equipment to the pockets prepared near to the press machineries plays an important role in finding anchoring equipment easily in mold setup step.

Figure 11: Tool car

MODIFICATION 2

MODIFICATION 2.1

The molds to be inserting to the press machineries need to be centered in the press plate. Uncentered molds damages press machineries to a great extent. When the liquid pressure increases suddenly in hydraulic presses and when the force is not distributed evenly in eccentric presses, the mold may split or press will breakdown. While exchanging molds mold must be fixed in the center of the machine table. If mold is not on the center, pressure of the machine will not be equal which causes mold or machine breakdowns. To centralize the mold to the table takes almost three – four minutes. To make centralize operation easily we design support equipment for every mold. As it can be seen on ***Figure 12***, worker puts the mold on press table and then pushes to the supporting equipment. This betterment reduces mold setup time. According to the time study; centralizing mold process's time reduce from three minutes to thirty five seconds.

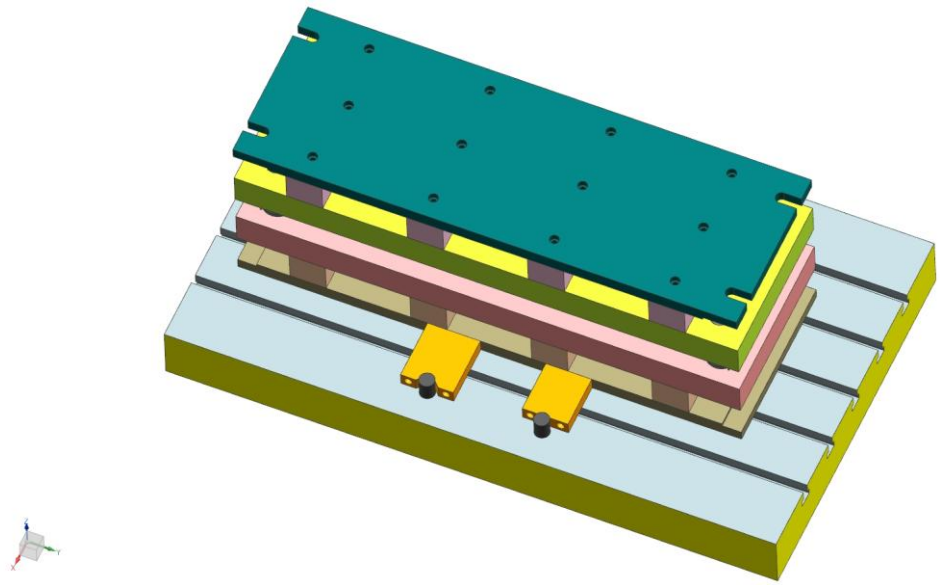

Figure 12: Support equipment

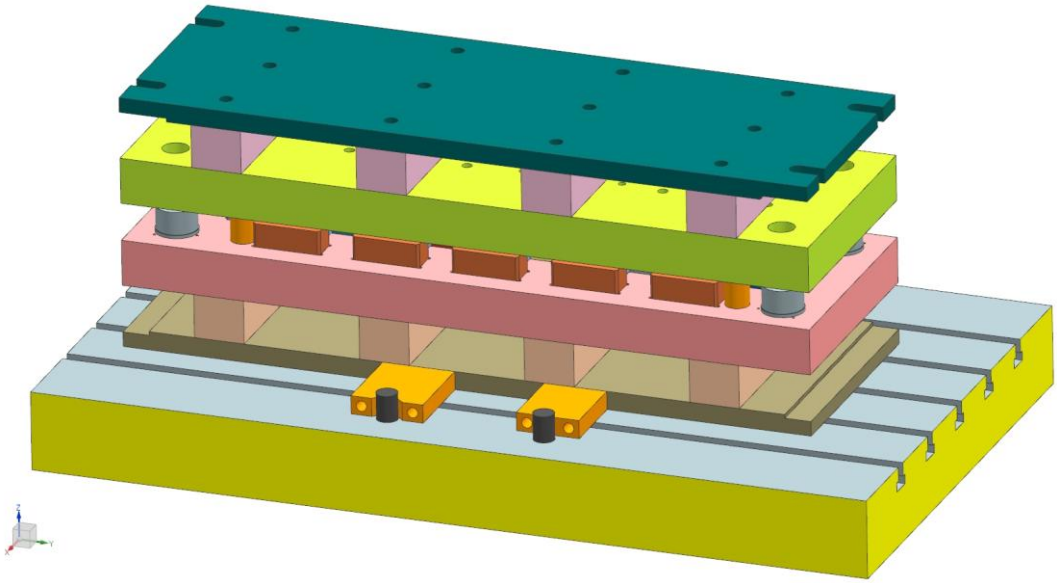

Figure 13: Support equipment side view

After the solid works drawings, we manufacture those supporting apparatus (see ***Figure 12 and Figure 13***) for each press machine.

