INTERVENTION OF DIGITAL PRINTERS: A GRAPHIC DESIGN METHOD

by

DORUK TÜRKMEN

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ABSTRACT

INTERVENTION ON DIGITAL PRINTERS: A GRAPHIC DESIGN METHOD

Doruk Türkmen

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Supervisor: Onur Fatih Yazıcıgil

Keywords: graphic design, printing, intervention, unique, chance

Print culture has become a mere representation of computer data. With practical solutions digital printing has brought, appreciation of printed matter and visual aesthetics lost their emphasis. While those practical solutions are useful, a lot of opportunities the digital printing could have offered were being missed out. This distant relationship between printed material and graphic design will be investigated in this thesis.

In this experiment, opportunities that digital printing offers will be explored with the emphasis on graphic design process. Methods used in an older experiment, titled Control Print, on print culture and human hand in digital printing will be evaluated. The experiment's main objective is to explore creative, unique and chance based possibilities of digital printing by modifications and interventions on ink and paper, and to find out if the outcomes can become a graphic design methodology.

ÖZET

DİJİTAL YAZICILARA MÜDAHALE: BİR GRAFİK TASASRIM METODU

Doruk Türkmen

Görsel Sanatlar ve Görsel İletişim Tasarımı Yüksek Lisan Programı, 2014

Tez Yöneticisi: Onur Fatih Yazıcıgil

Anahtar Sözcükler: Grafik tasarım, matbaa, müdahale, eşsiz, şans

Matbaa kültürü bilgisayar verisinin bir temsili haline geldi. Dijital matbaanın getirdiği pratik çözümler ile , basılı malzemenin takdiri ve görsel estetiğe verilen önem kayboldu. Bu pratik çözümler kullanışlı olsalar da, dijital matbaanın sağladığı bazı fırsatlar göz ardı ediliyordu. Basılı malzemeler ve grafik tasarım arasındaki bu uzak ve yavaş yavaş kopan ilişki, bu tezde sorgulanacaktır.

Bu deneyde, dijital matbaanın sağladığı fırsatlar, grafik tasarım üzerinde durularak araştırılacaktır. 'Control Print' adlı, matbaa kültürünü ve dijital matbaada insan elini inceleteyen bir deneyde kullanılan metodlar değerlendirilecektir. Deneyin en önemli amacı, dijital matbaanın sağladığı yaratıcı, eşsiz ve şansa dayalı olanaklar, mürekkebe, kağıda ve dijital yazıcılara müdahalelerde bulunarak araştırılacaktır. Deneyin sonuçları ve yapılan müdahaleler, bir grafik tasarım yöntemi olup olamayacağı konusunda ayrıca değerlendirilecektir.

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In the 15th century, Johann Gutenberg invented the most significant device of the past millennia. Printing press allowed mass communication for the first time in the history. Illiteracy began a rapid decline and civilizations started to make contact with visuals in daily basis. Visual communication started to develop rapidly with innovations in typography and book design. Printing has affected every aspect of culture and daily lives. Thinkers have spread their ideas through mass production and change have begun to show itself all around the world.

As the millennia came to an end, visual communication has seen a shift. Advancements in technology opened up new possibilities of communication with television, radio and personal computers. Soon visual communication started to move from newspapers, magazines and books to digital devices. Printing technologies were advancing simultaneously with new possibilities opening up. More small scale printing houses were establishing due to the affordable printing devices. New printing technologies like inkjet and laser printing allowed individuals to afford compact printers that could be used with personal computers. Digital printers gave people an urge to print personal information like photos and e-mails.

A team of researchers in Royal College of Arts, questioned the digital printing habits. They explained that printing has become a representation of 0s and 1s in computer data, making printing and printed material distant. With practical solutions that digital printing has brought, appreciation of printed matter and visual aesthetics lost their emphasis. While this attitude is understandable, a lot of opportunities the digital printing could have offered were being missed out.

They conducted an experiment called Control Print to transform digital information to a more personal print process. They questioned if accidents and randomness could have existed in printing.

In ‘Intervention on Digital Printers’ experiment, methods used by Control Print team were applied while new applications on digital printers were researched. The emphasis was on graphic design as the profession has become distant as well. All the designing process is happening on computer applications while printing is autonomous, with no human hand is involved. The experiment will attempt to merge the two processes making graphic design process more tangible while printing process becomes more unique and personal.

In the next chapter, an introduction to printing and its affects will be defined. The emphasis will be on visual communication as all preliminary advancements like writing and papermaking altogether establishes the print culture and graphic design. On the third chapter Control Print and other recent printing experiments will be evaluated. On the fourth chapter, the experiment will be explained in detail with outcomes and modifications evaluated in the way.

CHAPTER 2. INTRODUCTION TO PRINTING

2.1. Brief History of Printing

"We should note the force, effect, and consequences of inventions which are nowhere more conspicuous than in those three which were unknown to the ancients, namely, printing, gunpowder, and the compass. For these three have changed the appearance and state of the whole world. "

Francis Bacon, *Novum Organum*, Aphorism 129

The above statement from Francis Bacon sums up the importance of printing in the history of mankind. When Johann Gutenberg invented the printing press in 1439, it slowly started to change people conceive the world. Mass production of books and printed matter made the spreading of ideas possible.

However before printing emerges, writing and papermaking will be introduced briefly. Since the Homo sapiens started to paint the walls of caves throughout Europe and Africa (c. 35,000 B.C. to 4000 B.C.), we have seen the struggle to find better ways of communication to this day. Those stylized and simplified paintings were not the beginnings of art as we know it, rather they were the dawning of visual communications (Meggs 2006, 4). The inhabitants of those caves are simply trying to record memory and the simplistic symbols, while being accurate, are the beginning of the pictorial art and they formed the basis of writing.

Figure 1. Rock painting from San Raphael Swell, 2000-1000 B.C.

Sumerians who settled in the Mesopotamia, contributed to social and intellectual progress by having the most advanced social order to date. The invention of writing has brought a vast number of advancements, technological and cultural developments to future civilizations. The need to keep record of time and consciousness pushed Sumerians to come up with a solution to all the blurriness of time (Figure 2).

Figure 2. Early Sumerian pictographic tablet, c. 3100 B.C.

With the advancements in writing and the rise of village culture in Mesopotamia, a need for visual identification grew urgent as ownership of property and the specialization of trades and craft became something that couldn't be ignored. The small cylinders had images and writing etched into their surfaces. When they were rolled across a clay tablet, they left an impression of the depressed design, becoming a trademark for the owner. The importance of the cylinder seals lies in the fact that the need to express identity becomes a driving force behind these advancements and since the images could be reproduced, this can be seen as an initial form of printing.

Figure 3. Mesopotamian limestone cylinder seal and impression.

Over the years the invention of the Sumerians had reached Egypt. They came up with a writing system called hieroglyphs (Greek for "sacred carving"). Unlike Sumerians, who evolved their pictographic system to a more abstract form of writing, Egyptians used the picture-writing system for over three millennia.

They developed the papyrus, a paperlike substrate for manuscripts, was a major step forward in Egyptian visual communications. To help lead the people in to the afterlife, the Egyptians invented myths and legends to explain the afterlife. Scribes and artists were commissioned to prepare funerary papyri, called the Book of the Dead by nineteenth-century scholars. These were the first illustrated manuscripts in history, in which words and pictures were combined to communicate information.

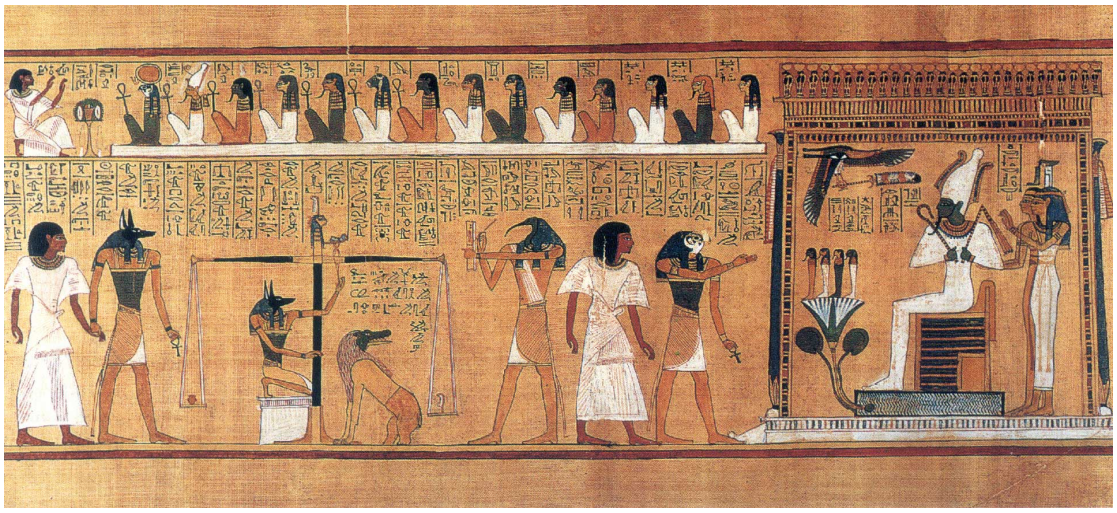


Figure 4. Detail from the Book of the Dead, from the Papyrus of Hunefer, ca. 1275 BCE

For centuries Egyptians wrote on papyrus while in Europe the writing medium was parchment produced from animal skins and wooden tablets. Parchment was expensive and Europeans would have to wait for a cheaper solution up until the 10th century while in China a mechanization attempt was sprouting.

In A.D 105, a governmental official Ts'ai Lun, reported his invention of paper to Chinese Emperor Ho. This breakthrough was as important as the discovery of printing. As opposed to silk or bamboo which was used by the calligraphers of Ancient Chinese, it was cheap, light weight and versatile. It quickly replaced early methods of impression.

Printing is considered to be discovered by the Chinese. The first form of printing was relief printing. The spaces around the image were cut away, leaving the image in high relief. Then the raised surface is inked, and a sheet of paper is placed over the surface and rubbed to transfer the inked image to the paper. Chinese used chops as identification imprints during the Han Dynasty (third century A.D.). These seals had calligraphic characters carved on its surface. Around 500 A.D. chops were made high relief and the precursor of woodblock printing was available. However the advancement leading to mass production of printed materials was the need to make permanent records

On 11 May 868 A.D. the relief printing was well developed, as the oldest surviving printed manuscript is the Diamond Sutra was printed on that day (British

Library, 2003). The quality shows us how the craft had advanced to a high level by the time it was produced (Figure 5).

Figure 5. Detail from the Diamond Sutra, May 11 868.

Apart from all these advancements, China was the first society in which ordinary people had daily contacts with printed images. When iron money shortage was critical, paper money was designed, printed and used instead of metal coins.

The quiet revolution that printing wrought upon Chinese intellectual life brought about a renaissance of learning and culture just as surely as Johann Gutenberg's invention of movable type in the West did more than five hundred years later (Meggs 2006, 39).

