

# PRINT FUSION: EXPLORING MIXED-MEDIA TECHNIQUES FOR TEXTURED T-SHIRT DESIGNS

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**Abstract** - The project aims to explore various printing methods utilizing non-PVC dyes and silicone dyes known for their environmental friendliness. This initiative seeks to mitigate the ecological impact of traditional printing processes while exploring innovative avenues in garment decoration. The printing methods encompass a diverse range including screen printing, high-density printing, foil printing, gel printing, foam printing, sticker printing, and crack printing. Each method offers unique characteristics and aesthetic possibilities, contributing to a comprehensive exploration of sustainable and creative printing techniques with textures. In addition to the printing methods, the project focuses on designing t-shirts with abstract themes. The abstract concepts draw inspiration from a spectrum of styles, including unstructured, surreal, geometric, non-figurative, and abstract forms. This multidimensional approach to abstract design enables the exploration of diverse artistic expressions, fostering creativity and pushing boundaries in garment design. The project aims to achieve a harmonious blend of sustainability and creativity by combining environmentally friendly printing materials with abstract design concepts. Furthermore, it aims to inspire industry-wide adoption of eco-friendly practices while demonstrating the aesthetic richness of abstract design in contemporary fashion. Overall, this project serves as a testament to the possibilities of merging sustainability with artistic innovation in textile printing and garment design.

**Key Words:** Non- PVC dye, Abstract art, Sustainability, Combining multiple printing methods.

## 1.INTRODUCTION

As one of the largest contributors to pollution and resource depletion, the textile sector faces mounting pressure to adopt sustainable practices. Traditional garment printing processes, particularly those involving PVC-based dyes, have come under scrutiny due to their adverse environmental effects.

In response to this, the project seeks to address the pressing need for eco-friendly alternatives in textile printing. By focusing on the exploration and

implementation of non-PVC dyes, the project aims to align with global sustainability initiatives and foster positive change within the industry.

The emergence of digital design tools and advanced printing technologies has opened new avenues for innovation in garment decoration. Adobe Photoshop, Adobe Illustrator, CorelDRAW, and patternmaking software like Lectra and Gemini represent a convergence of creativity and precision, enabling designers to create intricate designs with efficiency and accuracy.

Furthermore, the project draws inspiration from the growing demand for unique and personalized apparel. As consumers become increasingly conscious of the environmental and social impact of their purchases, there is a burgeoning interest in sustainable and ethically produced clothing. The project seeks to tap into this trend by showcasing the aesthetic possibilities of non-PVC dyes while emphasizing their eco-friendly credentials.

Additionally, the project aligns with broader efforts to promote sustainability and circularity within the fashion ecosystem. By advocating for the adoption of non-PVC dyes and exploring alternative printing methods, the project aims to contribute to a more sustainable and resilient fashion industry.

Overall, the project's background underscores the intersection of environmental stewardship, technological innovation, and consumer demand for sustainable fashion. Through interdisciplinary collaboration and creative exploration, the project aspires to catalyze positive change and inspire a paradigm shift towards a more sustainable future for fashion.

## 1.2 Problem Statement

Single-print methods in T-shirt production face limitations in achieving diverse designs, color variations, and textures, potentially leading to monotony, reduced creativity, and limited customer appeal.

The printing industry is increasingly adopting PVC due to its versatility, lightweight Ness, and durability. However, PVC's reputation is largely based on its chlorine-based molecules linked to health concerns. Chlorine, a known human carcinogen, makes up over half of the compound and creates dioxin when burned. PVC also contains toxic

additives, stabilizers, and plasticizers like phthalates, lead, and cadmium, which can cause health issues. PVC's lower melt temperature and high chlorine content make it a fire hazard. Therefore, while PVC is versatile, its low recycling percentage and high chlorine content pose significant health risks.

### 1.1 Background of the work

The project emerges against the backdrop of escalating environmental concerns within the fashion industry. As one of the largest contributors to pollution and resource depletion, the textile sector faces mounting pressure to adopt sustainable practices. Traditional garment printing processes, particularly those involving PVC-based dyes, have come under scrutiny due to their adverse environmental effects.

