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La democratización de diseño y nuevos paradigmas para la manufactura global

Dr Mark Goudswaard

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Contenido

- Parte A - La democratización de diseño
  - Enfocado en los motivos para mi doctorado
  - Definición de conceptos importantes
- Parte B – como se puede democratizar el diseño?
  - Enfocado en lo que hice para mi doctorado

¿Quién soy?

- Investigador Post-Doctoral
  - Universidad de Bristol
  - Design and Manufacturing Futures Lab
- Temas de investigación:
  - Integración de métodos de diseño físicos y digitales
  - La coordinación de recursos de manufactura distribuida
  - Procesos cognitivos de diseño
- Doctorado sobre la democratización de diseño para FDM (Impresión 3D)
- Hice un intercambio en Uniandes en 2013
  - Varias visitas desde entonces
  - Proyecto de ingeniería transdisciplinaria 2019
  - Colaboración con Project Clean Access durante la pandemia

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Parte A - La democratización de diseño

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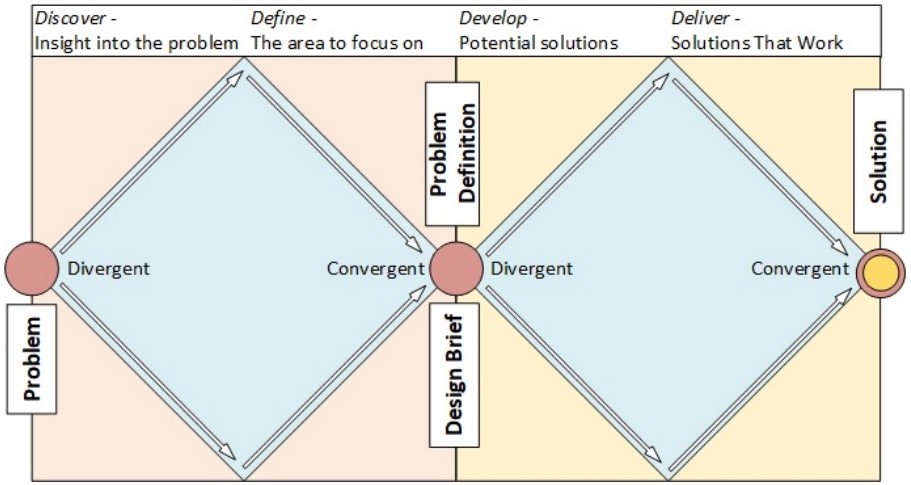
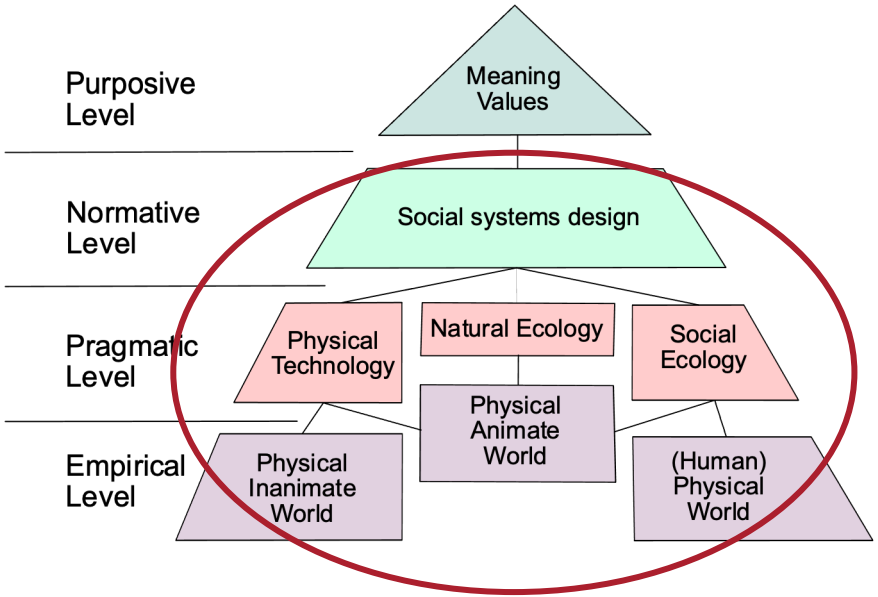
Que es diseño?

