An Aesthetic Characterization of Plaster of Paris as an Alternative Ink Medium for Silk Screen Printing

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An Aesthetic Characterization of Plaster of Paris as an Alternative Ink Medium for Silk Screen Printing

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This study investigates the potential of Plaster of Paris (POP) as an alternative medium for producing a water-based screen printing ink. The project is based on the concept of aesthetic experimentation through the 'jigsaw puzzle' technique to explore different types of print characteristics. For instance, in terms of consistency, workability, colour densities, and impression qualities. The evaluation measures include the use of medium – particle size through the Field Emission Scanning Electron Microscopy (FE-SEM) testing, microstructural and chemical composition analysis using Scanning Electron Microscope-Energy Dispersive Spectrometer (SEM-EDS), and toxicity analysis using Inductively Coupled Plasma Optimal Emission Spectrometer (ICPOES). The results show that the formulated medium has a unique property and provided opportunities in creating different types of luminosity and opacity effects. It also created unique print characteristics which is capable to derive a huge aesthetic potential

within the context of ideas development, concept, and creativity specifically for artists and designers.

Key words: *Plaster of Paris, Screen Printing, Aesthetic, Alternative Medium.*

Introduction

Silk screen printing is the process of making designs using stencil techniques where the ink is only pushed through the surface of the stencil by using a squeegee tool. Prints are based on designs and mediums that are ideal for producing attractive and unique effects that become "the language of visual expression" (Stankiewicz, 2004, p. 90). Screen printing is extremely flexible and can be customized for printing on various surfaces or materials such as plastic, metal, wood, paper, textiles and so on. Adam and Robertson (2003, p. 7) mentioned that "…valued for its speed and flexibility in terms of the variety of surface on which an endless range of colours could be printed" (Adam and Robertson, 2003), making screen printing popular for commercial production and for aesthetic works. Exploration and experimentation by artists and designers to print on various surfaces and incorporating various mediums, especially water-based pigments, can create new methods of mark making or image distortion which significantly influences the changes on surface characteristics (Kasikovic, Vladic, Milosevic, Novakovic and Stancic, 2013). According to Adam and Robertson (2003), many approaches to image creation can now be explored by various groups, and fine art screen printing no longer needs to be characterized or identified by certain effects (Adam and Robertson, 2003).It is free and open which allows "the overlap and displacement of domains of difference" (Bhabha, 2007, p. 2) or uniqueness.

The radical approach to continuing exploration and experimentation by artists and designers in the context of contemporary print art development has created a new visual aesthetic (Sedon, 2015), especially surface tactility and impression. Karim and Mohamed (2011) state that the artist has dared to leave the print convention and is free to undertake various mediums to produce artwork using new methods and other mediums that allow for new specific attributes and characteristics in printings. The flexibility of screen printing to suit any recent technological changes creates new discourses in the aesthetic and critical contexts, as well as expressions that can broaden the visual arts field. Hartt (1976) states that the change of style and art form is regarded as an evolutionary representation in technical and technological approaches.

Artists and designers are constantly exploring and referring to other visual aesthetic innovations to extend creativity towards idea migration and adaptation of approaches to printing in various possibilities and conditions which "challenged and changed the established perception of the medium" (Adam & Robertson, 2003, p. 8). Meanwhile, Carroll (1999) states that the form changes due to the occurrence of context changes, where it

requires a form of representation (Carroll, 1999). In this context, the transformation and development of aesthetic value has always led to the quest and creation of a unique new form where "printmakers developed bodies of work that embraced a broader realm of studio practice than that usually pertaining to the print (Kirker, 2009, p. 12).

The ongoing experimentation is very important in the development of the print field, especially in the context of industrial technology development. For instance, Merrill (1993, p. 8) states that "print is not a technique, a category, or even an object; it is a theoretical language of evolving ideas…where original and reproductive roles become complimentary possibilities rather than opposing categories" (Merrill, 1993). Meanwhile, Eames (2004) in Hamilton (2009) explained that the variety of markings available from the silk screen discipline offered the artist's dynamic visual content by developing an understanding of technology while using them throughout their practice (Hamilton, 2018). In other words, all forms of experimentation are a platform to find new possibilities, methods, and techniques in the field of screen printing as an "attempt to go beyond boundaries of the tradition in order to elevate printmaking parameters" (Mohamed Saat, 2009, p. 47 in Shahir & Mohamed Saat. 2009; Rahman & Zhang 2017).

