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Digitalisation of Commercial Serigraphy in Ghana

Dr. Eric Agyarkoh[1], Sumaila Mohammed Sumaila[2]

ABSTRACT

The paper researched into the pattern of technological development in digital serigraphy in Ghana and factors that contributed to the development. Qualitative research approaches such as field study, purposive sampling, unstructured interview, observation, thematic and descriptive analysis were employed for the study. After data analysis, the findings revealed that, the art of screen printing was introduced to Gold Coast in the 1930s by Britain through formal art education and experimentation by local sign writers. The craft started as manual technology in the Gold Coast until Information Communication Technology was introduced in the 1980s which ushered in industrial and digital screen-printing technology in Ghana. The findings also revealed that, factors such as colonisation, globalisation, trans-continental trade, formal art education, pragmatism, competition in multi-party elections and good government policies contributed to the development of screen-printing technology in Ghana. Based on the findings, the paper inferred that screen printing is one of the contemporary Visual Arts introduced to Ghana by Britain in the 19th Century. It also concluded that the craft has gone through stages of technological developments from the Gold Coast to its present electronic status. Also, implementation of prudent economic policies by PNDC government between 1983 and 1992, globalisation, trans-continental trade, pragmatism and introduction of ICT in Ghana in the 1980s set the pace for development of the local industry to its current status.

Keywords: Commercial serigraphy, digital serigraphy, digital image generation, industrial screen-printing technologies in Ghana.

1. Introduction

Screen printing is a type of indirect reproduction process used in communication design. It is an advanced form of stencil printing in which the image is photographed into an image carrier(screen) to create a stencil through which a squeegee is used to force printing ink to transfer the image unto a surface (Kurankye, 2014). Getlein (2002) stated that, since silk has been the traditional material used to prepare screen frames, the process has been called silk screen printing. The author also indicated that, it is sometimes called serigraphy which means silk writing. Screen printing is an ancient technology

[1]Lecturer, Communication Design, Department of Vocational and Technical Education (VOTEC), Faculty of Science and Technology Education, College of Education Studies, University of Cape Coast, Ghana. Email: eric.agyarkoh@ucc.edu.gh
[2] Lecturer, Textile Design, Department of Textile Design, Takoradi University. Email: Sumaila.sumaila@ttu.edu.gh

which has its roots from ancient Egyptian and Chinese civilisations, however, it developed rapidly across the world and was used in many cultures alongside block printing, from the ancient cultures through the medieval periods until the invention of letterpress printing during the renaissance period by Johann Gutenberg and subsequent invention of lithography and still-picture photography in 1798 by Alois Senefelder and Niphore Niepcy in 1824 respectively (Denis, & Jenkins, 1991).

Even though screen printing is practiced in Ghana, Amenuke et al. (1999) claimed that, it is a contemporary graphic art introduced to the Gold Coast by the colonial administration (Great Britain). Evidence from the local graphic design industry indicate that screen printing is one of the reproduction processes that have been used in Ghana for decades and it has contributed greatly to the development of commercial printing in Ghana. Anecdotal evidence in Ghana proves that the craft has developed from manual processes to its current digital status but there is not enough documentation on the systemic development of the art which can be used to monitor its pattern of development in Ghana. This paper sought to conduct a qualitative field study in the local screen-printing industry to investigate the digitalisation of the screen-printing industry in Ghana to identify the pattern of development and the factors that led to the digitalisation.

2. Review of relevant literature

Information for the literature review was retrieved from books, journals, Internet sources and others.

2.1 History of screen printing from global perspective

The antecedent of screen printing can be traced from the pre-historic period when the stone-age men used leaf as templates in their cave paintings. It is reported that the primitive people developed the idea of stencil printing from the observations they made of insects eating holes through leaf. Examples of these works can be seen in the early work of Polynesians Islands. Designs were cut into green banana leaf, and dyes were forced through the openings onto bark cloth or tapa (Adams, Fraux, and Rieber 1998).

Ancient Egyptians, Chinese and Japanese also pounded coloured pigments through stencils reinforced with human hair onto a variety of objects including pottery and fabrics. Denis and Jenkins further reported that, in Europe, the craft spread rapidly during the middle ages which were used to print religious images and laying cards. Also, in the 17th Century for instance, sheet stencils were used in England to make wallpaper decorations. The Americans also used stenciled designs directly on walls, furniture and textiles. By the 20th Century, sheet stencils had been developed to screen-printing. In 1906, a commercial screen-printing plant was set-up in California (USA). Denis and Jenkins stated again that, the process developed rapidly over time from hand craft to mechanical and chemical process when drying equipment, screen development materials and inks were developed in the 1940s. Adams Fraux and Rieber (1998), stated that, during the First World War, stencil printing was used to print quality short-run signs and illustrations. Denis and Jenkins also buttressed the use of stencil printing during the Second World War and stated that, the process was used massively to mark or identify military equipment and suppliers. It was also used to print posters and notices after the war. By 1953, screen-printing was described as the least industrialised of all graphic arts. Today, it is a mechanised industry and it is used as alternative for lithography.

2.2 Development of screen printing in Ghana

Screen printing which used to be a western art has also been practiced massively across Ghana by local commercial artists for many decades from pre-independent to post independent periods. According to Amenuke et al. (1999), Screen printing is a form of contemporary African art which emerged in the Gold Coast in the 1920s. Edusei (2004), also reported that, the introduction of art education at Achimota School in 1927 by the colonial administration contributed significantly to the development of screen-printing technology in Ghana. This is because the syllabus introduced the students to basic drawing, design principles, colour theory and application, lettering, printmaking and others.

Another initiative that contributed to the development of screen-printing technology in Ghana was the introduction of Painting and Decorating Craft programme at the then Takoradi Technical

Institute in 1955 which later changed to Takoradi Polytechnic in 1963 (Takoradi Polytechnic, 4th congregation Brochure, 2005). The curriculum of the programme consisted of lettering and signwriting, drawing, designing, printmaking, colour theory and application and others (City & Guilds of London Institute, 1986). Apart from the Painting and Decorating and Visual Art graduates from technical and secondary schools, art education graduates from Advanced Teacher Training College, Winneba, (ATTC), and industrial art graduates from Kwame Nkrumah University of Science and Technology, Kumasi, also contributed significantly to the development of local screen printing before 1980. It must be emphasised that the early art graduates applied their skills in lettering, drawing, designing and printmaking to create designs and print into T-shirts for individuals and associations. Local sign writers learned the skill and integrated it into their operations so it was practiced alongside sign writing.

