رؤية تطبيقية مبتكرة لتطوير تجهيزات معامل الطباعة الفنية الشبكية وأثرها على وسائط التعبير

INNOVATIVE PRACTICAL VISION FOR DEVELOPING THE EQUIPMENTS NEEDED FOR SCREEN PRINTMAKING LABORATORIES AND ITS IMPACT ON EXPRESSIVE MEDIA

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ABSTRACT

By presenting own experiences of the researcher, this paper addresses the technological deficiencies in providing the equipment and supplies for printing laboratories, especially porous Screen Printmaking supplies. The aim is enriching and developing the laboratory equipment for fine arts colleges and Egyptian universities, and using them in executing special works. These experiments include several equipment, which are rare inside Egyptian universities' laboratories. The researcher also discusses methods of developing and implementing auxiliary laboratory tools and a set of machines to facilitate printing for artists and students. The research covers several techniques and mechanisms for preparing and operating some materials of screen printmaking, such as photosensitive and light-sensitive bichromate emulsions and chemical compositions. Additionally, the research addresses several printing experiments using innovative mechanisms to measure their suitability for expressive and artistic aspects. Finally, the research discusses how to provide artists with great creative and expressive abilities in modelling their works.

KEYWORDS

Innovative practical vision; Screen printmaking laboratories; Means of expression.

الملخص

يتناول البحث عدة تجارب تقنية مبتكرة، قام بتنفيذها الباحث لتلبي النقص التقني في تطوير معدات وتجهيزات معامل الطباعة الفنية وخاصة مستلزمات الطباعة الشبكية وذلك بهدف إثراء وتطوير التجهيزات المعملية لكليات الفنون الجميلة والجامعات المصرية، ولهدف استخدامها في تنفيذ الأعمال الفنية الخاصة، وتشمل تلك التجارب عدة تجهيزات لمعدات المعامل الطباعة الفنية الرئيسية والتي يلاحظ ندرتها وعدم وجودها داخل المعامل بالجامعات المصرية، وكذلك يتناول الباحث طرق تطوير وتنفيذ أدوات معملية مساعدة ومجموعة من الآلات ساعياً لتوفير الجهد وطرق الطباعة علي الفنانين والطلاب، كما يتناول البحث عدة تقنيات وآليات تجهيز و تشغيل لبعض المواد المستخدمة في الطباعة الشبكية مثل الغرويات البيكروماتية والحساسة للضوء وتركيبات كيميائية لمواد طباعية رئيسية، وكذلك يتطرق البحث لعدة تجارب طباعية بتلك التجهيزات والمواد مستخدماً آليات مبتكرة لقياس مدي ملائمة تأثيرها علي الجانب التعبيري والفني، ويناقش البحث كيفية إثراء التجربة الفنية من خلال التطوير التقني المستمر والتجريب الذي يمنح الفنان قدرات إبداعية وتعبيرية كبيرة في صياغة أعماله.

الكلمات المفتاحية

رؤية تطبيقية مبتكرة؛ معامل الطباعة الفنية الشبكية؛ وسائط التعبير

1. INTRODUCTION

The research addresses a group of applied and technological experiments in order to support the printmaking laboratories inside the faculties of fine arts. Therefore, the researcher used some techniques and tools for printmaking, which were designed and implemented inside the Egyptian universities to solve some problems, in addition to finding more applied results. The research discusses the possibility of supporting and operating the screen printmaking laboratories, which is known also as the screen porous printing or the passing printing.

This research aims to find suitable practical and experimental environments to achieve the art works without technical problems to enable the artists and the students of plastic art, especially the printmaking, by developing the printmaking laboratories, its tools, the different techniques and assistant laboratory tools, in addition to providing the required chemical compounds to make the light-sensitive pastes and emulsions. Hence, the importance of this research is to achieve expressive media and applied multimedia of different techniques, and simple technical applications by developing innovative laboratory tools to be compatible with the current technological advancement for the academic students inside the faculties and laboratories of Egyptian universities.

As well, this research discusses the historical background of screen, silk printmaking and the importance of screen-printing laboratories (Mesh printing) inside the academic environments, and the fields of screen printmaking, in addition to the necessary tools and equipment for designing, preparing, modeling, light exposure, coloring, emulsions and printing units. The research defines the aims of applications and preparation, which include 8 main innovative new applications that were designed and implemented by the researcher throughout the laboratory tools, then they were subjected to quality assessment, in addition to providing and creating many technical-applicable tools, supplies and procedures to prepare the laboratory materials and the assistant tools.

The applications that were implemented by the researcher include; UV lamp exposure, screen frame dryers and other multi-functional tools, in addition to developing and using 3 tools to dry the printing plates and roast the bichromate polygel. Additionally, the researcher developed and updated three models of screen stretching machine on printing frames and plates. Besides, the researcher designed and implemented a washout tank with backlight, which is supplied by the factors of laboratory safety, as also plate silk screen printing racks (silk screen frames). Also, he prepared and used an innovative screen-printing plate from aluminum frames and utilities for adjusting the printing spots, which could be fixed upon the metal plates. The researcher developed also an innovative designed portable table for multi-copied colorable prints on silk screen, and also designing and utilizing the assistant laboratory and portable tools, such as the hinge clamps.

1.1 Research problem

The scientific artistic academic and university communities face many challenges in establishing high quality suitable laboratory units to train students and researchers about the required techniques and skills, whether in choosing the appropriate equipment and tools, or the necessity of their continuous development to be compatible with the scientific and laboratory advancement. Additionally, our universities suffer from deficiency in resources, beside the high cost of demanded equipment, what could impact on the efficiency of their function. Also, some of them lack the requirements of occupational safety and health standards because of their obsolescence and the need to regular development and maintenance, what could affect the experimental production of the artists, and their ability in continuing their artistic practices because of being fearful from the lack and deficiency of the basic laboratory supplies.

The researcher discusses the problems of research by providing some real printing techniques and equipment, which were developed and used to overcome the problems of Egyptian universities, then getting suitable results, as the research problems are;

- Could screen printmaking laboratory equipment be developed inside the Egyptian universities by local experts?
- Is it possible to design and use the electromechanical and thermoelectric equipment and tools to activate the different methods of artistic expression?
- Could the printing bichromate emulsions be developed to suit the artistic experiment?
- How to achieve innovative artistic works through self and local development for the assistance laboratory equipment and tools?

