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FUNCTIONAL REDESIGN WITH SOLIDWORKS AND 3D PRINTING

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Abstract *– The article demonstrates how additive manufacturing can enhance the functionality and ergonomics of industrial testing devices. A redesign case of a control unit housing for heavy industry is presented, emphasizing form optimization, power portability, and connector limitations. The design process included concept analysis, comparison with existing solutions, modelling in SolidWorks, and adaptation for 3D printing.*

Keywords *– 3D printing, industrial design, additive manufacturing, device housing, SolidWorks, redesign, rapid tooling.*

Problem statement. In modern engineering practice, the ability to rapidly and effectively redesign or replace components of a technical system is essential. Devices frequently need to be adapted for new working conditions, space constraints, or operational improvements. Traditional manufacturing methods are often limited by time, tooling, and production costs. In contrast, 3D printing offers a flexible and efficient solution, enabling quick customization of components in response to real-world requirements. It allows engineers to modify the configuration, shape, and internal structure of a part without significantly increasing development time or resources. This approach is particularly relevant for enclosures and functional housing in industrial devices, where ergonomics, size, power supply, and mounting constraints often vary. This paper presents a case study in redesigning housing for an industrial control unit, demonstrating how 3D modelling and printing support the creative engineering process.

Analysis of Recent Research. Modern engineering increasingly demands faster and more creative approaches to problem-solving. Over the past decade, 3D printing has become a widely adopted tool across nearly all engineering domains—from aerospace to automotive industries. Additive manufacturing enables rapid prototyping, ergonomic optimization, and miniaturization of existing systems while maintaining functionality and structural integrity [1].

3D printing, as a form of additive manufacturing, constructs physical objects layer by layer based on digital CAD models. This method offers flexibility in producing complex and customized components quickly and cost-effectively, especially for low-volume applications. Unlike traditional prototyping systems, modern 3D printers are more accessible and seamlessly integrated with CAD environments, making them well-suited for tasks such as functional prototyping, small-batch manufacturing, and fast part replacement [2]. At the provided link [3], viewers can watch a video that demonstrates how 3D printing is used for rapid tooling – producing molds, patterns, and dies for low- to medium-volume manufacturing. The video outlines the workflow from CAD design to the practical use of the printed tool in real production settings.

Formulation of Goals. These examples illustrate the broad potential of 3D printing in both household and industrial settings, from part replacement to rapid tooling. In this paper, we focus on a practical redesign case involving an industrial testing device enclosure. The goal was to reduce the overall dimensions of the housing, improve its ergonomics, and integrate a portable power supply – while preserving compatibility with a fixed central connector. The redesigned model was developed using SolidWorks and prepared for 3D printing, demonstrating how additive manufacturing can be used not only for prototyping, but also for functional, customized product improvement.

The main part. The subject of this case study is a control unit used for testing industrial control panels. The original device featured an outdated and oversized plastic enclosure that was no longer optimal for use. The main constraint in redesigning the housing was the presence of a fixed HARTING central connector measuring 145.6 × 55 mm, which could not be altered due to standardized mounting requirements. Additionally, the locking mechanism required significant force to secure, necessitating strong and well-aligned attachment points.

The objective was to improve the form factor of the device without compromising its functionality. The updated design included the following improvements:

- Reduced external dimensions to enhance portability and usability in constrained workspaces;
- Internal optimization of component placement, including LED indicators and control elements;
- Integration of a 9V battery slot, allowing the device to function independently from a stationary power source;
- Refined geometry of mounting brackets and wall thickness to ensure durability under mechanical stress.

The entire redesign was executed in SolidWorks [4], where the geometry was modelled parametrically for flexibility. Attention was paid to tolerances relevant for FDM or SLA 3D printing, and materials were selected based on the required mechanical strength and thermal resistance. After completing the model, prototypes were printed and tested to verify fit, ergonomics, and component access. Minor adjustments were introduced, and the final version was prepared for deployment.

The print settings were configured to achieve a balance between mechanical strength and printing efficiency. Some selected parameters are illustrated in Fig. 1–2. The part was printed using FDM technology with the following key parameters:

- Layer height: 0.2 mm; first layer – 0.24 mm, for better adhesion to the build plate.
- Wall structure: 3 perimeters and 3 solid layers for both top and bottom surfaces, ensuring sufficient mechanical strength.
- Infill: 15% grid pattern with aligned rectilinear structure, balancing strength and material efficiency.
- Print speed: up to 140 mm/s for perimeters and infill, with reduced speeds for external walls and first layers to improve surface quality.
- Acceleration and autospeed: Acceleration for external perimeters was limited to 5000 mm/s² to reduce vibrations, while infill and general motion reached up to 10,000 mm/s². Autospeed limited the max print speed to 140 mm/s.
- First layer speed: set to 100 mm/s for reliable adhesion.
- No ironing or extra top surface smoothing was used, prioritizing mechanical functionality over aesthetic finish.

Fig. 1. Layer height and wall structure parameters

The selected parameters represent a typical balance for technical enclosures: moderate wall thickness, low infill density, and reduced speed for outer surfaces to improve accuracy. The model was printed using the Anycubic

Kobra 3 Combo FDM 3D printer [4], equipped with a high-speed CoreXY system and multi-material capabilities. Its stable structure and auto-levelling system ensured high dimensional accuracy and adhesion throughout the process.

As printing material, Polymaker PLA filament (1.75 mm) was used [5]. This filament is known for its high rigidity, excellent surface quality, and low warping, making it a reliable option for functional prototyping of enclosures.