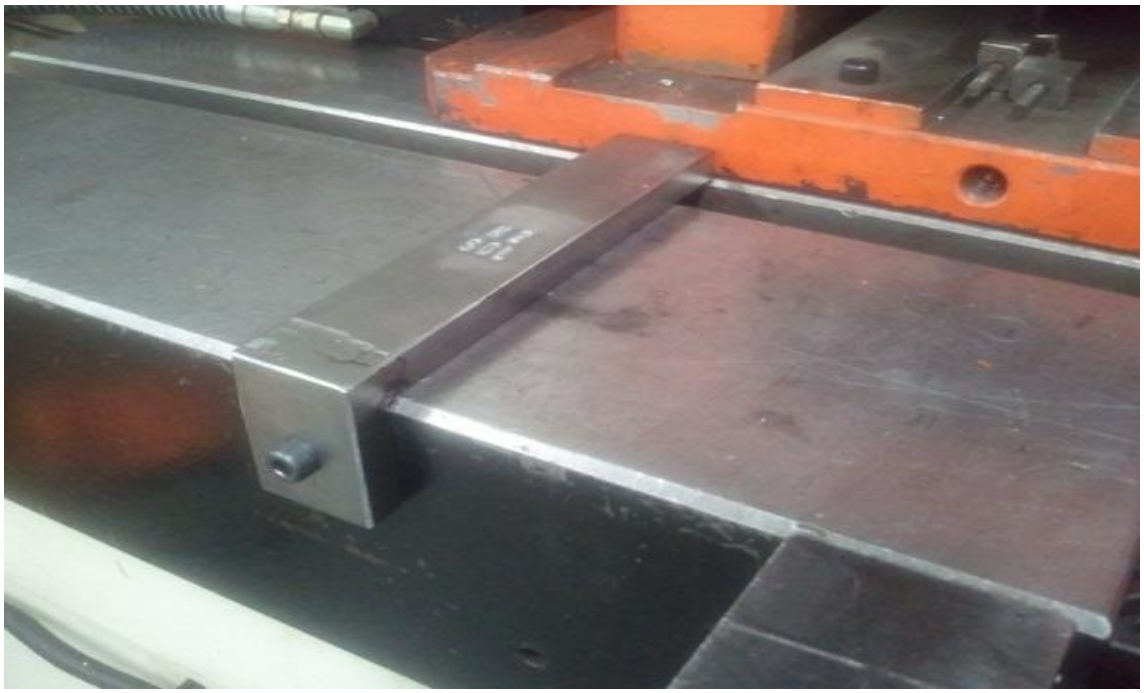

Figure 14: Mold align tool

MODIFICATION 2.2

Another modification is drawing the mold shape on machine table. First to examine the modification we used solid works (see ***Figure 15*** and ***Figure 16***) and tested the applicability.