Project Outline

The experimental approach was used to investigate, explore, and develop the potential of the Plaster of Paris (POP) as a suitable medium for screen printing application through the 'jigsaw puzzle' technique. The investigation includes the technical aspect of medium - particle size, textural quality and aesthetic value, the condition and strength (durability/flexibility) of the medium, and the printing process suitability. Field Emission Scanning Electron Microscopy (FE-SEM) testing was conducted to determine the size of particle - physical properties. The composition analysis was conducted through a microstructural and chemical composition analysis using the Scanning Electron Microscope-Energy Dispersive Spectrometer (SEM-EDS) to determine the component of the medium. The medium was also tested for toxicity analysis using the Inductively Coupled Plasma Optimal Emission Spectrometer (ICP-OES) and was compared with minimal risk levels list from Agency for Toxic Substances & Diseases (ATSDR).

The project is concerned specifically with the idea of the aesthetic characterization as followed:

- To develop a prototype of ink paste by utilizing the Plaster of Paris-based medium for the Silk Screen Printing application.
- To evaluate the quality of the medium within the context of consistency and print characteristics which are in terms of textural effects, colour densities and impression

qualities.

- To optimise the flexibility and workability application of the medium for variety of material and surfaces.

The Experimentations

Preparing the Plaster of Paris

Initially, the POP was prepared by mixing the POP powder with water until it reaches a smooth consistency to produce a POP solution, wherein the preferable ratio of the water to the POP powder is 1:2. Then, pouring the POP solution into a mould and drying until it becomes hardened and dried is the later step. The next processes include crushing and pulverizing the hardened POP solution to obtain a fine powder and blending using a ball mill machine (YLK, YKM 12L) to get a very fine powder.

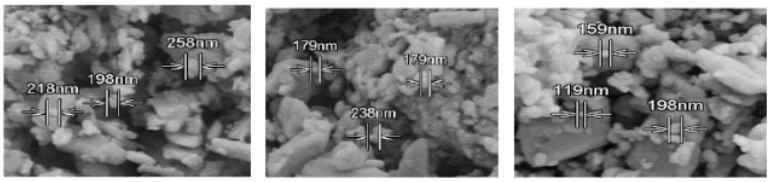
Field Emission Scanning Electron Microscopy (FE-SEM) Analysis

In this study, the analysis of the surface morphology of the treated POP using SEM (HITACHI, SU8020) was done after it has been treated with different procedures such as temperature, duration of grinding and rpm of the grinder. All the samples of POP were coated with platinum for 30 seconds using the Sputter Coater model Quorum Q150PS to prevent complications due to charging. This procedure is important in order to get clearer images during analysis. A primary electron or electron gun was produced from tungsten filament at the top of the column where the voltages are greater. The primary electron beam travels through the electromagnetic field and condenser lenses, which focuses the beam down towards the sample. Once the primary electron beam hits the sample, the secondary electron and back-scattered electron are exited and detected by a detector. The detector converts them into a signal by the scanning coil and is then sent to the monitor screen in image types.

The SEM image of POP is presented in Figure I. The image shows the surface morphology of POP after being treated with different methods of grinding process with the voltage of 5.0 kV and 5,000x magnification. Three samples of POP (A1, A2 and A3) were prepared from different condition of the revolutions per minutes (rpm). The duration for each grinding process was set for 30 minutes.

In Table 1, the results show that A1 displayed a dense and porous texture (Figure. 1, A1) with average size of the porosity 198-258 µm when the rpm was set to 300 rpm. The texture of A2 (Figure. 1, A2) which had better result of smooth and dense surface texture showed average of the porosity size 179-238 µm. Meanwhile, A3 showed the best result with porosity size average 119-198 µm when the rpm was set at 500 rpm (Figure. 1, A 3). Therefore, the particle size at this stage is ideal for producing fine and consistent paste in terms of viscosity.