- Ciencias son el estudio de **lo que hay**
- Diseño es el estudio de **lo que debe ser**
- *Diseñar es para crear cursos de acción con el objetivo de cambiar situaciones actualizadas a otras que son preferidas*

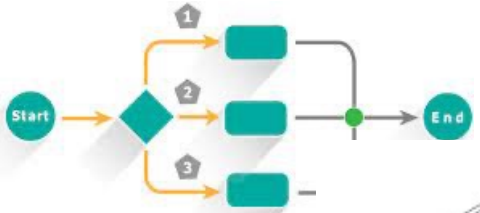
¿Que es ingeniería de diseño?

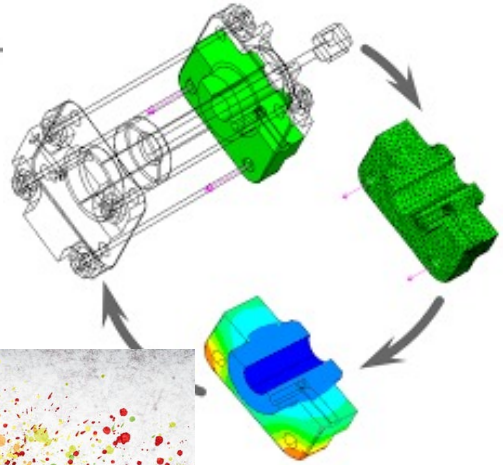


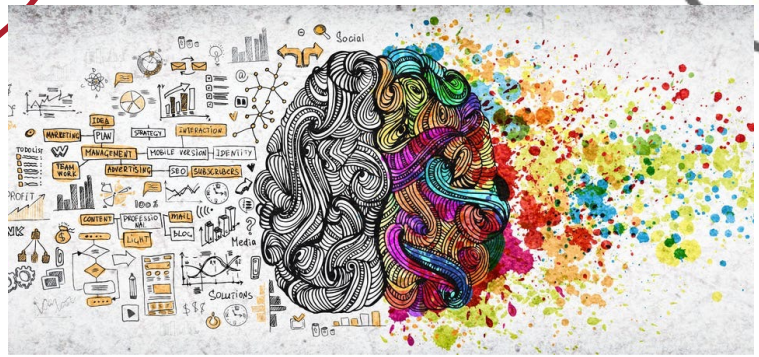


¿Que produce ingeniaría de diseño?

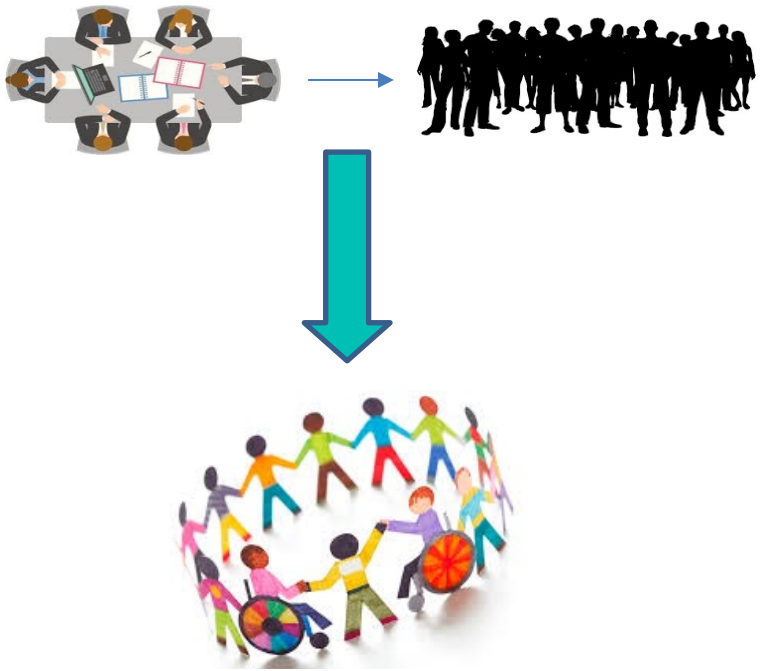
- Productos
- Procesos
- Herramientas
  - CAD / CAE
- Entendimiento de como el diseño ocurre
  - Creatividad
  - Trabajo en equipo





