R2D2

GDP1-3D Printing Farm | University of Southampton | Alejandro Parra Pintado | 27/10/2024

Changelog

Name	Date	Notes
Alejandro	27/10/2024	Created the document and added the primary sections along with preliminary example requirements.

This Robust Requirements and Design Description (R2D2) document is provided as a technical collection of the capabilities that the 3D Printing Farm should achieve while also responding to the human factor.

The document is written taking direct inspiration from NASA's "How to write a good requirement" guideline for engineering: https://www.nasa.gov/reference/appendix-c-how-to-write-a-good-requirement/, and it therefore follows the same nomenclature:

Use of Correct Terms

- **Shall** = requirement
- **Will** = facts or declaration of purpose
- **Should** = goal

Product Requirement Considerations

- The requirement is in the form "product ABC shall YZ." A requirement should state "The product shall" (do, perform, provide, weigh, or other verb) followed by a description of what should be done.
- The requirement is free of implementation. (Requirement should state WHAT is needed, NOT HOW to provide it; i.e. state the problem not the solution. Ask, "Why do you need the requirement" The answer may point to the real requirement.)
- The requirement is free of descriptions of operation. (Is this a need the product should satisfy or an activity involving the product? Sentences like "The operator shall…" are almost always operational statements, not requirements.)

Every single requirement should be later referenced by a design decision in the GDP's Design Report or in the Group Report submission document.

Abbreviations

- GDP: Group Design Project
- UoS: University of Southampton
- R2D2: Robust Requirements and Design Description
- HCD: Human-Centered Design
- FDM: Fusion Deposition Modelling
- SLA: Stereolithography (resin) printing

Requirements Table – Global

The following table incorporates not only technical requirements (with ID prefix TECH_) but also requirements that consider the human factors of design. Additional human-centered design considerations are addressed outside of the table later in this document.

Requirement ID	Title	Description	Compliance
TECH_1	Job Automation	The product shall coordinate multiple 3D printers to perform and manage prints without the need for user intervention after a user has requested a printing job.	Non-compliant
TECH_2	Pre-print Tasking	The product shall perform pre-printing checks autonomously after system initialisation.	Non-compliant
TECH_3	Printer Versatility	The product shall interface with 3D printers from different brands.	Non-compliant
ENV_1	Carbon Footprint	The product shall inform the user of and log the operation's electric consumption and carbon footprint.	Non-compliant
FIN_1	Financial Independance	The product shall NOT incorporate paid-subscription-service software.	Fully compliant
HCD_1	Intuitive Use	The product shall be intuitive of use unless the user requests to enable an advanced functionalities option.	Non-compliant

NOTES:

- TECH_1 implies that no troubleshooting should be carried out by users after a job has been requested to the system; a failed print should be addressed and managed automatically by each printer.
- TECH_2 also involves switching printers from idle or power-saving mode to functional or "on" mode.
- FIN_1 is established to retain control over the costs of running the product regardless of how much an established 3D printer farm service (which would have otherwise been incorporated into the product) changes its running costs.

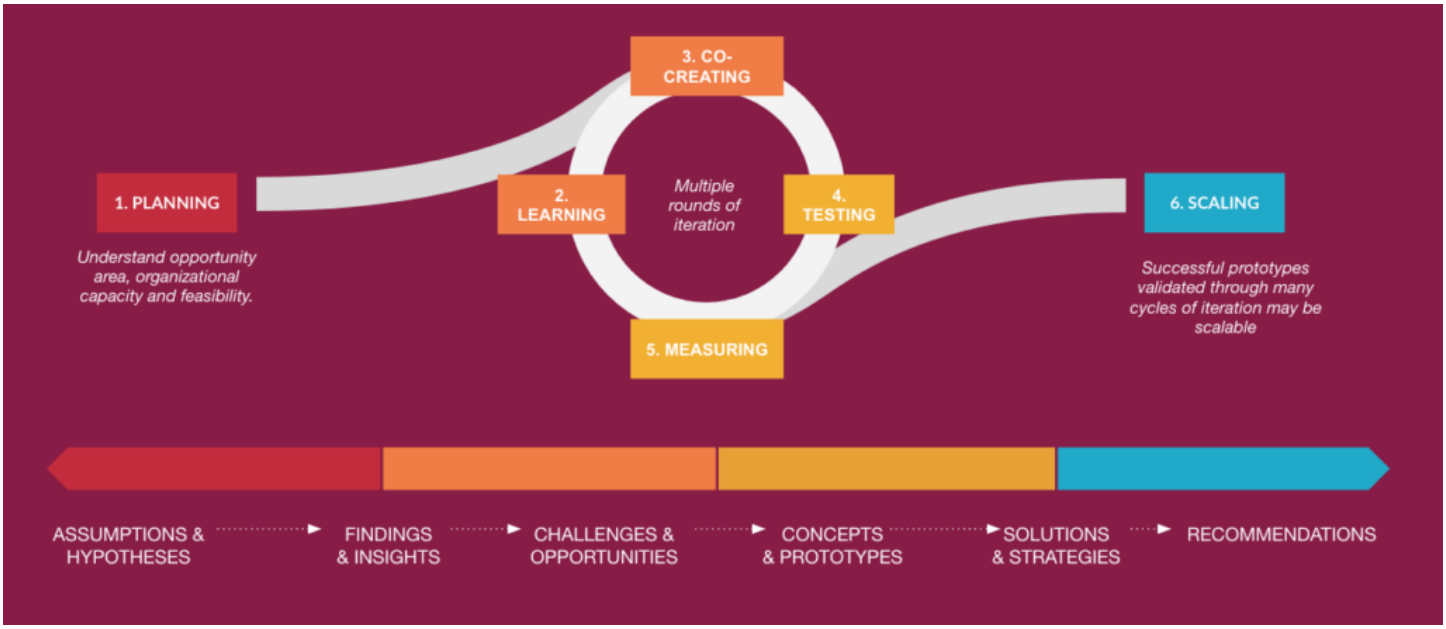
The Human Factor

A set of considerations shall be addressed to achieve a human-centered design (HCD). This practice was properly established in this context by John E. Norman, who first proposed the idea that engineering design should be human-centered.

The four principles of HCD are:

- People centered
- Solve the right problem
- Everything is a system
- Smal and simple interventions

The process follows the following steps:



https://dalberg.com/what-is-human-centered-design/

Note that the Double Diamond Design process is still applicable.