Figure 1. FESEM surface morphology



A1 **A2** **A3**

Table 1: Processing Method and Particle Sizes

Sample	Method of processing	Particle sizes (µm)
A1	300rpm	198 - 258
A2	400rpm	179 - 238
A3	500rpm	119 - 198

*duration = 30 minutes

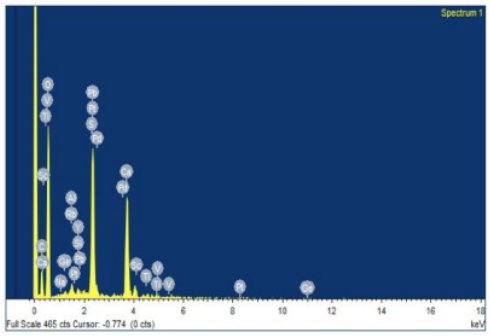
Scanning Electron Microscope-Energy Dispersive Spectrometer (SEM-EDS) Analysis

The composition analysis was conducted through microstructural and chemical composition analysis using the scanning electron microscope-energy dispersive spectrometer (SEM-EDS) to determine the component of the medium. The EDS peaks of elements in the POP are shown in Figure II. The concentration of elements i.e. C, O, S, Ca and Pb is presented in Table 2. The C content of medium surface were 11.64%. The Si and Ca content were found to be slightly higher in value at 8.10 and 8.32%, respectively. Among the elements, the content of O was observed to be much higher in comparison to others, 69.20%, while other elements showed below 1%.

Table 2: Composition Analysis

Element	Weight %	Atomic %
C	6.67	11.64
O	52.79	69.20
Na	0.11	0.10
Al	0.54	0.42
Si	0.39	0.29
S	12.39	8.10
Ca	15.90	8.32
Sc	0.52	0.24
Ti	0.60	0.26
V	0.34	0.14
Ge	0.63	0.18
Rb	0.40	0.10
Y	0.74	0.17
Pd	0.15	0.03
Pt	0.70	0.08
Pb	7.15	0.72
Total	100	

Figure 2. EDS Spectrum



Inductively Coupled Plasma Optimal Emission Spectrometer (ICP-OES) Analysis

The medium also has been tested for toxicity analysis using the Inductively Coupled Plasma Optimal Emission Spectrometer (ICP-OES). The analysis presented the mean concentration levels of Cr, Co, Ni, As, Se and Pb were found to be 1.51, 0.14, 2.10, 0.12, 0.91 and 1.36 µg/g, respectively. The analysis also showed that no Hg were detected in the medium.

It is shown that the concentrations of the heavy metals determined in the tested medium were lower than the admissible ones regulated by the Agency for Toxic Substances and Disease

Registry (ATSDR), therefore the medium is safe and can be used for general purposes especially to humans. The results were summarize as shown in Table 3.

Table 3: ICP-OES Analysis

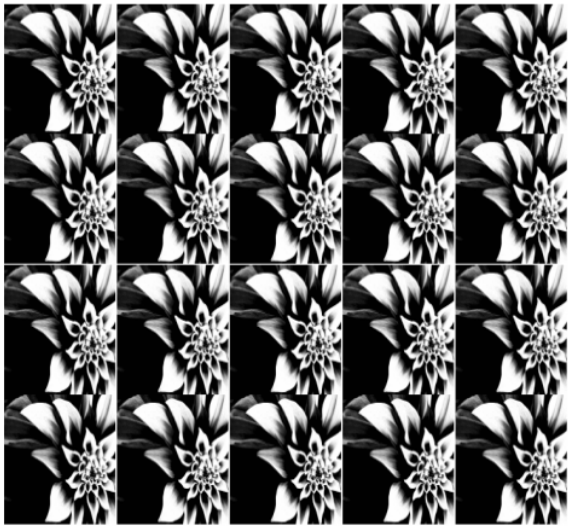
No.	Metals	POP Paste	Min risk levels (µg/g)
1.	Cr (chromium)	1.51	5.00
2.	Co (cobalt)	0.14	10.00
3.	Ni (nickel)	2.10	0.20
4.	As (arsenic)	0.12	5.00
5.	Se (selenium)	0.91	0.50
6.	Hg (mercury)	None	2.00
7.	Pb (leads/plumbum)	1.36	2.00

Consistency

The most important aspect for any screen printing medium is the consistency and reproduction capability. Ink paste is produced through a combination of processed POP powder, thickener, binder, water and printing paste. 20 editions of black and white images were printed with the treated POP and they worked perfectly without any sign of drying on the screen during the printing process. The drying period of the medium is about 15 minutes, which is quite similar to any commercial medium. Throughout all the conditions including the preparing, the printing process, and testing of the treated POP, it showed that POP based paste is capable of reproduction and mass production.