It took almost 400 years for all of these inventions and advancements to reach Western Europe. For them to spread across Asia, it took several encounters of Eastern and Western civilizations. The woodblock craft moved to Baghdad, Damascus, Egypt and then finally to Sicily, Italy (Meggs, 2006, 65). However paper didn't make that impact it made in China. Paper production served the needs of merchants, bureaucrats and preachers, but the same number of man-hours was still required to turn out a given text.

We don't know for sure how woodblock printing has reached Europe. It would be plausible to say that the Crusades played a role for opening Europe to Eastern civilizations' influence. Europeans printed playing cars on textiles by the 1300s. The games were played in taverns, establishing an underground printing industry, as card games were illegal. Apart from the entertainment, the playing cards were the first printed pieces to move into an illiterate culture in Europe.

Regarding the impact on visual communication, Europeans printed religious images and text on small sized papers. These early prints evolved into block books with religious subject matter. Those books played a big role to raise the literacy of the middle class (Meggs 2006, 67). The demand for printed books was higher than anytime by the early 15th century. Ars moriendi (art of dying) and Biblia pauperum (Bible of the poor) were the two commons block books (Figure 6).

Figure 6. On the left is Biblia pauperum (Bible of the poor). On the right is an Ars Moriendi. Both were popular circulating prints from the 15th century.

2.1.1. The Printing Press

All these advancements eventually arrives at the point where Gutenberg's invention of movable type. Gutenberg first brought together the complex systems necessary to print a typographic book around 1450 (Meggs 2006, 69). The invention paper provided a cheap and versatile substrate to silk or any other textile. The screw press was available for centuries and recently it was used as a cloth press for printing patterns (Schneider, Helmuth 2007, 144-171) The key to Gutenberg's invention was the type mold, used for casting the individual letters. A steel punch is used to stamp an impression of the letterform into a softer brass matrix. The printing press displaced earlier methods of printing and led to the first assembly line-style mass production of books. (McLuhan 1962, 124)

As a goldsmith, Gutenberg came up with a solution for making thousands of impressions need to print a large book like his 42-line Bible. He needed a metal that was soft enough to cast but hard enough to cast type with critical tolerances. After the matrix is slipped into the bottom of the two-part type mold, the mold is filled with the molten lead alloy to cast a piece of type. After the lead alloy cools, the type mold is opened and the type is removed (Figure 7).

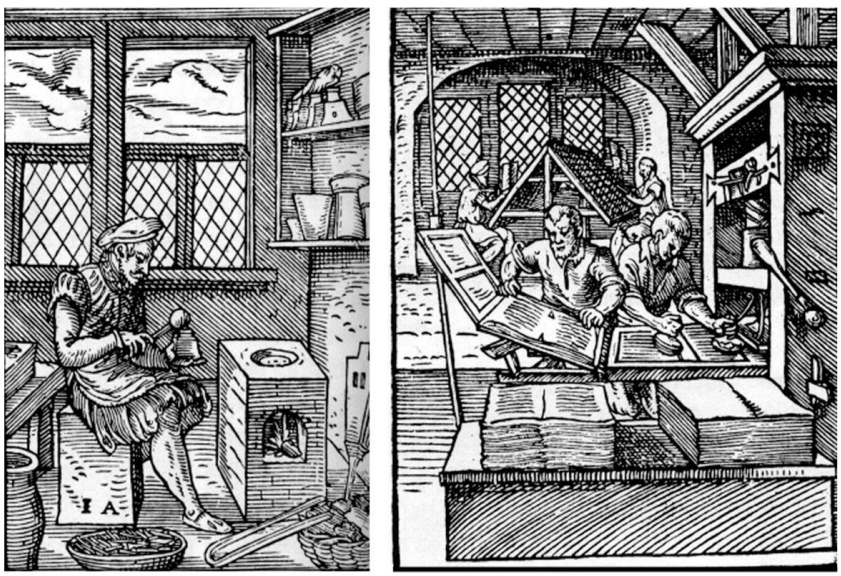


Figure 7. Typecasting and the printing press illustrated in woodcut prints by Josh Amman, 1568.

The reusable molds, allowed for large book to be printed. The compartments that hold type are set letter by letter. After a page was printed, the type was returned to the compartments letter by letter. The first specimen by Gutenberg was the letters of indulgence issued by Pope Nicholas V. Thousands of letters were ordered and the agents selling them realized the value of printing this letter in quantity.

Gutenberg's magnum opus was his 42-line Bible. The superb typographic legibility and texture, generous margins, and excellent presswork make this first printed book a canon of quality that has seldom been surpassed. An illuminator added the red and blue headers, initials, and text by hand (Meggs, 2006, 75). 42 lines per column were chosen to save sixty pages in total. Each page had over 2,500 characters set from a font of 290 different characters (Figure 8). Type casting allowed usage of generous number of alternative characters and ligatures, hence the manuscript's pages were rich and varied in character. The block printing allowed the reuse of only the characters set for that page, which they can't be used individually.

Figure 8. Gutenberg Bible (42-line Bible) displayed at the New York Public Library.

Elizabeth Eisenstein explains the increase in book production during the first century of printing with this statement: A man born in 1453, the year of the fall of Constantinople, could look back from his fiftieth year on a lifetime in which about eight million books had been printed, more perhaps than all scribes of Europe had produced since Constantine founded his city in A.D. 330.

Printing press brought in an age of mass-communication. Mass production enabled that identical images, maps, and images could be viewed simultaneously by different readers. Which brought a kind of communications revolutions itself (Eisenstein 1983, 22). Abundant of printed material changed the way people thought books. Approach to book design changed completely.

Illiteracy began a long, steady decline. Literacy was of limited value to a medieval peasant who had no hope of gaining access to books. But tumbling book prices, the beginnings of such popular writing as romantic novels, and the proliferation of the ever-present broadside made reading desirable and increasingly necessary for Renaissance townspeople (Meggs, 2006, 78).

2.2. Printing Press and Graphic Design

A decade after printing press came out of Gutenberg's workshop, book design was changing already. As more and more printing shops had presses, more and more classical literature was being reprinted. Germans started to illustrate their book with woodblock prints. That was a new design choice for printers. Albrecht Dürer earned renown through illustrated books and broadsides (single page books, pre-cursor to posters). In Germany, graphic design continued its tradition of textura typography and vigorous woodcut illustrations (Meggs, 2006, 89). Innovations regarding metal type were being developed by one of Dürer's students. Johann Schoensperger managed to imitate the freedom of pen on metal type by adding calligraphic swashes to the letters. Martin Luther's ideas of Protestant Reformation spread through printed broadsides. This shows us the power of visual communication through masses.

In Italy, the first Roman-style letters was designed by Conrad Sweynheym and Arnold Pannartz who were commissioned by a cardinal to publish Latin classics and his

own writings. These scholars had design letterforms that became the prototype for the Roman alphabets still in use today.

In the 16th century, the innovations in printing and graphic design reached France by war. Geoffroy Tory and Claude Garamond created visual forms that were embraced for two hundred years. Tory designed Roman capital initials that captured the imagination of French printers in 1526. Claude Garamond's roman typefaces were designed with such perfection that French printers in sixteenth century were able to print books of extraordinary legibility and beauty. Eventually his fonts established the old-style type category and modern roman typefaces like Adobe Garamond and Sabon have direct relationship with Garamond's original letterforms.

In the late 17th century French king Louis XIV, who had a strong interest in printing, had a vision of establishing a royal typeface. He issued a mathematician to construct a grid. Letters were designed with fewer calligraphic properties, a mathematical harmony was achieved by measurement and drafting instruments (Figure 9). Louis XIV's vision moved type design forward and Romain du Roi established a category of types called transtitional. Modern transitional typefaces include Times New Roman and Baskerville.

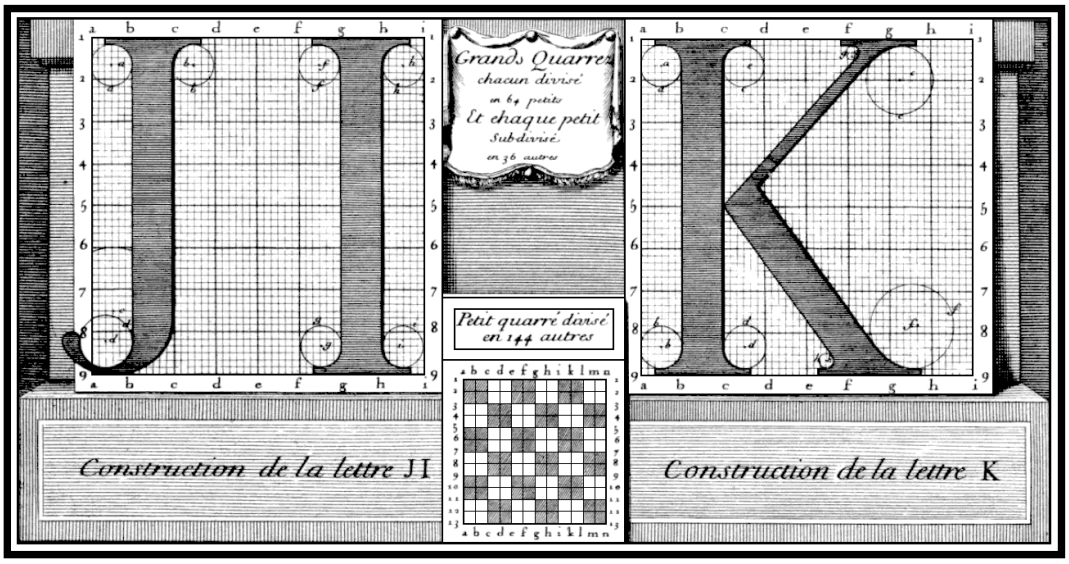


Figure 9. Letterform designs by Louis Simonneau for the Romain Du Roi, 1695.

Across the English Channel, William Caslon emerged as a native genius in England. His Caslon Old Style was used extensively for 60 years after its first emergence. Printer Benjamin Franklin introduced Caslon into the American colonies, making the typeface the official font for the printing of the Declaration of Independence. Caslon's type designs were not particularly fashionable or innovative. They are considered "comfortable" and "friendly to the eye" because of their outstanding legibility and sturdy texture (Meggs 2006, 121).

Individuals continued to find ways to improve the look of the printed page over the decades. In the 18th century, printer and typographer John Baskerville created a way to make paper whiter and smoother so that in printing, the ink showed up strong and crisp. He also was the pioneer for adding wide margins to the printed page, as well as spacing — or leading — between lines of text. With trial and error, he developed an unusually dense black ink which seemed odd to the eyes to the audience of the time (Figure 10).

