INDIAN INSTITUTE OF TECHNOLOGY, ROPAR

PROJECT REPORT

APPLICATIONS OF ADDITIVE MANUFACTURING IN THE CLOTHING INDUSTRY

Submitted By: Group 3

Korupolu Deekshitha – 2021MEB1292

Nakka Nishika – 2021MEB1301

Surkanti Sai Sahasra – 2021MEB1328

Under the Guidance of:

Dr. Prabir Sarkar

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1. INTRODUCTION

Clothes are more than just what we wear—they're a way we tell our story. Whether it's a fancy work outfit or laid-back casual wear, each piece says something about us. The fabric, patterns, and designs all work together to express who we are and what we connect with.

Additive manufacturing, commonly known as 3D printing, has made significant inroads into various industries, and the clothing industry is no exception. This innovative technology has revolutionized the way clothing and fashion accessories are designed, produced, and customized.

By layering materials to create three-dimensional objects, additive manufacturing offers numerous advantages, including the ability to create intricate designs, reduce waste, and enable on-demand production. In the clothing industry, it is being utilized for creating unique garments, personalized accessories, and even functional clothing for specialized applications.

This report will explore the fascinating applications of additive manufacturing in the clothing sector, highlighting its impact on design, sustainability, and consumer experience.

2. SUSTAINABILITY ASPECT

The clothing industry contributes to environmental harm through excessive textile waste, pollution from production processes, resource depletion, and the environmental impact of fast fashion. These practices harm ecosystems, contribute to climate change, and strain valuable resources. Transitioning to sustainable and eco-friendly practices is crucial for minimizing these environmental impacts.

1. <u>Harmful Chemicals:</u>

Toxic dyes and chemicals: The use of hazardous chemicals in textile production can harm workers, consumers, and the environment.

2. <u>Fast Fashion Culture:</u>

Overconsumption: The promotion of frequent clothing purchases encourages overconsumption, leading to excessive waste and unsustainable practices.

Short-lived trends: Rapidly changing fashion trends contribute to clothing obsolescence and further waste.

3. <u>Pollution:</u>

Textile production involves the release of harmful chemicals and dyes into the environment, contributing to air and water pollution.

4. <u>Reduced Waste:</u>

Traditional clothing manufacturing often results in significant material waste due to cutting patterns and unused fabric. 3D printing allows for precise and additive manufacturing, minimizing material waste by only using the amount of material necessary for the garment.

3. IDEA – INFINTY WEAR

3.1 Aim

- Reduce the consumption of cloth by altering logos rather than purchasing new.
- Reduction of amount that is to be spent by an individual on buying clothes.
- Address the issue of excessive textile waste and overconsumption in the fashion industry.

3.2 Materials

We used Eco-friendly material R-PLA. We can also use PETG & PC-ABS etc.

- Recycled Polylactic Acid (R-PLA) A biodegradable and bioactive thermoplastic derived from renewable resources, such as corn starch or sugarcane.
- Polyethylene Terephthalate Glycol-modified (PETG) PETG is a recyclable thermoplastic that can be recycled into new filaments, making it an excellent choice for eco-friendly 3D printing.
- PC-ABS (Polycarbonate-acrylonitrile butadiene styrene)

3.3 Procedure

Fused Deposition Modelling (FDM) is a popular 3D printing technology that constructs objects layer by layer. It utilizes a thermoplastic filament that is melted through a heated nozzle and deposited onto a build plate. The 3D printer follows a set of instructions in G-code, generated by slicing software, to create the object's geometry. FDM is widely used for its versatility, cost-effectiveness, and ability to produce functional prototypes and end-use parts.

The process of preparing a 3D model for Fused Deposition Modelling (FDM) printing involves several steps, and it often includes the generation of G-code, a set of instructions that tells the 3D printer how to move and extrude material.

Here's a brief overview of the preparation process:

1. Design the 3D Model:

We started by creating a 3D model using computer-aided design (CAD) software. The model should be in a format compatible with 3D printing, such as STL (Standard Tessellation Language).