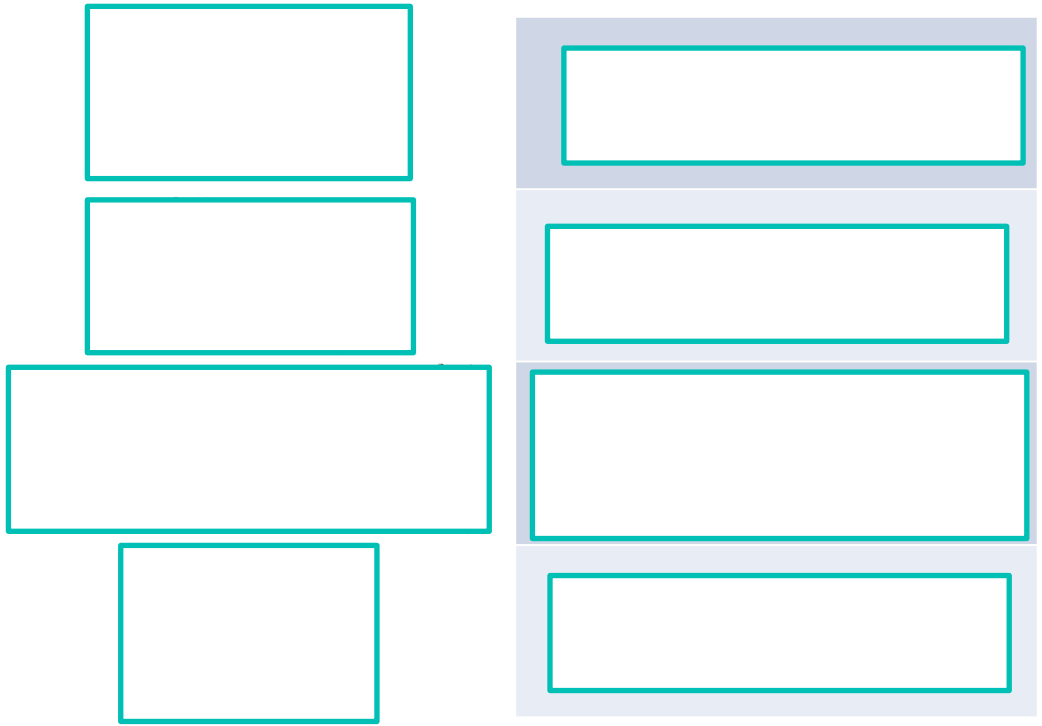


¿Que es la democratización de diseño?



- ¿Que es?
  - La aumentación de la accesibilidad de conocimiento y tecnología necesario para diseñar productos funcionales
- ¿Que permite?
  - Permite que la gente puede diseñar y fabricar productos para satisfacer sus propias necesidades.
- ¿Que cambia?
  - Aprovechemos el poder creativo del mundo!
  - Cambiamos ”consumers” a “prosumers”
  - Spanglish -> Consumadores a Prosumadores

La importancia del diseño



Los beneficios de DdD

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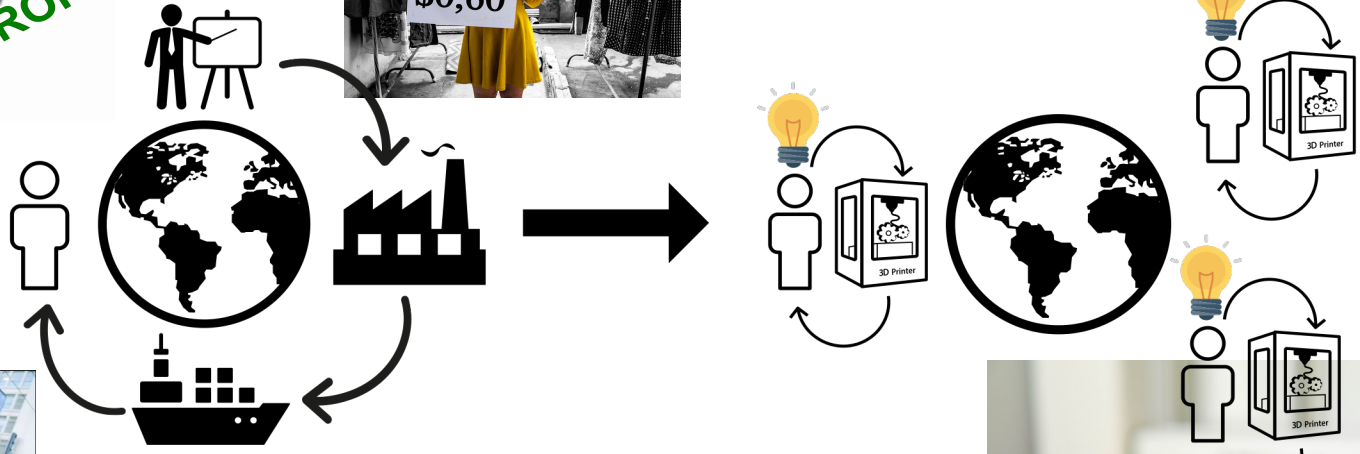
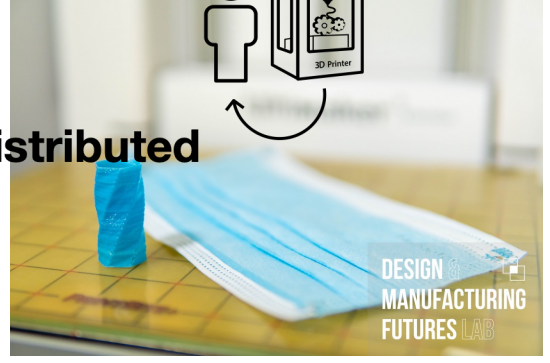
¿Porque es la DdD importante ahora?