1.2 Research objectives

The research aims to create suitable experimental and laboratory environment to produce art works, without technical obstacles, that are suitable for the students and practitioners of plastic arts, particularly the printmaking, by developing the printing laboratories and toolkits, beside the different assisting different techniques, laboratory tools and many chemical compounds that are useful to provide the light-sensitive pastes and emulsions.

1.3 Research importance

The importance of this research is to achieve expressional media, new horizons of multimedia of different techniques and usable simple technical applications by developing innovative laboratory toolkits, which are consistent with the recent technical advancement, and to achieve the highest standards of laboratory and practical training across different academic stages of arts inside our Egyptian universities and laboratories.

1.4 Research methodology

The researcher followed an analytical descriptive method in presenting and descripting the previous experiments, and an applied experimental method in making the models, laboratory equipment and assisting tools in producing the art works by using the tools, which were developed and implemented by himself.

1.5 Previous studies

Some previous researches addressed how to process the art works by using the techniques of mesh screen, but they did not discuss the development of laboratory tools and their applications. These studies include:

- Ahmed Hussein Abd El-Jawad, using the screen pores printing in the monumental art works, doctorate thesis, Alexandria, 1999.
- Emad Ahmed Mohamed Ashiba, using untraditional methods of pores printing in creating a contemporary work of art, doctorate thesis, Alexandria, 2014.
- Shimaa Salama Ibrahim, Shimaa Abd El-Aziz Hamed, a new applied artistic vision in reviving the silk screen printing, applied arts, Helwan University, International Journal of Designing, The 1st international scientific conference of specialized palaces, 2017.

2. HISTORICAL BACKGROUND

Screen printing is considered an impact printing, which requires, during the printing process, a direct contact between the printing plate and surface in the presence of direct pressing to transfer the printing ink. This type of printing has a range of terms such as; stencil, which was used as a

technique by hiding the unprinted spots to get the required picture, as this technique was termed scientifically as "Screen printing" because the usage of silk screens, it was termed as well "Silkscreen" after the natural or manufactured silk gauzes that were used in making the printing plates, and the word of gauze here alludes to the screen fibers, to make these screens by using organic mesh or the artificial fibers such as polyester, nylon or even the metal fibers of stainless steel. It was termed also as the pores printing, after the silk screen that permits the ink to pass through (Marsh, R., 1968).

Indeed, many Arabic terms used to describe this technique including; (Masamiya – porous) and (Nafiza – Permeable), to explain the operation of this printer and the involved mechanisms of ink throughout the pores of the silk screen. It is called as the "Nafiza" owing to the permeability of printing inks through the pores of printable and unprintable spots, while many preferred to call it as the silk printing or the mesh printing, as silk was used to prepare the printing plates. Although these terms were used to describe this printing operation scientifically and technically, the term of "Silk-Screen" is the most used throughout all mediums.

The linguistic terms are changeable in searching for more precise words, during the 1930s, the term of "Serigraphy" was known between some artists, including the American Anthony Velonis (1911-1997), the American Hyman J. Warsager (1909-1974), and the English artist Max Arthur Cohen (1903-1993), who pioneered the printing techniques of porous silk screen with their important writings and leading experiment. Those artists were appointed by one of the most famous federal American associations that financed and sponsored the artists to develop their techniques and arts, it was the national project of art "Federal Art Project" (1935-1943), which included financing the visual arts, artists, scholars and practitioners by the sponsorship of Works Progress Administration (WPA). The word of Serigraphy was used according to the porous nature for the printing material, because this word was suitable, whether for the production or the application. The term of "Serigraphy" is a Latin word consists of two syllables, sēricum that means silk and graphein mean painting (Lengwiler, G., 2013).

The English artist Max Arthur Cohen, under the supervision of Andy Warhol (1928-1987), produced many printed successful and creative models, what can challenge all the critics and sceptics of screen printing as an artistic technique. Other artists followed Warhol, such as the American Arther Okamura (1932-2009) and the American, of German origin, Robert Rauschenberg (1925-2008), in addition to The Pop American artists Roy Lichtenstein (1923-1997), and the American artist of printmaking Harry Gottlieb (1895-1992) and Mary Lynn Kotz (2004). Thus, the techniques of porous printing became an artistic and technical experimental destination for all the seekers inside the depths of technology and the formative applied development, as well it became a sanctuary for artists, experimenters and others who call for categorizing silk screen printing, as one of the genuine techniques of artistic innovation (Hunter, S., 1999).

The American association (EAT) concerns with the experiments of art and technology and interests in developing the artistic techniques, tools, and machines, in addition to the general production of formative and applied arts, so that it contributes considerably in developing multiple scientific techniques and applications, which are related to art, particularly the technical experiments and developments of mesh printing. Indeed, this association has a very fruitful impact by founding direct partnerships that include the elites of scientists and artists endeavoring to develop the arts and artistic production. (Hoppes, W., & Davidson, S., 1997).

Of the most notable figures in the field of artistic technical development is the American businessman and inventor Michael Vasilantone, who is regarded a pioneer in developing the porous printing during the modern age, as he presented the first developed model of a colored porous printer,

the rotatable printing machine that print the multi colored rounded screen in 1960, and in 1967 he was patented for inventing a logo printer, then soon the porous printers spread, according to accepting this development considerably, what led to a boom in the porous printing. (Lengwiler, G., 2013).

3. THE FIELDS OF SCREEN PRINTING (MESH PRINTING)

The silkscreen or mesh printing is a printing technique that possesses many properties and forms including the direct, indirect, traditional and untraditional forms, owing to its limitless technical ability in printing over any medium or surface. All materials or surfaces could be printed by the silkscreen printing techniques, because of its compatibly with all forms of printable materials such as paper, textile, glass, wood, metal, fabrics and even pottery, mud and porcelain, as the process of the reduced process of impact because of the natural presence of pores through the used printing silk, because the printing process is being executed by using a rubber flexible scraper that allows the printing ink to flow throughout the printing screen, what made this technique suitable for most of surfaces and materials without causing any damages, unlike the intaglio, relief or lithographic printers, which cause more impact and require more press and bigger printing tools. (Biegeleisen, J.I., & Auerbach, C.S.,1963).