2. Import into Slicer Software:

We used slicer software (Cura) to convert the 3D model into printable layers. This software takes the 3D model and "slices" it into individual layers, generating the toolpaths needed for the 3D printer to recreate the object layer by layer.

3. Adjust Printing Settings:

We have set various printing parameters, including layer height, print speed, infill density, temperature settings, and support structures. These settings can impact the quality and strength of the final print.

4. Export G-code:

Once all the settings are configured, the slicer software generated G-code, a set of instructions in a specific format that the 3D printer understands. G-code includes details about the toolpaths, temperatures, and other parameters needed for printing.

5. Transfer G-code to the 3D Printer:

Save the generated G-code file and transfer it to the 3D printer. This can be done using an SD card, USB connection, or other means, depending on the printer model.

6. Calibrate the 3D Printer:

Before starting the actual print, we have calibrated the 3D printer. This involved levelling the build plate, ensuring proper nozzle temperature, and checking filament flow to achieve accurate and consistent prints.

7. <u>Initiate Printing:</u>

We started the 3D printing process on the FDM printer. The printer follows the G-code instructions, moving the print head and build plate to deposit material layer by layer.

8. <u>Monitor the Print:</u>

During the printing process, we monitored the printer for any issues such as layer adhesion problems, warping, or other defects. Some printers allow for adjustments while printing is in progress. Once the print is complete, we removed the object from the build plate.