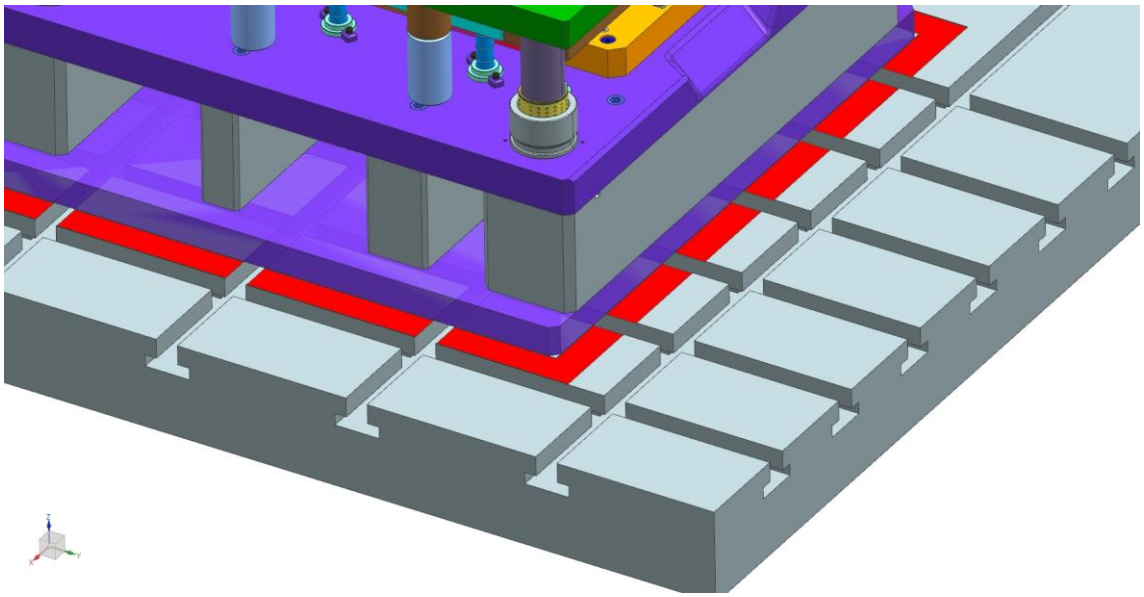

Figure 15: Painted mold shape on press table

Top side view of press table and mold can be seen on ***Figure 16.***

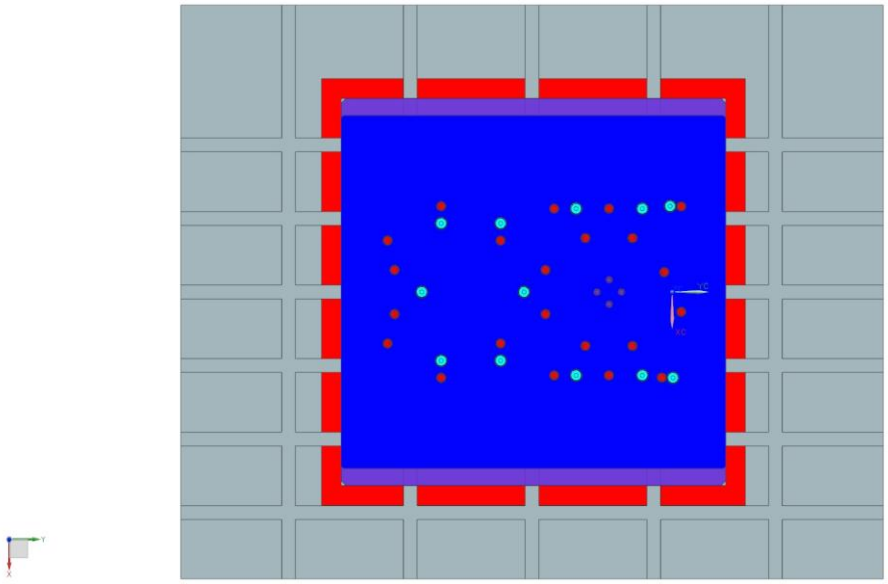

Figure 16: Top view of press table

MODIFICATION 3

After analyzing the mold exchange operation, we continue to try and decrease unnecessary time wastes. When setup process starts, worker inserts coil-to-coil opener and attaches fixing bolds (see ***Figure 17)*** to the opener. Coil opener has four fixing bolds. Removing those four bold with one-wrench takes almost two minutes. Changing the fixing bold remove/insert system saves time. Worker spends too much time and energy to remove bolds.

Figure 17: Coil opener before

According to time study removing fixing bolds from the coil opener takes three minutes. If we change fixing system from bolts to mandrel (see ***Figure 18***), reduces coil insert time three minutes to forty five seconds.

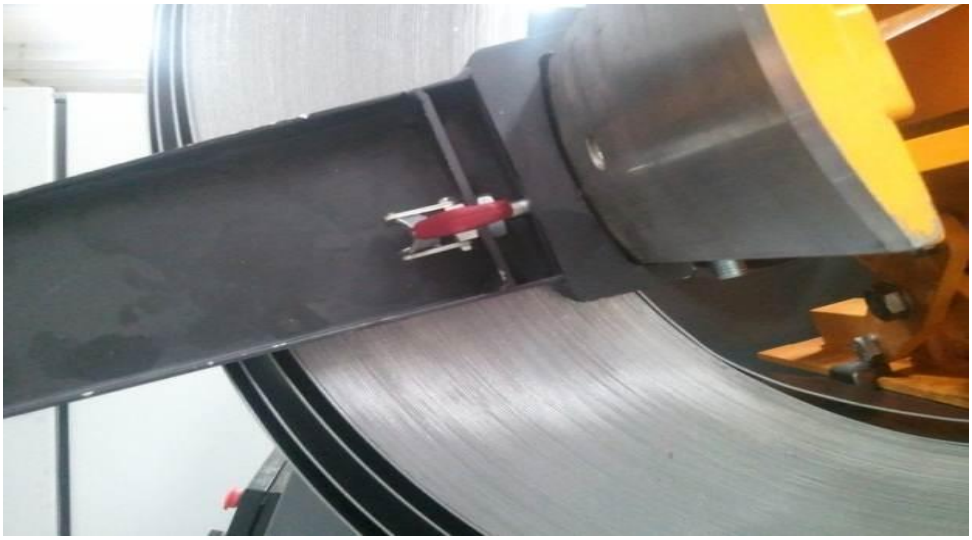

Figure 18: Coil opener after

5 RESULT & DISSCUSSIONS

The company saves on man power and fuel by reducing distance between mold shelf and machine. Forklifts travel 16% less on account of the reduced distance. This means less working time for forklift operators.

One of the most important steps of the mold change is centralizing mold to the machine table. To centralize the mold to the table used to take almost three – four minutes. This betterment reduces the mold setup time. According to the study of the mold setup time, the time required for the process of centralizing mold is reduced from three minutes to thirty five seconds. After this betterment we save two and half minutes on every mold change. If we multiply two and half minutes with six hundred, which is a monthly change rate, we expect to save twenty five hours per month, which is equal one work day.

Another improvement is about coil opener. The coil opener has four fixing bolts. Removing those four bolts with one-wrench takes almost two minutes. Changing the fixing bolts in the remove/insert system saves time. Worker spends too much time and energy to remove bolts. With new equipment worker remove the four clothes pins in twenty seconds. Inserting and removing those items takes forty seconds. With this improvement the Company saves three minutes per change. The Company is expected to save almost thirty hours per month.