4. THE MAIN REQUIRED UNITS OF SCREEN PRINTING (THE MESH PRINTING)

1- The equipment and devices of design unit. 2- The equipment and devices of screen preparation unit. 3- The equipment and devices of light exposure unit. 4- The equipment and devices of color and ink unit. 5- The main devices of printing unit 6- Screen printing machines.
7- Dryers 8- Squeegees. (Adam, R. & Robertson, C., 2003).

4.1. Purposes of the laboratory applications, devices and tools, which were developed and implemented by the researcher

Undoubtedly, the lack of laboratory tools hinders the implementation of scientific experiment, and may be to its failure eventually. During his career as a teacher of silkscreen printmaking, the researcher realized how students suffer, particularly on processing the films and drying the plates in darkrooms then print them, as they could fail or get non-standard results. So that, the researcher sought to reduce the obstacles and facilitate the work by presenting well-studied scientific solutions, which can provide the laboratory tools and devices, in addition to operate or develop some of them, the devices as the following:

- Screen Frame Dryer& Light Exposure Table.
- UV Lamp UV Exposure.
- screen stretching machine.
- Screen printing washout tank with backlight.
- Frame screen Printing Rack.
- Aluminum Screen Printing Frames.
- Silkscreen Printing Table.
- Hinge Clamps.

5. THE APPLICATIONS THAT WERE MADE AND DEVELOPED BY THE RESEARCHER TO DEVELOP THE PRINTMAKING LABORATORIES IN THE EGYPTIAN UNIVERSITIES

5.1 The 1st application: Screen Frame Dryer& Light Table

A mesh printmaking machine that was designed and implemented by the researcher himself in 2022, and found now inside the printmaking laboratories of Egyptian-Russian university in Badr city. As well, the researcher used it to roast the sensitive bichromate inside the porous and permeable printing

plates of different silkscreens. The purpose of this machine is to dry the printing plates as temperature is digitally controlled via a panel in a lower box, and the upper box contains a device for light exposure using florescent lamps (UVA). The uppermost part is insulated totally by thermal resistant insulation chips to protect the lamps and from the accumulation of water vapor upon the upper glass, the machine also roasts, fixes and dries the light sensor by increasing the temperatures inside the oven, see fig. (1).

Additionally, the researcher edited a table to classify the tool, and to clarify the required user precautions, warnings and the features of the machine. During the trials of operating this machine, the researcher noticed that it is costly to import such machines from abroad, in addition to the inadequate properties of the imported machines to the nature of artistic work, the high pressure of usage and the un-standard conditions as it is being used by many students. So that, the researcher considered how to protect the individuals in the working environment from electricity danger, table (1).

Figure 1, Screen Frame Dryer & Light table, designed and implemented by the researcher

Table 1, ***Screen Frame Dryer & Light table***

Classification: - An electric laboratory machine for silk printing (220 Volt) - A photoelectric and thermoelectric device.	
Properties of machine: - Made out of stainless materials. - Could be used during winters to roast the bichromate poly gel with high temperatures as a substitute to the sun. - 8 mm glass disc, digital control for setting the light exposure duration. - Layers of galvanized steel, processed in temperature of 300 degrees by acrylic. - Digital temperature control, heat sensor, a digital screen for setting the temperature of furnace and a cooling system for the control panel and the florescent lamps UVA. - Blower (0.5 Horsepower), a drying system by using a renewable electricity and an inverter to control the speed of internal airflow.	
Max screen Area (m.m)	750 x 850 mm
Number of plates	5
Temperature range	Room temp. 140
Voltage	220 volts
Power	4kw
Plate Exposure type	Single face Automatic
Exposure area	850X750mm
G.W. (kgs.)	410 kgs
Machine Dimensions (mm)	1400X950X1500mm
Light exposure	UVA lamp type 20w X9 pcs

Precautions:
- Don't use the machine beside a direct source of water.
- Don't use the machine with wet hands, especially the control panel.
- Before turning on, be sure that the machine surface is clear from anything or coins.
- Before turning on, be sure that the glass surface of the upper light exposure box is clean from dust.
- Before turning on, be sure that that furnace cavity is empty and clear from dust.
- Students are not allowed to approach the machine while operating for a circle of 0.5 meter around the machine, at the painted line on the floor of the laboratory, except by the presence of a specialist and the trials should be watched from this distance.

About the experimental and expressional properties, the researcher tested Screen Frame Dryer & Light table to assess their ability to process films and fixing the polygel sensor by using the machine, then printing the films. The preliminary tests included processing films for a design of 1 and 4 plates by using the CMYK color model, the details of scientific experiment are as the following:

5.2 Test (1), a printing test for the silk screens by using the Screen Frame Dryer and Light Table

Firstly: tools and preparations

- Screen Frame Dryer& Light Table, which is the most important used devices and the focus of this test to assess the difference on using the assist laboratory tools and how to use them.
- 4 plates of aluminum, prepared by the researcher, 2cm×4cm, supplied by printing silk of 43 inches.
- A polygel sensor, prepared by the researcher, (8 units of polyvinyl acetate, 1 unit of bichromate sodium, 1 unit of color, 10 g of liquid soap for each 1000 g).
- A printed film in black ink, Keno printing ink, and a print with linoleum surface, which prepared before by the researcher to fit the experiment.
- 4 films of celluloid, black duco pens and flowmaster pens.
- Plastisol transparent ink, and powder-colored inks that were dissolved by few amounts of printing DOP oils.
- A rubber wiper Squeegee (as a printing presser).