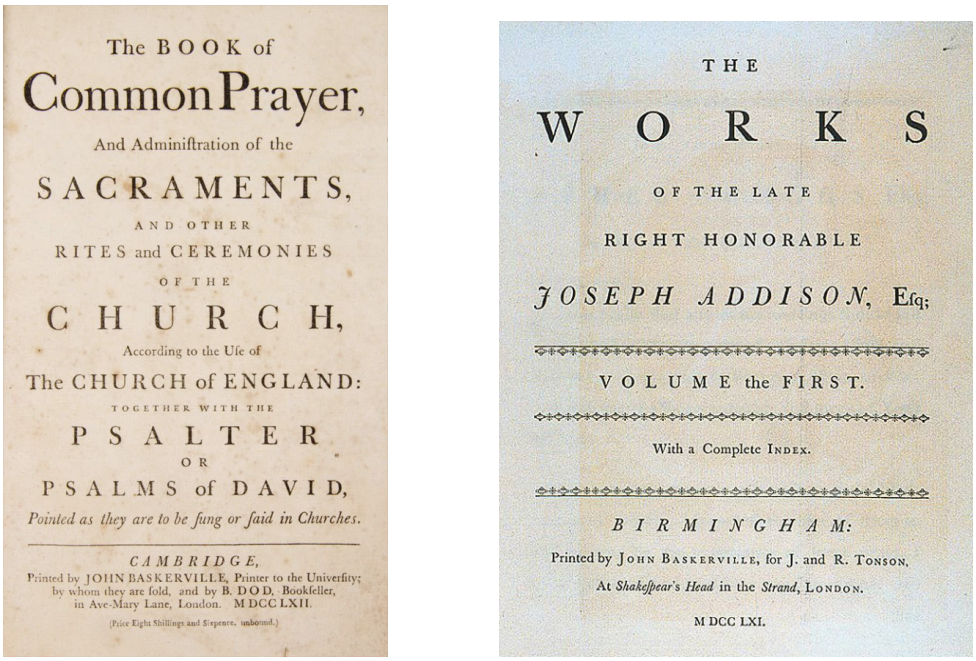


Figure 10. Book cover designs by John Baskerville, late 18th century.

Up until Industrial Revolution, printing press has seen little change in its working mechanics. Before the Industrial Revolution a family of printmaking techniques have appeared. Intaglio is the opposite of relief printing where the image is incised into a surface, and the incised line or sunken area holds the ink. Intaglio printing

consists of etching, engraving, aquatint and mezzotint. Engraving as printing process was available at the same time as the printing press and was used by artists like Albretch Dürer. However etching emerged as a printing technique in ca. 1470-1560 (Meggs 2006, 87). It is still in use as a technique in printmaking.

In the late 18th century, Alois Senefelder introduced lithography (Meggs 2006, 130). The technique is based on the fact that oil and water don't mix. An image is drawn to the surface of a smooth limestone. The stone was treated with a mixture of acid and gum, etching the portions of the stone that was not protected. When these etched areas retained water, an oil-based ink could then be applied and would be repelled by the water. The ink would then be transferred to a blank paper sheet.

Lithography is the precursor of offset printing, which is the leading mass printing technique and is still in use in different art forms.

Lithography was the last printing technology introduced before mechanization of printing with the Industrial Revolution. In the following century, printing and typography will see a rapid advancement with the mechanization of production in every aspect of manufacturing.

2.3. Printing Technologies Then and Now

In late 18th century, the steam engine was perfected by James Watt. The world was on the brink of another political and social shift. With production taking form as autonomous, moving away from the human hand, printing has seen a change as a craft. Earlier, a printer was involved with all aspects of his craft, from typeface design and page layout to the actual printing of books Over the course of the nineteenth century, however, the specialization of the factory system fractured graphic communications in to separate design components. New typefaces emerged, from Egyptian sans serifs to extreme novelty styles (Megg 2006, 134).

William Caslon IV, heir of William Caslon the type designer from the sixteenth century, designed the first sans serif typeface in 1816, called “Two Lines English Egyptian”. The first sans serifs saw little attention until 1830s, when other designers started to design their own (Figure 11). In today’s type specification terms like Gothic and grotesque, emerged from the names the designers gave to their sans serif typefaces (Meggs 2006, 134).

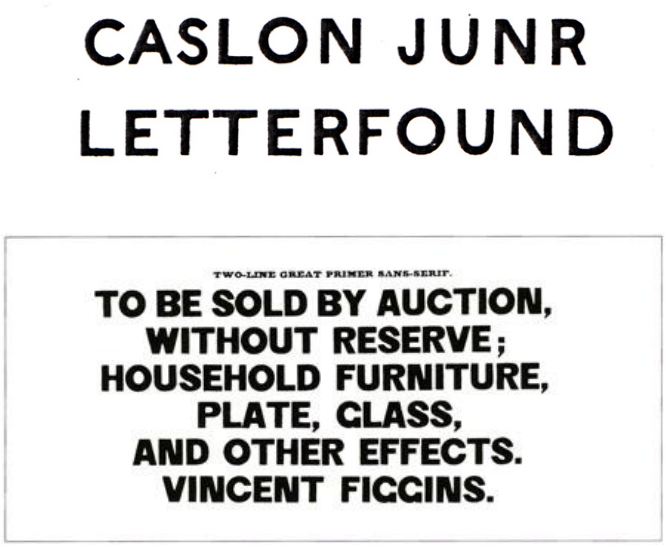


Figure 11. Two of the first sans serif typefaces designed by William Caslon IV and Vincent Figgins respectively.

The printing press, which saw little change the last three or four centuries, was adapted to the new mechanization age. First in 1800, Lord Stanhope developed a printing press constructed completely of cast-iron parts. The next step, however, converted the printing into high-speed factory operation. Fredrich Koenig developed a steam-powered printing press in 1810. That printing press had evolved in to a machine that could handle newspaper printing and soon Koenig was commissioned to print Times in London. While production times are reduced dramatically, typesetting was still handled by hand. Unable to keep up with the newspaper production, typesetting would see its own mechanization several decades later.

In 1886, Ottmar Merganthaler perfected his Linotype machine. The linotype machine operator enters text on a 90-character keyboard. The machine assembles matrices, which are molds for the letterforms, in a line. The assembled line is then cast as a single piece, called a slug, of type metal in a process known as "hot metal" typesetting. The matrices are then returned to the type magazine from which they came,

to be reused later. This allows much faster typesetting and composition than original hand composition in which operators place down one pre-cast metal letter, punctuation mark or space at a time (Figure 12).

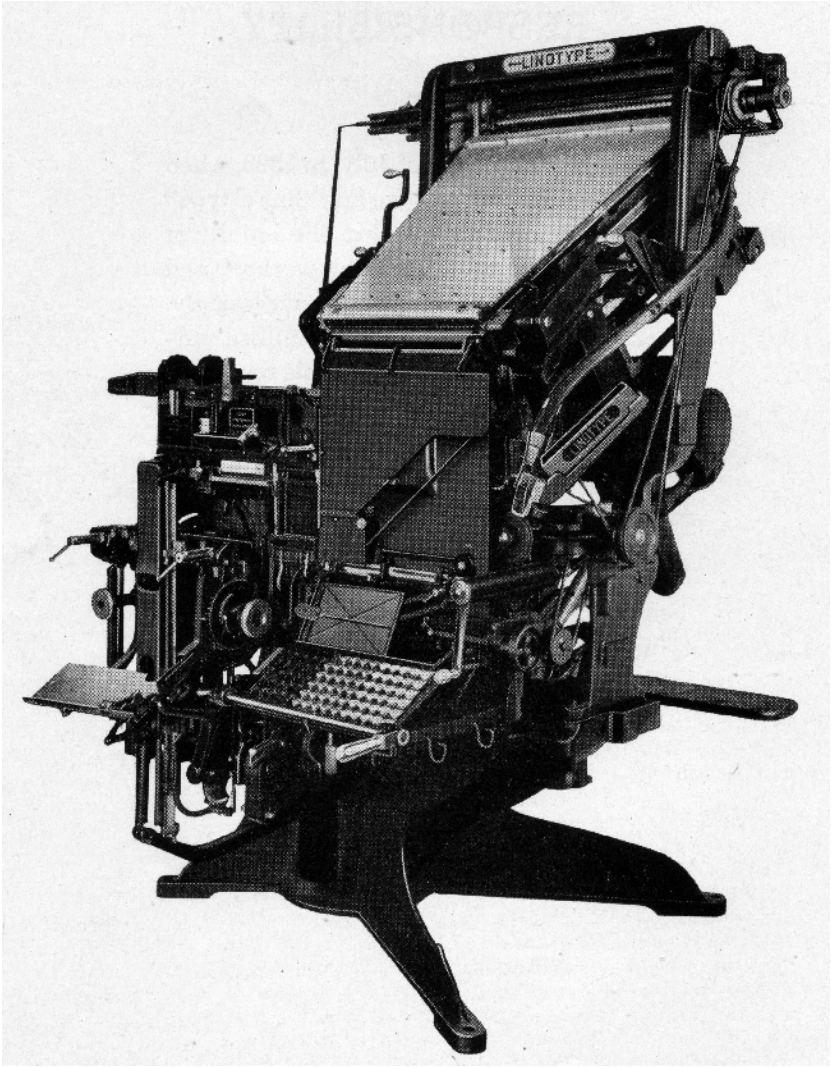


Figure 12. Linotype machine Model 5 that was used in 1906.

Linotype became the standard in newspaper, magazine and poster production. Weekly and daily publications thrived and handset typography was only used for editorial headlining in magazines until the advent of phototypography (Meggs 2006, 142). Linotype's keyboard, together with typewriters that was developed during the same decades as the Linotype, is the precursor to computer keyboards we use today.

Photography was developed in the nineteenth century by simultaneous researches and collaborations of three men: Joseph Niepce, Louis Jacques Daguerre and William Henry Fox Talbot. They all managed to create photographic images by

exposing light sensitive substrates to light. Their initial techniques were different but they all contributed to the development of photography and eventually application of photography to printing.

Before photography was introduced, wood-block engravings were used to print illustrations for editorial and advertising communications. Wood-blocks could be used in letterpresses and printed with type. However this process was costly, thus numerous inventors and tinkerers continued the research to find an economical and reliable photoengraving process for preparing printing plates. In newspapers and magazines, wood-engraved illustrations were used to document events where a real photograph was used as a guide.

In 1871, John Calvin Moss developed a feasible photoengraving method for translating line artwork in to metal letterpress plates. This has cut the cost and time required to produce printing blocks, however the method of reproduction of a photograph with full tonal range found in 1880 by Stephen H. Horgan. It was printed from a halftone screen that broke the image into a series of minute dots whose varying sizes created dots Frederick Ives perfected the process in 1881 by using the etching technique to produce the first commercial halftone printing plates (Meggs 2006, 147-149). As the decades passed, photographic process was defined as the new communications tool. Advertorial and editorial design saw a huge attention.

Printing press was the leading commercial printing device through the first half for the 20th century until offset printing was developed and perfected. The first rotary offset lithographic printing press was created in England and patented in 1875 by Robert Barclay. This development combined mid-19th century transfer printing technologies and Richard March Hoe's 1843 rotary printing press—a press that used a metal cylinder instead of a flat stone. The offset cylinder was covered with specially treated cardboard that transferred the printed image from the stone to the surface of the metal. Later, the cardboard covering of the offset cylinder was changed to rubber, which is still the most commonly used material.