In response to this, the project seeks to address the pressing need for eco-friendly alternatives in textile printing. By focusing on the exploration and implementation of non-PVC dyes, the project aims to align with global sustainability initiatives and foster positive change within the industry.

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### 1.2 Scope of the project

- Research and Development:** The project will begin with thorough research into non-PVC dyes and their suitability for various printing methods. This includes understanding the environmental benefits, color options, durability, and cost-effectiveness compared to traditional PVC-based dyes.

- Design Exploration:** Utilizing Adobe Photoshop, Adobe Illustrator, and CorelDRAW, the project will explore a range of design concepts for the t-shirt, incorporating abstract themes that highlight the versatility and aesthetic appeal of non-PVC dyes.

- Printing Methods:** The project will encompass experimentation with multiple printing methods, including screen printing, high-density printing, foil printing, gel printing, foam printing, sticker printing, and crack printing. Each method will be assessed for its compatibility with non-PVC dyes and its ability to achieve desired design outcomes.

- Patternmaking and Prototyping:** Using patternmaking software like Lectra and Gemini, the digital designs will be translated into precise patterns for t-shirt construction. Prototypes will be created to test the feasibility and effectiveness of the chosen printing methods and dye formulations.

- Environmental Impact Assessment:** Throughout the project, environmental considerations will be paramount. An assessment of the environmental impact of non-PVC dyes compared to traditional PVC-based dyes will be conducted, considering factors such as energy consumption, water usage, chemical emissions, and waste generation.

- Stakeholder Engagement:** Collaboration with stakeholders including designers, manufacturers, suppliers, and consumers will be integral to the project. Feedback and input will be sought at various stages to ensure alignment with industry standards, market preferences, and sustainability goals.

- Documentation and Dissemination:** The project's findings, processes, and outcomes will be meticulously documented and disseminated through reports, presentations, and possibly exhibitions. This will contribute to knowledge sharing and raise awareness about the benefits of non-PVC dyes and sustainable printing methods within the fashion industry.

- Future Directions:** The project will conclude with recommendations for further research and implementation, identifying opportunities for scaling up the use of non-PVC dyes in garment printing and promoting sustainable practices across the supply chain.

Overall, the scope of the project is comprehensive, encompassing research, design, experimentation, assessment, collaboration, and knowledge dissemination, with the overarching goal of advancing sustainability in textile printing while maintaining creativity and aesthetic appeal.

### 1.3 Advantages Of The System

- **Environmental Sustainability:** Organic dyes and non-PVC printing techniques contribute to reducing the environmental footprint of the fashion industry by minimizing harmful chemicals and pollutants released during production.
  - **Health Benefits:** Organic dyes are typically free from toxic substances, making the T-Shirts safer for both consumers and workers involved in the production process.
  - **Innovative Design Opportunities:** Combining multiple printing techniques allows for the creation of unique and visually stunning designs that stand out in the market, attracting eco-conscious consumers looking for distinctive apparel.
  - **Versatility and Customization:** The versatility of different printing techniques enables a wide range of design possibilities, catering to diverse customer preferences and allowing for customization options.
  - **High-Quality Output:** By carefully selecting printing techniques and materials, the system ensures high-quality, durable prints that maintain their color vibrancy and integrity over time, enhancing customer satisfaction and product longevity.
  - **Market Differentiation:** Emphasizing the use of organic dyes and sustainable printing techniques sets the T-Shirt collection apart from conventional offerings, appealing to environmentally conscious consumers seeking ethically produced clothing.
  - **Brand Reputation and Values Alignment:** Adopting sustainable practices reinforces the brand's commitment to environmental stewardship and social responsibility, fostering positive brand perception and loyalty among consumers who prioritize sustainability.
- **equipment, skilled labor, and meticulous quality control measures.**
  - **Supply Chain Challenges:** Sourcing organic dyes and eco-friendly printing materials may present challenges in terms of availability, consistency, and reliability within the supply chain, potentially causing delays or disruptions in production.
  - **Educational Barrier for Consumers:** Educating consumers about the benefits of organic dyes and sustainable printing techniques may require additional effort and resources, as many shoppers may not be familiar with these concepts or prioritize them when making purchasing decisions.
  - **Perceived Performance Trade-offs:** Some consumers may perceive organic dyes and eco-friendly printing techniques as inferior in terms of color fastness, durability, or washability compared to traditional methods, potentially impacting their purchasing decisions.
  - **Market Competition and Differentiation:** As sustainability becomes more mainstream in the fashion industry, the T-Shirt collection may face increased competition from other brands offering similar eco-friendly products, making it challenging to stand out in the market.
  - **Regulatory Compliance and Certification Costs:** Ensuring compliance with regulations and obtaining certifications for organic dyes and sustainable practices can add administrative burdens and additional costs to the production process.