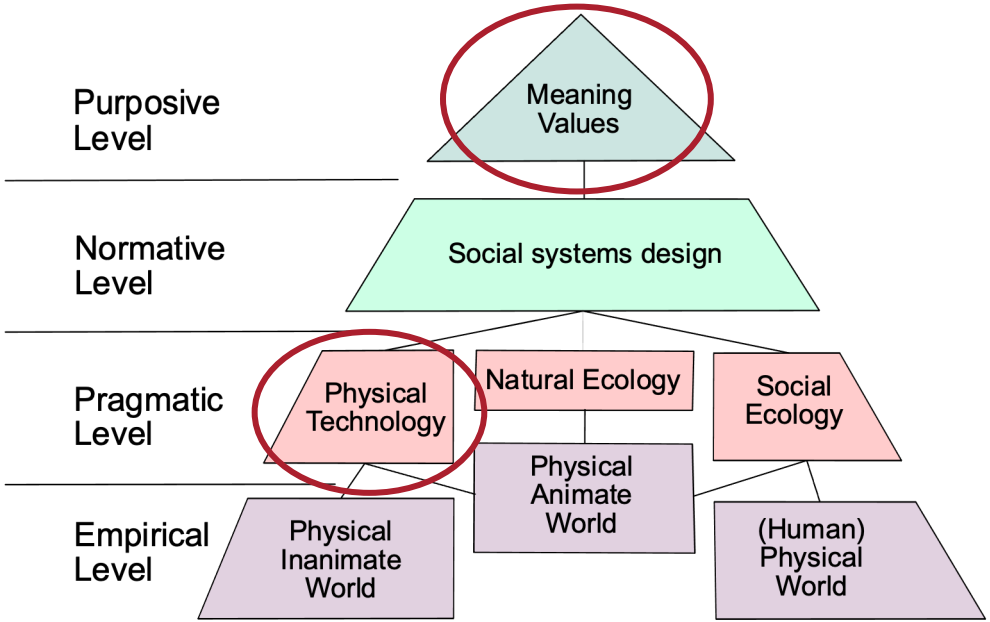


Localised

Distributed



La democratización de diseño y Jantsch



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Parte B – como se lo hace?

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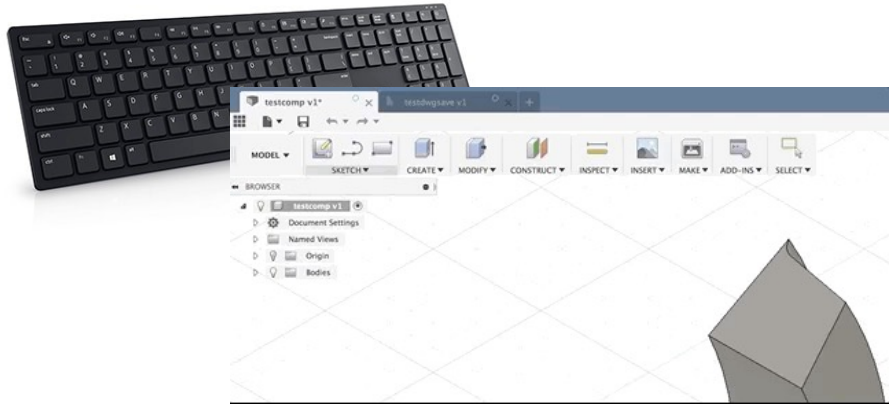
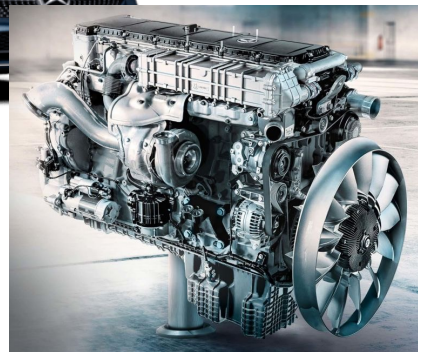
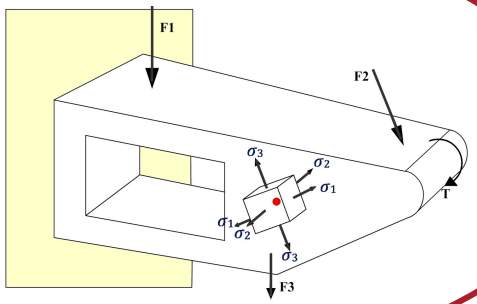
¿Cómo se puede democratizar el diseño?