As the 19th century closed and photography became popular, photoengraving, a process that used halftone technology instead of illustration, became the primary aesthetic of the era. Many printers, including Ira Washington Rubel, were using the

low-cost lithograph process to produce copies of photographs and books. Rubel discovered in 1901—by forgetting to load a sheet—that when printing from the rubber roller, instead of the metal, the printed page was clearer and sharper. After further refinement, the Potter Press printing Company in New York produced a press in 1903.

Offset lithography is one of the most common ways of creating printed matter. A few of its common applications include: newspapers, magazines, brochures, stationery, and books. Compared to other printing methods, offset printing is best suited for economically producing large volumes of high quality prints in a manner that requires little maintenance (Howard 2005, 140-149).

As decades passed in to the 20th century, new printing techniques emerged; however they were used briefly as offset printing continued to lead the printing industry. After the 1950s, developments on computer technology were the heralds of the digital information age. With the advent of commercial computers, visual communication and printing have seen a shift. Soon the offset printing was adapted to the digital technology. Dot matrix printers were introduced and Xerox has developed laser printing. Inkjet technology, which was a concept researched in the 19th century, was developed as a technology during 1950s. The greatest difference between traditional printing and digital printing is that there is no need to replace printing plates in digital printing. The results are faster and cheaper printing but a decrease in quality as opposed to traditional printing.

After the 1980s, when the personal computers were introduced, low cost inkjet and laser printers were developed for individual use like homes and offices. That move had an effect on print culture where visual aesthetics and the tactility of traditional printing diminished. Apart from some small printing houses, printing press has disappeared. Printing has become a representation of computer data. With a simple input, the last 400 years of evolution in printing is in our hands.

In the next chapter, experimental approaches to digital printers and printing in general will be explored and a brief description of how the graphic design process is taking shape with digital printers will be given. In addition, inkjet technology will be described in Chapter 4.

CHAPTER 3. INTRODUCTION TO THE EXPERIMENT

3.1. Printer Repurposing

For the purpose of eliminating any misunderstandings, the experiment explored in this thesis is titled Intervention on Digital Printers and will be abbreviated as I.D.P.

According to Miriam-Webster online dictionary, the definition of repurposing is "to change (something) so that it can be used for a different purposes". A purpose of a printer is printing and in I.D.P, a digital printer's purpose will still be printing. So can this experimentation called "repurposing"? When searching online for any material about repurposing, most of the things that comes up are "creative" ways to use old objects with new ways, ranging from reusing old ladders as bookshelves to changing old suitcases to chairs. Mostly these objects are not mechanized or they are broken and out of order.

Couple of years ago, people all over the world started to post videos of old but working floppy disc readers used as musical instruments. They are normally loud computer parts and it was a clever way of using things that are not valid anymore. The intervention is making the floppy discs work without a computer input. However they are connected to an external interface called Arduino which a user can develop a series of codes that send input to floppy discs to trick them into working without a computer. This process is considered repurposing. Floppy discs now have a purpose of making music rather then reading data.

When it comes to printers, I have seen broken printers used as flower pots, shelves and even barbeques. These examples can be called simply "recycling". The printers that are out of order are put back in use for a different purpose rather being thrown out. Exactly like paper. Papers that can't be used are recycled to their raw materials. They would end up as a chair or a pencil.

Gonzalo Ramirez is an interaction designer who started a project called "Vincent Zero". Ramirez is using parts from an old HP plotter that has malfunctioning cartridges. He had been building a new printer with cartridges produced from a 3D printer and motors and other crucial parts from the plotter. Rather then building a conventional plotter, he is designing the printer with advanced and experimental behavior.

Vincent Zero experiment is nothing but a DIY (do it yourself) challenge however it is one of the printer experiments found on the web that in fact involves printing. Ramirez aims to reconstruct the plotter's printing heads through a 3D printer that will allow him to mount different, unconventional devices from a robotic arm with a mounted brush, to a paintball gun shooting at wall taking parameters from software, gathering statistical and analytical procedures, visiting concepts of generative composition (Ramirez 2012) (Figure 13).

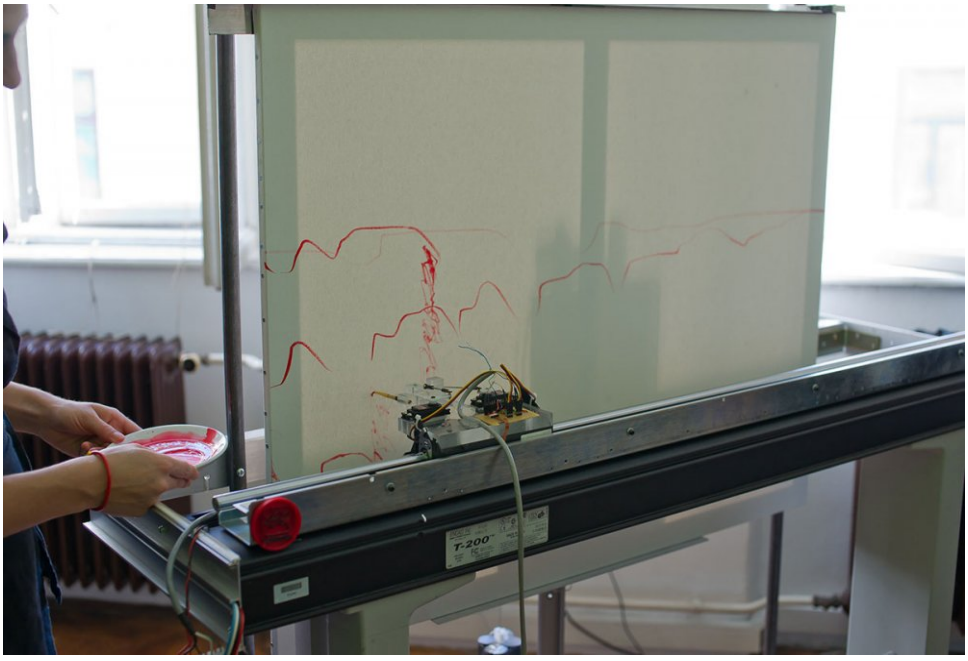


Figure 13. Reconstructed plotter from Gonzalo Ramirez's experiment Vincent Zero.

Hardware modifications and gestures similar to what Ramirez has done will be discussed as future work.

3.2. Control Print

The main inspiration for I.D.P is an experiment conducted by Royal College of Art in 2005 titled Control Print. The research team explored the interaction between the physical and digital information and why humans have the urge to print their personal "recordings" like e-mails, photos or essays. They say that the rise in computer use made way to small -scale printing technologies be available to everyone, pushing people to have tangible copies of digital information. This tangibility is coming from an increased drive to record senses and experience. A simple example is the book. The book conveys its meaning through both physical form and content. While reading a book all your senses start recording. (Carneholm and Harrison Bailey 2009, 28) The feel of the cover, smell of the pages and the weight of the paper, all of these features contribute to the uniqueness of each book. A hardcover book can imply importance while a paperback with a signature from the author may leave a sincere feeling.

The digital printer is a place of transformation according to Russell Warren-Fisher from the Control Print research team (Warren-Fisher 2010, 22). The printer is where the bits and bytes of information, the 1s and 0s of code becomes reality says Russell. And this transformation happens without an aid from the human hand. It is a distant action, just hitting "print" and seeing the outcome. These prints on paper will exist forever but to have that sincere feeling and the emotional attachment mentioned above, the book is the perfect medium.

Sensual experience of a book increases with personal attachment. With the power of small-scale digital printing, we can create our own books. This is where the physical experiments of Control Print lift off. The research team sees the digital print as 'the people's ' creative medium rather than seeing it as a 'cheap, practical solution'. To break the general consensus of "what you see on the screen is what you'll see on the paper", a human intervention is needed, to have a hand in the making.

When the human intervention is the subject, the chance factor comes in. Accidents do happen when humans are involved in anything. The question is how much

control can we give away when printing? Or is ‘uncontrol’ the stronger factor here? Where do these terms reside in communication design?

After the initial talks and the research on the subject, the research team turned their eye on the outside world. A collaborative exhibition was planned and academicians, students, artists and designers got together. During the discussions, terms like ‘accidental’, ‘chance’ and ‘unique’ emerged. The methods used to understand these terms were to print with unconventional ways like overprinting or meddling with the nozzles of the printer. The result is different from the screen hence the print is the original rather then the reproduction of the screen (Figure 14).

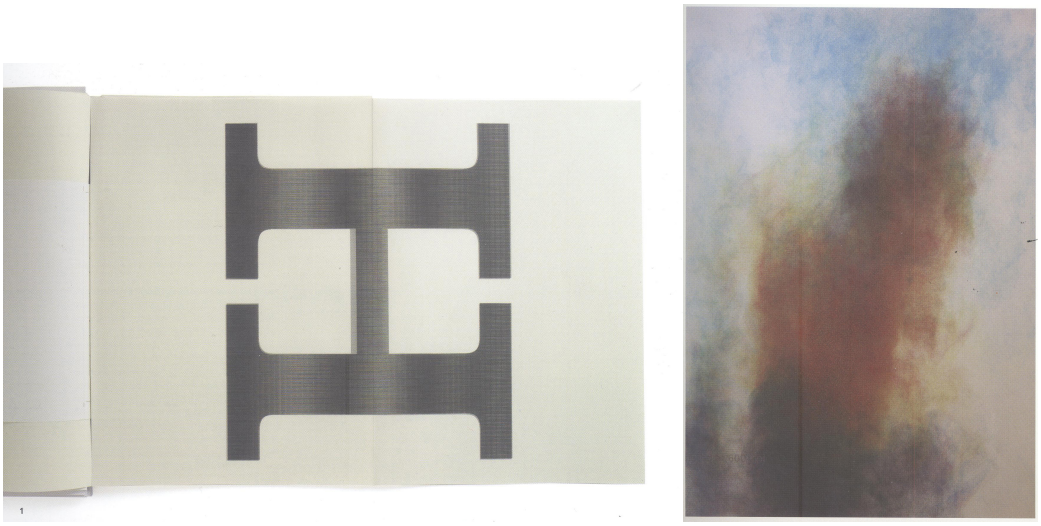


Figure 14. Example prints from the Control Print experiment.

3.3. The Graphic Design Process

Graphic design is a problem solving process. Graphic designers solve problems by constructing visual communications harmony using signs, symbols, words and images to assemble a total message. The success of transmitting the message relies on the skill of the designer because “information” by itself is a dry notion. A visually

appealing and harmonious message conveys information much stronger than a wall of text or a single empty image.

Philip Meggs describes the graphic designer's task with these words: "The conceptual nature of graphic design process generates public confusion about the designer's task. The designer combines graphic materials–words, pictures, and other graphic elements–to construct a visual communication gestalt." (Meggs 1992, 1). Gestalt is a German word that has no direct English translation. It means a configuration or structure with properties not derivable from the sum of its individual parts.