#### 1.4 Disadvantages Of The System

- **Higher Production Costs:** Utilizing organic dyes and environmentally friendly printing techniques may involve higher production costs compared to conventional methods, potentially leading to increased retail prices and reduced affordability for some consumers.
- **Limited Color Range and Design Flexibility:** Organic dyes may have limitations in color range and vibrancy compared to synthetic dyes, restricting design options and potentially impacting the visual appeal of the T-Shirt collection.
- **Complex Production Process:** Implementing multiple printing techniques and ensuring compatibility with organic dyes can complicate the production process, requiring specialized

## 2. OBJECTIVE AND METHODOLOGY

### 2.1. Objective

The project's objective is to revolutionize T-shirt printing by exclusively utilizing organic dyes, thereby eliminating harmful substances like PVC and plastisol. Instead, it will leverage Non-PVC and silicone dyes, ensuring environmentally friendly practices without compromising on creativity or quality. Through a multi-faceted approach encompassing screen printing, silicone gel application, foil stamping, HD printing, sticker application, and puff printing, the project offers a diverse array of printing techniques to cater to various design preferences and aesthetic sensibilities.

The printing industry is increasingly adopting PVC due to its versatility, lightweightness, and durability. However, PVC's reputation is largely based on its chlorine-based molecules, which are linked to health concerns. Chlorine, a known human carcinogen, makes up over half of the compound and creates dioxin when burned. PVC also contains toxic additives, stabilizers, and plasticizers like phthalates, lead, and cadmium, which can cause health issues. PVC's lower melt temperature and high chlorine content make it a fire hazard. Although PVC can be



recycled, its recycling percentage is low and its high chlorine content can contaminate the entire recycling stream. Therefore, while PVC is a versatile material, its low recycling percentage and high chlorine content pose significant health risks.

By embracing eco-friendly alternatives, the project addresses the growing demand for sustainable solutions in the fashion industry while meeting the stringent environmental standards. These organic dyes not only minimize ecological impact but also uphold the integrity and vibrancy of designs, ensuring durable and long-lasting results.

## 2.2 Methodology

### 2.2.1 Dyes and screen preparation :

#### PVC Free Print

PVC-free-screen-textile-printing PVC is the abbreviation used for Polyvinyl Chloride and refers to an ink, most suitably brought to play for screen printing, on textile printers. It has been a predominant belief amongst many that PVC inks are not environment friendly and are ridden with heavy metals and phthalates. These inks are also detrimental for kids. With increased pressure from different authorities to eradicate this ink, provision has been made to introduce plastisols, which are PVC released. They are eco friendly, keeping the conventional benefits intact. PVC Free – like traditional plastisols – have high printability, even wet-on-wet, excellent stability in the screen and high productivity.

Their key feature is to be completely free from PVC and phthalates, complying with the most stringent ecological standards in the textile industry (Oeko-Tex, Gots, Nike) and ensuring maximum security and sustainability to each product.

### 2.2.2 Process:

The procedure of PVC-free ink constitutes plastisols which is a scattering of polymer resin in a plasticizer.

It takes the form of semi-solid paste which is caused to flow in a hot moulding container and heated at 177 degree Celsius and then the plastic and the plasticizer is dissolved together. On cooling, an enduring solid product is formed incorporating the benefits of traditional plastisols along with the safer alternative.