Re-arranging mold shelf and equipment used in mold change operation has saved time and work power. At the beginning, metal dies setup time ranged between thirty and forty three minutes. After improvements average setup time has reduced to a range between fourteen and twenty one minute. If we consider monthly total change rate by approximately fifteen minutes saved for each mold change, with monthly six hundred mold changes, we expect to save 150 hours per month.

Overall contribution of my thesis to the Company is about 22%. Before the monthly mold change takes 750 hours. After the improvement Company saves 165 hours and decreases mold change duration from 750 hours to 585 hours. Overall, machine efficiency increases.

REFERENCES

[1] Antonio, C. M., & Gil, C. P. (2011). *Single minute exchange of Die. A Case Study Implementation*. Jurnal of Tecnology Management & Innovation, 130-146

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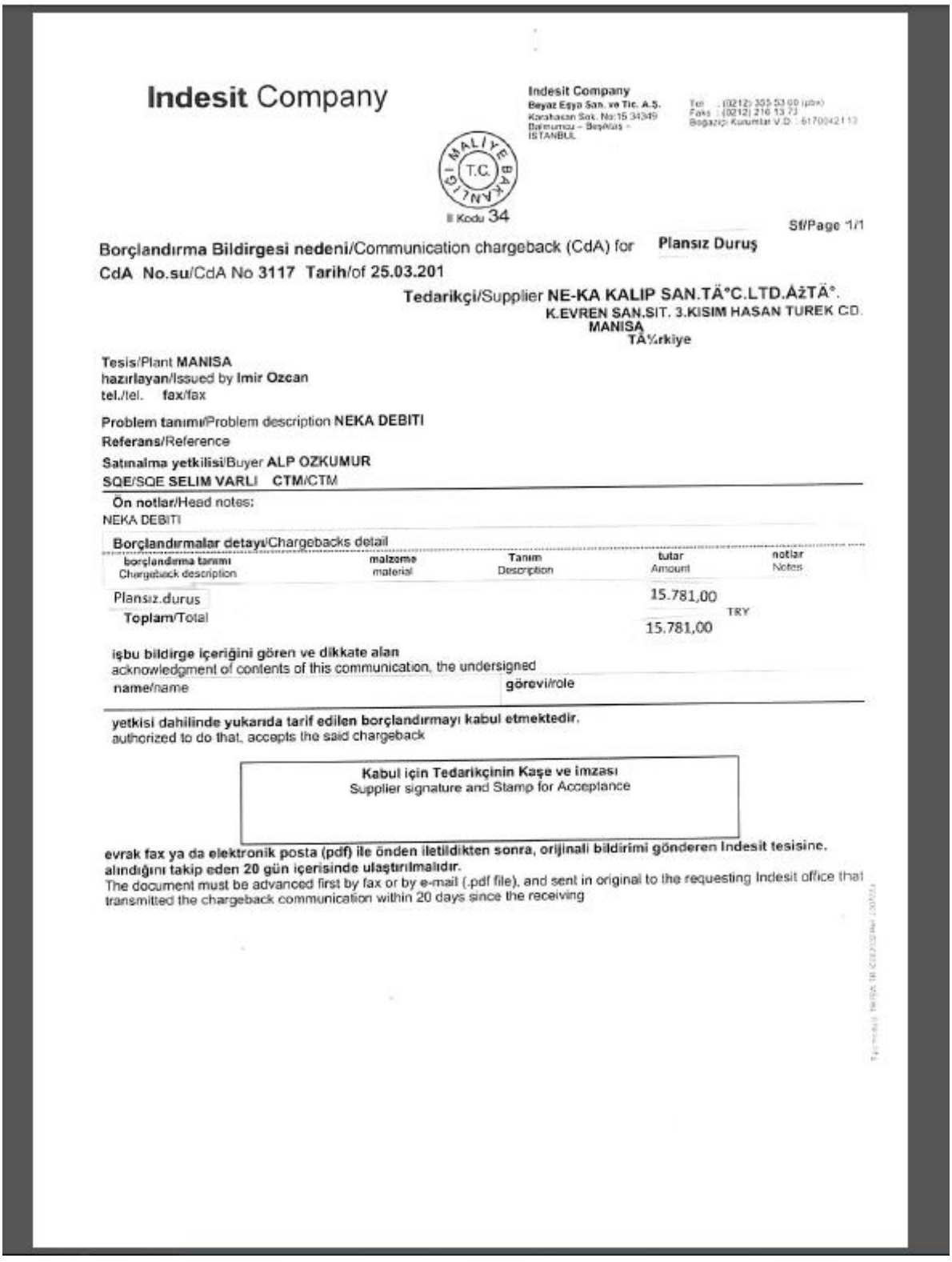
[3] M. Takasee and S.Tatetpantarak, *Kaizen*: *Heard of productivity in Japanese Style*, Thailand Productivity Institute, Bangkok. 2000.