Introduction of desktop publishing in Ghana in the 1980s also contributed immensely to the digitalisation of screen printing in Ghana. Desktop publishing according to Broekhuizen (1992 p.127) "Is a process of combining text and graphic, into a page layout using a computer, a printer and special software" In other words, it includes the use of personal computers and simple office machines such as ink-jet, laser, xerographer, scanners and comb binders to generate and organise graphic elements to produce a graphic communication item.

Anecdotal evidence in Ghana indicates that, this form of data processing started in Ghana in the 1980s when personal computers and office printers were imported into the country by government and some private organisations as data processing equipment in offices. In the public service, Microsoft Office (MS) suit was used for data processing and simple desktop Ink-jet printers were used. Gradually, some of the secretaries stated using MS word to design simple posters, business and invitation cards. As the ICT technology developed in Ghana, some Graphic design departments in tertiary institutions introduced computer designing in their programmes in the early 1990s. Initially, they stated with Corel Draw and later Adobe Photoshop was added.

According to a seasoned screen-printing technician in Ghana, in the late 1980s, Affromedia (a local advertising agency) had stated using Corel Draw and Ink-jet printers to generate and reproduce their designs for screen printing. The agency and the then Graphic Corporation were using process Cameras to process black and white photographs into half-tone images for one colour screen printing (Interview, with Mr. Albert Koufie on 20th January, 2020). It is obvious that graphic design graduates from tertiary institutions who were employed in the advertising agencies might have applied their knowledge and skills in computer graphic design to produce designs for screen printing and this gradually might have facilitated the development of digital designing in the local screen-printing industry. Advertising Association of Ghana (2012) also reported that, globalisation and good government policies facilitated development of digital image generation in Ghana in the 1980s and subsequently unfolded industrial mechanical screen-printing press machines, chemicals, frames, substrates and printing inks.

2.3 Development of screen-printing technology

Even though the antecedent of screen printing is cut stencils as claimed by Stewarts (1984), the author further reported that, before 1930s, the only method of reproducing repeat designs quickly was by cut or sheet stenciling. He also claimed that, sheet stenciling had limitations so through rigorous experimentation, the screen-printing process was developed later. By 1950 screen printing had become the most effective method of reproducing repeat designs of high quality in the advanced countries. Stewarts therefore stated the basic equipment and materials used for screen printing at the initial stages as wooden frame, support (Fabric) and stencils. The stencils started with hand cut designs or letters.

Stewarts (1984) explained that, the wooden frames were constructed with softwood and different types of supports were used. These include organdie, silk, and synthetic fabrics such as nylon and polyster. These equipment/materials have also been stated by Adams, Fraux, and Rieber (1998); Denis and Jenkins (1991). Stewarts also explained that, the hand cut stencils were prepared from duplex papers of coated films. They were available in two types: Greenfilms and Amberfilms also called profilms. He described the duplex paper as thin coating applied to wax transparent backing paper. The design was cut from the coating and the backing paper held it together until the coated side was adhered to the support when the backing was peeled off. Stewarts also stated that, Green film was

suitable for synthetic fabrics such as silk and polyster whiles Amerfilms were suitable for cotton fabrics such as organdie. He also stated that, profilms consisted of a soluble plastic coating applied to a clear acetate film. They were expensive than duplex papers but could be applied to any support and used with any type of ink. The hand cut method of preparing designs for photo stenciling was also reported by O P U S Framing &Art Supplies (2018) as one of the basic screen printing used in Europe and America.

Stewarts (1984) also explained that, the photo stencil technology developed later and they could be direct, indirect or direct/indirect. Direct stencils were coatings which were applied to the screen. Indirect stencils were coated films which were applied to the screen, and direct/indirect combined both processes to produce well adhered stencils, mainly for long term runs. The functioning principle of the photo stencils was similar to photographic printing. A photosensitive material was used which when exposed to ultraviolet light became soluble in water whiles unexposed areas remained insoluble. In respect of the direct/indirect process, the design was painted unto a transparent film or paper and placed over the photosensitive material, when the design was exposed, the image part became soluble in water and the rest of the coating became hard. After exposure the design was developed with water to bring out the design to create the stencil. These screen stencil processes were also alluded to by Broekhuizen (1992); Adams, Fraux, and Rieber (1998) and Denis and Jenkins (1991).

Stewarts (1984) again stated that, other equipment used to prepare wooden frames and photo-stencil at that time were wooden lightbox, squeegee, wooden printing bench, stipple gun, stretching pliers and others. Stewarts reported that, another method of preparing artwork for photographic screen stencil emerged where the image was hand drawn to the required size with drawing tools and inked unto tracing paper with black opaque water-based ink and Rapidographic pen, ruling pen and steel rule before the design was exposed in a light box for development into stencil. He also shared that, wooden drying racks were used to dry screens and masking tape was used to reinforce screens before printing. In the advanced countries, both water-based and spirit-based printing inks were used in the 1950s and 1960s. Stewarts also stated that, the inking process was used to separate multi-colour designs to prepare multiple screen stencils. These manual processes of producing screen stencils were also shared on airconway.com (2020) and Grigar (2010). It was reported on the website that, traditional or manual silk screen printing uses cut out stencils or photographic screen generated from manually inked designs. Such designs are produced with rapidographic pens, sable brushes, drawing tools, opaque rotring inks and a tracing paper. Whiles traditional silk screens use hand-cut screen stencils to position the ink on the fabric, modern silk screen technology uses light-sensitive emulsions to photograph the image (stencils) into a screen, one for each colour.

Adams, Fraux, and Rieber (1998) also reported that, half-tone image preparation process emerged in the 1969s where process camera was used to separate full colour images into cyan, magenta, yellow and black for full colour screen printing. The authors also reported that, multi-colour Rotary screen-printing press equipment also emerged in the advance countries which were used for mass production. Denis and Jenkins also reported that, continuous experimentation has led to the development of industrial equipment and production methods for screen printing. In respect of development of industrial screen-printing press machines, Denis and Jenkins stated that, Rotary press machines, Rocker-type press machines, bottle press machines and flatbed-type press machines have been developed. These developments introduced electronic screen exposure equipment such as vacuum frame and self-contained unit screen exposure equipment. Denis and Jenkins claimed that, different types of inks for industrial screen printing have also been developed. These include, water-based inks such as textile inks, oil-based inks like poster inks, synthetic enamel inks, lacquer-based inks, plastisol inks, ultraviolet inks and special formulation inks.