3.4 CAD Model and G-Code

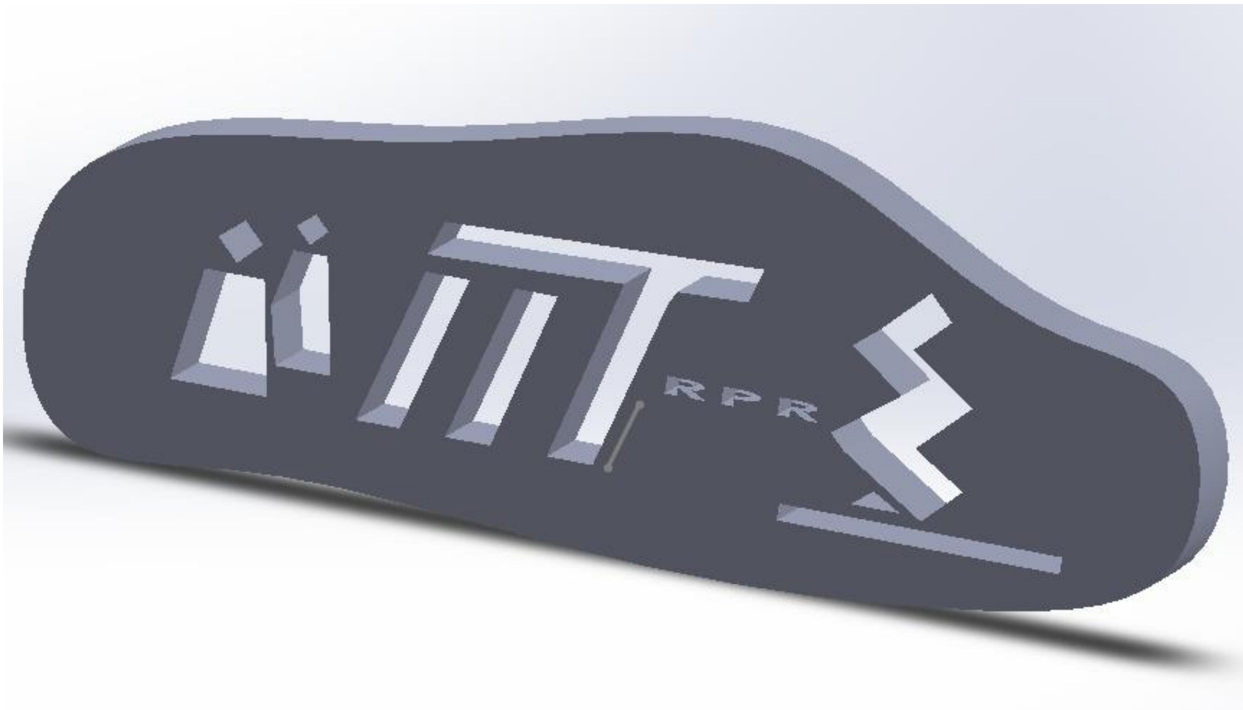

Fig 1. CAD MODEL

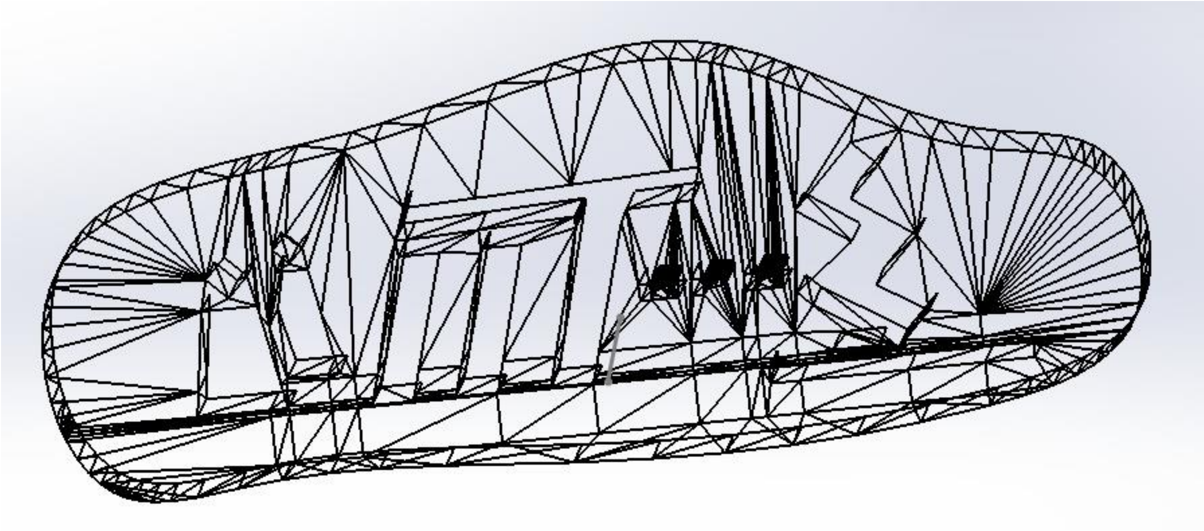

Fig 2. STL FILE

G-CODE:

```
;START_OF_HEADER
;HEADER_VERSION:0.1
;FLAVOR:Griffin
;GENERATOR.NAME:Cura_SteamEngine
;GENERATOR.VERSION:5.5.0
;GENERATOR.BUILD_DATE:2023-10-25
;TARGET_MACHINE.NAME:Ultimaker S5
;EXTRUDER_TRAIN.0.INITIAL_TEMPERATURE:205
;EXTRUDER_TRAIN.0.MATERIAL.VOLUME_USED:31732
;EXTRUDER_TRAIN.0.MATERIAL.GUID:44a029e6-e31b-4c9e-a12f-9282e29a92ff
;EXTRUDER_TRAIN.0.NOZZLE.DIAMETER:0.4
;EXTRUDER_TRAIN.0.NOZZLE.NAME:AA 0.4
;BUILD_PLATE.INITIAL_TEMPERATURE:60
;BUILD_VOLUME.TEMPERATURE:28
;PRINT.TIME:5948
;PRINT.GROUPS:1
;PRINT.SIZE.MIN.X:39.772
;PRINT.SIZE.MIN.Y:69.892
;PRINT.SIZE.MIN.Z:0.2
;PRINT.SIZE.MAX.X:290.227
;PRINT.SIZE.MAX.Y:170.106
;PRINT.SIZE.MAX.Z:6.6
;SLICE_UUID:44ed17e2-7890-4639-a656-3ee771f08681
;END_OF_HEADER
;Generated with Cura_SteamEngine 5.5.0
T0
M82 ;absolute extrusion mode
```

Entire Code Link - G-CODE

STL File Link- STL File

4. PRODUCT

4.1 Description

An attachable and detachable logo is prepared, which can be used on various clothes and various logos can be used on the same cloth, **ultimately reducing the consumption of excess cloths.**

Attachment and detachment can be done in many ways like using Velcro, making small slots to insert, gummy substance to stick, Badge type etc.

