Modular Course D: Customization Engineering

Unit D3: 3D Printing for Customization

Lecture: LD 3.1 – 3D Printing Technologies and Basic Pipeline

Co-funded by the Erasmus+ Programme of the European Union

DISHOLEA | Improving the digital skills of workforce in Shoe and Leather goods Industry in Jordan and Palestine | GA 101129194

T2.2 – Development of modular courses and training material.

D2.4 – Modular Course in Customization Engineering

Contents

Introduction

- Leather & Footwear industry transformation
- Growing demand for customization
- Benefits of 3D printing:
  - Layer-by-layer production from digital models
  - Personalized fits (insoles, lasts, midsoles)
  - Reduced waste, faster prototyping
  - Quicker trend response & localized production

3D Printing Overview

- Additive manufacturing vs. traditional manufacturing
- Applications in multiple industries
- Democratization via CAD software & affordable printers

Birth of 3D Printing

- **1980s:** Stereolithography (SLA) – Charles Hull
- **1989:** Fused Deposition Modeling (FDM) – Scott Crump
- Early innovations → multiple additive technologies

General Process of 3D Printing

1. Create 3D model in CAD → export as STL
2. Slice STL → generate G-code
3. Layer-by-layer printing
4. Post-processing (supports, sanding, curing, painting)

Manufacturing Techniques

- **SLA & DLP:** Resin-based, smooth surfaces
- **SLS:** Powder-based, durable prototypes
- **FDM:** Thermoplastic filament, cost-effective, popular in education

FDM Technology

- Filament → heated nozzle → extruded layer-by-layer
- Key components:
  - Extruder motor, hot end, nozzle, build plate, motion system
- Troubleshooting tips: stringing, warping, adhesion

Materials Used

- **PLA:** Biodegradable, beginner-friendly
- **ABS:** Strong, heat-resistant
- **PVA:** Water-soluble supports
- **HIPS:** Dissolvable support for ABS
- Advanced materials: TPU, carbon-fiber, high-temp nylon

Setting Up a 3D Printer

- Bed leveling, filament calibration, nozzle temperature
- Slicing software (e.g., Ultimaker Cura) → set layer height, infill, supports, speed

3D Software

- **Autodesk Inventor:** Parametric modeling, iterative design
- **Ultimaker Cura:** G-code generation, print preview, beginner & advanced modes

3D Printing Technologies in L&F

- FDM, SLA, SLS, PolyJet, DMLS
- Applications: Customized lasts, insoles, midsoles, tooling
- Considerations: Cost, resolution, durability

3D Printing Pipeline

1. Digital Design (CAD modeling)
2. Slicing
3. Printing
4. Post-processing
5. Validation & Testing

Summary

- 3D printing enables:
  - Customization & personalization
  - Sustainability & reduced waste
  - Faster prototyping & trend adaptation
- Expected to continue reshaping manufacturing