Denis and Jenkins (1991) further shared that, industrial screen-printing machines can print designs on curved, cylindrical, and other flat surface shapes. They can also print on different substrates such as fabric, paper, wood, metal, glass, leather, rigid and flexible plastics, rubber, etc. the technology can be used to print products such as advertising displays, mugs, bottles, wallpaper, and others. Adams, Fraux, and Rieber (1998) and Denis and Jenkins (1991) acknowledged that image generation in modern screen printing is done with computer graphic applications and electronic reproduction printing processes.

Analysis of the above literature revealed that screen printing technology has developed from simple manual hand processes to modern sophisticated mechanical and electronic processes, and

different industrial chemicals have been developed to prepare screen stencils as well as inks that can print on different substrates.

3. Methodology

In order to achieve the objectives of the study, a comprehensive plan was developed to guide the study.

3.1 Research design

The researchers used descriptive qualitative research approach to conduct the study. This approach was used because the objectives of the study were situated in the interpretativism research paradigm which according to Kincheole (1991) and Goetz, & LeCompte (1984) forms strong philosophical bases for descriptive qualitative studies. Henneh (2012) opined that, both interpretivism and qualitative research approaches allow researchers to adopt multiple flexible data collection instruments and procedures to collect extensive primary data for thorough analysis. Denscombe (2008) also buttressed the opinion of Henneh (2012) by pointing out that qualitative studies allow a researcher to collect data in words rather than numbers and such data required objective considerations of the perspectives, accounts and experiences of the participants during the interpretation and analysis of the data. The study also adopted a case study method to study the activities of the large-scale commercial screen-printing companies selected for the study. These methods enable a researcher to become participant or non-participant observer in the study (kumer, 1999; Silverman, 2001 & Yin, 2009).

3.2 Population of the study

The population of the study consisted of all large-scale commercial screen-printing companies and signwriting shops in the Accra metropolis. However, due to the large number of such companies, the study was concentrated only on the accessible ones in the metropolis.

3.3 Sample and sampling procedure

To enable the researchers, obtain reasonably accessible number of large-scale commercial screen-printing companies and sign writing shops in the metropolis to facilitate data collection, three large-scale commercial screen-printing companies and two sign writing shops were purposively selected from the accessible ones to constitute the case study (Cohen, Manion and Morrison, 2000). These businesses were selected because their level of technological development and scope of operation in the local industry were advanced and they have also operated in the local industry for decades. A reasonable number of respondents were purposively selected from each company. The following criteria were used to select the respondents: years of working experience, area of specialisation in the industry, job schedule and position the person occupies in his/her shop. Tables 3.1 and 3.2 respectively indicate details of large-scale commercial screen-printing companies, sign writing shops and respondents used for the study:

Table 3.1

Number of signwriting and large-scale screen-printing companies used for the study.

Name of company	Location
Appointed Time Screen printing	Accra
Global Screen Printing	Osu
Screentech	Anyaa
ChrisArt and Screen-printing Services	Abosiokan
A-& Chate Art	Odokor

Note: The Number of signwriting and large-scale screen-printing companies in Accra selected from the fieldwork in 2020 and used for the study.

Table 3.2

Sample distribution table.

Category of staff	Number selected
Owners	5
Production Managers	3

Screen printing technicians	6
Graphic designers	3
Sign writers	2
	Total=19

Note: Table 3.2 indicates the number of respondents selected for the study from the fieldwork in 2020.

3.4 Data collection instruments

Unstructured observation, unstructured interview schedules and documentary study were used to gather relevant primary and secondary data for the study. The unstructured interview schedule was adopted because, the nature of the study required detailed information about different aspects of screen-printing technologies that have evolved in the local industry for about three decades which require in-depth and continuous observation on the field to gather primary data. The interviews were conducted for all the respondents and the observation schedules were used to study the operations of the technical personnel as well the equipment, materials, and general operations of the companies. The documentation was used to study the brochures, invoice, manuals and products of the companies. This research instrument was used because, it provides opportunity for the researcher to attach himself/herself to the institution under study as covert or overt participant (Creswell, 2008) cited in Henneh (2012).

3.5 Data collection procedure

The researchers collected both primary and secondary data for the study. However, majority of the data collected were primary due to the nature of the research topic and the objectives of the study. The researchers were permitted into the premises of all the five sampled businesses in the Accra metropolis through an introductory letter. In all the shops the management assigned one front office staff to lead them to the various sections and introduced them to the technical staff. The researchers therefore visited every relevant unit or section in each of the companies that could be accessed during the study to observe their operations, tools, equipment, materials, products and designs, interviewed them and took photographs. During data collection, the researchers triangulated the instruments to identify consistencies and inconsistencies in the responses of the respondents.

The researchers also engaged some of the technical staff in casual conversation through unstructured interviews on their schedules and other issues concerning their companies and recorded on audio tape and mobile phone. However, the researchers wrote down the responses of the interviewees who did not allow them to record their voice electronically and also took some field notes during the observation periods. To ensure ethical standard and trustworthiness in the study, the researchers verbally sought the consent of the management of the study organisations and all the respondents prior to data collection, and assured them of maximum privacy, anonymity and confidentiality of their identity, responses and photographs in the presentation and publication of the research. The publication of the pictures, names and textual information obtained from the field work therefore were based on their consent.

3.6 Method of data analysis

The primary data gathered from the recorded interviews and the field notes were manually transcribed, expanded and coded to develop major and subordinate themes based on the objectives and research questions of the study. The photographs were also sifted and edited electronically and placed under appropriate themes. The findings that emerged from the analysis were discussed using descriptive qualitative methods, narrative and inductive analysis. These types of qualitative analysis methods are strongly proposed for qualitative research (Creswell, 2003; Merriam, 1998; Silverman, 2001b & Fraenkel & Wallen 2009). During the analysis, the researchers paraphrased the narratives of the respondents to enable them construct the history in a logical, coherent and systematic manner to unfold the history appropriately. However, some statements made by some of the respondents were presented verbatim to indicate their voices in the transcription.

4. Data presentation, analysis and discussion of findings

The data was analysed, discussed and presented under the following major and subordinate themes:

- Developmental trends of digital screen-printing technology in Ghana
- Factors that brought about digital screen-printing technology in Ghana.

4.1 Developmental trends of digital screen-printing technology in Ghana

The analysis revealed that, before 1990s, screen printing technology in Ghana was purely manual. All the owners of the sign writing shops who are seasoned commercial artist in the local industry and started commercial screen printing in Ghana in the 1970s agreed during the interviews that, digital screen-printing technology started emerging in Ghana in the 90s. They recounted that, during their apprenticeship days in Accra in the 1970s, their masters did screen printing. They used manual tools, equipment and materials such as Wawa (wood), stippling machines and pins, nails and organdy to prepare their frames and hired carpenters to construct their frames for them. They further recounted how the frames were prepared. The wood was planed and sand papered to a smooth finish and cut into strips of about 1.5 inches. The size of the screen was measured on the strips in relation to the size of the design with reservoirs and cut. The ends of the wood strips were cut to mitre joints and the strips nailed together to form the frame. The organdie was stretched on the frame by stippling to a drum-tight and the excess organdie trimmed off.