All of the above summarizes the job of a graphic designer: The designer combines visual signs, symbols and images into a visual-verbal gestalt that the audience can understand.

Paul Rand has a more direct and simple approach to design: "Design is the synthesis of form and content." This statement is true for all forms of design, architecture, web design or industrial design. When the audience can't distinguish the form and content from each other, that design is a successful and strong one (Rand, 2010).

Graphic designers do not have control over the content, but they control how the content will be formed and expressed. For the sake of the experiment, form will come first as we can control it. At times sample content will be used irregularly throughout the experiment.

Design process is a struggle. It is an attempt to construct a solution for a problem. It begins with an assignment the designer receives form the client. The designer evaluates the problem and tries to come up with solutions. These solutions might directly lead to a final design with a lucky finding or serendipity, however it may take constant research and sketches until a satisfactory outcome has been achieved.

In I.D.P. these serendipitous findings are explored, however, there are no existing clients, the problem solving or idea finding will be skipped, emphasis will be on generating form and visual elements. The evaluation will not be made upon how the design is expressing the content but how certain forms or elements are generated that

suits some of the printed graphic design materials like visual identity, poster or book design.

Apart from the problem solving or idea finding, the experiment will try to determine if a digital printer can affect a design choice or can take part in those serendipitous findings.

Almost all graphic designers nowadays use software applications to create their design projects. After a design is satisfactory, the software file is sent to the printer. Tens of thousands of prints are produced as a result. This mass production is inherently part of graphic design. For the information to reach masses, message must be designed accordingly. What if the printer was involved in the problem solving? Aside from using the printer for outputs, can the printer take part in forming the content? Finally, what would happen to the accuracy between the screen and the print?

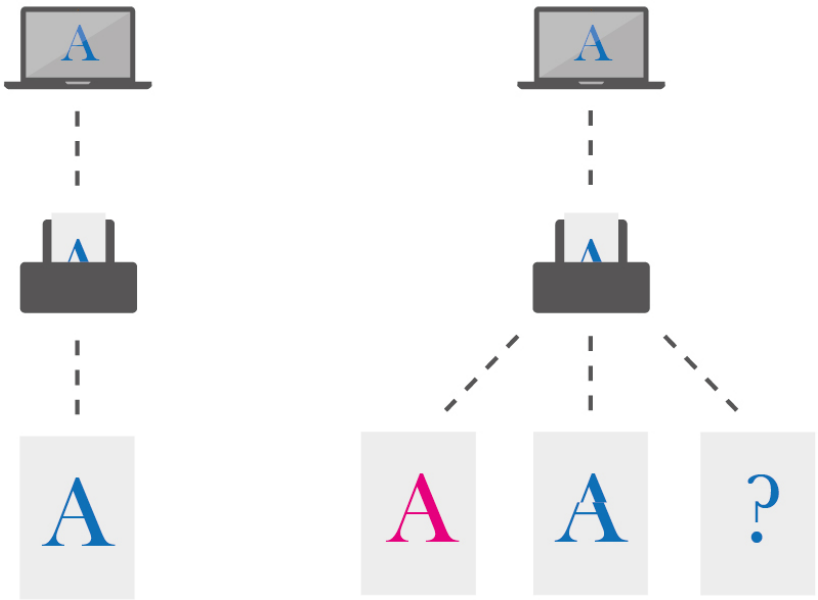


Figure 15. Diagram on the left describes a standard digital printing process. The output is accurate to the screen. The aim of the experiment resembles the diagram on he left, the outputs are unpredictable and inaccurate to the screen.

When a design is taking shape, the designer makes decisions so that the output on the printed medium is “loyal” to the one on the screen (Figure 15). Choices are made

according to the medium. Typefaces and colors are chosen accordingly. Negative space usage is different for each medium. Decisions are made for every design element.

What happens to “loyalty” when the printer does not produce the image on the screen? Can this still be considered as graphic design if mass production is not fulfilled?

How can it be possible to reproduce serendipitous or accidental outputs?

I.D.P. takes place during the process after the data sent to the printer and while the actual printing occurs. The resulting prints may be used as a final design or they can be taken account as simply inspiration and/or research.

CHAPTER 4. BREAKDOWN OF THE EXPERIMENT

4.1. Past Findings

In the digital age, human contact with the printed material is decreasing rapidly. Some people who caught up with the technological advancements, stopped reading printed newspapers or books. Those printed materials are replaced by websites and mobile applications that readers prefer to read on their devices. While indirect, distribution of movies and music through the internet reduces the chances of people appreciating the DVD or CD cover designs.

Most printed materials are now adapted to other digital mediums. Books are adapted to be read on kindles, visual identities are designed to work on a website or on mobile applications, and other countless examples. However we are still clinging to the fact that books are parts of our life. The reasons behind this are mostly practical but the tangible feeling the books convey might be the reason we continue to have bookshelves.

The main objective of the experiment is to print unique outputs using a digital printer. To achieve that, the human hand intervenes the printing process to alter the workflow. During the experiment observations will be made regarding the notions of unique, chance and accidental. However the process and the outcome will be evaluated as a method of creative contribution to graphic design process, whether it will be successful as a method or not is determined by how the outcomes can be applied as graphic design products.

A year ago I decided to redo the Control Print experiment with a compact inkjet printer. The experiment was incomprehensive for a number reasons. The first one is the fact that the printer's diagnostics are so powerful, any interference during printing shuts

down the entire process. This is completely understandable concerning that everyone from every occupation and age are using these printers and they need to be alerted if something goes wrong during the printing process. If the ink supply in cartridges are below a certain percentage and the paper's or the print heads' movement are hindered for any reason, printing stops. To get around this I did not intervene with any hardware what so ever.

The second reason is connected to the first one. Without any engineering and/or developing skills, I wasn't able to change the way the printer works or do any modifications on it. And lastly I wanted to keep the interventions simple. That is to keep the experiment and if possible the product personal. With an overly modified printer, the process would be moved away from being personal to autonomous.

The revision of the experiment is aimed at finding out if this method can be applied to professional graphic design works (Figures 16-18). Can it only be used as a way to extend the possibilities when coming up with ideas or can it be integrated more comprehensively so that the method becomes a contribution to design process?

Figures 16 -18. Examples from Deconstructing the Printer experiment. All the method used in this experiment will be investigated in the next section.

4.2. Breakdown of the Method

Throughout the experiment there are two approaches to the method: Controlled and uncontrolled. In the controlled approach, the modifications are done to reach a predefined outcome. Uncontrolled is not a direct approach, hence it is the accidental or progressively changing outcome the controlled approach produces.

A low cost consumer type inkjet printer, an HP Deskjet 1000 j110 series, was picked for the experiment. Because of the nature of the experiment there is high chance for the printer to break down, in that case a replaced must be made immediately. With a low cost one the damage can be reverted quickly.

Inkjet printers have 3 main parts that the experiment is concerned of. Rollers move the papers through out the printing process. The printhead is the part that applies ink to the papers. Lastly the ink cartridges hold the ink in their sponges and are split in to two types: Black and color cartridges. However for almost all consumer type inkjet printers, the printhead and ink cartridge is a single unit. Stepper motors move the cartridges according to the input they get from the computer and they move in sync with the rollers to move the printhead and the papers to print correctly. As no hardware modifications will be made, stepper motors will not be my concern regarding the modifications.

The workflow of the printer starts with the papers. HP 1000 is an A4 type printer and holds no paper larger then A4. The rollers move the paper from the feeder in to the chamber. After receiving the data from the printing application or the operating system itself, the motors move the print heads by a fraction of an inch. At every stop, print heads spray ink from the nozzles at the tip of the cartridges. Most HP inkjet printers use thermal bubble method when printing. Tiny resistors generate heat that vaporizes ink to make a bubble. As the ink bubbles expand, they push out of nozzles and onto the paper. When a bubble collapses out of a nozzle, it creates a vacuum that pulls more ink from the cartridge into the nozzle. (Discovery Science Website, accessed September 27, 2013).

The experiment aims to intervene or alter while all that is happening. Alterations that can be done are limited, however considering the fact that the modifications are done by hand, guidelines can be made regarding each part of the printer(?). The test subject is the capital letter ‘A' typed in Baskerville Old Face. Testing medium is Adobe Illustrator CS6 for vector based input, Photoshop CS6 is for pixel based inputs.

Printing resolution is 300 dpi and the print quality is the ‘best’ setting the printing application provides.

4.2.1. Paper

Paper represents the tangible aspect of printing. It is where all the information conveying happens and both the first and the last variable in the printing process. Thus it is the first challenge in the experiment. The variable is the paper in this test therefore the cartridges are genuine HP color and black cartridges and no intervention was done to any other part of the printer.

Paper used in compact digital printer are generally between 60 g/m^2 and 120g/m^2. Because of this consensus, consumers do not need anything other than low cost printer paper sold in bundles of 500 sheets. Thus the first intervention is to change the type of paper.

250 g/m^2 paper is sold in bundles and when fed in to the printer the results are not that different from the 80 g/m^2 paper, except the ink absorption is rapid and the colors are vivid. Because of the cost of heavier paper, ephemeral printing needs like documenting or proof reading on heavy paper is redundant.

Papers used in drawing, painting or other fields of art are generally heavier to hold the graphite, paint or other substances the art medium leaves on the paper. Some papers have different textures based on the art medium and the artists’ preferences. Feeding those kind of heavier and textured papers in to the printer is out of ordinary regarding digital printing. A heavily textured, 300 g/m2 watercolor paper was fed in to the printer (Figure 19).

Figure 19. Watercolor paper's texture is significant in this print.

The emission level was quite expected, however the colors are not vivid like the ones printed on a 250 g/m^2 digital printer paper. The colors are not solid like they should have been, on the contrary they are pale as if they were tinted on Illustrator.

One challenge was to feed the watercolor papers properly in to the printer. Because of the thickness of the paper, the rollers couldn't pull the paper and they needed a hand in feeding it.

The same tests were done with a set of different papers with varying weights, textures and thicknesses. The outcomes are nothing out of ordinary while the same problems with thick papers being jammed persist and the best printing quality is achieved with 250 g/m^2 paper for digital printers as they were designed to hold inkjet printer inks.

A different approach to the paper parameter is to re-feed the papers in to the printer more than once. Re-feeding is never done for daily printing needs except when the user needs to print on a used paper for the sake of not spending a new paper. However most of the time the paper is re-fed once, thus the accidents are not noticed or even do not occur.

During the experiments conducted last year, several accidents with the re-feeding approach were observed. Low cost 80 g/m^2 paper can not handle re-feeding and it becomes damp and supersaturated in terms of ink.

250 g/m^2 papers are quite strong with little to none deformation and dampness. To test how the colors react to re-feeding, offset printing process was partly imitated. Offset printing is one of the most common printing methods. To summarize, offset printing is achieved by transferring ink from rubber blankets to the printing surface. Colors are achieved by re-feeding the paper and imposing the CMYK model inks onto one another. CMYK color model is the model used in color printing. The CMYK model works by partially or entirely masking colors on a lighter, usually white, background. The ink reduces the light that would otherwise be reflected. Such a model is called subtractive because inks "subtract" brightness from white. Imposing all the colors forms black.