Indesit Company

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MALİYE BAKANLIĞI T.C. Kodu 34

Sf/Page 1/1

Borçlandırma Bildirgesi nedeni/Communication chargeback (CdA) for **Plansız Duruş**

CdA No.su/CdA No **3117** **Tarih**/of **25.03.201**

Tedarikçi/Supplier **NE-KA KALIP SAN.TÄ°C.LTD.ÅžTÄ°.**
K.EVREN SAN.SIT. 3.KISIM HASAN TUREK CD.
MANISA
TÃ¼rkiye

Tesis/Plant **MANISA**
hazırlayan/Issued by **Imir Ozcan**
tel./tel. **fax**/fax

Problem tanımı/Problem description **NEKA DEBITI**

Referans/Reference

Satınalma yetkilisi/Buyer **ALP OZKUMUR**

SQE/SQE SELIM VARLI **CTM**/CTM

Ön notlar/Head notes:
NEKA DEBITI

Borçlandırmalar detayı/Chargebacks detail

borçlandırma tanımı Chargeback description	malzeme material	Tanım Description	tutar Amount	notlar Notes
Plansız.durus			15.781,00 TRY	
Toplam/Total			15.781,00	

işbu bildirge içeriğini gören ve dikkate alan
acknowledgment of contents of this communication, the undersigned

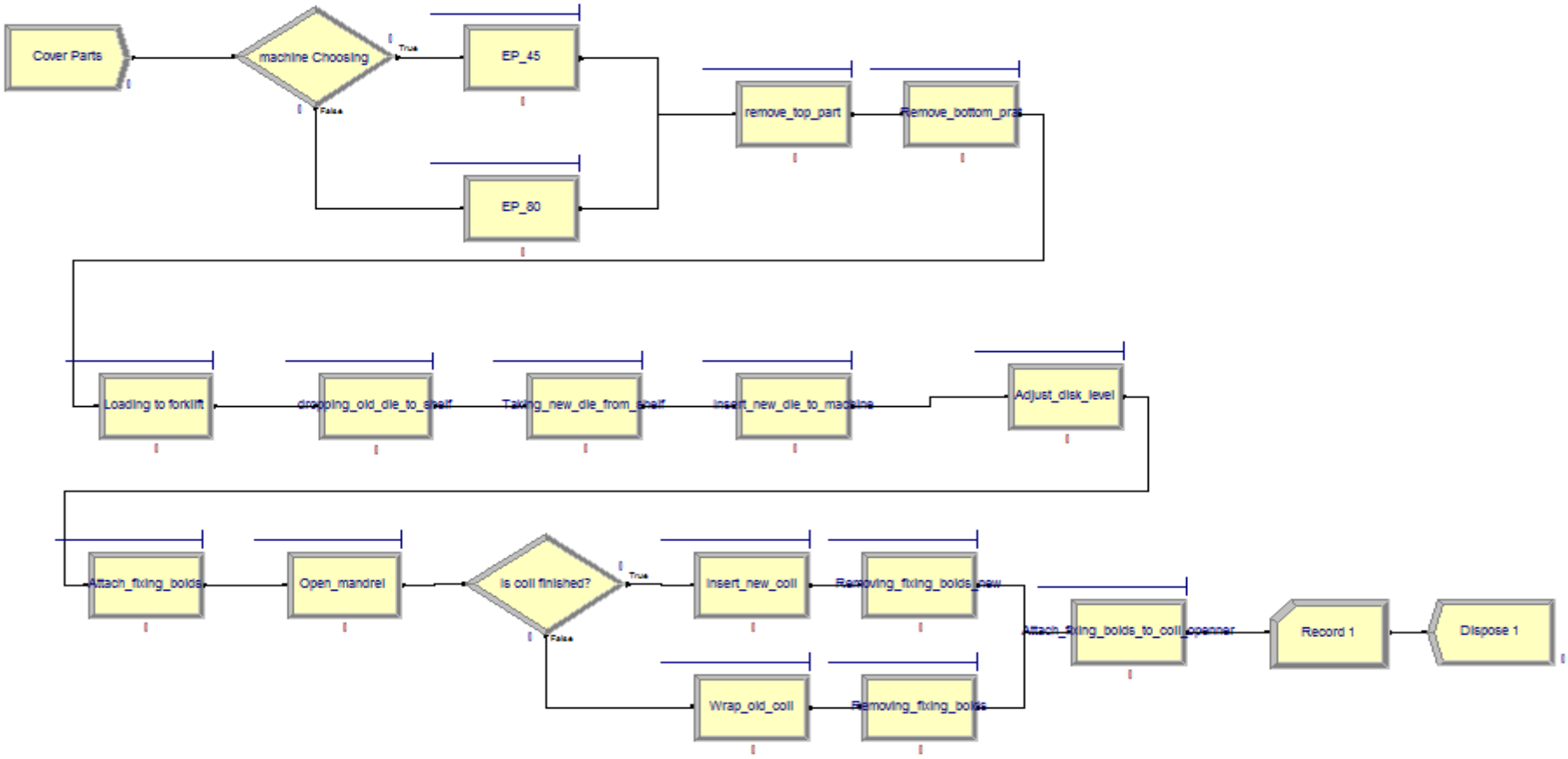
name/name **görevi**/role

yetkisi dahilinde yukarıda tarif edilen borçlandırmayı kabul etmektedir.
authorized to do that, accepts the said chargeback