Secondly: The procedures

- The first stage is drilling the linoleum plate to be modelled as a printing design in black ink, then it was printed by black ink, because the black color does not permit the light to pass through, so that the Calque paper is appropriate to transform the printed design into film that could be painted on a printing screen plate by using the sensitive bichromate emulsions. See fig. (2).
- The second stage is to produce a colored design by coloring a copy from the printing design using flowmaster pens. See fig. (3).
- The third stage is to separate the colors upon a transparent material of thermal celluloid films, which could be painted by using duco pens. Thus, the yellowish area that contains the yellow, orange, green, brown and black colors is being covered then separated, the same for the reddish area of red, purple, orange, brown and black colors, then the blueish area of blue, purple, green, brown and black colors, while the black color is already obtained at the beginning. Fig. (4)
- The fourth stage includes preparing 4 aluminum frames to be fit for making printing silk plates, 80 cm length and 60 cm width. The researcher prepared the metal plates by himself of aluminum sections of 2cm×4cm, which were weld by using Argon, then supplied by the natural silk of 43

size. A special strapping machine was functioned for this stage, which was manufactured by the researcher to prepare the metal plates, (figs. 15-20). The researcher believes that the aluminum metal printing plates are ideal to be used inside the laboratories of Egyptian universities according to their accuracy and stability during the printing process, in addition to being light weight and waterproof, as the researcher has the desire to offer these skills and experiences. (Figs. 5, 22)

- The fifth stage includes preparing the bichromate photopolymer as a coating over the silk screen surface, size of 43, then the printing plates are being dried inside a furnace, which was used for the scientific and applied tests, at a controlled temperature of 60o, as increasing the temperature leads to the solidification of sensitive bichromates to both temperature and heat. The researcher used the poly gel bichromate, as he prepared, processed and manufactured them by himself in an innovative laboratory method, by adding 8 units of polyvinyl aetate (as white glue could be used), but the researcher preferred the pure polyvinyl to avoid the possibility of commercial fraud for the white glue, then a water purple pigment is added, with ratio of 1 unit of pigment to 1 unit of sodium bichromates, then adding a little of liquid soap, not more than 10g for each kilogram.

Figure 2, A printed design of linoleum on transparent calque paper to be used as a printable film over silk screen plate.

Figure 3, Coloring the design with flowmaster colors, as the design contains primary and secondary colors and the hues of black and brown.

- During the sixth stage, the films and the printing plates are being exposure to UV lamp light for 5 minutes, the lamps are prepared inside the light exposure machine. After an exposure duration of 5 minutes, the plate is cleared up by using the water direct pressure.

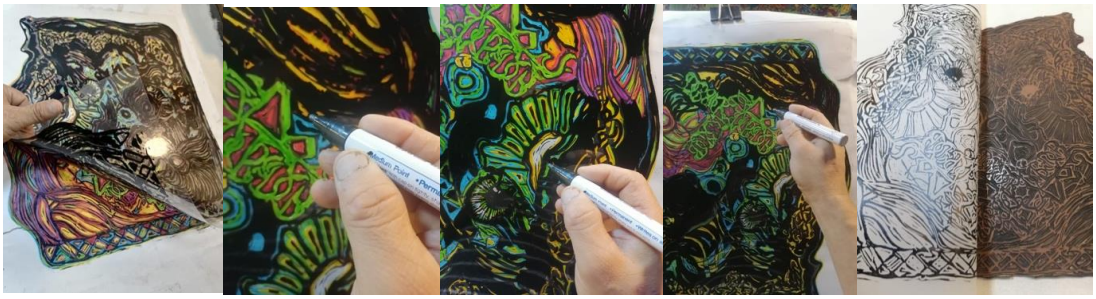

Figure 4, Separating the color by using CMYK method of duco pens over transparent celluloid paper to get separate films of yellow, red and blue colors, while black is obtainable by printing the linoleum plate.

- The seventh stage is to clear up the printing plates by water, as water is poured directly on the printing plate, on both sides, before being affected by the surrounding light, as water is the only

means to breakdown its sensitivity. Besides, the water solvates the unhardened printing spots, which did not expose to light, then the plates are being dried and roasted in high temperature and flowing hot air, most of specialists use the air blower or even the hair drying devices. However, the researcher consider that specialized devices are safer and faster inside the laboratories, so that he used a device of his design (The frame dryer), then the plates are put inside the thermal cavity of the furnace, which occupies one of the five racks of the machine for the purposes of drying and roasting.

- The eighth stage prepare the printable plates after fixing and roasting the bichromate emulsions.
- The last stage involves sequenced and successive printing process. The researcher uses a specialized table of his own implementation to control the positions and spots of color records of the colored printing plates, in the form of wooden mobile tables for printing textiles, paper and a lot of other materials. Fig. (5, 6).

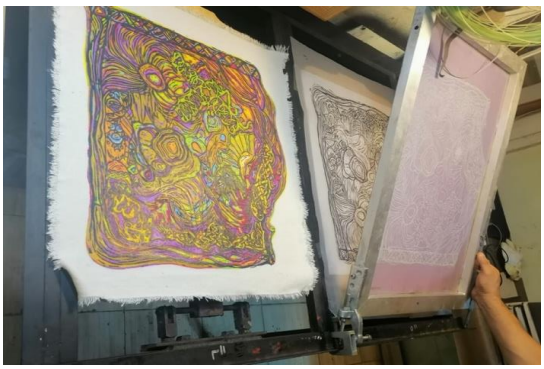

Figure 5, Fixing the printing plate during the printing process over the table by the researcher.

Figure 6, A printing table with mobile tables, the researcher prepared 24 mobile table for faster implementation and printing.

The most concerning issue for the artist is how to get printed copies while controlling the printing procedures. So that, the preliminary procedures and preparing the printing table is a priority for the researcher. The researcher devoted a part of his work to verify the standards of materials that used to make the printing table (of the mobile tables), to fulfill the artists' wish in getting rapid and bigger production, while controlling the colored positions and the harmony of printing plates. Figs (21, 22).

5.3 The 2nd application: Screen Frame Dryer& Light Multi-use Table

Many artists worldwide tend to design their own tools, especially the spaces and the tools of storing the printing plates and make them more accessible and closer to the places of painting or drying to achieve the stages of implementation. So that, the tools should be close to each other and reachable. So that, many tools adopted compacted features in order to facilitate the requirements of artists and printing laboratories (Robert Adam & Carol Robertson, 2003). Hence, the researcher in 2019 made this multi-task application in the form of 4 compacted tools that carries many technical potentials to facilitate the tasks of artist and to ease the work inside the printing laboratories. This tool is supplied with processed corrosion resistant wheels to enable its movement and transportation, in addition to units to store the wooden and metal printing frames, and it is designed to facilitate its maintenance and repairment. This device was helpful for the researcher in implementing his prints, with a treated wooden led that was used as a wooden table covered by glass to be used as a table for preparing the plates and other items. Figs. (7, 8).