In respect of how copies were designed for screen printing during the pre-digital era, they stated that initially, their masters used pencil to set out the design direct on the 'mesh' (Screen fabric) of the stretched screen and used sable brushes and polish, lacquer, white glue or varnish to block the screen positively or negatively depending on the nature of the design. They left it to dry and used to print.

They also recounted that, later profilms were introduced into the system and their masters transferred text from them unto acetate for exposure and development. They collectively agreed that, their masters coated their screens with PVA adhesive and allowed to dry. A crystal sensitizer dissolved in clean water was applied unto the screen in a darkroom and upon drying, the design and the screen were setup with plain glass in a darkroom and exposed to sunlight. After exposure, the screen was developed in a sink filled with water. They also recounted that, some sign writers used locally made wooden light box to expose their screens and used a piece of semi-rigid plastic sheet and photo-emulsion to coat their screens in a dark room. The design was positioned on the light box and secured it with transparent solution tape. The dried screen was placed on it and weighted it with sand bags. The white light was switched on and timed to expose the design. The design was developed immediately after exposure. The interviewees also recounted that, after some years the profilms started fading out from the system and some of the sign writers used drawing tools and white bond sheet to set out their designs and used Rotring pens, sable brushes, tracing paper and black Rotring ink to 'ink' their designs.

With regards to how they used the screen to print the design, they recounted that, when the screen was thoroughly dried, they blocked all pinholes with photo-emulsion and allowed it to dry. After that the screen was reinforced with masking tape and the T-shirts printed on a blanket padded wooden table using wooden squeegee and water-based printing ink. With the question of how they printed multi-colour designs, they explained that, they did colour separation during inking and developed one screen for a colour. They stated that, in those days, they could print only flat colours. They bought mesh, chemicals, printing inks, and tools from Nigerian business men. However, some were purchased from some shops in Accra. With the question of the kind of works they produced, all of them mentioned printing of T-shirts, badges, flags, paper caps, scarves and posters.

Examination of the narratives given by the respondents revealed that, before 1980 screen printing in Ghana was manual and that it required special skills to be able to do it. All the manual processes narrated by the respondents have also been buttresses by Airconway.com (2020) and Stewarts (1984). However, Stewarts (1984m reported that, these manual technologies were predominant in Europe in the 1950s and 1960s. This clearly confirms the claim by Amenuke et al. (1999) that screen printing is an exotic artistic technology imported to Ghana by the colonial administration.

4.1.1 Developments in the 1980s

The results indicated that, local sign writers continued to use manual tools and processes to execute their routine screen-printing jobs in the 1980s. However, most of them leant the light box technology and discarded the sola method. The respondents also recounted that, by 1990, spirit- based sticker inks, opaque sticker sheets, opaque printing paste and fine mesh had been imported into the country by some sign writers and art stores in Accra which made it possible for them to print stickers. According to one of the interviewees, it was during that period that the half-tone technology was introduced by Afromedia and the former Graphic Corporation. This technology commenced the use of screen printing to print half-tone images into black T-shirts with white opaque inks. He also said that,

In 1988, Afromedia sponsored one of their designers called Mr. Albert Koufie to Britain to study full colour screen printing and introduced it in the agency upon return. By 1990, Afromedia had already started full colour screen-printing.

The other seasoned sign writers recounted that, between 1990 and 1991, Tallal Fattal the CEO of Metro TV, Ghana imported a machine that could break full colour photograph into half-tone and separate the colours into CMYK unto transparent films. He used the technology to print coloured images into a lot of white T-shirts for the National Democratic Congress (NDC) in the 1992 national elections. The two seasoned sign writers stressed that fine mesh was used to produce the half-tone screens and trichromatic or processed colours (cyan, Magenta, yellow and black) were used to print the tones. However, they used opaque/spot colours to print vector designs and also stated that, all the sign writers printed black colour first whenever they reproduced half-tones into continuous-tone.

A thorough analysis of the responses of the interviewees indicates that, introduction of mechanical image preparation technology, spirit-based printing inks and process colours in the local screen-printing industry stated in Ghana in the 1980s because some prominent graphic design related businesses and freelance graphic designers were able to procure process cameras and such materials from abroad and used them in their operations. This induction further confirms that technological development in the advanced countries had great impact on the development of industrial serigraphy in Ghana because according to Adams, Fraux, and Rieber (1998) and Denis and Jenkins (1991), by 1060s, industrial process cameras and printing inks were used by industrial screen printers in Europe and America.

4.1.2 Emergence of digital screen-printing technology in Ghana from 1990s

In respect of when computer application stated in the local screen-printing industry, the seasoned sign writers and all the owners of the large-scale screen-printing companies insisted during the interviews that, Afromedia was the first large-scale outdoor advertising agency in Ghana to use computers and desktop printers in their screen-printing activities in Accra in the 1990s. They indicated however that, before 1990, some sign writers in Accra had started using computers and their accessories to generate designs for their screen printing jobs but they were not popular. The results finally pointed out that, since 1990s, manual designs for screen printing had gradually transcended into computer designing. However, few conservative traditional sign writers continue to rely on manual processes.

The transcriptions of the researchers' field notes and the personal observations on the activities of the large-scale screen printing technicians they studied revealed that, drastic technological developments have occurred in the local screen printing industry in the 21st Century and this was spearheaded by Appointed Time Screen Printing and Screen Tech all in Accra between the year 2000 and 2005 respectively when they started importing a number of sophisticated modern screen printing technology into the local industry. The findings were analysed and discussed under the following subordinate themes:

4.1.3 Developments in copy Generation technology

According to the graphic designer respondents, Corel Draw dominated copy design for screen printing in the 1990s until Adobe Photoshop and Illustrator were introduced in the local industry in the 21st Century. Initially, Pentium two computers with low memory and processing speeds were used. Improvement in ICT education in Ghana in the 21st Century made the practitioners to start using complex ICT equipment such as Pentium 4 and Pentium M personal computers, laptops, scanners and

ink-jet electronic printers, and subsequently, laser electronic printers were also introduced. They used these equipment and software to generate and print out their designs unto bond sheets in black ink and oiled them for screen exposure. The designs could be generated in vector or bitmap images and separated into half-tone and print unto separate laser films or white bond paper for exposure. Figure 4.1are samples of colour separations for a full colour bitmap image:

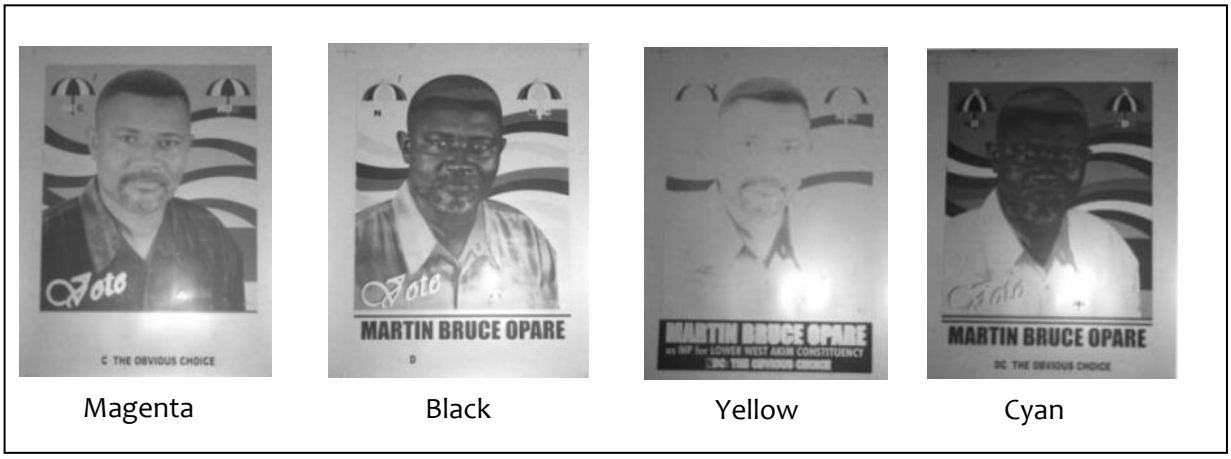

Figure 4.1. Samples of full colour separation films

Note: Continuous-tone image separated into half-tones (CMYK) unto films, retrieved from Appointed Time Screen printing in Accra during the Field study in 2020.

A thorough analysis of the responses of the graphic designers the researchers' interviewed and observed revealed that, all the large-scale screen-printing companies they visited used high-capacity computers, scanners and laser printers to prepare their designs for screen printing, and all of them used similar software to generate their designs. This means that they have discarded the traditional manual designing methods. The results also revealed that, the computer design and printing were faster, produced sharp images and accurate print outs which have enhanced the quality and quantity of output in the modern screen-printing industry when compared with manually designed copies. All these digital copy generation technologies have also been stated by Denis and Jenkins (1991) to have stated in Europe and America in the 1970s.

4.1.4 Developments in frame preparation technology

The screen-printing technicians of one of the large-scale screen-printing companies the researchers interviewed indicated that, the company started operation in the year 2003 with wooden frames, fine, medium and coarse mesh and old traditional tools and processes to stretch their screens. They used coarse mesh for less intricate designs for fabric printing, medium mesh for very intricate designs for fabric and leather supports and fine mesh for designs which were to be printed on glass, plastics, metal, glossy papers, stickers and others. He also said that, "In the year 2005, my company imported a metal screen stretching setup and aluminum frames from China and invited the manufacturers to Ghana to train the technicians how to use the equipment". He further said that, "The frames were imported already formed in different sizes". In order to probe further about how the setup was used, the researchers observed the technician operating the setup, asked questions, made short notes and took photographs. Below is the account of the observation:

The outside of the frame was slotted into the structure and operated the adjustable screws manually to adjust and locked the frame to the structure. A mesh slightly bigger than the frame was placed on the frame, stretched by hand and pressed down the lockers to lock it tightly to the frame. After that the handles at one side of the stretching rod were rolled manually to stretch that side of the mesh to the screen. The same process was followed to stretch the mesh at the other three sides of the screen to a taut or drum-tight finish. After that a spirit-based adhesive (Formica glue) was applied on top of the mesh on the frame with a one-inch brush or small squeegee and allowed it to dry thoroughly. The screws were unlocked to remove the stretched screen from the structure. Some of the glue was

applied to the sides of the frame to stick the excess fabric and allowed it to dry. The excess fabric was trimmed from the screen.

In respect of how used aluminum screens could be reclaimed for another work, the screen-printing technicians responded that, the mesh is removed from the screen completely and a new mesh stretched on it, or the photo-emulsion could be removed from the mesh and the screen recoated. They explained that, to remove the mesh completely, cellulose thinner must be applied on the glued sides of the screen and leave it for some time to dissolve the glue before the mesh is peeled off. On the other hand, the photo-emulsion could be removed by applying bleach and parozone unto the screen and leave it for some time to soften the photo- emulsion before washing and rinsing with clean water, allow it to dry thoroughly and recoat. Figures 4.2 2 (a and b) indicates the tools, equipment and materials used to stretch the aluminum frame. Figure 4.3 and 4.4 respectively also show pictures of the processes the screen-printing technicians went through to prepare the aluminum screens:

(a)
Set-up for aluminium frame

(b)
Adhessive and brush for fixing mesh

Figure 4.2 (a and b)
Tools, Equipment and Materials Used to Stretch Aluminum Frame.

Note: The metal structure in (a) is the set-up being arranged by the screen-printing technician prior to stretching the alluminum frame. (b) are the adhesive and brush used during the process of fixing the screen fabric to the frame).

Step 1: Locking of frame.

Step 2: Spreading of meshStep.

Step 3(a): locking of mesh

Step 3(b): Locking of mesh.

Step 4(a): Stretching of mesh.

Step 4(b): Stretching of mesh.

Step 5(a): First glueing of mesh.

Step 5(b): first glueing of mesh.

Figure 4.3. Processes of Stretching Aluminum Frame.

Note: Figure 4.3. are the first 5 steps involved in stretching screen fabric unto an aluminum screen observed by the researchers' on the field at ATSP, Accra in 2020).

Step 6: Stretched & glued screen

Step 8 (b): Second gluing of mesh

Step 7: Unlocking and removing screen

Step 8(c): Untrimmed screen

Step 8(a): Second gluing of mesh

Used Aluminum Screen

Figure 4.4. Processes of stretching aluminum frame continued.

Note: Figure 4.4. are the continuation of the steps involved in stretching screen fabric unto an aluminum screen the researchers' observed on the field at ATSP, Accra in 2020.

The response of a senior technician of another large-scale screen-printing company also confirmed that they used only Wawa wood and old traditional tools, and processes to stretch their screens. However, the researchers observed that they also used coarse, medium and fine meshes for their operations. With the question of whether they used any order screen apart from wooden screens he said no!