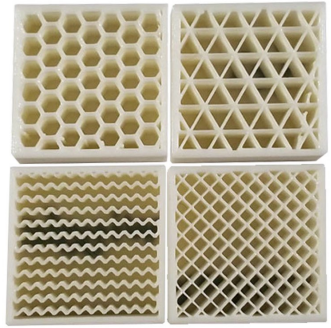


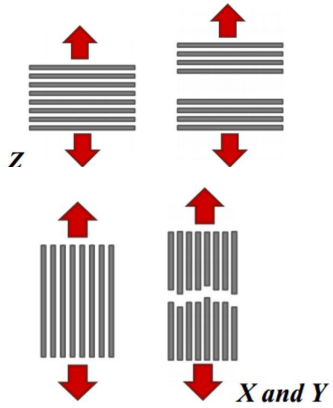


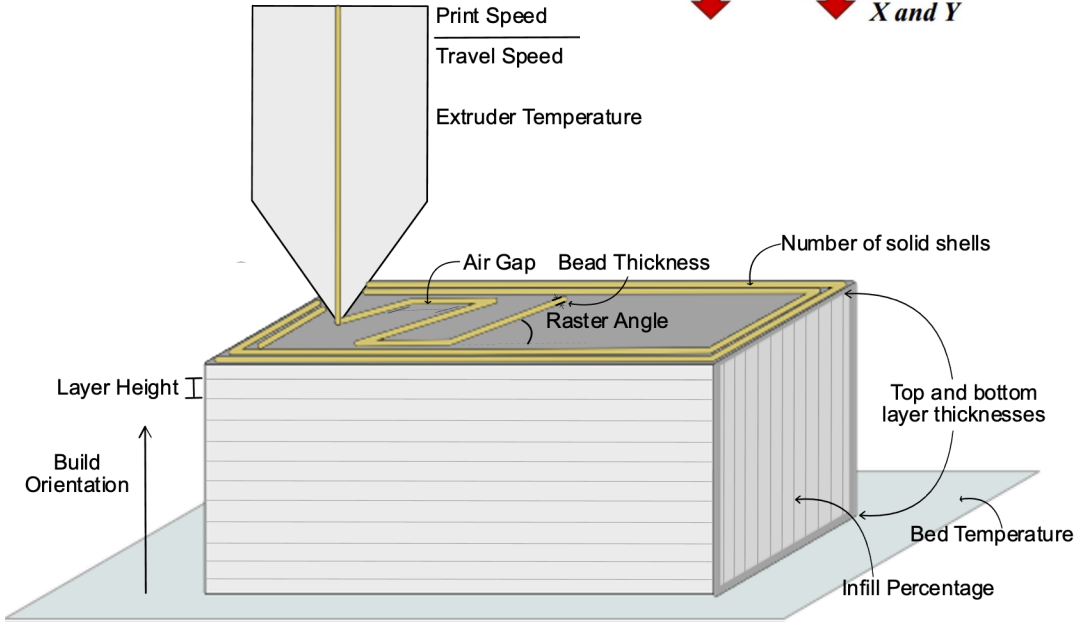


Retos

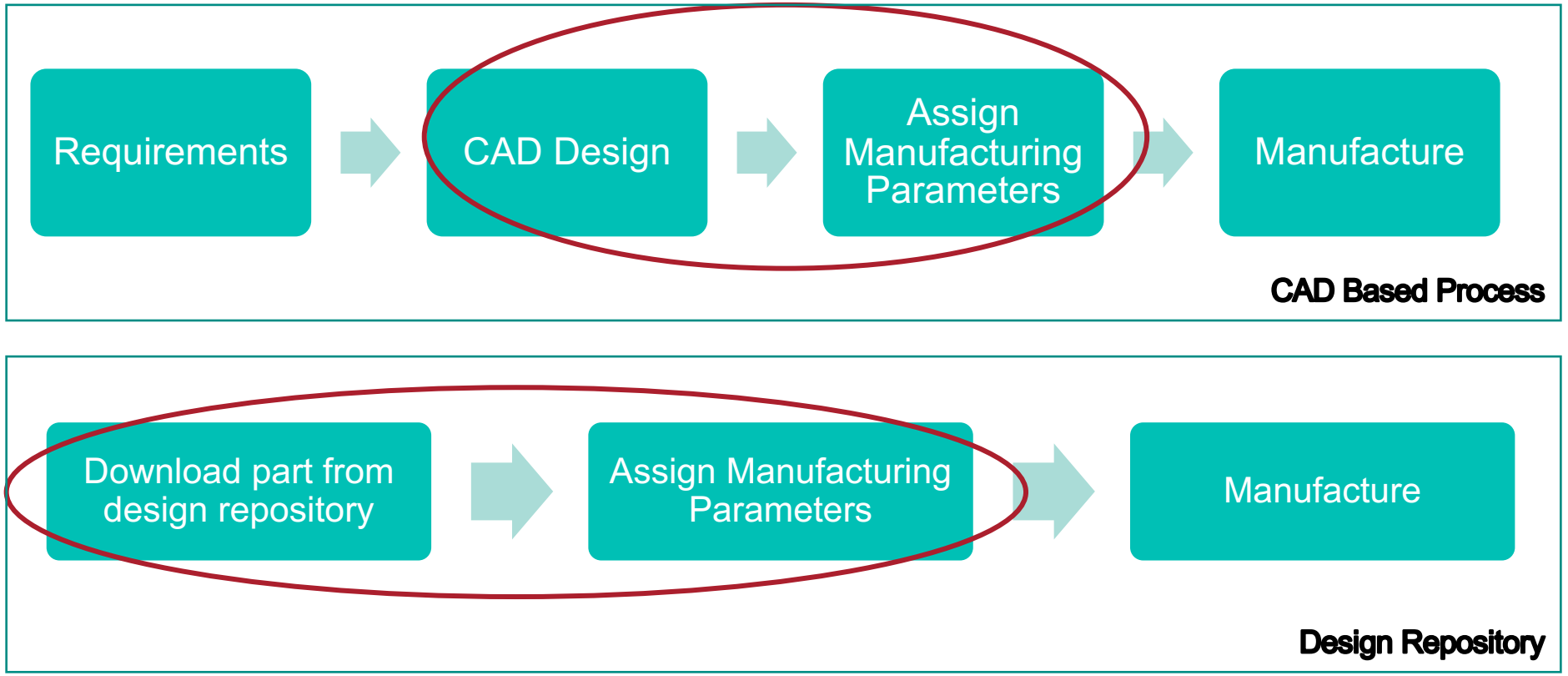
- El diseño es muy difícil
- Diseño para FDM es mas difícil todavía
  - Parámetros de manufactura
  - Propiedades anisotropías
  - Propiedades mecánicas desconocidas