5.3.1 The advantages and tasks of this machine include

- A drying furnace for the printing silk plates, consisted of 5 racks, treated by stainless Epoxy 131.

- A heater box, to get suitable temperatures in order to roast the bichromate gelatin.
- The machine could be used for light exposure via a digital stopwatch for setting the duration time in the control panel.
- The machine includes an upper frame locker (the printing silk plates), big enough to store 20 printing plates.
- The exposure box could be covered by a specific wooden led to be used as a table for other utilizations.

Figure 7, A profile for Screen Frame Dryer& Light Table, 2019, designed by the researcher.

Figure 8, A frontal photograph for Screen Frame Dryer& Light Table, 2019, designed by the researcher.

5.3.2 The benefits and scientific applied results of designing and operating the multi-task Screen Frame Dryer& Light Table

Such machines and devices are characterized by the ability of achieving main tasks in a short time. Otherwise, the researcher may have to use the outer printing workshops to implement these tasks, what could lead to unsatisfactory results, in addition to the high cost of implementing them, what makes it difficult to repeat the experiments to improve them and limits the artist's passion in continuing his artistic experiments. On the other side, implementing the art works with lower capabilities and devices, without these machines, will produce works of low quality and limit the imagination and passion of the artists, in addition to his ability in spontaneous and direct expression. The researcher implemented many works. Figs. (9, 10).

Figure 9, Colored backgrounds, printed from several silk plates, and the techniques of manual painting after printing, 2020

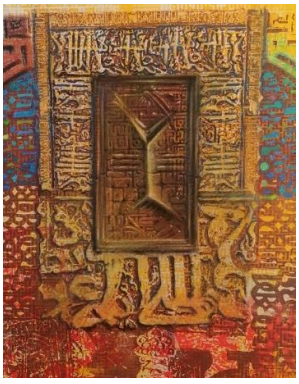

Figure 10, A work executed in for Screen Frame Dryer& Light Table, 2020, "The Mausoleum"

5.4 The 3rd application: Grand Drying Cabinets

The researcher invented a grand machine to dry and roast the poly gel bichromate that houses printing frames to 110×80cm, a machine with rare characteristics along the printing laboratories of Egyptian universities. Besides its low cost, if compared to the imported ones, this machine is more efficient with a power capacity of 1 horsepower, and a heating box of 6 kw electric potential, in order to cover bigger space of the inner distant cavity, because the size of machine is large. The researcher intended to make a unique device by adding new and innovative properties, as this machine could be dismantled into small reassembled pieces to overcome the issue of mobility because of its big size and weight, as this machine is used to prepare the big printing plates and requires to be easily transported and lifted to higher floors. In light of this trait, this machine has no parallel abroad. Indeed, the researcher continues to refine and modify these tools to overcome the problems and obstacles which face the preparation process. Figs (11, 12).

Figure 11, Grand Drying Cabinets, it was designed to be dismantled and reassemble easily for transportation, because of its big size. 100x70cm

Figure 12, Grand Drying Cabinets, 4 racks and frame store.

This machine showed great results in preparing the big sized printing plates in a short time. These works include a group of works that were implemented on big sized printing wooden plates of 110x80cm. Figs. (13, 14), across 15 big sized works were executed in 1/7/2020.

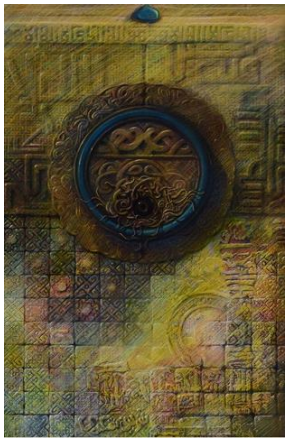

Figure 13, A work implemented in the printing-colored backgrounds on big sized printing plates

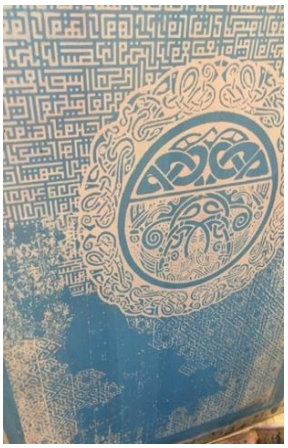

Figure 14, A printing plate 70cm×100, Prepared by a grand drying cabinet

5.5 The 4th application: Metal Screen Stretching Machine

According to the importance of this machine, the researcher was interested in its development until reaching standard specifications. This machine stretches the natural silk on metal plates that could be made out of steel or aluminum. The researcher prepared three models of this machine, each mode with a specific property and potential to solve some technical problems in order to reach the best

model, which will be helpful in achieving the best standard printing plates, the base of screen-printing techniques, not to mention the high prices of imported machines. Each model treated a specific problem, as the following:

Firstly: The first model (Oblique Tensile Angle Stretching Machine), which was made out of intensive steel sheets, and could be used for stretching many sizes. Otherwise, its solidity means that it takes many steps to modify the positions of its parts to change the frame size, and it can stretch silk frames up to 60×80cm as it catches the silk in an oblique side way. Fig. (15, 16).

Figure 15, Stretching process in being implemented in an oblique angel by using wooden pieces and dragging machine, composed of rolling bearings and a Spanish steel axis.

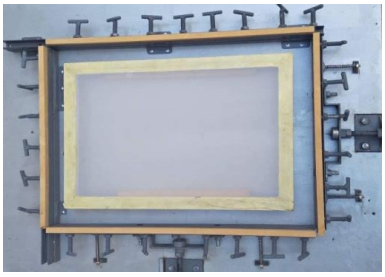

Figure 16, A Stable Oblique Tensile Angle Stretching Machine. Designed and made by the researcher.

Secondly: The second model (Mobile Oblique Tensile Angle Stretching Machine), which was made by the researcher by using lower density iron sheets. This machine is of light weight that could be transported easily and fixed on any table. By using this model, the researcher treated the deficiency of the former machine as it enabled the stretching of many sizes, without the long steps to change the frame size. But it still catches the silk in an oblique side way. Figs. (17, 18).