After thorough analysis of the findings, the researchers induced that even though there have been remarkable improvements in the quality of 'mesh' (screen fabrics) used in the local industry, most sign writing shops and large-scale screen-printing shops still use wooden screens. However, Appointed Time Screen printing (The largest screen-printing company in Ghana) is the only local company that uses aluminum frames alongside wooden frames. This clearly indicates that even though industrial screen-printing technology is developing in Ghana, the development is slow because all these metal frame technologies and the use of fine mesh have emerged in the advanced countries decades ago. This induction of the researchers is also buttressed by Denis and Jenkins (1991).

4.1.5 Developments in screen exposure and development

With regards to screen exposure and development, the responses revealed that, all the large-scale screen-printing shops the researchers visited and observed used automatic light box imported from China. The light box consisted of one high voltage white bulb fixed in the middle of the box and another low voltage one feet fluorescent bulb fixed at one side of the inside walls and both lights were

controlled by different switches. There was a plain glass on top of the light box with an air vacuum cover inside of which was lined with a light black silky fabric in which air was blown from a fan inside the box to build up at the back of the air vacuum liner. The light box had an automatic timer which was used to set the exposure time.

The responses also indicated that, one of the large-scale screen-printing shops had a modern darkroom consisted of three electronic screen drying racks and each had a number of drawers and slots in which coated screens were packed for drying. One of the racks had a glass top with a number of four feet fluorescent tubes connected underneath it on an aluminum sheet which blocked the drying chamber from the light table. This unit was used to strip printed designs prior to exposure. The company also had another small light table with calibrations on it. It was also noticed from the responses that, all the two companies did manual stripping prior to exposure and had large ceramic washing sinks. They used different sizes of metal coating troughs, one-kilogram sachet of imported sensitizer called 'Diazo Sensitizer' and an imported water resistant adhesive available in white, blue, green colours etc. called 'Forward W-220' both of which were combined in appropriate proportions to produce their photo-emulsion. The ratio of the mixture was one sachet of Diazo Sensitizer is to one litre of Forward W-220 adhesive.

The results of the observation also showed that, the electronic light box functioned just like the wooden light box except that the electronic type had automatic timing and weighting mechanisms which the wooden type does not have. Figures 4.5 and 4.6 Show pictures of some of the tools, equipment, materials and chemicals the large-scale screen-printing companies in Accra used to expose their screens:

Figure 4.5. Modern screen development tools and equipment

Note: Figure 4.5. are some of the modern tools and equipment used by the local screen-printing companies selected for the study. These were found during the fieldwork at ATSP, Accra in 2020.

Forward W-220 PVA adhesive.

Diazo Sensitizer

Figure 4.6. Modern screen development materials and chemicals.

Note: Figure 4.6 are the two chemicals combined in appropriate proportions to form a photo-emulsion. These were retrieved from ATSP at Accra during a Fieldwork in 2020.

Analysis of the findings revealed to the researchers that wooden light box, PVA adhesive and Sensitizer which had been used in the local industry for over three decades had been discarded by local large-scale screen- printing companies in Accra and replaced with imported photo-emulsion. Also, the use of light tables enabled the large-scale screen -printing companies to register their copies effectively before exposure and this has enhanced the quality of their printing works. The electronic screen drying racks also protect the coated screens against stray lights which could pre-expose the screen. The researchers also found out from the findings that, the electronic light box had eliminated the use of sandbags in the modern screen-printing industry and the intensity of the ultra-violet light in the electronic light box and the automatic time setting facilities confirm that the electronic light box has enhanced qualities than the traditional wooden light box. The analysis of the results also indicated that, the electronic drying systems and the metal screen coaters have also contributed to improve the quality of screen coating in recent times. In fact, all these industrial screen-printing processes and materials have already been alluded to by Denis and Jenkins (1991) to have been prevalent in the advanced countries about three decades ago.

4.1.6 Developments in screen printing press machines

The responses of the interviewees and the results of the researchers' field observations indicated that, all the large-scale screen- printing companies used similar manually operated and electronic screen- printing machines imported from China. Each of the companies had two manual and one electronic screen- printing press machines. The manual screen- printing press machines had four flat metal printing boards called 'palettes' on which the T-shirts were placed during printing. The palettes had metal hooks called 'stations' which held the screen to the palettes. The hooks were locked with screws and were also used to register the T-shirt unto the palettes. The main bodies of the machines stood on a metal base on a revolving device which made it possible for the frame holding the screen to be moved horizontally by the printer during printing. The machines had an electric drying device called 'flash cure' which dry the ink immediately after printing. The stations were controlled by springs which made it possible for the screen to be lifted up from the T-shirt after a single print. The stations were fixed with gauging devices which registered the screens exactly in the middle of the stations and the palettes. The printing machines used both wooden and aluminum screens.

The researchers observed that one person used the machine at a time. The faces of the T-shirts to be printed were placed on the palettes face-up and the stations were pushed downward to lie on the T-shirts. The appropriate screen was fixed into the frame and adjusted to register perfectly on the T-shirt and screwed it into the stations. The printer applied printing ink into the screen and printed the design with squeegee. After printing, the frame was lifted from the T-shirt and pushed the palette to spin horizontally to position the printed design under the flash cure to dry the ink whiles another palette moved to the position of the printer for another printing. It followed in that order until all the

four T-shirts were printed. When multi-colour designs were printed, the palettes were sprayed with an adhesive before the T-shirts were placed on them. The transcriptions revealed that, one manual screen -printing machine could print a four-colour design in 300 T-shirts in one day and for a one colour design, one person could print about 1500 T-shirts in one day.

The electronic screen-printing machines on the other hand, had palettes, stations and an electric drier. However, each had twelve printing palettes and the designs were printed mechanically by metal squeegees fixed in the screens by the printer. They were also powered by electricity and operated electronically with a keyboard on the machine. They were mostly used for mass printing of full colour designs.

The researchers also observed that, one of the screens- printing companies had modern printing benches which the other company did not have. The company had four long metal printing benches and each was fixed with a number of flat metal rectangular palettes each measuring 1 inch by 2 inches were arranged in an interval of about 8 inches. There were two rolls of palettes on each printing bench and each roll consisted of 18 palettes making it a total of 26 palettes on each bench. Each palette had two lockers which were used to register the screen to the middle of the palettes and each bench had an electronic drying machine fixed on it which moved on two wheels in rails at both sides of the bench along the length. The drier had a heating element which was regulated to dry the ink. The printing benches used only aluminum screens.