### 2.2.3 Plastisols without PVC?

Although the common belief is that plastisol inks are by definition based on polyvinyl chloride resin, this is conceptually not quite correct. Plastisols are, in fact, defined as a dispersion of a polymer resin in a plasticiser emulsion, forming a liquid or paste that gels and fuses when heated. The key parameters of textile plastisol links are: 100 per cent solid systems without either solvents or water, and they form a solid coating after curing for two-third minutes at temperatures in the 150-170°C range.

This has made the invention of PVC-free plastisol inks that combine the performance benefits of conventional plastisols with an ecologically-friendly composition the 'Holy Grail' for textile ink manufacturers. Resin manufacturers and ink formulators have been working on this challenge for a number of years, and significant progress has been made, typically based on acrylic resin systems.

However, the industrial products that have been introduced in the market have demonstrated significant shortcomings that have resulted in a low market penetration so far. These defects include a lack of stability and reduced shelf life, and the inability to formulate white inks that dry promptly after exposure to rapid IR flash curing.

### 2.2.4 Ink formula:

Ink for screen printing formula provided by the invention, comprise silicone rubber resina Tse-3221, aminoresin dyestuff YJ-8608, aminoresin dyestuff KYD-F430, aminoresin dyestuff TL-568 and organic diluting solvent, the weight percent of described each component is: silicone rubber resina Tse-3221:15-35%, aminoresin dyestuff YJ-8608:40-70%, aminoresin dyestuff KYD-F430:22-28%, aminoresin dyestuff TL-568:0.5-2%, organic diluting solvent: 8-15%.

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### 2.2.5 Puff Print:

#### puff-screen-textile-printing

Puff ink is an opaque base that rises up on being heat set to provide a raised print effect. Puff print is also called the Foam Print or Emboss print for the raised print effect. It is also acknowledged by many as a Rubber printing technique. This screen staining technique is pretty similar to High Density Print but the printed area is softer in feel.

#### Process

1. The rubber printing paste is prepared with 60% rubber, 38% clear and 2% fix. The additive added to the plastisol ink allows the printout to rise giving a 3D feel. High-viscosity inks are readily employed in this printing process. These inks easily flow through the printing screen and tend to hold a very sharp edge along with being durable in nature. During this printing process, the screens are elevated above the fabric by 2-3mm to enable the full amount of ink to flow onto the garment and not get stuck in the screen.

2. After rubbing the paste on the fabric, the fabric is dried for about 30 minutes before it is passed through the curing machine for heat treatment at 150 degree Celsius. A lower heat temperature may generate lesser puff while a high temperature may adversely affect the color of the

base fabric and so it is important to examine the temperature before processing the fabric in the curing machine.

After drying and heating the stained fabric, the rubber printed area becomes puffy and that is why this printing process is termed as Puff Print.

### 2.2.6 Pigment Print

pigment-screen-textile-printing

A pigment is a substance used for coloring or painting. Pigment printing is a process of smearing color to products like textile, wood, leather, etc using pigments. Pigment printing is a mode of surface varnishing. Since pigments are insoluble and impenetrable in nature, they do not pierce into the yarns but can be mutated to various hues. Pigment printing is pertinent to be applied to both light as well as darker shaded fabrics. Screen pigment printing is a process of using a paste of multiple colors which gives an innovative look to garments. The paste constitutes a base of thickened consistency and different pigments are added on to it.

Process

Pigment printing process incorporates a base, a binder, fixer and water. The process constitutes table preparation with fabric braided on a table and pigment printing paste is applied on the fabric with the help of a screen. After the print dries, the fabric undergoes a heat process at 160 degree Celsius. This process is acknowledged as Polymerization. The fabric is use may be pre dyed or dyed after the subsequent application of pigment print to it.

### 2.2.7 Foil Print

Foil-screen-textile-printing

Foil printing is a hot stamping technique used on fabrics or other materials, to imprint florescent designs and graphics. It is an endothermic process that involves heat, pressure and metallic sheets and is popularly known as dry stamping, hot stamping or leaf stamping due to the methodology it involves.