Figure 17, Stretching process in being implemented in an oblique angel by using wooden pieces and dragging machine, composed of rolling bearings and a Spanish steel axis.

Figure 18, A Mobile Stable Oblique Tensile Angle Stretching Machine. Designed and made by the researcher, One arm of other four units

Thirdly: The third model (Horizontal Tensile Direct Stretching Machine). Eventually, the researched designed this machine in order to surpass all the obstacles of previous models. It is made out of lower density iron sheets. Its light weight enabled the artist to carry it everywhere, in addition to its low production cost and doesn't require a base to be fixed upon, as it could be fixed over any table. No fixing tools are needed, as it catches silk directly in a horizontal pose, not oblique, and has two stretching handles. It is made out of high compacted density rubber, and sheets of coated stainless steel, 2mm thickness. This model can stretch many sizes, and the researcher indicated its suitability to the needs of Egyptian university laboratories. Fig. (19, 20).

Figure 19, Stretching process in being implemented in a horizontal pose, and could be fixed and used on any surface.

Figure 20, A Horizontal Tensile Direct Stretching Machine. Designed and made by the researcher.

5.6 The 5th application

The silk printing table for the multi-copy color printing with moveable tables: This device is considered a printing table, which was developed and made by the researcher to match the procedures of silk screen printing, especially for color and multi-copies printing, in a controlled and easy way for different printing materials. Its design enables the stability of plates during printing process by using aluminum tools and stainless-steel nails of 316 steel gauge. These tools, which designed by the researcher, fix the metal frame, then detect the printing spots over the table, Fig. (22). Additionally, the table includes sub-tables of processed wood, 20 mm thickness, which could be adjusted, moved, dismantled and reassembled easily. The researcher implemented virtual designs to ensure the development of this application in the future, as it could be implemented on movable lockers to store the tools in order to create a multi-task laboratory machine. Fig. (21). Moreover, this table fulfill the expectations of artists, in light of its mass and rapid productivity, adjusting the color positions and keep the stability of printing plates in position. So that, it is quite suitable for producing the colored printing copies on textile, cartoon and plastic. Figs (23, 24).

Figure 21, A photograph for metal pieces as marks on the table

Figure 22, A virtual form of a table, designed by the researcher with mobile tables.

Figure 23, A colored printing work in screen plates, implemented by the researcher via printing table.

Figure 24, A table with mobile tables, designed by the researcher

5.7 The 6th application: Stainless Steel Backlight Washout Booth, 304-gauge stainless steel

A necessary device inside the screen-printing laboratories along the artistic, academic and even the applied environments. It is often substituted by the ordinary washout basins, but this machine is of blacklight, which play a key role in the irreplaceable stage washout and cleaning the printing plates (Beth Grabowski & Bill Ficker, 2009). The researcher created a device for this tool to facilitate the execution of printmaking, as he prepared its ground to fit the stability of printing plates and to still in front of the water pressure. It is already existed in the printmaking laboratory of Egyptian Russian university, Figs. (25, 26). The researcher gave a great attention to this application, because of its lack in our laboratories. For safety considerations, the researcher edited a table, which describes and classifies this tool, in addition to providing some warnings, table (2).

Figure 25, IP control panel separated from the machine and a 130 BAR water pump.

Figure 26, 304 mm Stainless Steel Backlight Washout Boot, invented by the researcher.

Table 2, **A descriptive table for a laboratory device. Classification: (Electric-Photoelectric)**

Stainless Steel Backlight washout booth (304-gauge steel)	
Classification	An Electric laboratory device to washout the screen printing plates (Silkscreen), uses electric current of 220V and transformer of 12V

A detailed description to the machine: Important printing laboratory machine, which being used to washout the plates after the light-exposure stage. It functions the water high pressure to clean the plates, to be reused. It is an irreplaceable machine inside the printmaking laboratories, and the machine body is made entirely out of 304-gauge stainless steel, to resist the rust or the interaction with acids, soaps or alkali. At the back of this machine there is a waterproof IP light box to show the details of procedures during the washout process and cleaning the printing plates. The light units are LED lamps that operate by 12V electric current via a power supply inside a separate IP control box, which could be remote-controlled. The machine contains a high-quality PVC valve for water direct drainage, which can bear the hard conditions of water pressure and acids. The machine is supplied by a 138-bar high pressure washout unit, which compromises a water gun and another low for low pressure. As well, the machine is supplied by lower wheels to facilitate the movement of machine, washing the underneath area and maintaining it, in addition to changing its place during unusual conditions.

Advantages of the machine: made out of suitable materials and properties to the laboratory environment, 0.9, mm 304-gauge stainless steel, LED light unit 12V that is operated by a power supply inside a separate locked control box, 130 bar high pressure washout unit with a water gun and another low pressure one operates via an ordinary battery. The machine is entirely supplied by a lower wheel for movement, cleaning and maintenance purposes. Supplied by a direct drainage high quality PVC valve that bears the hard conditions of pressure and acids.

Max screen Area(mm)	900 x 850 mm
Voltage	220 volts
Power	1 kw
Back Area Light box	900X850mm
G.W. (kgs.)	35 kgs
Machine Dimensions (mm)	1000X900X1750mm

Precautions:

- As a photoelectric machine uses the water pressure on a light box, it must consider the following points:
. Clore and dilute alkalis, such as caustic soda, are allowed to be used.
. Ensure that the water source is open before operating the water pump.
. A water filter must be installed before the water pump to avoid the blockage of water pipes and the high-pressure water gun tubes.
. Don't use the machine without a specialist, the supervision of a teaching member of one of the assists.
. Use the machine only according to the declared schedules or by a permission from the dean or the faculty management.
. Before turning on, ensure that the machine is empty entirely.
. Silkscreen plates are the only permitted objects. Use it only to prepare the printing porous plates only.
. Avoid using the control switch with wet hands.
. Don's approach the machine while operating at a circle of half a meter around the machine at the painted line on the floor of the laboratory, unless under the supervision of a technician, and the experiment must be watched from this distance.