In respect of how they used the benches to print, it was observed during the observation that, the T-shirts were placed and registered in the middle of the palettes with locks. One printer printed the first colour manually with aluminum screen and squeegee, another printer followed with the second colour and it followed in that order until all the colours were printed. After printing, the drying machine(s) were operated to move left and right to pass on the printed T-shirts along the length of the bench to dry the ink.

The researchers also observed that, the company had one large modern drying machine called the 'conveyor' which they used to dry inks used to print designs in fabrics permanently. The machine consisted of three main units: feeding, drying and delivery units. The feeding unit consisted of a flat conveyor board unto which the semi- dried printed materials were packed and when the machine was operated, the conveyor moved the materials into the drying unit where the heater blew hot air unto them to dry the ink. After drying, the materials moved to the delivery unit where they were removed for folding and parking. Figure 4.7and 4.8 respectively, indicate pictures of the manually operated and electronic screen-printing machines, a drying machine and the printing benches:

(a) Mechanical screen-printing machine

(b) Electronic screen-printing machine

Figure 4.7. Mechanical and electronic screen- printing equipment

Note: Figure 4.7 are samples of mechanical and electronic screen-printing press machines found at ATSP, Accra during Fieldwork in 2020.

Electronic drying machine

Metal Screen Printing Benches

Figure 4.8. Modern Screen-printing Equipment Continued.

Note: Figure 4.8 are samples of electronic drying machine and metal printing bench found at ATSP, Accra during Fieldwork in 2020.

Examination of the results revealed that, the large-scale screen-printing companies the researchers' visited used modern industrial screen-printing machines to print their designs which hitherto did not exist in the local industry. The findings also proved that, the machines were easy to operate and boosted the quality and quantity of their productions. It could also be detected from the results that, only one company had long metal printing benches and more screen printing machines. This means that they could print more works than their competitors. The electronic drying machines could also facilitate production and improved the fixing of ink into the fabrics when compared to other companies that used natural air and sun to dry their works. The researchers can therefore conclude that all these improvements in the local industry commensurate with some industrial screen- printing technologies used in the advanced countries as shared by Adams, Fraux, and Rieber (1998) and Denis and Jenkins (1991).

4.1.7 Developments in screen printing inks

In respect of type of screen- printing inks that were used in the local modern screen- printing industry, the responses indicated that, the companies used the following inks to printing their works: plastisol, opaque, acrylics, textile ink, sticker ink puff and blinks. The plastisol was used to print designs on fabric and was dried by heating after printing. The opaque ink was used to print flat colour designs into dark-coloured fabrics such as black, blue, green etc. The acrylic and the textile inks were used to print on fabrics. The sticker ink was used to print on all kinds of smooth non-absorbent materials such as sticker sheets, leather, plastics, tarpaulin, glass etc. The puff was also used to print one colour flat designs into fabrics and it was ironed after printing whilst wet to puff in relief upon drying. The blinks were flakes of varying sparkling colours which were sprinkled unto the inks after printing whilst wet.

Analysis of the transcriptions on printing inks used in the local screen- printing industry revealed to the researchers that, different types of printing inks are used in the local industry nowadays and some are used for specific works depending on their characteristics and the nature of the work to be printed. It also shows that, the variety of inks have made it possible for the companies to produce variety of works for clients. It is very obvious from the discussion that, even though textile ink is still used in the local industry, most screen printers prefer plastisol for general fabric printing. This might be due to its superior qualities over the other fabric printing inks. Some of these industrial screen-printing inks have been mentioned by Denis and Jenkins (1991) as some of the inks used for industrial screen printing in the advanced countries.

4.1.8 Works produced by modern screen- printing industry in Ghana

The responses of the screen-printing technicians and the researchers' personal observations during the field revealed that, generally, the following works were produced in the local screen-printing industry: Buntings, Umbrellas, Hats, Caps, T-shirts, Handkerchiefs, Scarves, Flags, Wall hangings,

Badges, Plaques, Stickers, Mugs, Pennants, Bags, Canopies, jerseys, etc. Figure 4.9 show pictures of samples of the works produced in the local screen-printing industry currently:

Figure 4.9. Samples of Modern Screen-printing Works.

Note: Figure 4.9 are samples of modern screen-printing works produced in the local screen-printing industry, retrieved from ATSP and Ink-IT in Accra during Fieldwork in 2020.

The researchers induced from the findings that, artifacts produced in the local screen-printing industry currently have increased and the quality of finish could be superior to the ones produced before 1990s. This could be attributed to the gradual development of industrial chemicals, mechanical and digital screen-printing press machines, variety of substrates, industrial printing inks and computer-generated image designs. Apparently, these types of modern screen- printing products are reported by Adams, Fraux, and Rieber (1998) and Denis and Jenkins (1991) to have been produced in the advanced countries about three decades ago. This proves to the researchers that even though the local screen-printing industry is developing, the development has been slow because most of the modern industrial screen-printing products stated by Denis and Jenkins are not produced in the local industry.

4.2 Factors that contributed to the development of screen-printing technology in Ghana

The result revealed that, introduction of art education and painting and decorating craft by the colonial administration in the Gold Coast in 1927 and 1956 respectively contributed immensely to the emergence of the art of serigraphy in Ghana in the 1950s. According to AAG (2012), government policies and globalisation were the major factors that influenced technological developments in local screen-printing technology from 1980s to 2012. The association believed that, the Economic Recovery Programme (ERP) and the Structural Adjustment Programme (SAP) implemented by the Provisional National Defense Council (PNDC) government in the 1980s and 1990s, improved infrastructural development across the country which served as impetus for small-scale enterprise development. It further believed that, the divestiture programme implemented as part of the ERP and reduction of corporate taxes, reduction of interest rate and import and export charges also encouraged private sector participation and provided a fertile ground for a lot of local and international entrepreneurs to set up businesses in Ghana and formed partnerships with local businessmen. The association also opined that, effects of globalisation, international trade, and curiosity of local sign writers, screen printers and graphic designers contributed significantly to the development of industrial screen-printing technology in Ghana.

The responses also indicated that, all the seasoned traditional sign writers and digital screen printers the researchers interviewed unanimously intimated that, introduction of ICT and internet technology in Ghana were the major factors that influenced technological development in the local screen-printing industry. They also identified high demand for quality finish as another significant

contributing factor and one of them mentioned introduction of multi-party democracy in Ghana in 1992 as another contributing factor.