Using the Illustrator, three different capital ‘A’s were typed in colors cyan, magenta and yellow respectively. When the paper was fed 3 times, a black capital ‘A’ is achieved. However the black is not a %100 black, because the printheads spray ink as forms of dots so that the human eye can perceive them as solid colors. To achieve %100 black, black color must be printed on the paper. Offset printing works the same way.

During testing, an accidental discovery was made. Aside from testing with capital ‘A’, some page sized solid color prints were printed and re-fed the same way before. The results were identical. However the rollers that take the papers from the paper tray are smudged with ink from re-feeding page sized solid colors. Thus after printing a page with blank spaces, smudge marks were observed on the spots where the roller first grabs the papers from the paper tray. This outcome is an accidental and one of the uncontrolled interventions. While a choice is made on the design application, the result is not the same with the one on the screen.

The printer’s diagnostics are very limiting in terms of achieving uncontrolled results. If the paper is moved during the printing process, the diagnostics stop the printing entirely, giving the user a ‘paper jam’ message. Thus pulling the paper sideways with a small force, without alerting the diagnostics by moving the paper too much, misplaces the ink spray and distorts the image that was being printed. The print

heads are prompted to spray on an exact place by the algorithms when the user clicks 'PRINT', thus moving the paper increases the size the ink is sprayed. An accidental and manual 'half-toning' occurs. While this occurrence was observed, the paper that was used for the this test (a 250 g/m^2 A4 Schoeller) could not absorb the ink rapidly, thus a misplaced touch on the printed area messed with the ink, leaving the print open to any other interventions by the hand (Figures 20 -21).

Figures 20 - 21. At the top is the detail of the capital A that was printed while pulling the paper form side to side. At the bottom, the capital A was intervened by a watercolor brush after printing.

Inkjet technology adapts to different paper weighs and textures quite well. No major malfunctions that would damage the printer or any of its parts were observed.

4.2.2. Cartridges

Printer cartridges are the parts where all the “printing” happens. Compact inkjet printers like HP 1000, use combined cartridges consist of printheads and ink chambers. Older models have separate cartridges and printheads.

Inkjet cartridges are subjects of controversy since inkjet printers were introduced in to the market. Unused and genuine cartridges generally cost more than a brand new consumer type inkjet printer. A research by Which? Magazine in 2003 reports that branded cartridges cost more than vintage champagne (BBC News, 2003).

The magazine further reports that most printers give a premature warning of ink shortage that users can ignore and continue printing until they see a decrease in print quality. Most cartridges give people the option of continuing printing. However Which? found out that Epson embeds a chip which stops the cartridge running when the ink runs low. The company says that it employs the cut-off system to "protect customers from accidentally damaging their printer or producing sub-standard print quality". A Which? researcher who over-rode the system found that in one case he could print up to 38% more good quality pages, even though the chip stated that the cartridge was empty.

In the case of HP inkjet printers, they give a premature warning yet continue to print. Almost all users stop using the printer when they see a low quality print. They buy a new set of cartridges, take the old ones to a refill store or refill them themselves. HP 1000 series J110a model printer costs 80 Turkish Liras (TLs). Genuine HP black and color cartridges cost 90 TLs together, which is more than the printer itself. The printer is packaged with “test drive” cartridges that hold less ink than the genuine cartridges, still it is logical to buy a new printer.

For the sake of the experiment, 3 sets of black and color cartridges were used- brand new genuine HP cartridges, depleting genuine cartridges and second hand

genuine cartridges. Generic cartridges are nowhere to be found in Istanbul because of the market of the HP 1000 series. They are one of the most common inkjet printers in the market and a store clerk reported that consumers are not reluctant to buy genuine cartridges for that model.

Observations showed that cartridges gave the most frequent uncontrolled accidents. It was hard to foresee the result when testing a cartridge because of the lack of experience using malfunctioning or near depletion cartridges.

An inkjet cartridge consists of an ink chamber, data recipients and the printhead. Testing involved printing after the printer gave the low ink alert and seeing how the quality changes and using that opportunity to integrate the malfunction in to the design process. Moreover, refilling was tested with refill kits sold at printer stores. Manufacturers don't recommend refilling but it is a low cost and a good way to further test how the printer can be involved in the making of graphic design products. How do accidental and chance based results can be advantageous in creative process?

In addition cartridge test phase will question the screen vs. print notion. How can the printer change what it seen on the screen to something different on paper after clicking "print" on the printing application? Can the outcome be considered as graphic design if it is not possible to reproduce the design or the image?

Cartridge modifications consisted of swapping inks around the chambers and filling with different liquids other inks.

Inkjet cartridges have sponges inside them that hold ink. Color cartridges have a chamber for each colored ink and separate sponges that hold them. When the printing application sends the data to the printer, print heads heats the ink in the specific chambers containing the particular color. There is no way to recognize what colored ink is in which chamber other than assigning a chamber for each color. HP 301 cartridges that j110 series use, have predefined chamber-ink relationship. In every HP 301 cartridge, each color's chamber is in the exact place.

The black cartridges have only one chamber thus the first tests were done with black cartridges. At the time of this test, a nearly depleted black cartridge was available thus testing to swap inks with that cartridge was logical.

A local printer store that sells printers, cartridges and refilling service was selling a refill kit. The inks were unbranded as they were quite low cost. They were sold in syringes ready to refill without any preparation. After refilling 10ml of yellow ink in to the black cartridge, some test pages were printed. A4 sized black rectangular shape were printed and the color printed was yellow with a mix of black in it but it was not a smooth color. The explanation would be that the colors mixed in the sponge but black was closer to the printheads thus color black was printed before yellow. The second test subject was the famous black and white photograph of Albert Einstein. Yellow was printed instead of black but the color wasn't vibrant. It resembled a negative film. (figure)

The ink swap test involved color cartridges. The idea was to swap all the inks in a color cartridge thus altering a colored print completely. A HP 301 color cartridge has 3 chambers for each color, cyan, magenta and yellow. Access to those chambers is through 5 holes on the case of the cartridge. Although there are no pointers on the case that show which hole opens in to which color's respective chamber, a research on the internet revealed the location of the chambers.

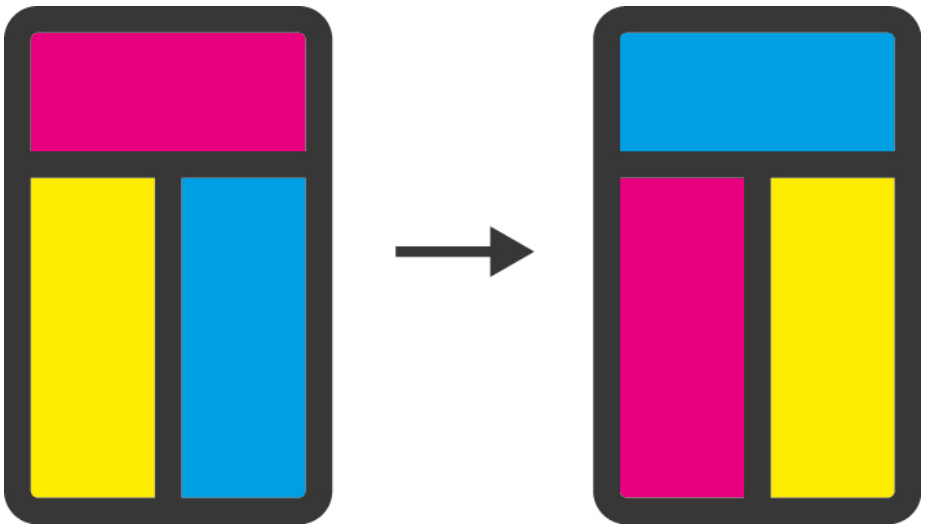


Figure 22. Diagram on the left shows the standard placement of ink in the HP301 cartridge. The one on the right is the new placement after injecting ink to the respective chambers.

Colors are swapped in the direction of counter-clockwise (Figure 22). Thus cyan is injected to magenta, magenta to yellow and yellow to cyan. After injecting 5mls of ink to every hole with the respective colors in to a nearly depleted second hand cartridge, a sample image was chosen. Edward Munch's painting The Scream is a good

sample to test this feature because it is a well known painting that the audience might have a direct opinion as soon as they see the modified results. As a side note, while injecting ink, an overfill accident has occurred. The effects of this accident will probably reveal on the consequent prints.

The first print of the image lacks most of the colors. The reason behind this situation must be the lack of ink near the printheads. Manufacturers recommend consumers to print a couple test pages after installing a new cartridge to reach the desired print quality before printing any documents or images. Another reason would be that 5mls were not sufficient. Additional 5mls of ink were injected to each chamber before the second print. In the second print, there is an excessive amount of magenta. However magenta gets closer to a purplish color as it was mixed with cyan (Figure 23).

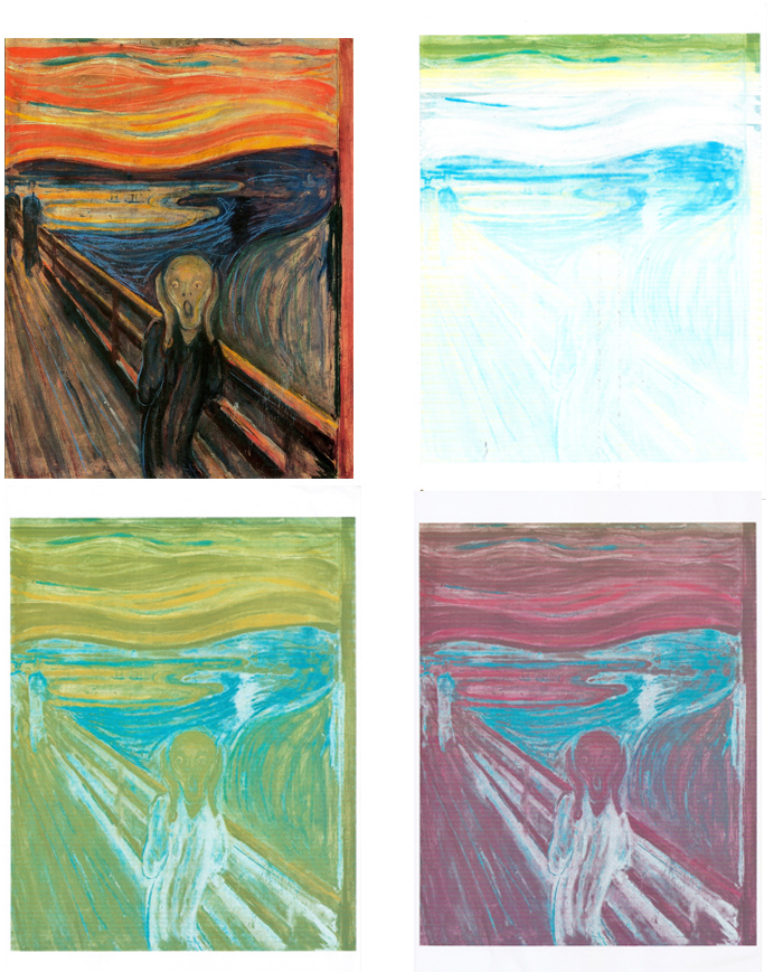


Figure 23. Progression of The Scream. On the top left is the original painting. Others are printed after the cartridges were modified.