Kabul için Tedarikçinin Kaşe ve İmzası
Supplier signature and Stamp for Acceptance

evrak fax ya da elektronik posta (pdf) ile önden iletildikten sonra, orijinali bildirimi gönderen İndesit tesisine, alındığını takip eden 20 gün içerisinde ulaştırılmalıdır.
The document must be advanced first by fax or by e-mail (.pdf file), and sent in original to the requesting Indesit office that transmitted the chargeback communication within 20 days since the receiving

APPENDIX 1- Punishment bill



APPENDIX 2: Arena model

	INVENTORY CODE	DEFINITION	QUANTITY	PRICE	TURNOVER
A GRUP PRODUCTS	21018490601	ASS.TREVERSA PTF 60	25.241	2,18	55.025,38
	13408779603	CABINET TOP (DKP)	23.310	1,89	44.055,90
	13409506101	TOP IN LAMIERA 3 HOLE FEP01	20.267	2,15	43.574,05
	21013680602	O/KUSAK GRB.B-SIZ CB50 FS	33.224	1,24	41.197,76
	21020548500	HOT GAS BOR.B-MUS CB50-50 Grubu	25.425	1,21	30.764,25
	21020003201	KOMPR.SASESI M-700 VER-4D	12.440	2,42	30.104,80
	21020003101	KOMPR.SASESI M-700 VER-2	11.557	2,42	27.967,94
	13409771600	ALT KUSAK B.SIZ RA 24/23	45.504	0,51	23.207,04
	13403324102	ON UST KUSAK	44.880	0,51	22.888,80
	21015367001	CERNIERA INFERIORE ALT MENTESE 7001	14.935	1,53	22.850,55
	13407893305	FZ SEPET RAYI KAPI MONT.ELEMANI UST SAG DX	11.950	1,9	22.705,00
	13407893405	FZ SEPET RAYI KAPI MONT.ELEMANI UST SOL SX	11.950	1,9	22.705,00
	14000195700	CERN.CENTR.(GAGALI MENTESE)	33.698	0,63	21.229,74
	13408779304	MOSTRINA INFERIORE	45.075	0,45	20.283,75
	11500159201	HOTGAS BORU 59201	10.500	1,89	19.845,00
	13407887500	KAPI ICI SEPET RAY TAKVIYESI (4D)	26.880	0,63	16.934,40
	13405927902	GOVDE PANELI B.SIZ (DKP-SAC)	7.916	2,03	16.069,48
	13409194201	UST PANEL(SACI)B.SIZ -PW PNF	5.860	2,15	12.599,00
	11500143500	HOTGAS BORU 43500	7.500	1,44	10.800,00
	11200139303	VASSOIO GOCCIOLATOIO UP NF	6.488	1,6	10.380,80
	13408895400	DUVAR SABITLEME SACI (STABILITY WALL BRACKET)	9.506	1,07	10.171,42
	13407885103	FZ.RAY.MONT.D.SACI ZN:1,5*35*292 MM	24.320	0,36	8.755,20
	13400590103	STAFFA FISS M/C KMF 300	84.600	0,1	8.460,00
	11500159401	HOTGAS BORU 59401	4.700	1,8	8.460,00
	11500142701	HOTGAS BORU 42701	7.300	1,15	8.395,00
	11500151402	HOTGAS BORU 51402	4.300	1,84	7.912,00
	11500151302	HOTGAS BORU 51302	6.275	1,26	7.906,50
	13408497900	KOMPRESOR SASESI	3.056	2,5	7.640,00
	13406806502	COMP.MTG CLAMP BRKT	132.713	0,05	6.635,65
	11500152101	HOTGAS BORU 52101	4.200	1,53	6.426,00
	13407886902	4D DIKEY KUSAK	6.245	1,02	6.369,90
	13405919900	U/K PANO SACI B.SIZ ARS70 (ESKI CRUSSCOTTO)	2.951	2,05	6.049,55
	13407887000	4D YATAY (ORTA) KUSAK	7.575	0,71	5.378,25
	14000168500	ORTA MENTESE DD55 CROM17	11.962	0,44	5.263,28
	13403322301	GOVDE UST PANEL B.SIZ	9.294	0,54	5.018,76
	13401977402	RINFORZO CERNIERA INF DX-SX	37.350	0,13	4.855,50
	13408604100	RINF.PER.MANIGLIA ESTERNA AR STANDARD KAPI KOLU DESTEK SACI	60.000	0,08	4.800,00