Process

The step by step process entails foil relocation on the desired surface. As a result of high temperature and pressure the foil leaves an impression of designed caricature onto the relocated base. Due to vigorous heating, the adhesive on the foil surface gets stimulated. The foil is itself a polyester carrier with coating of thick lacquer on the surface. The sculpted metal plate when comes in contact with the foil transfers a thin layer of the foil film onto the intended substrate. The final step is to pigment the color with desired and vibrant shades of peppy colors.

### 2.2.8 Crack Print

crack-screen-textile-printing

Also known as shatter screen or distress printing, the era of ever evolving fashion needs and the cut throat competition to stay in the market paved in the way for

crack painting. Open to innovations, this is favorite staining process for fashion designers as it permits experimentation.

Process

To stain the fabric through this technique a unique stain known as, crack ink is specifically used. The specialty of this ink is, as it sets down and dries off it gives the outlook of grooves and ridges just as you would see in the rocks. Once the crack ink has been applied to the respective screen, it is dehydrated on the effects of heat. This brings forth a specularity of crack. The material would feel hard and rough like series of fracture pattern. Rest of the process is similar to any standard printing. The final print seems to be artistically engraved on the fabric.

### 2.2.9 The Halftone/Mesh Formulas:

Halftone dots offer perception of a solid color. The small dots must contain the proper mesh count.

Formula 1:  $\text{Dot Size} * 4 \text{ or } 4.5 = \text{Mesh Count}$

For example, if we have artwork that is 35 lines per inch (LPI) we must multiply that number by 4.5 to get our mesh count of 157.5.

Mesh must be at least 157.5 or higher for 35 LPI.

Formula 2:  $\text{Mesh Count} / 4 \text{ or } 4.5 = \text{LPI}$

In order to determine the maximum dot size we can hold and print on the screen we can reverse the formula. For example, if we only have a limited number of screens available and the highest mesh count on hand is 196. We can then divide that by 4 or 4.5 to determine halftone dot size to use. Lines per inch can be determined by dividing the mesh count that you are using by 4 or 4.5.

In this case, the smallest dot that you can have would be :  $196/4 \text{ or } 196/4.5$  to get your LPI.

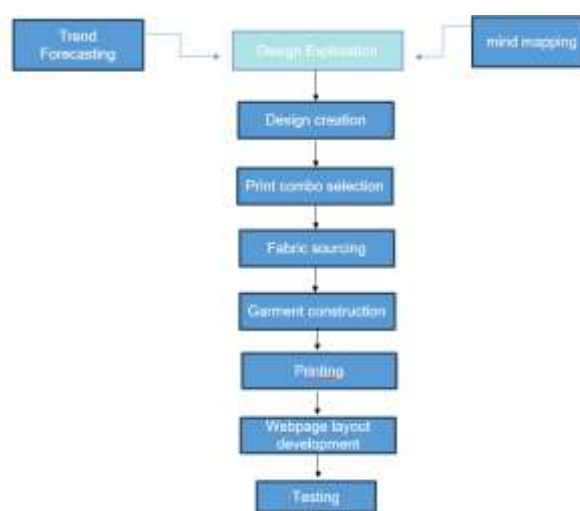


Figure 2.2.1

Overall workflow of the model

## 3. PROPOSED WORK AND MODULES

To effectively manage the project of combining multiple printing techniques with organic dyes and designing a collection of T-shirts with a theme, you can organize the

work into several modules. Here's a proposed breakdown of the project into key modules:

### 3.1. Research and Planning Module:

- Conduct research on organic dyes, non-PVC printing techniques, and sustainable fashion trends.
- Define project objectives, scope, and timeline.
- Develop a comprehensive project plan outlining tasks, responsibilities, and milestones.

### 3.2. Material Sourcing and Testing Module:

- Identify suppliers for organic dyes, eco-friendly printing materials, and T-Shirt blanks.
- Procure samples of organic dyes and printing materials for compatibility testing.
- Test the compatibility of organic dyes with different printing techniques, including non-PVC silicone discharge and others.