Swapping colors is a design choice in this situation. Even if a choice is made, the results might be unpredictable regarding the ink swap test. There is no record to compare the behavior of the printer in this situation. In addition to the refilling, the chambers were overfilled and the excess ink spilled in to the other chambers.

After the second print of The Scream, the third and the subsequent prints had a dark magenta and greenish color.

Yellow and tints of yellow dominates the original painting. The printers now prints green in place of cyan, purplish blue in place of magenta, and a color close to magenta in place of yellow. The painting is nearly unrecognizable.

To test further accidental outcomes, a magenta capital 'A' was printed. The result is a red like color that is closer to magenta but the uncanny part is the bottom part of the letter. Near the baseline of the letter 'A', some yellow lines have penetrated the magenta/red letterform (Figure 24). The printheads probably first vacuumed the magenta ink which was at the bottom of the ink chamber, then the yellow ink is printed, with an accidental form.

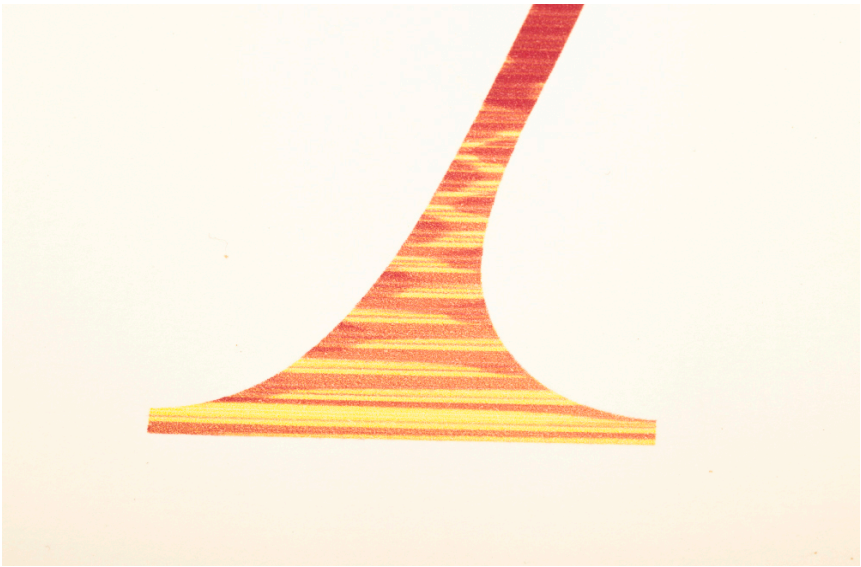


Figure 24. Detail of the malfunctioning print of capital 'A'.

Another simple test was assigning each color in the CMYK model to a primitive form and print each form in %100 solid colors. The "glitchy" textures probably happen because of the overfill accident occurred while filling the ink. But the texture fades as more and more prints are done using the modified cartridge. On every shape, there is a

portion of green, which shouldn't have been there in the first place. The print heads first vacuum the excess ink left on the tip of the nozzles, then the ink on the chamber. Green color probably formed after the excess inks mixed near the nozzles (Figure 25).

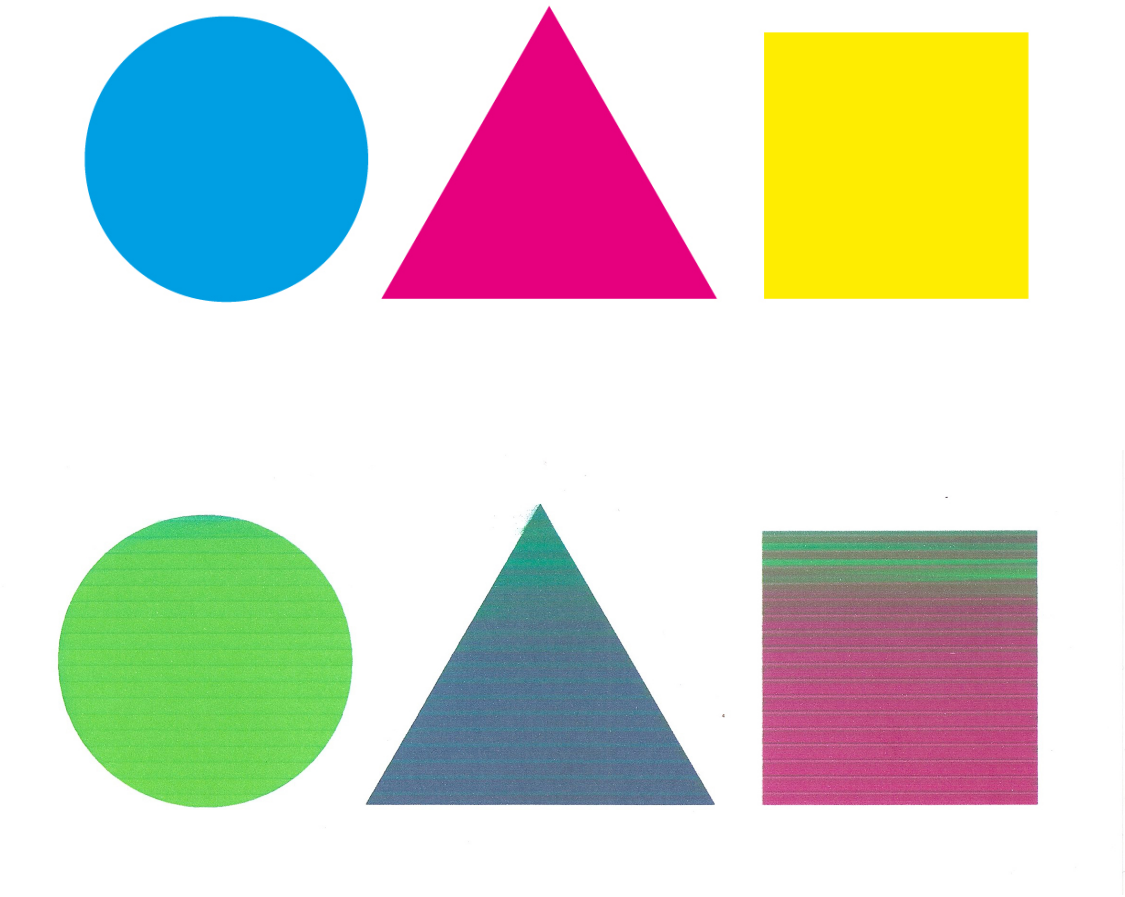


Figure 25. The image at the top shows the design on the screen. At the bottom is the outcome with the modified cartridges.

A final test involving modified cartridges is the test print of Piet Mondrian's painting 'Composition with Red, Blue and Yellow'. The result is predictable this time, however the black borders are printed using the color cartridge instead of the black one. The painting is recognizable by the forms, but the colors are all different that the original.

These accidental results might be a unique design, or not even worth anything at all. The significance is these accidents are trying to prove that the digital printers, if

they are modified a bit, may be designing tools rather than devices to get outputs. To prove this point some more testing is needed.

4.2.3. Movement

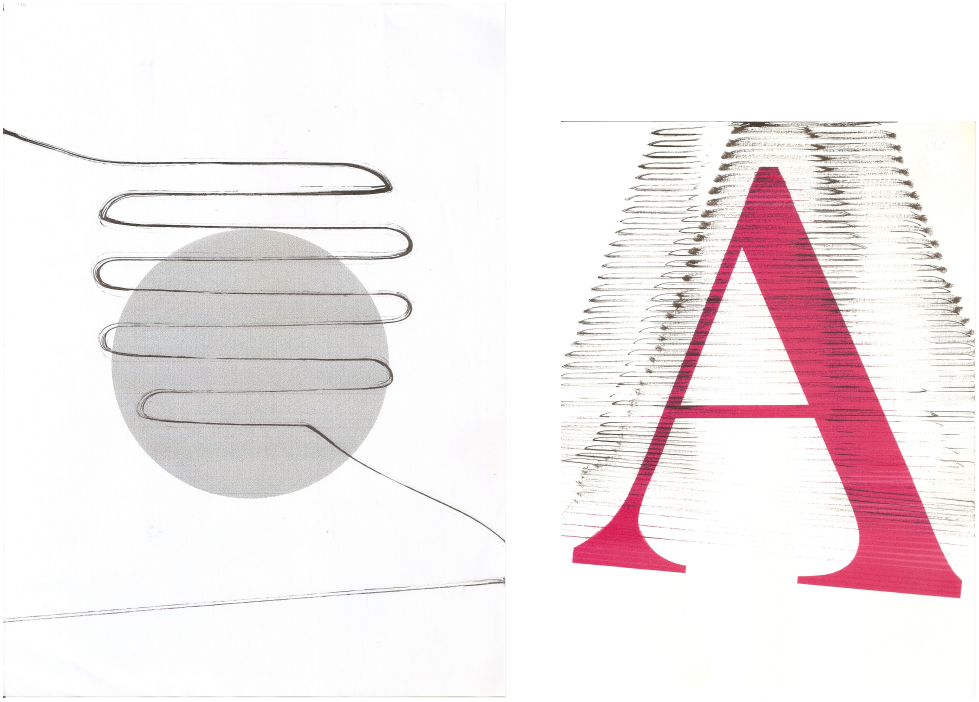
Cartridges and print heads move on a belt, powered by a stepper motor. This movement is based on the image that is going to be printed. When printing a full-page photograph, cartridges move constantly with the same pace throughout the process if there are no white areas on the image file. If the file consists white spaces, the cartridges stop and the paper moves by a small fraction and the printing continues afterwards.

A variable like image quality, changes the pace of the paper movement. Best quality prints have higher resolution thus the dot sizes are dense. The paper moves slowly to print with higher resolution. If an image is printed with the draft quality, the paper moves faster and because the dots will be sparse.

Movement happens in 2 directions inside a printer, horizontal and vertical. By taking advantage of this movement, the design can be intervened before the print comes out of the printer.

Although the diagnostics of a digital printer are powerful and the design of a printer makes little room for any “preparations”, some brushes can be glued on the cartridge cases, thus while the paper moves together with the cartridges vertically and horizontally respectively, ink on the brushes draw lines on the paper. The stroke pattern changes based on the image and the print quality.

This test is an autonomous version of the previous brush gesture. Some papers need time to absorb the ink, with that in mind, newly sprayed ink will be smudged. On other papers that can absorb ink rapidly, a curved brush stroke following the print heads’ movement appears (Figure 26).



