Department of Computer Science and Engineering  
The University of Texas at Arlington

System Test Plan

Team: Ink3D

Project: 3-D Printer Fabrication System

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Table of Contents

[Table of Contents 2](#_Toc381722675)

[2 Introduction 3](#_Toc381722676)

[2.1 Purpose 3](#_Toc381722677)

[2.2 Scope 3](#_Toc381722678)

[3 References 3](#_Toc381722679)

[4 Test Items 3](#_Toc381722680)

[4.1 Product Version 3](#_Toc381722681)

[4.2 Design Decomposition 3](#_Toc381722682)

[4.3 Assumptions 3](#_Toc381722683)

[4.4 Restraints 3](#_Toc381722684)

[5 Risks 3](#_Toc381722685)

[6 Features to be Tested 3](#_Toc381722686)

[7 Features Not to be Tested 3](#_Toc381722687)

[8 Testing Approach 3](#_Toc381722688)

[8.1 Overall Approach 3](#_Toc381722689)

[8.2 Unit Testing Approach 3](#_Toc381722690)

[8.3 Component Testing Approach 3](#_Toc381722691)

[8.4 Integration Testing Approach 3](#_Toc381722692)

[9 Item Pass/Fail Criteria 4](#_Toc381722693)

[9.1 Unit Testing Level 4](#_Toc381722694)

[9.2 Component Testing Level 4](#_Toc381722695)

[9.3 Integration Testing Level 4](#_Toc381722696)

[10 Test Deliverables 4](#_Toc381722697)

[11 Test Schedule 4](#_Toc381722698)

[12 Approvals 4](#_Toc381722699)

# Introduction

## Purpose

The 3-D Printer Fabrication System will provide an interface for converting standard stereo lithography or STL files into realized items. The system will use a simple graphical user interface to select the files and materials to be used in the production of the 3D model. When a file is loaded, the system will translate the STL file in to a series of layers based on the granularity of the materials to be used in the final build. The system will then use the layers to produce a series of paths for the print head to traverse to deposit the correct material to the specified location. From this series of steps, an instruction set will be produced for the printer to execute each path for every layer and material. Finally, the instructions will be issued to the printer and it will execute the commands producing the designed object that was described by the original STL files.

## Scope

The scope of the 3-D Printer Fabrication System is to develop software that will produce suitable machine code for a 3-D printer head that is capable of depositing multiple materials within a single print run. The system will present the user with an interface that will allow them to specify which STL files are to be loaded and specify the material properties of the respective STL files. The system will then use this information to process the geometry such that a suitable set of G-Codes can be issued to the device. The system will also provide a method for streaming the information to the printer control hardware via a serial interface. The system is intended to be used by 3-D printer operators, CNC operators, Dr. Shiakolas, and other experienced operators in the research field. The system is not intended for the consumer market.

# References

Throughout this System Test Plan we will refer to other documents created in the design process of the 3-D Printer Fabrication System. For completeness key features of these documents will be represented here for testing considerations. The documents referenced will be the SRS, ADS, and DDS.

## System Requirements Specification

The System Requirements Specification shows the analysis and gathering of customer, packaging, performance, performance, maintenance, and other requirements. The requirements for each set are detailed below. To improve clarity we will only include requirements that are going to be implemented in this project.

### Customer Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| Requirement Number | Requirement Name | Description | Priority |
| 3.1 | STL File Input | The system shall provide a way for the user to select an STL file and then input that STL file into the system for processing | 1 - Critical |
| 3.2 | Graphical User Interface | The system shall provide a graphical user interface from which the user can import 3D models and initiate print operations. The GUI must be both intuitive and responsive. | 3 - Moderate |
| 3.3 | Generate Machine Instructions | The system shall generate instructions needed by the printing hardware in order to print a given 3D object. | 1 – Critical |
| 3.4 | Issue Machine Instructions | The system shall issue generated machine instructions from the software component to the printing hardware component. | 1 – Critical |
| 3.5 | Monitor Temperature | The system shall monitor input from heat sensors attached to the printing hardware. The temperature of each extruder’s nozzle must be monitored at all times to ensure that material is extruded at the proper temperature. | 1 – Critical |
| 3.6 | Monitor Position | The system shall monitor the position of the printing head at all times during operation. The system must be aware of the position of the printing head in order to adhere to a predefined printing path. | 1 – Critical |
| 3.7 | Adhere to Material Constraints | The system shall adhere to the material constraints that limit the movement speed, extrusion rate, and nozzle temperature. Different materials have different properties that the system must account for in order to produce a properly printed object. | 1 - Critical |
| 3.8 | Identify Materials | The system shall provide a method for the user to select the material for each discrete part that is being used for printing the 3D object. | 1 - Critical |
| 3.9 | Identify Shapes | The system shall identify the shape of the object being printed by dividing it into smaller shapes for each individual material used. | 1 - Critical |