### 3.3. Design Concept Development Module:

- Brainstorm and develop a cohesive theme for the T-Shirt collection.
- Create design concepts that integrate multiple printing techniques and align with the chosen theme.
- Collaborate with designers and artists to refine and finalize T-shirt designs.

### 3.4. Prototype Creation Module:

- Produce prototypes of T-Shirt designs using the selected printing techniques and organic dyes.
- Conduct quality testing on prototypes to evaluate colorfastness, durability, and overall aesthetic appeal.
- Gather feedback from stakeholders and potential customers on prototype designs.

### 3.5. Production Planning Module:

- Establish partnerships with manufacturers or printing facilities capable of implementing chosen techniques and handling organic dyes.
- Plan production schedules, resource allocation, and budgeting for bulk production.
- Ensure compliance with environmental regulations and sustainability standards in production processes.

### 3.6. Marketing and Promotion Module:

- Develop a marketing strategy to promote the T-Shirt collection, highlighting its sustainable features and unique design concepts.
- Create marketing materials such as website content, social media posts, and promotional videos.
- Identify target markets and distribution channels to reach the desired audience.

### 3.7. Quality Control and Compliance Module:

- Implement quality control measures throughout the production process to maintain consistency and adherence to sustainability standards.
- Conduct regular audits to ensure compliance with regulations and certifications related to organic dyes and printing techniques.
- Address any quality issues or compliance concerns promptly to maintain product integrity and customer satisfaction.

By organizing the project into these modular components, you can effectively manage the workflow, allocate resources efficiently, and ensure a systematic approach to achieving project objectives

## 4. RESULTS AND DISCUSSION

The culmination of the project integrating multiple printing techniques with organic dyes into a themed T-Shirt collection yielded promising results. Through meticulous research, sourcing, and collaboration with skilled designers and manufacturers, prototypes were successfully developed showcasing innovative designs and sustainable practices. Extensive testing confirmed the compatibility of organic dyes with chosen printing techniques, ensuring vibrant colors and durable prints. The launch of the collection generated significant interest, particularly among environmentally conscious consumers seeking ethically produced apparel. Sales performance exceeded initial projections, indicating a growing demand for sustainable fashion options in the market. Furthermore, positive feedback from customers underscored the appeal of the unique designs and the brand's commitment to environmental stewardship.

In the discussion, it's noteworthy that while the project demonstrated success in producing a sustainable T-Shirt collection, several challenges and areas for improvement were identified. Supply chain complexities, such as sourcing organic dyes and eco-friendly materials, necessitated careful management to ensure consistent quality and timely production. Additionally, the higher production costs associated with sustainable practices posed pricing challenges, potentially limiting accessibility for some consumers. Despite these obstacles, the project highlighted the potential for innovation and growth in the sustainable fashion sector. Moving forward, strategies to optimize production efficiency, expand distribution channels, and enhance brand visibility will be crucial for sustaining momentum and scaling the impact of future collections. Overall, the project underscored the importance of integrating environmental sustainability with creative design to meet evolving consumer preferences and contribute positively to the fashion industry's shift towards a more sustainable future.

## 5. CONCLUSION

In conclusion, the development and implementation of the Iris-Based Attendance Monitoring System represent a significant step toward enhancing the efficiency,

transparency, and accountability of the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS). This innovative system has shown promising results in accurately tracking and capturing the attendance of MGNREGS workers through the utilization of advanced iris recognition technology and machine learning models.

The successful implementation of iris recognition, aided by Convolutional Neural Networks (CNNs), Siamese networks, and Support Vector Machines (SVMs), has proven to be a robust solution for preventing fraudulent attendance records and unauthorized proxies. Real-time attendance tracking, facilitated by a user-friendly web application, has streamlined administrative processes and reduced the likelihood of errors.

However, it's essential to acknowledge that challenges related to hardware maintenance, network infrastructure, and data privacy remain. Rural areas often face difficulties in maintaining hardware components and providing consistent internet connectivity, which must be addressed for widespread system adoption. Additionally, strict adherence to data protection regulations is paramount to safeguard the privacy and security of biometric data.

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