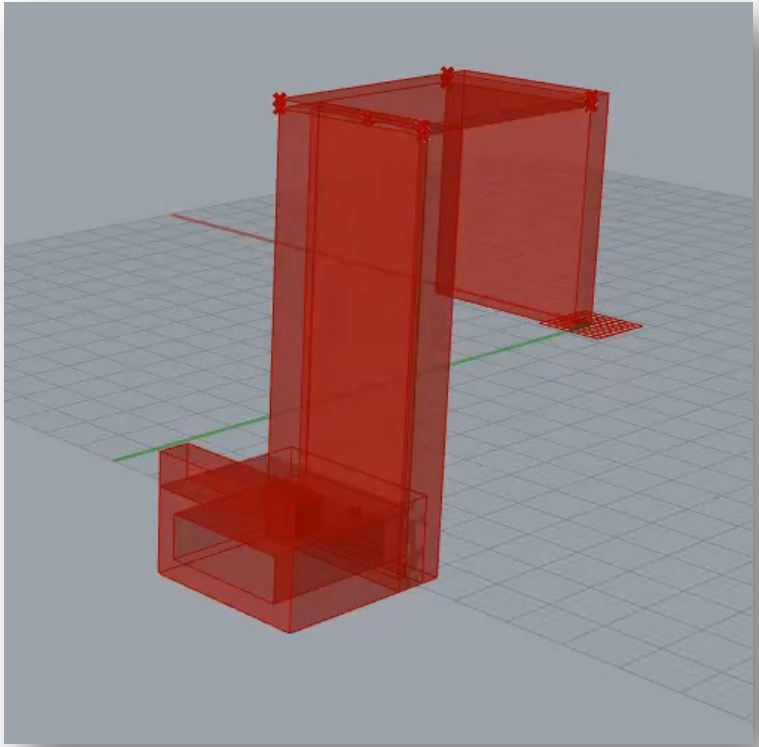


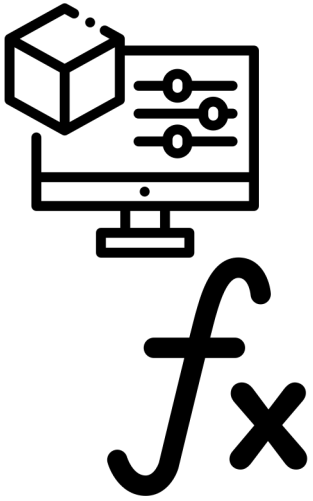
Métodos existente de diseño para FDM



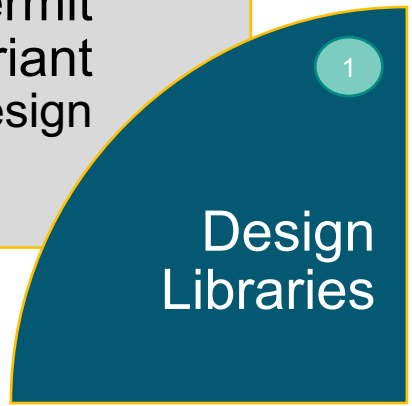
Diseño generativo

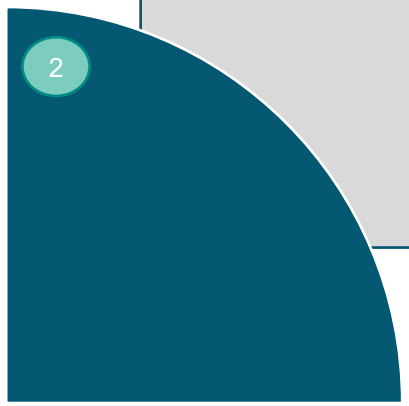
- El proceso de crear cosas que crean cosas
- ¿Como se puede aplicar diseño generativo para aumentar la capacidad de repositorios de diseño?

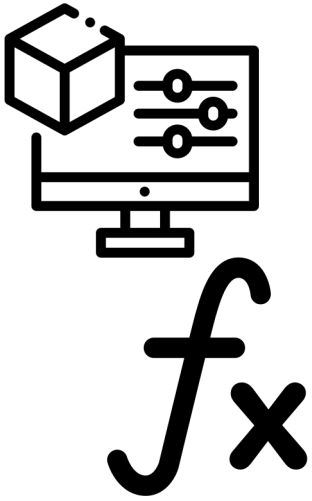




- Permit Variant Design





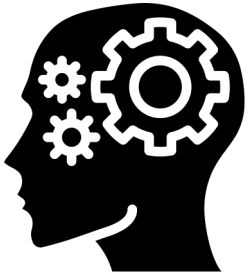


- Permit Variant Design

1 Design Libraries

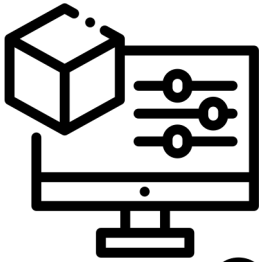
2 FDM capability model

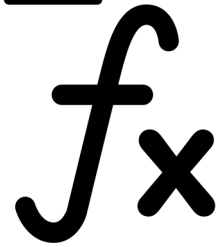
- Embody knowledge of manufacturing process