4.2 Application

Fig 3. The same logo can be used on different shirts

Fig 4. 3D Printing

4.3 How to use the Product

The CAD Model should be printed using the 3D Printer

1. Take a shirt/kurta on which the logo/design is supposed to be attached.
2. The attachment can be done in many ways like using **Velcro**, **making small slots to insert**, gummy substance to stick, Badge type etc.
3. The attachment type for the logo can be decided based on the type of cloth.
4. Different designs for the logo can be made.
5. Another type attachment is by using a type of **press-fitting typ**e method.

Another design that can be used for specific department

Press-fitting method. Here the logo can be attached by making a nut and bolt type/ pressing so that it can be removed later.

4.4 Advantages

The advantages of promoting logo customization and transformation in the fashion industry are multifaceted.

1. **<u>Versatile -</u>** This approach is highly versatile, allowing individuals to refresh their clothing without discarding entire pieces.
2. **<u>Cost-Efficient -</u>** It proves cost-efficient, offering a sustainable alternative to frequent apparel purchases.
3. **<u>Environment Friendly –</u>** Embracing logo customization has a positive environmental impact, as it reduces the need for new material production and minimizes textile waste.

4.3 Cost Analysis

Additive Manufacturing offers advantages in inventory and transportation costs as well as supply chain management. Build time, energy consumption, and labour are also important factors that affect the cost.

Case – Assume we need 5 types of t-shirts for 5 events

<u>Traditional Manufacturing</u> -5 x (cost of each T-shirt = 250) = 1250 Rupees

<u>Additive Manufacturing</u> - Machine Purchase (one time investment – ideally) – 2 Lakh
Material consumed=20 g (May vary with size) The material spool cost=Rs 80/kg.
Other expenses (Electricity, labour costs, etc.) =60 Rs.
The cost of one logo= (1.6) +(60) = 62, Cost of 5 logos=310 Rs.
Time to produce 5 logos= 4 hours (may vary with size)

From this cost analysis, we can conclude that our idea of using replaceable logos is not only environmentally sustainable but also cost-effective. It reduces the cost of branding for five events from 1250 Rs to just 510 Rs, demonstrating a significant cost saving.

5. FUTURE SCOPE

1. **<u>Technique Modification:</u>** Customization entails adjusting manufacturing techniques to incorporate different materials, colours, and designs, offering consumers personalized options. We can use VAT polymerization for printing with rubbery materials using photopolymer resin

2. **<u>Extended Applications:</u>** Beyond clothing, the concept of logo customization can be seamlessly applied to jewellery and footwear manufacturing, providing a creative outlet for individual expression in various fashion domains.

3. **<u>Eco-Friendly Practices:</u>** Embracing sustainability, the exploration of more eco-friendly materials for crafting logos and products is integral, contributing to reduced environmental impact.

4. **<u>Cross-Industry Applicability:</u>** The versatility of logo customization extends to industries like Aerospace and Defence, where personalized applications can be explored for specialized suits, demonstrating adaptability and innovation in design practices.

6. CONCLUSION

In essence, our project spearheads a **sustainability revolution** in the fashion sector by challenging conventional t-shirt manufacturing methods. Leveraging additive manufacturing, we've innovatively implemented replaceable logos on our garments, presenting a solution to the pervasive issues of overproduction and excessive waste. This forward-thinking approach not only **minimizes environmental impact** but also aligns with a more conscientious and responsible model for the fashion industry. By introducing this transformative concept, we aim to set a precedent for a greener, more adaptive, and consumer-friendly approach to clothing production.