3D printing and plastic recycling in Sierra Leone

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"3D Printing for All" is a project aiming to democratise access to 3D printing and standardise fusion deposition modeling (FDM)[1] 3D printers as tools for Médecins Sans Frontières (MSF) projects.

3D printing, also known as additive manufacturing, is a process of creating three-dimensional physical objects from digital models or computer-aided design (CAD) files[2]. The process involves building up successive layers of material until the final object is formed. This contrasts with traditional manufacturing processes such as machining, where material is removed from a larger block to create the final shape. 3D printing allows for the creation of complex and customised objects, as well as rapid prototyping and small-scale production on site.

Sierra Leone was the first country where this initiative was implemented in June 2023, bringing with it substantial organisational benefits. However, over a year of 3D printing activities resulted in more than 300 printed parts, which used approximately **35 kg of factory-made, imported filament**. The environmental impact of this method has been a significant concern. The following practices are therefore being implemented to mitigate the negative environmental impact.

RESPONSIBLE SELECTION OF 3D PRINTERS

The desktop FDM 3D printer market has grown since 2014[3], especially due to the expiration of related patents. New companies have emerged, giving users a wide choice of printers. Given the increased options, "3D Printing for All" defined the main criteria for selecting printers as their ability to work in a wide range of climate conditions (high temperatures and dust), their resilience to power outages, and their on-site repairability.

MSF Laboratory Supervisor, Ibrahim Massaquoi and MSF 3D printing Tech Lead, Silvestr Tkáč, standing in front of the MSF 3D printer in Makeni, Tonkolili district, Sierra Leone. Photographer: Mohamed Saidu Bah.

The selected manufacturer, Prusa Research, is known for its long-term support of older hardware, comprehensive knowledge base[4], and focus on sustainability (sustainability report). Some spare parts for this 3D printer can even be printed on another printer[5].

Since roll-out in MSF projects in four countries, there have not been any technical issues that could not be solved locally, or through remote support that encourages user-based repairs.

PRINTING IMPACTFUL ITEMS AND REDUCING WASTE

3D-printed items can extend the lifespan of other devices, or repair items that would otherwise be beyond repair, thereby reducing the negative impact related to premature disposal.

The project defined three categories of 3D printer products: replacements and copies of existing items, enhancements of items, and new solutions to specific problems. The main intended impact is to decrease the individual importation of specific items.

1 https://www.hubs.com/knowledge-base/what-is-fdm-3d-printing/
2 https://www.autodesk.com/solutions/3d-printing
3 Application of 3D Printing in the Metamaterials Designing – Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/D-printing-market-sizes-for-each-year-form-2014-up-to-2025-in-millions-USD-6-Different_fig3_336024754 [accessed 24 Oct 2024]
4 https://help.prusa3d.com/
5 https://www.printables.com/model/451501-mk4mk39-printable-parts

Ministry of Health Laboratory Supervisor, Mamoud Bah, placing a pipette on a 3D printed pipette holder, inside the laboratory of the Magburaka Government Hospital. Photographer: Mohamed Saidu Bah.

Two practical examples of 3D printer use include replacing broken battery covers on pulse oximeters and producing clamps that reinforce the handles of oxygen concentrators. They are particularly useful for solving the common problem of thread wear. The main limitation to the scope of applications is related to the safety and regulatory frameworks that govern medical devices and equipment, which are strictly followed to ensure patient safety remains the top priority.

Some of the most commonly printed items are hand sanitiser holders, designed to attach bottles in convenient locations and improve accessibility.

SMART DESIGN SOLUTIONS

3D printing gives users the freedom to manufacture unique, customised items that would not be easily manufacturable by other methods. Through several iterations of design, a user can achieve a significant decrease in the amount of plastic material used, as well as time- and cost-efficient manufacturing. A practical example from Sierra Leone is the iteration of a hand sanitiser holder, which led to a decrease in the amount of plastic used from 60g of plastic to 19g.

Most 3D printing waste is generated during the product development phase, during which multiple iterations of prototypes are manufactured and tested before the final file is sent for 3D printing to the projects. Locating this stage of the process near recycling facilities capable of handling 3D-printed plastic waste is crucial for minimising the ecological impact of the project. Additionally, optimising 3D printing processes reduces user-based failures, and following basic design principles[6] for additive manufacturing reduces waste related to support materials.

LOCAL RECYCLING

According to Engineers Without Borders Sierra Leone, waste management is a significant problem. The country produces 96,000 tons of plastic waste annually and lacks a well-functioning waste disposal system[7]. Therefore, an important next step will be to implement the use of locally recycled filament rather than factory-made, imported filament.

While this is not yet standard, "3D Printing for All" has started implementing local recycling of plastic bottles using the desktop PETMachine, allowing the production of 3D printing filament from common PET bottles. This filament can be used for manufacturing non-critical small items. After testing the process internally and recycling approximately **70 bottles** since May 2024, the "3D Printing for All" project aims to provide two devices to two local organisations (SkillPool and an informal group of students) and develop a sustainable framework to engage communities in manufacturing and buying the filament from them. Similar collaboration is planned in Kenya with local startup ChipuRobo. It is also technologically possible to recycle decommissioned 3D printed items, either by collaboration with local plastic waste recycling facility or by specialised machinery[8]. Due to relatively low amount of printing at the projects, collaboration with local facilities is considered the most feasible for the future.

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6 https://wikifactory.com/+wikifactory/stories/ultimate-guide-how-to-design-for-3d-printing
7 https://creadis.com/news/engineers-without-boarders-and-dis-creadis-team-up-to-block-plastic-pollution-in-sierra-leone/
8 https://felfil.com/