THE CHINESE UNIVERSITY OF HONG KONG
DEPT OF MECHANICAL & AUTOMATION ENG

MAEG5160 Design for Additive Manufacturing

Final Project

by

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Introduction

This report presents the final project for the course MAEG5160 Design for Additive Manufacturing. The task is to optimize a desk design that meets the specified requirements and loading conditions. The optimized desk design will be 3D printed using Fused Deposition Modeling (FDM) with PLA material. The project's aim is to develop a lightweight desk design that can support a $5\ \mathrm{kg}$ load in both horizontal and inclined conditions.

Design Methodology

The desk design was optimized using SolidWorks software. The model features a four-legged structure that weighs only 20 grams and can support the $5\ \mathrm{kg}$ load in both loading cases. The optimized design is shown in Figure 1a.

Topology optimization was applied to the model, considering the following boundary conditions:

1. Four legs of the table are fixed.
2. A force of $-49.24\ \mathrm{N}$ perpendicular to the table top is applied.
3. A force of $8.68\ \mathrm{N}$ parallel to the table top is applied.
4. Mass constraint: 40%.
5. Stress constraint: 80%.

These conditions were set to ensure the structural integrity of the desk design while minimizing its weight. The optimization process resulted in a unique design that satisfies the requirements and loading conditions.

3D Printing

The optimized desk design was 3D printed using FDM with PLA material as shown in Figure 1b. The following printing parameters were used:

1. Layer height: $0.15\ \mathrm{mm}$
2. Printing speed: $60\ \mathrm{mm/s}$

These settings were chosen to achieve a balance between print quality and speed.

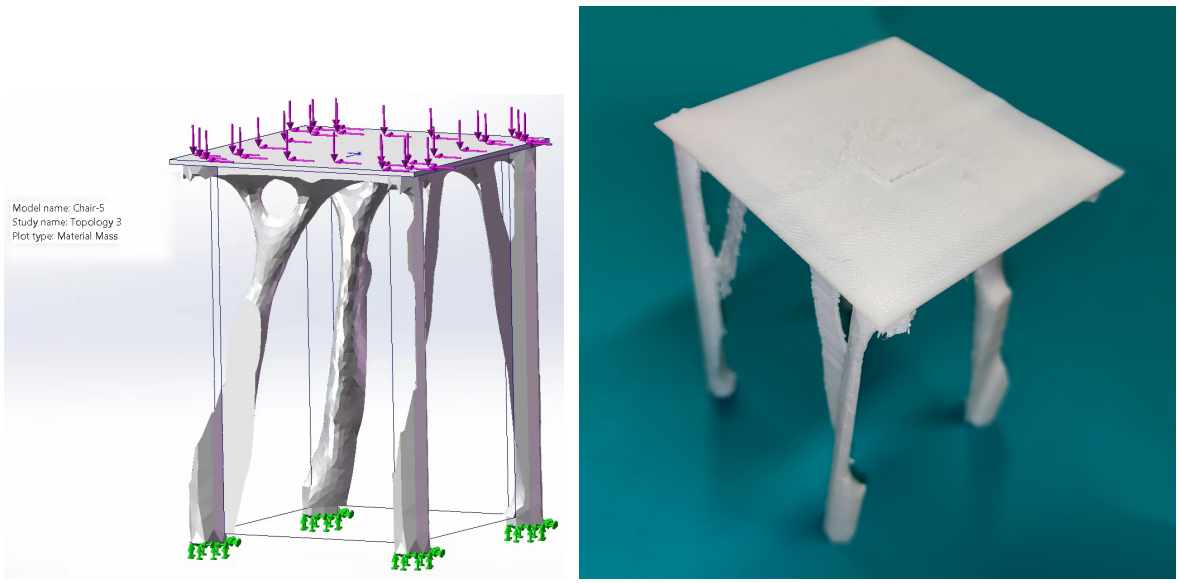
Results and Discussion

The 3D printed desk passed both loading cases, supporting a $5\ \mathrm{kg}$ cylindrical mass with a diameter of $100\ \mathrm{mm}$ as shown in Figure 3. The optimized design met the requirements:

Dimension: $100 \times 100 \times 100\ \mathrm{mm}$; Desktop height above the ground: $81\ \mathrm{mm}$; Material filling ratio: $< 50\%$. The analysis results are shown in Figure 2.

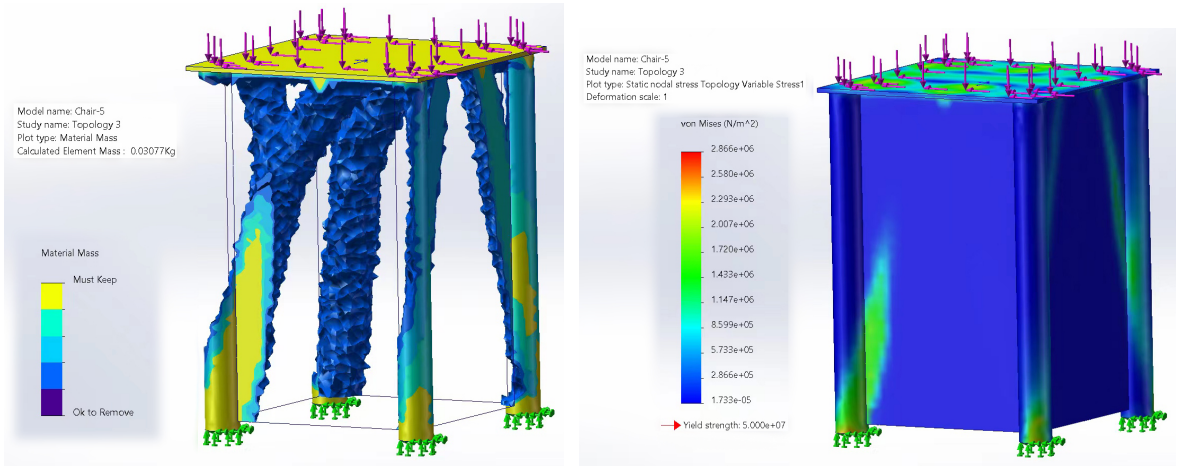
Conclusion

In conclusion, the final project for the course MAEG5160 Design for Additive Manufacturing was successfully completed. The optimized desk design met all the requirements and loading conditions. The 3D printed desk demonstrated the effectiveness of topology optimization in creating a lightweight, structurally robust design suitable for additive manufacturing.



(a) Topology results in SolidWorks. **(b)** Printed part.

Figure 1: Topology results.



(a) Material mass distribution. **(b)** Stress field distribution.

Figure 2: Topology results analysis.

Figure 3: Printed parts with 5 kg loads on it.