5.8 The 7th application: Hinge Clamps, designed and implemented by the researcher

The hinge clamps are used widely for screen printing, owing to their varied forms and different properties, and considered a highly marketable commodity across the artists of printmaking (Beth Grabowski & Bill Fick, 2009). On the other hand, this tool is very expensive in the absence of local production or new ideas to be accessible for artists and scholars, especially that its components are simple and cheap but the Egyptian market lack it and being imported from abroad. So that, the

researcher began in implementing a suitable model for an effective artistic tool to be used in the colored printing. The researcher achieved an experiment by using the water colors, fig. (27), to test this tool and its ability to accomplish the color matching and the precise recording, fig. (28). It is noteworthy the mobility of this tool and could be carried easily by the students to achieve their artistic experiments outside the printing laboratories. Thus, this tool was tested throughout the fine arts students of Helwan and Alexandria universities and showed remarkable results to achieve the works and experiments in a short time, as this tool could be used for different printing plates, even outside the printmaking laboratories, and is regarded a helpful mobile tool.

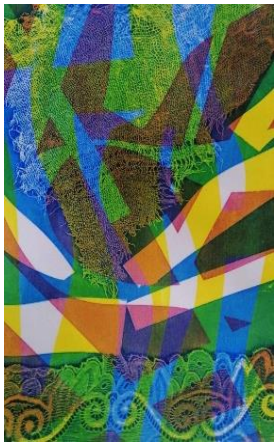

Figure 27, Using the hinge clamps to produce colored prints and controlling the color effects, on A4 paper.

Figure 28, Hinge clamps, designed by the researcher.

5.9 The 8th application: controlling the ingredients and proportions of colored printing inks, and its relation to the printmaking

Some academic and laboratories parties considered all forms and applications of making the printing-colored inks and pigments inside the printing laboratories, by providing all of the required ingredients, packed in special bottles, to be ready for direct use and filling the printing plates with the suitable quantities, then storing them in prepared lockers. The international companies provide all forms of printing inks that fulfill the requirements of artists, including water, greasy, self-drying evaporated and the heat evaporated inks, of both types; the dark and transparent. (Robert Adam & Carol Robertson, 2003).

In addition, some institutions refuse to by the ready mesh printing inks to motivate learning the manufacture technology from the primary ingredients inside the colored ink units of the mesh printing laboratories, which is called as "the color kitchen". This probably aims to more control of the color properties, such as density, brightness, transparency, darkness or dryness, in addition to its high cost some times. The researcher believes that we have to understand the formation of some ingredients of mesh printing-colored inks because of the following:

- Controlling the properties of transparency or darkness.
- controlling the properties of preservatives, which could cause danger on direct use.
- Avoiding the usage of some components such as glue binder with inks, which is used to fix colors into the clothes and avoid the danger of polymer as a transformer, because it may block the silk pores and impairs the plate, unless being used under control, as it is designated for productive printing and could be used continuously to print many copies, but the artists needs only few quantities and spend considerable time in checking the work of art between a print and the

following one. This glue substances can dry up over the silk surface, what leads to blocking the printing pores. So that, excluding these glues is a better choice, because it is used originally to print textiles and to guarantee fixed colors on washing the clothes with soap. So that, the researcher argues that, these glue Copolymer Acrylic dehydrated should be abandoned these, and the researcher stresses that making the printing inks facilitate the control of their properties, especially excluding the glue substances to achieve the color effects during the printing process on paper, without being confined to ready colors. Figs. (28, 30).

- The materials of these components are cheaper 10 times than the ready-made product, with better control possibility.

6. THE TRANSPARENT COLORED PATES WITH THICKENERS

The transparent pates could be manufactured out of raw material in a simple and controlled method to adjust their properties and the degree of transparency. Originally, the printing paste is a medium with specific density and viscosity to carry the colored pigment and passing through the holes of printing mesh. Indeed, the ready-made printing pastes are good, but expensive and can block the pores of printing silk. Next is the composition of water transparent pastes, which made by the researcher and used to get touchable visual effects:

- Of their major feature is the possibility of printing sequential layers to look like the water colors as the colored layers are being melted over each other to form a remarkable visual transparency, only by avoiding the glues to achieve this special visual and artistic state. Fig. (30).
- A specific water thickener is being mixed with the paste, by adding distilled water (1:40 ratio), and whipping them strongly for 2 minutes.
- A water color pigment is added to the colored pastes, then stir them. Fig. (29).
- The above-mentioned mixture should not made in large quantities to avoid the formation of bacteria, because it is free from preservatives. It is preferred to be made of small quantities and preserved in a refrigerator or a cold place.
- In case of using preservatives, it is advised to add a few of ammonia, not the formalin.
- It is used for direct printing or by using effects, grids and lines to find more favorable visual effects.

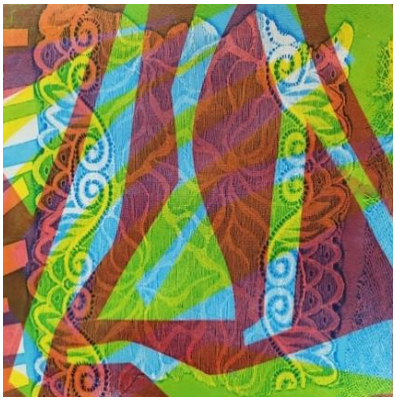

Figure 29, Copying a colored print and controlling the color effects, on A4 paper by using the printing transparent pastes.

Figure 30, Transparent printing pastes by adding a thickener to distilled water, water pigment and some effects.

7. THE AESTHETIC AND ARTISTIC VALUES OF USING THE PRECEDING APPLICATIONS, WHICH INNOVATED BY THE RESEARCHER

The researcher sought to rapid and easily reachable aesthetic and artistic values by developing and executing the previously mentioned application, whether by supplying and developing specific machines and tools, by developing the printing materials and colors, or even by using assisting laboratory tools. Indeed, the majority of artistic models, which executed by the researcher, showed clear results about the aesthetic and artistic values including:

1. The spontaneous performance and the rapid execution of the artistic experiment, owing to using printing plates, which were implemented in well organized and elaborate methods.
2. The easily reachable artistic effects with touchable visual and screen properties, because of controlling the properties of printing pastes, other assistant tools and the methods of bichromate printing due to using the laboratory machines. As shown in (Fig. 31), where the researcher could execute a sample as an experiment about controlling the color effect, visual and screen touches for a paper size of A4.