|  |  |  |  |
| --- | --- | --- | --- |
| 3.10 | Determine Shape of Support Material Structure | The system shall determine the shape that the support material needs to be for stabilizing the 3D object as it is being printed. Without the support, the object could collapse during printing. | 1 - Critical |
| 3.11 | Create Printing Path | The system shall determine a route that the printing head must follow as it prints. | 1 - Critical |
| 3.12 | Database Interface | The system shall have an interface that allows the user to view what material is already stored in the database and enter new information for material not already stored. | 1 - Critical |
| 3.13 | Store & Load Material Records | The system shall be able to load the material records stored in the materials database in order to control the temperature, movement speed, and flow speed of the nozzle at the correct setting. | 1 - Critical |
| 3.14 | Slice Geometry into Thickness Levels | The system shall be able to process geometry in such a way as to generate sub-models of appropriate and customizable thickness such that the 3D printer can print each layer of the given thickness. | 1 - Critical |
| 3.15 | Monitor Flow Sensors | The system shall monitor nozzle flow sensors and be able to maintain and adjust accordingly if the sensor begins to read out of bounds. | 1 - Critical |
| 3.17 | Allow for UV Head Polymerization | The head shall be able to use UV light to cure or dry the extruded material. The system shall accommodate the use of UV to be turned on and off such that the material can be cured. | 1 - Critical |

Table 2‑1: Customer Requirements

### Packaging Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| Requirement Number | Requirement Name | Description | Priority |
| 4.1 | Software Installer | The host software shall be delivered as an executable installer via USB flash memory and Compact Disc. | 1 - Critical |
| 4.2 | Host Software to Printer Connection | The host software shall be connected to the printing hardware using a DE-9, DB-25, or Universal Serial Bus cable. | 1 - Critical |
| 4.3 | User Manual | The system shall be delivered with a user manual. The user manual will include detailed instructions on how to operate the host software and how to properly connect the host software to the printer. | 3 - Moderate |

Table 2‑2 : Packaging Requirements

### Performance Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| Requirement Number | Requirement Name | Description | Priority |
| 5.1 | Startup Time | The host software shall start in one minute or less. | 4 - Low |
| 5.2 | STL Import Time | The host software shall import STL files in one minute or less. | 4 - Low |
| 5.3 | Object Processing Time | The host software shall perform object processing and machine instruction generation in five minute or less. | 4 - Low |
| 5.4 | GUI Responsiveness | The graphical components of the user interface shall be responsive to user interaction. | 3 - Moderate |
| 5.5 | Real Time Sensor Monitoring | The system shall monitor data from sensors in real time during operation. The sensor data must be monitored in real time to ensure proper printer functionality as well as enforce safety systems. | 2 - High |

Table 2‑3 : Performance Requirements

### Safety Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| Requirement Number | Requirement Name | Description | Priority |
| 6.1 | Temperature Cutoff Threshold | The system shall include a temperature cutoff threshold for the printer head. If the temperature of the printer head reaches the cutoff temperature, the system will abort the operation and shut off the heating device. | 1 - Critical |
| 6.2 | Printing Area Restrictions | The system shall only extrude material within a configured area. Material extruded by the printer will be at a high temperature and may cause harm to the printer’s surroundings; therefore it is important to ensure that the material is only extruded in a specified safe area. | 1 - Critical |

Table 2‑4 : Safety Requirements

# Test Items

## Product Version

[detail Stages]

## Design Decomposition

[Drawing]

## Unit Tests

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test ID | Hardware | Input | Expected Output/Action | Test | Risk |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

## Component Tests

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test ID | Hardware | Input | Expected Output/Action | Test | Risk | Dependent Tests |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

## Integration Tests

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test ID | Hardware | Input | Expected Output/Action | Test | Risk | Dependent Tests |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

## Validation Tests

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test ID | Hardware | Input | Expected Output/Action | Test | Risk |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

# Risks

[Risks bad test, poor coverage, configurability, ME team, and 3rd party software.]

# Features to be Tested

## STL File Input

**5.1.1 Description:** The system shall provide a way for the user to select an STL file and then input that STL file into the system for processing.

**5.1.2 Source:** Dr. Panos S. Shiakolas (Sponsor)

**5.1.3 Constraints:** The system must support multi-material objects but the STL file format does not support material information. Model must be closed / complete.

**5.1.4 Standards:** STL (STereo Lithography) File Format

**5.1.5 Priority:** 1 – Critical

## Graphical User Interface

**5.2.1 Description:** The system shall provide a graphical user interface from which the user can import 3D models and initiate print operations. The GUI must be both intuitive and responsive.

**5.2.2 Source:** Dr. Panos S. Shiakolas (Sponsor)

**5.2.3 Constraints:** None

**5.2.4 Standards:** Java Swing/AWT

**5.2.5 Priority:** 3 - Moderate

# Features Not to be Tested

[Modular scalable design, Abstract hardware interface]

# Testing Approach

## Overall Strategy

## Configurations

## Regression

## Metrics

# Item Pass/Fail Criteria

## Unit Testing Level

## Component Testing Level

## Integration Testing Level

# Test Deliverables

## JUnit tests

## Test output reports

## Coverage Report

# Test Schedule

[Sages]

# Approvals