Figures 26. On the left is a simple circle printed with the ‘draft’ setting. The capital ‘A’ on the right is printed with the ‘best’ setting, thus the strokes are frequent. While the strokes follow the shape of the image, they are not accurate as the brushes cover more area than the nozzles.

There can be more modifications involving the movement inside the printer, however with limited space inside the printer and the power of diagnostics makes it impossible without any direct hardware modifications.

All the tests and outcomes have been constructive towards understanding printers’ role in the design process. In the next and the last chapter, some more “straight to the point” tests will be done to determine if a digital printer can intervene to the graphic design process to produce usable graphic material.

CHAPTER 5 – EVALUATIONS AND CONCLUSION

5.1. Evaluations

Previous tests showed that a design outcome can be altered during the process of printing. Whether being design choices or unpredictable results, there are outcomes that might lead to a creative method.

Paper based tests involved feeding different papers used in diverse art forms affected the process with small touches. Feeding heavier papers other than standard printer paper that weighs between 50 – 80 g/m^2 resulted with varying ink emissions, which is not a great benefit to the experiment. However after the print comes out with ink that was not absorbed completely, human hand can intervene to further affect the design or the image.

Modified cartridges showed the most diverse results. Algorithms that work in the background during the printing process, direct the print heads to spray the specific inks in the specific chambers, without any knowledge on the placement of each ink. When the inks are swapped, print heads spray the ink in the predefined chambers they are directed to spray. If there is yellow ink in place of magenta, for every magenta color data, the ink that is in the magenta specific chamber will be sprayed.

Outcomes of the above test show results that look like malfunctions, which normally happens when the cartridges are low on ink. Some colors are mixed with each other even the color data is single, like %100 magenta. There are textures on the forms that are not accurate with the designs on the screen.

Reprints of known images like Mondrian's or Munch's paintings are recognizable only by their forms. Every step of the The Scream's progression is unique, with changing color patterns while newly injected inks are settling inside the sponges in

the cartridge. Thus a reproduction is impossible. Only way to produce the same texture is scanning it and reprinting. However that is conflicting with the mindset of the whole experiment: Achieving uniqueness and serendipity through printing only.

By changing the swapping pattern, different results may occur. Every ink that is not in its correct place, makes the printing process unique.

Movement based modifications couldn't go further from being small gestures of brushes and strokes in this state. Without direct control of the print heads' movement, achieving new graphic forms seems impossible. Driver and hardware hacking is not uncommon regarding printers, however that is a subject of future work.

5.2. Conclusion

A professional graphic designer has to come up with multiple solutions to a problem and the client chooses the ultimate design to be used. Form is the most significant element in a design. Color, order, space, balance and other elements work together to achieve the visual gestalt to communicate with the audience.

While the client has the ultimate decision on a solution, the designer has to decide on all of the design elements to express the idea. To decide upon the elements, the designer researches new forms, looks for suitable typefaces, decides on color and other elements. During decision making, accidental forms and randomness may help with researching new forms.

During testing, some of the outcomes are given further attention to evaluate if these outcomes are worth anything as a graphic design product.

A collage of type and other forms were printed to test. Forms and counter forms in the collage may lead to new forms when researching for a design solution. That collage may be scanned and sent to Adobe Photoshop to be cut and pasted again to come up with new forms. However the print and the collage on the screen is not different considering forms. That collage might have been done on a software (Figure 28).

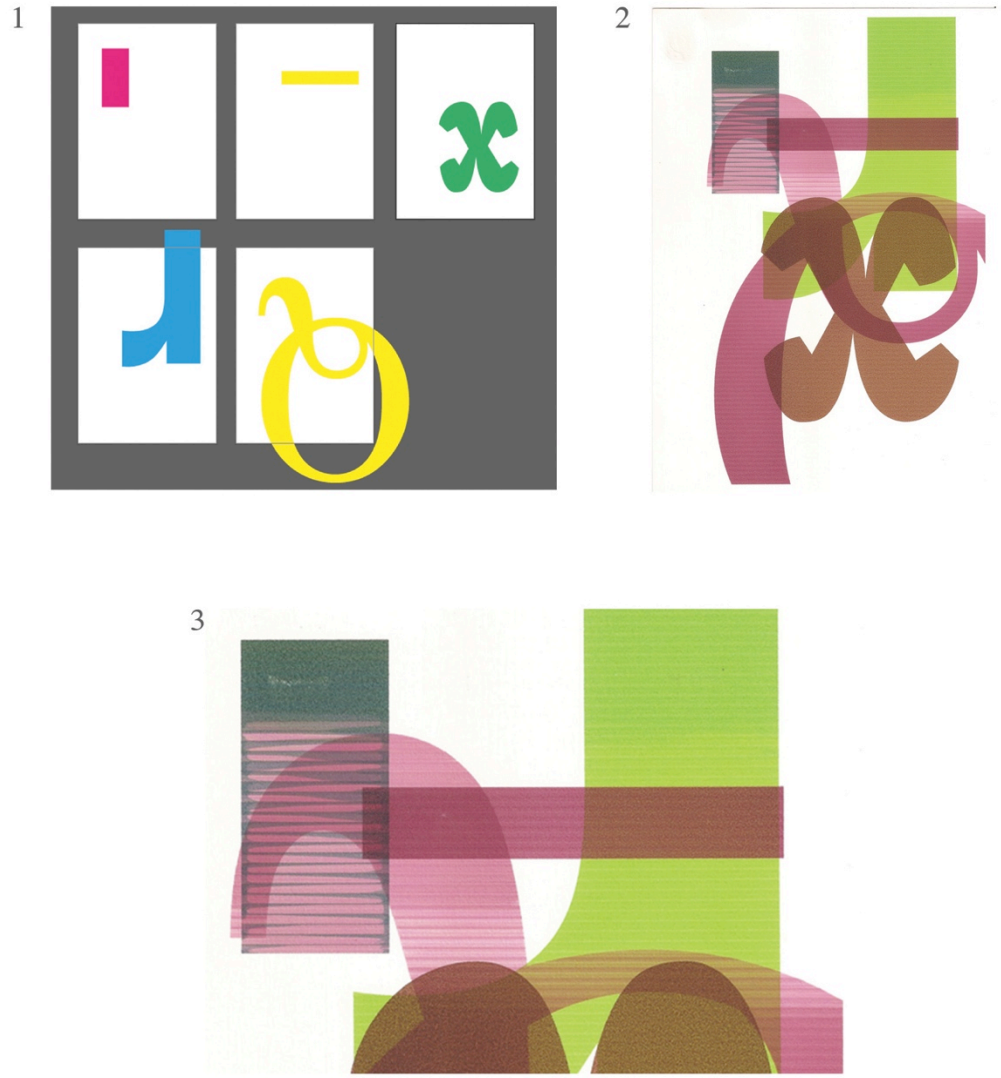


Figure 27. Collage test.

On figure 28. , randomly chosen shapes and letterforms are put in to different artboards in Adobe Illustrator. The placements are at random, with no order or space usage in mind. When they are printed on the same paper by re-feeding 5 times, the result is the figure 28.2. The colors are different as the cartridge used is the modified one with swapped inks. The textures resemble the malfunctions occurred before, with

inks not mixing correctly or leftover inks sprayed before the actual input. However the textures or colors are not granting new forms.

The print itself can be a design product directly, if the client were asking for a poster. If the client were asking for a visual identity, the designer needs to come up with new forms to establish a consistent, rigid system. The design on the figure 28.2 has interesting textures, but they are not consistent, if the same test was to be done, the result would be different.

New forms can be shaped from the collage that was printed, yet the same collage can be designed on Photoshop with similar transparency settings and exactly the same forms. The modifications made on the printer do not help with establishing new forms, thus designing a consistent system is impossible in this state. The printer is ineffective in generating new forms.

Aside from visual identity, there might be more design products that the printer can take part in the making. The advantage of progressive results of a single method, like the examples of The Scream painting, can lead to interesting results in multi-page designs. Outputs from the method can be used directly as a page for a book, a magazine or a brochure. A chapter of a book may consist random pages printed with a modified printer or a predefined page of a magazine can have randomized textures or typesetting on every copy of an issue. Poster series can have different design features on every print together with consistent features like typefaces and typesetting.

The randomness of the features on a print may lead to customized designs for textile products. When used with screenprinting, every t-shirt a designer makes can have different features. Now that the digital printers are much more affordable than before, everyone can make customized designs with the methods discussed in I.D.P. experiment. Even the 3D printers are close to being affordable by individuals, if that happens in the near future, 3D printers will introduce a whole new dimension to customized design.

5.3. Future Work

As a final conclusion, the experiment in this state indicates that a digital printer can be involved in the graphic design process as a final step and/or a visual research instrument. The output of the printer can be transferred to the digital environment to be used as research for new design projects. Randomness can take part in forming new content even if the outputs are not used directly. As a final step, the outputs can be applied to different design products from posters to book designs and fashion design.

Hardware and software modifications may take this experiment to a new direction providing more diverse results and more controlled experiments. Driver hacks can help control the workflow of the printer while hardware modifications can lead to more interesting results. There are some possible alterations that can be done in a future work.

It is possible to control the printheads manually to have direct control over the print process by hacking the motors inside the printer. A controller can be connected to the printer to move the printheads directly during the printing process. That way the ink will be sprayed according to the input from the computer however the placement of the ink will in direct control of the user.

The contents of an inkjet printer's ink may be modified. There are some key ingredients in the inkjet ink that are mandatory for printing but there can be some additions to the inks' structure. The ink may react differently to the printing process.

Drivers that control the printheads movement may be altered to randomize or re-direct its movement. The direction of the movement may be reversed or completely changed. This method may prove difficult because of the diagnostics of digital printers.

Aside from more diverse modifications, other types of printers can be integrated in this experiment. Digital presses can be modified to allow mass produced items such as books, posters and magazines to be customized. That way, the methods discussed during I.D.P. can be applied to professional design works and commercial publications.

Laser printers and other types of digital printers such as plotters, dot-matrix printers and etc. weren't suitable for these initial tests because of practical reasons. Plotters and dot-matrix printers are older printing solutions, making them hard to work with some operating systems now in use. Their cartridges and parts are hard to find, even finding a working dot-matrix printer is rare. In the future, I am considering to go deeper in the world of digital printing and make use of older technologies together with new ones.

Aside from the technical possibilities, digital printing allows users more customized design choices, allowing a break from the ordinary design and printing processes. I.D.P. proved that digital printers grant possibilities of customization and modification without any engineering skills. With simple modifications on the interchangeable elements such as paper and ink, the accuracy between screen and the print can be broken to achieve unique results.

Technological advancements allow users more customized experiences. Soon we will see 3D printers in our homes that will take customization literally to a new dimension adding the 'z' axis to printing and the modifications. When that happens, I.D.P. will be integrated in to 3D printers too.

I.D.P. is an ongoing project. The initial tests proved that digital printers can take part in making printing process unique and customized thus bringing back the tangible feeling and the appreciation of visual aesthetics of earlier printing technologies. With more research and testing, the digital printer can become a standalone tool for creative purposes.

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