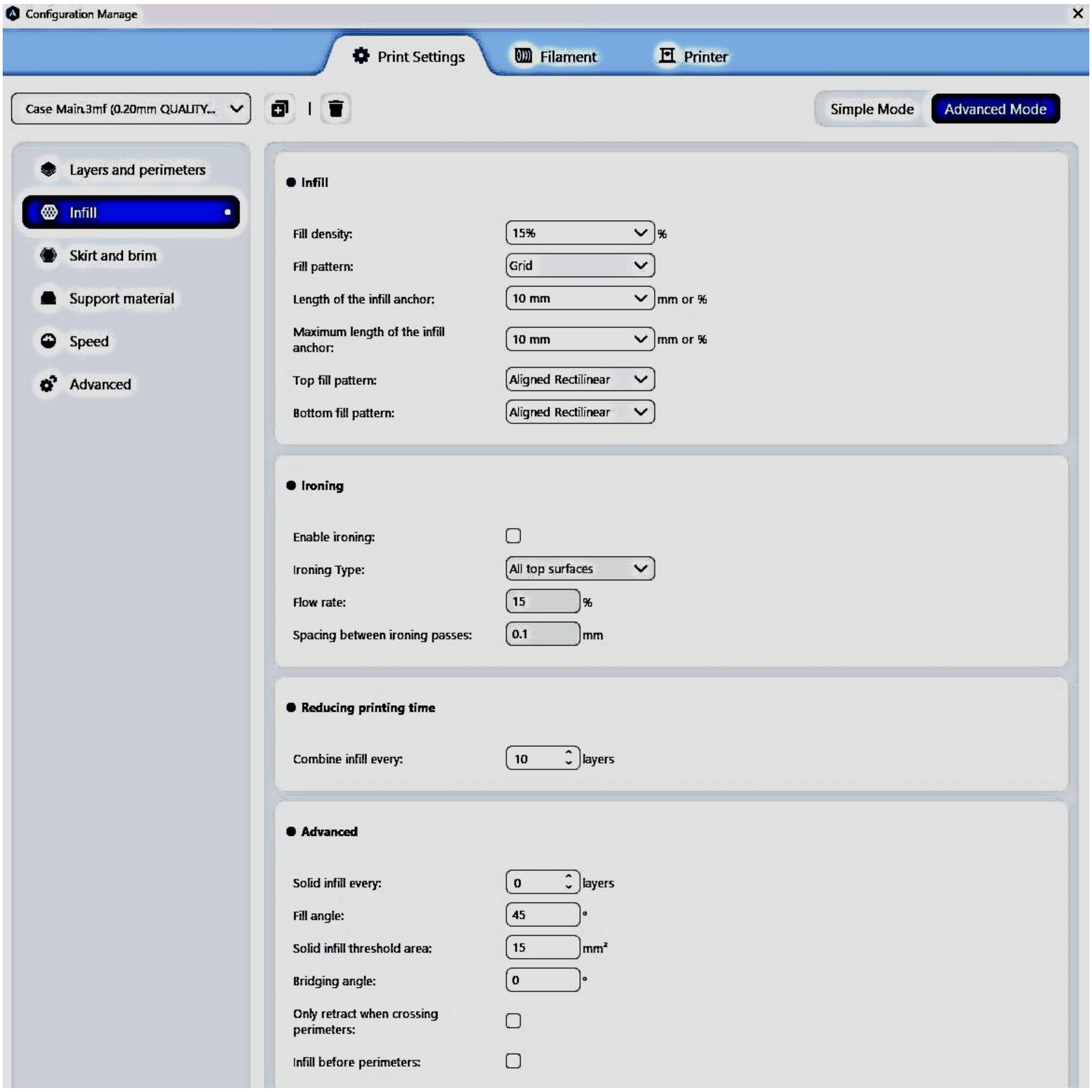

Fig. 2. Infill configuration with 15% grid pattern and aligned rectilinear structure

The final version of the redesigned enclosure is shown in Figures 3 and 4. A similar redesign task was conducted in a previous student project, where a broken DEWALT screwdriver was successfully repurposed for testing automotive components [6].

Fig. 3. Front view of the finalized 3D-printed enclosure for the industrial control uni
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Fig. 4. Front view of the finalized 3D-printed enclosure for the industrial control unit

The presented case study demonstrates the practical value of 3D modelling and additive manufacturing in solving real-world engineering problems. Through the redesign of an industrial testing device enclosure, we showed how 3D printing enables compact design, functional integration, and improved usability, while adapting to fixed structural constraints such as standardized connectors.

Importantly, this project highlights the educational potential of additive technologies, encouraging students to apply technical knowledge creatively and to iteratively improve their designs. The use of SolidWorks and FDM 3D printing offered a flexible, cost-effective, and accessible workflow for rapid prototyping and functional customization.

When combined with other examples, such as the repurposing of an old power tool, it becomes clear that 3D printing supports diverse applications – from sustainable product reuse to small-batch manufacturing. This confirms its relevance not only as a prototyping tool but as a viable method for engineering innovation in both academic and industrial contexts.

This and the current case illustrate the versatility of additive manufacturing in addressing different engineering objectives – from component miniaturization and functional integration to the creative reuse of existing devices. This example highlights how additive manufacturing facilitates iterative product development and supports functional redesign tailored to specific technical and environmental constraints.

Conclusions. This article presented a practical application of 3D modelling and printing in the redesign of an industrial device enclosure. The project demonstrated how additive manufacturing supports compact, functional, and customizable design solutions. The approach proved effective for both technical problem-solving and creative engineering tasks.

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