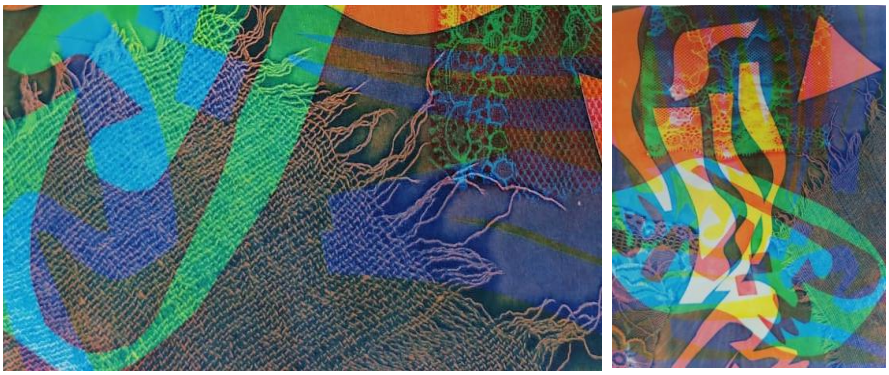

Figure 31, An A4 sample, executed by the researcher

3. The significant potential of controlling the printing ink layers and their quantities on the printed paper, fabric or wood to achieve the artistic innovations by using the water and oil colors, phosphoric foam pates and other material, owing to the used laboratories tools to prepare the metal printing plates and the printing table. As shown in (Fig. 32), we can see the special visual effects of using oil ink of phosphor and thermal foam, processed by the UV rays, in an installation executed in Mixed Media methos and shows the high density of inks and the accuracy of Bichromate painting, under the title of "The tunnel of civilizations".
4. By overcoming the technical difficulties, the artist can use the printing media comfortably and being enabled to execute the colored lines and areas, the colorable interventions, transparency and the touchable effects, in addition to controlling the ink layers, density, typology and rapid dryness, what leads to the spontaneously of performance and reducing the duration of dryness process on adding a color over another. As shown in (Fig. 33), where the researcher could execute a model of using the UV processed lightening phosphor ink on paper scraps, which were installed in Mixed Media method, and shows the special visual effects, under the title of "The tunnel entrance".
5. The high control of the stability of printing plate, during the printing process, without shaking, in addition to selecting the printing spot accurately, and avoiding the damage of prints. As shown in (Fig. 34), where we can see a sample executed by the researcher as an experiment of using the

plastisol ink on silk 90, and shows the transparency and accurate color printing and the precision bichromate painting.

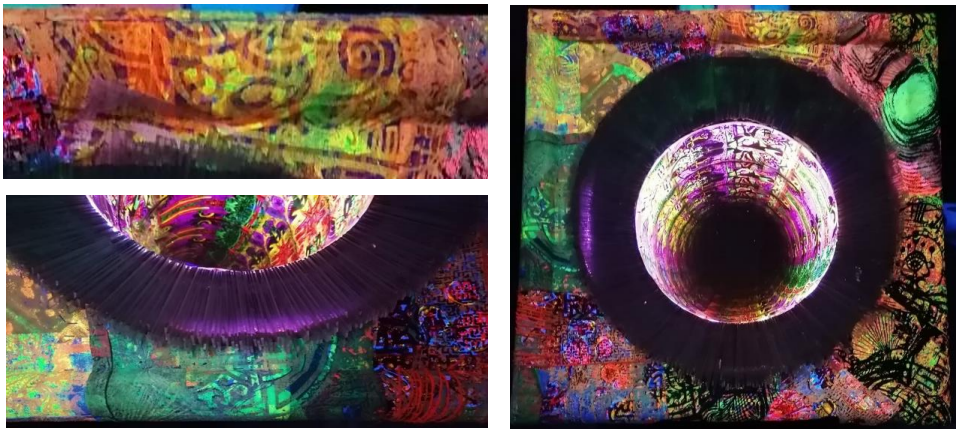

Figure 32, An installation executed in Mixed Media methods under the title of "The tunnel of civilizations", (Source: the researcher)

Figure 33, A model executed by the researcher.

Figure 34, A sample executed by the researcher as an experiment of using the plastisol ink on silk 90.

8. RESULTS

- According to the researcher own experiments, before and after preparing the laboratory tools, the researcher concluded that laboratory tools are necessary that must be developed and updated. In addition, it is essential to make future plans to develop all forms of laboratories inside the faculties of fine arts, which should be prepared according to specialized researchers.
- The researcher implemented 8 applications and a group of necessary silkscreen printmaking laboratory machines, which are applicable inside the specialized laboratories of fine art faculties.
- The researcher's applications are implementable, and some of them were already implemented and produced art works. These applications include; light-exposure machines, printing frame dryers, multi-task light exposure machine and three applications that were used as dryers for the printing plates and to roast the bichromate poly gel. The researcher developed and updated three models of a silk starching machine on printing plates and frames. Besides, he designed and implemented a washout unit, supplied by a backlight and safety factors, in addition to movable lockers to store the printing silk plates (Silk screen frames), a locker to dry the printed copies, and screen-printing plates from aluminum frames and the assist tools to adjust the printing positions, which could be installed on metal plates. The researcher created an innovative design for a silk

printing table to print colored multi copies with mobile tables, in addition to designing and implementing the assist laboratory mobile tools, such as hinge clamps.

- The research discussed the results of applications that were practiced inside the laboratories of fine art faculty of the Egyptian Russian university.
- The results of art works of the researcher and the students of fine arts were successful in limited time owing to the presence of suitable and developed equipment.

9. RECOMMENDATIONS

The researcher recommends with:

- The necessity of founding scientific basis to develop the printmaking laboratories and their equipment.
- Conducting a regular forum or a symposium to gather the artists in order to implement their works, what guarantees the effectiveness of art galleries in the process of laboratory art production, to develop the resources of this forum.
- Taking advantage of developing the laboratories by launching paid specialized training programs and workshops to increase the faculty resources through the laboratory units, which is being developed.
- Applying this research to the operating system and designing the printmaking laboratories inside the Egyptian national universities, as new universities that require successive laboratory models in order to find more professional student training programs about keeping up with the global changes in the field of formative and applied arts, what qualifies the student to settle in the changes of labor market.

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