A thorough assessment of the documents and the transcriptions reveal that, ERP and SAP set the pace for the commercialisation of this country three decades ago. The researchers also found out from the analysis that, these policies revived international trade in Ghana by encouraging local and foreign investors to form partnerships and encouraged private entrepreneurs to import goods from abroad and export goods therefore expanding commercial activities in Ghana. This finding was vehemently supported by the opinion of AAG (2012) and Mongabay.com. (2012) who stated that, the ERP and SAP liberalised the market system in Ghana by curtailing bureaucratic bottlenecks and repealing stringent laws and regulations that hindered private investment in the local economy from 1983 to 1992 and thereafter.

It was also obvious from the discussions, that liberalisation of the economy coupled with globalisation increased the demand for quantity and quality screen-printing works in the country and all these might have created keen competition in the local industry therefore compelling some of the proactive large-scale screen-printing companies at the time to import modern materials, tools and equipment to boost their production and improve the quality of their services. This is why some of the local practitioners reported that, some of the large-scale outdoor advertising agencies sent some of their designers abroad to study modern screen-printing technologies in the 1980s who came to introduce them in Ghana and also imported modern materials and equipment for such services. Also, the analysis of the opinions and observations of the seasoned sign writers clearly reveals that, the introduction of computer-generated graphic design in the local screen-printing industry in the late1980s by some leading outdoor advertising agencies in Accra improved the quality of their designs when compared to the designs of signwriting shops that used manual processes.

This claim of emergence of computer application in the local industry by one of the seasoned outdoor advertising agencies that, by 1988 Afromedia had already started using computers and computer accessories to execute their T-shirt designs, confirms the findings the researchers made in the discussions. Also, the use of ICT by the leading outdoor advertising agencies in the late1980s and 1990s might have encouraged other small-scale and medium-scale screen printing shops to adopt ICT to improve their operations. The analysis of the responses also suggests to the researchers that, the introduction of internet technology in Ghana might have provided opportunity for local sign writers to study modern screen-printing technology on the internet and imported modern materials, tools and equipment from the advanced countries through internet marketing.

The researchers also induced from the analysis that, the introduction of ICT in Ghana and the demands of industry due to globalisation led to the inclusion of computer-generated graphic design in the graphic design syllabi of our tertiary programmes in the 1990s. It is obvious that this course introduced graphic design students to basic graphic design software and since some of these graduates were employed by local outdoor advertising agencies in the late 1990s and beyond, they might have exhibited their prowess in computer design in industry and encouraged some local entrepreneurs to adopt the technology into their operations.

The claim by one of the seasoned sign writers that, the introduction of multi-party democracy at the beginning of the 4th republic also influenced the technological development in the local screen-printing industry can be acceptable because, the 1992 national elections might have increased the demand for political T-shirts, flags, scarves and others by political parties. This claim is confirmed by the example given by one of the seasoned sign writers that Tallal Fattal (CEO of Metro TV, Ghana) was the first sign writer to print full colour political T-shirts for NDC during the 1992 national elections.

5. Conclusions

Based on the findings that emerged from the analysis and discussions, the researchers inferred that, screen printing was introduced in the Gold Coast in the 1930s by the colonial administration through formal art education and developed through experimentation by local sign writers in Accra. It stated as a manual technology until mechanical and digital industrial screen processes started emerging in Ghana in the 1980s through Afromedeia Ghana Limited and Graphic Corporation. Initially, the

technology was monopolised in Accra until 1960s to 1980s when globalisation, trans-continental trade and the free-market system spread screen printing activities to many towns across Ghana.

The researchers will also conclude that, the sponsorship of Mr. Albert Koufie to Britain in 1988 to train in half-tone colour screen printing technology and importation of industrial process cameras to Ghana by Graphic Corporation, contributed immensely to the digitalistion of the technology in Ghana. Also, importation of different types of modern screen-printing equipment, chemicals and inks into Ghana in the early 1990s by Afromdeia Ghana Limited, and importation of image setters from abroad by Mr. Tallal Fattal in early 1990s is another significant contributing factor to the development of screen-printing technology in Ghana. It can also be concluded from the discussions that, increased activities in trade and commerce, multi-party democracy and competitions in corporate, product and political advertising in Ghana from 1980s to date have contributed to development of screen-printing technology in Ghana.

Furthermore, the researchers can infer that, introduction of desktop publishing in the public and private services in Ghana and ICT technology in Ghana in the late 1980s set the pace for the development of industrial and digital screen-printing processes in Ghana. Also, introduction of Internet technology in Ghana in 1998 helped local sign writers and screen printers to research into ICT applications in the modern screen-printing industry from the advanced countries. The spread of desktop publishing and computer designing by the large outdoor advertising companies in Ghana in the late 1980s inspired communication design departments in tertiary institutions in Ghana to incorporate computer-generated graphic design into their programmes.

As much as this study focused on documenting developments of digitalisation of serigraphy in Ghana, the development has not been static but continues to evolve. The researchers would therefore recommend that, other researchers can also continue to monitor other developments that are emerging in the local screen-printing industry and document them for posterity.

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APPENDIX 1

UNSTRUCTURED INTERVIEW GUIDE USED FOR DATA COLLECTION

These were the perceived questions the researchers used as a guide on the field during data collection. The questions were focused on the two broad objectives of the study:

- Developmental Trends of Digital Screen-Printing Technology in Ghana
- Factors that Contributed to the Development of Screen-Printing Technology in Ghana.

Developmental Trends of Digital Screen-Printing Technology in Ghana

1. When did commercial screen-printing start in Ghana?
2. Which individuals or organisations started commercial screen printing in Ghana?
3. What tools, equipment, materials and processes were used for commercial screen printing in Ghana before the digital era?
4. What are the types of works or items produced with screen printing in Ghana before the emergence of digital or mechanical screen-printing?
5. When did digital or mechanical screen-printing start in Ghana?
6. Which individuals or organisations started digital or mechanical screen printing in Ghana?
7. What tools, equipment, materials and processes characterise digital or mechanical screen-printing in Ghana?
8. What are the types of works or items produced with digital or mechanical screen-printing in Ghana?

Factors that Contributed to the Development of Screen-Printing Technology in Ghana

1. What factors contributed to development of manual commercial screen printing in Ghana?
2. What factors contributed to development of digital or mechanical screen printing in Ghana.

APPENDIX 2

OBSERVATION GUIDE USED FOR DATA COLLECTION

The researchers used the following checklist as a guide during the field study:

1. Identification and characteristics of tools, equipment, materials and processes used in the local commercial screen-printing industry before the digital or mechanical era.
2. Identification and characteristics of tools, equipment, materials and processes used in commercial digital or mechanical screen-printing industry in Ghana.
3. Identification and characteristics of works or items produced in Ghana during the era of commercial digital or mechanical screen-printing.