APPENDIX 3: Monthly production

	INVENTORY CODE	DEFINITION	QUANTITY	PRICE	TURNOVER
B GRUP PRODUCTS	13406041801	ORTA KUSAK	18.351	0,26	4.771,26
	13406954901	STAFFA FISSAGIO MOTOVENTILATORE	24.980	0,19	4.746,20
	13401823601	ORTA KUSAK B.SIZ 450 23600	8.935	0,52	4.646,20
	13406990002	DIKEY KAPI KOLU ALT DESTEK SACI	15.230	0,3	4.569,00
	13407751900	DIKEY KAPI KOLU KUCUK DESTEK SACI	30.000	0,14	4.200,00
	11200151601	ALUMINYUM PLAKA BIG 70	10.395	0,4	4.158,00
	13408149301	TRAVERSA POSTER PORTA INFER 4D	5.497	0,72	3.957,84
	13401443801	REFORC DOBR.INF	54.000	0,07	3.780,00
	11500128901	HOTGAS BORU 28901	2.575	1,43	3.682,25
	21010846600	TERM.BULB GRUPLU 46600	33.000	0,11	3.630,00
	13407891502	KAPI KOLU TAKVIYE SACI 4D	60.000	0,06	3.600,00
	13406999000	REFORC DOBR.INF.SAG MENTESE	7.651	0,46	3.519,46
	21013680402	O/KUSAK GRB.B-SIZ CB50-RFA52P	2.555	1,32	3.372,60
	13402519202	GOVDE UST PANEL B.SIZ (450)	6.297	0,53	3.337,41
	13406998900	REFORC DOBR.INF.SOL METESE	6.880	0,46	3.164,80
	13406480500	ORTA KUSAK (KILCIKLI)	8.374	0,37	3.098,38
	13404495802	GOVDE UST PANEL SIMIL INOX (DONGSHIN PLALAM)	5.004	0,54	2.702,16
	13406448600	STAF.FISS.FRIGO ZINCOCROM (TIRMIK)	5.000	0,5	2.500,00
	13400717303	PIASTRINA X COND.MARCIA	48.000	0,05	2.400,00
	13406466902	KUSAK B.SIZ INC 265 AL/BCF3	4.340	0,52	2.256,80

APPENDIX 3: Monthly production

	INVENTORY CODE	DEFINITION	QUANTITY	PRICE	TURNOVER
C GRUP PRODUCTS	14000168400	ORTA MENTESE (CB55-ANKASTRE)	2.000	1,09	2.180,00
	21012057702	HOT GAS BORUSU GR.RZA TT5	1.850	1,15	2.127,50
	11500157700	HOTGAS BORU 57700	1.650	1,28	2.112,00
	13408086802	ALT/UST KUSAK TT60 B.SIZ	7.492	0,25	1.873,00
	21016948305	O/KUSAK GRB.B-SIZ (ASSIEME MOSTRINA CENTRALE)	1.990	0,89	1.771,10
	13409596401	CB55 TOP IN LAMIERA 3 HOLE KRINKLE BLACK	2.704	0,54	1.460,16
	13406354101	PROF.ANK.UST KUSAK	4.450	0,32	1.424,00
	11500156002	HOTGAS BORU 56002	1.050	1,33	1.396,50
	21015178001	ORTA KUSAK GRB.B-SIZ PNF BI	1.015	1,27	1.289,05
	13405236204	UST KUSAK TT-55	5.901	0,21	1.239,21
	13408234400	PARABOLA PER LAMPADA	2.490	0,49	1.220,10
	13408612603	GOVDE UST PANEL BLACK (PLALAM)	2.048	0,54	1.105,92
	21020175400	AIR EVACUTION PIPE GRB	800	1,34	1.072,00
	11500161402	HOTGAS BORU 61402	750	1,42	1.065,00
	13408804001	CABINET TOP (GRANIT)	1.628	0,54	879,12
	21019219800	BULB SACI GRUPLU (L=550)	2.900	0,3	870,00
	13405945802	UST PANEL B.SIZ (PW)	423	2,03	858,69
	13401498502	ISIK YANSITICI	4.970	0,17	844,90
	13403469803	GOVDE UST PANEL ARL 703 L70	1.480	0,54	799,20
	13405209101	CABINET TOP (SIMIL INOX)	1.466	0,54	791,64
	22041317000	LING.AGGANCIO POST	6.000	0,13	780,00
	11500162701	HOTGAS BORU 62700	550	1,39	764,50
	11500161201	HOTGAS BORU 61201	550	1,29	709,50
	13407388202	BAGLANTI DESTEK SACI	6.750	0,1	675,00
	13407344700	JOINING KIT LOWER PRONT SPACER BRACKET	515	1,15	592,25
	21012002500	TERM.BULB GRUPLU 02500	5.000	0,11	550,00
	22041316000	STAFFA AGGANCIO POST	6.000	0,09	540,00
	13409595901	CB 55 TOP IN LAMIERA 3 HOLE INOX	994	0,54	536,76
	11200090700	BULB SACI (MINI CAVALLOTTO)	3.650	0,14	511,00
	13409311701	COMP.MTG CLAMP BRKT	48.180	0,01	481,80
	13408393700	U/K PANO SACI PRISTINA ARS70 (ESKI CRUSSCOTTO)	100	4,44	444,00
	13404544303	GOVDE UST PANEL 450 SIMIL INOX (DONG SHING-PLALAM)	754	0,54	407,16
	13403466102	GOVDE UST PANEL ARL703	686	0,54	370,44
	21017719701	TERM.BULB.GRUPLU 19701	7.000	0,05	350,00
	22040152000	SLITTINA X MANIGLIA KRF	4.500	0,06	270,00
	21017719602	TERM.BULB. GRUPLU 19602	5.000	0,05	250,00
	13409511100	JOINING KIT UPPER FRONT BRACKET (P.WHITE)	100	2,45	245,00
	13409329902	G.UST PANEL KRINKLE CB50 PNF	434	0,54	234,36
	14803380801	SPESSORE X STAFFA DI FISSS KRF 3100	2.500	0,09	225,00
	21016324202	TERM.BULB BORU GR.L960 TT60 LARDER	2.000	0,1	200,00
	13407345100	JOINING KIT REAR BRACKET	395	0,5	197,50
	13401296409	RINF.X AGGANCIO SPORT (*)	3.000	0,06	180,00
	13405936503	UST PANEL SIMIL INOX RA27	328	0,54	177,12
	14804562600	MULTIFLOW SONDA KAPAGI NF	2.935	0,06	176,10
	13408209803	G.UST PAN.BIG70 DD NF S.BLACK	298	0,54	160,92
	21019219600	TERM BULB SACI GURUBU	500	0,3	150,00
	13403230801	GOVDE UST PANEL MT40/45 NF	266	0,54	143,64
	13409511200	KIT LOWER PRONT SPACER BRACKET (P.WHITE)	100	1,15	115,00
	11200173701	UP NF + (ALUMINYUM TAVA)	38	2,13	80,94
	21019219700	TERM.BULB GRUPLU 19700	250	0,3	75,00
	13405920000	U/K PANO SACI PEARL WHITE (ESKI CRUSSCOTTO)	20	3,4	68,00
	13408625401	SASE BRAKET	5.150	0,01	51,50
	21012083800	TERM.BULB GRUPLU 83800	1.650	0,03	49,50
	16500903800	TERM.BULB. GRUPLU 03800	1.000	0,04	40,00
	21016657603	POMPA BORUSU GRUPLU	60	0,32	19,20
	17400198601	PIPE RUBBER TERM. BULB. BORUSU	200	0,06	12,00
	13409576700	KAPI KOLU TAKVIYE SACI KESILMIS (UK YP)	19	0,07	1,33
	21020176701	ASS.CERN.INF.PERNO.ARISTON	720	0	0,00
	14804300201	SEPET DESTEK PROFILI TRIMLI	100	0	0,00
	23001248700	CB70 NF 2 DRW HOT GAS TUBE EGE	100	0	0,00