Figure 3. POP paste (white) and black acrylic mixture

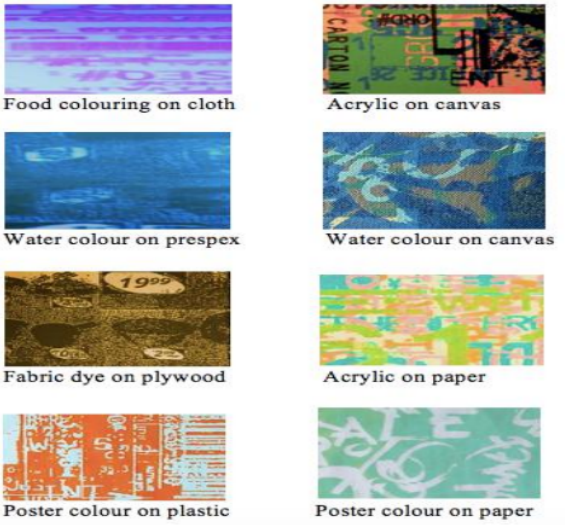
Figure 4. Edition Series Example



Mediums and Materials Experiments – Print Characteristics

Experimentation was done on different surfaces quality such as plywood, plastic, Perspex, paper, cloth and canvas by using and combining different colour mixture. Aesthetically, the colour reacts differently depending on the colour mixture and printing layers, materials and surface characters which create variation of textural effects, colour densities and impression qualities. For example, poster colour mixture on paper creates an opaquer outcome which produces more brilliant and thicker colour impression. While the food colouring or water colour on screen mesh creates a more subtle effect. The water colour mixture creates more translucent quality, but the opacity can be found in poster colour mixture. The medium is also capable to work on smooth surfaces like plastic and Perspex which work perfectly as any other commercial printing mediums.

Figure 5. Mediums, materials Experiments



Results and Discussions

Impression quality is an important element in the print aspect, which is the main representation of the image. The composition displaying flower images through posturize techniques incorporates acrylic colors printed on canvas. By changing the mixture ratio between the medium (paste) and the color to 70%: 30%, it can produce a strong color contrast and is able to construct a clear form and space illusions or realistic representation. Figure. 6 is a composition that uses a combination of acrylic and poster colors produced through 8 layers of color printed from light to dark tones (posturize technique). The combination of vivid colors gives a counterintuitive effect on the illusion of form and image.

Figure 6. Composition 1

Application of silk screen printing is very wide in the context of commercial production for various products such as handicrafts, decorations and so on. Prints are made on paper, plastics and fabrics for stationery items, cards, paper foil and decorative lamps for the

exploration of the suitability of medium applications (paste) for a variety of usage. All product samples (Figure. 7) uses a single layer printing technique. Blue watercolor mixture was printed on the handmade paper using organic image composition to serve as a packaging paper. The watery nature of the watercolor paint has a striking transparent effect on the surface of the effect. Whereas, fish composition images are printed on plastic and paper surfaces using black poster color mixture as a decorative stationery product. The round-shaped lamp decoration was printed using black ink mixture on handmade paper, while the box-shaped lamp decoration was printed in black acrylic mixture on canvas which produces opaque color effects. The experiments carried out show that this ink paste medium is suitable for commercial purposes which can be printed on hard and soft surfaces, especially for decorative and stationery products.

Figure 7. Stationary, craft and decoration applications

In Figure 8, the work comprises of twelve overlapping layers on a printed canvas using poster colour, water colour, and food colouring mixtures. The use of different colours and text characters in this work produced the illusion of tactile surfaces, while the bright colours both on the bottom and top images strongly modified viewers' perception and created a rhythmic balance illusion that create variation of visual qualities.

The density of the textual text composition in translucent effect through combination of different colour pigments create an interesting effect through the contrast of light and dark values which creates variation of tactual impressions. The bright texts harmoniously blend with the chromatic composition where the density of the codes' composition on the background and variation of images that are arranged in grid formation stimulates an active visual experience between positives and negatives spaces. Through its variation of printing characteristics, there is no doubt that the medium (paste) works perfectly and is suitable for screen printing process.

Figure 8. Abstract artwork application

Conclusions

The project has explored and significantly formulated the alternative water-based medium (paste) from Plaster of Paris for screen printing which is applicable to be mixed with any other water-based colours (pigment/liquid/powder). Aesthetically, the medium reacts differently depending to the colour mixture and printing layers, materials, and surface characteristics which provides an opportunity to create a variety of print characteristics (densities and impression qualities). The medium is significant to the field of creative arts by creating an alternative medium that allows exploration of printing application. Its unique characteristics have a huge potential for artists, designers, decorators, and printmakers for aesthetic construction or commercial purposes in building and developing ideas in the context of the application, concept, and creativity.

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