APPENDIX 3: Monthly production

Tasks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	min	max	avg.
Stop machine and open die	50	78	80	67	74	91	100	85	93	95	73	44	65	61	56	39	105	100	93	102	37	105	77,55
Remove top die part	174	150	181	253	219	158	127	166	118	110	225	78	156	223	272	99	95	282	216	199	78	289	175,05
Remove bottom die part	109	131	100	166	104	172	182	88	149	115	111	69	91	143	100	78	76	86	100	108	63	182	113,9
Loading to forklift	46	54	46	58	51	45	51	58	58	51	53	57	53	59	47	51	56	59	48	48	45	59	52,45
Dropping old die to shelf	148	347	201	212	136	303	202	154	335	274	285	225	183	229	255	131	295	309	271	208	128	348	235,15
Taking new die from shelf	139	120	141	119	95	106	118	144	102	137	112	95	119	100	136	106	108	104	124	126	95	148	117,55
Insert new die to machine	196	207	245	234	356	168	195	227	255	258	249	236	188	275	327	344	347	273	199	293	168	356	253,6
Adjust disk level	49	51	55	49	41	46	45	41	58	49	40	49	57	41	59	48	52	50	54	45	37	59	48,95
Attach fixing bolts	109	105	126	93	124	141	127	130	112	100	114	127	120	105	118	139	95	134	95	94	93	142	115,4
Open mandrel	38	32	48	33	37	38	43	46	46	49	38	38	43	47	45	49	44	36	45	46	32	51	42,05
Wrap old coil	167	128	139	128	176	123	143	160	153	145	140	147	179	175	137	177	162	175	171	153	120	180	153,9
Removing fixing bolts from coil opener	127	107	184	109	156	156	122	128	113	144	158	88	175	151	160	113	182	131	156	113	87	143	138,65
Removing old coil	185	185	173	186	166	167	180	169	172	173	172	170	180	185	182	170	180	179	169	180	164	186	176,15
Insert new coil	177	155	176	183	204	181	201	169	188	193	162	183	158	177	166	171	171	168	200	161	150	204	177,2
Attach fixing bolts to coil opener	135	98	94	126	122	98	106	114	108	91	89	104	134	96	93	101	109	117	93	87	84	138	105,75

APPENDIX 4: Time study