4

3





- Permit Variant Design

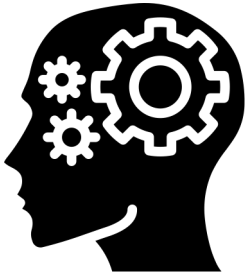
1

Design Libraries

2

FDM capability model

- Embody knowledge of manufacturing process

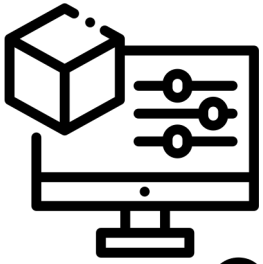


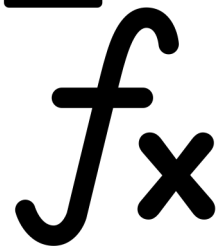
4

3

Design space exploration tool

- Take design decisions on behalf of user



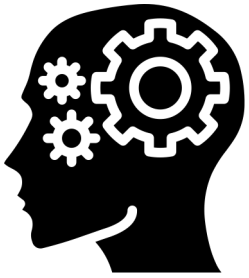


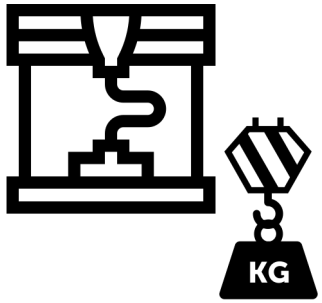
- Permit Variant Design

1 Design Libraries

2 FDM capability model

- Embody knowledge of manufacturing process



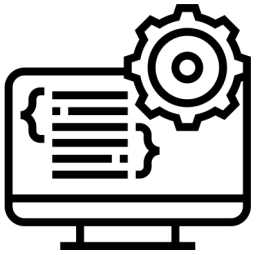


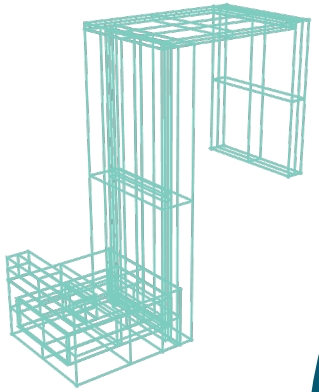
- Account for variance in process

4 Manufacture and test

3 Design space exploration tool

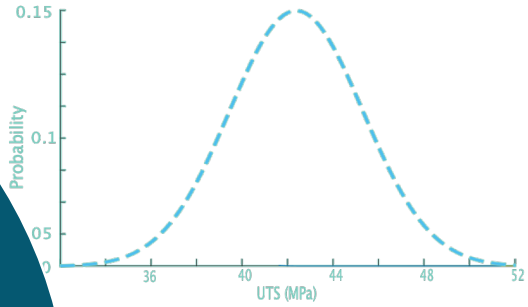
- Take design decisions on behalf of user

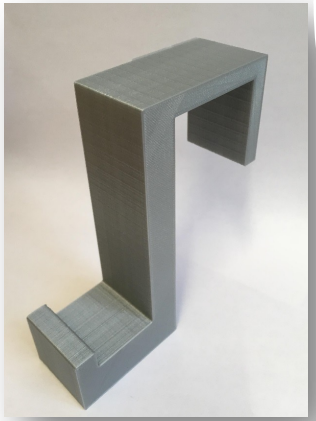




1 Design Libraries

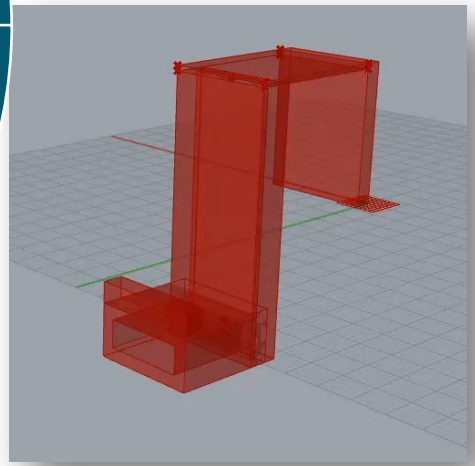
2 Capability model

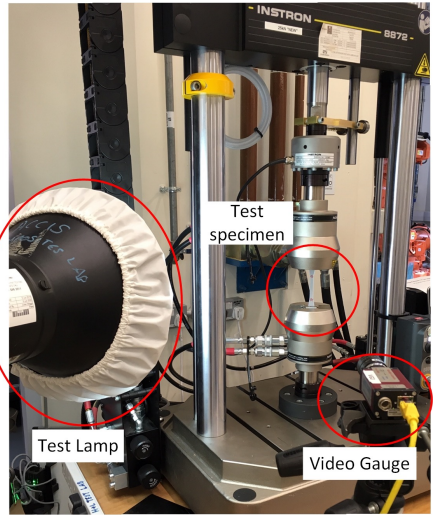


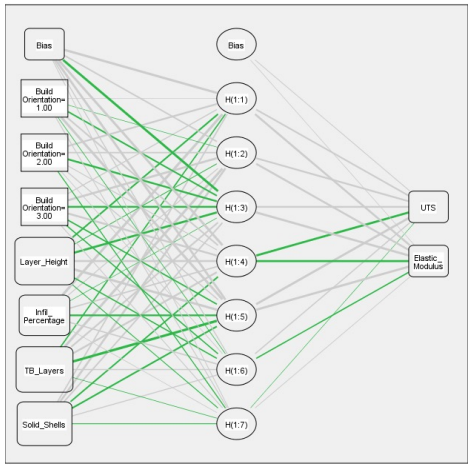


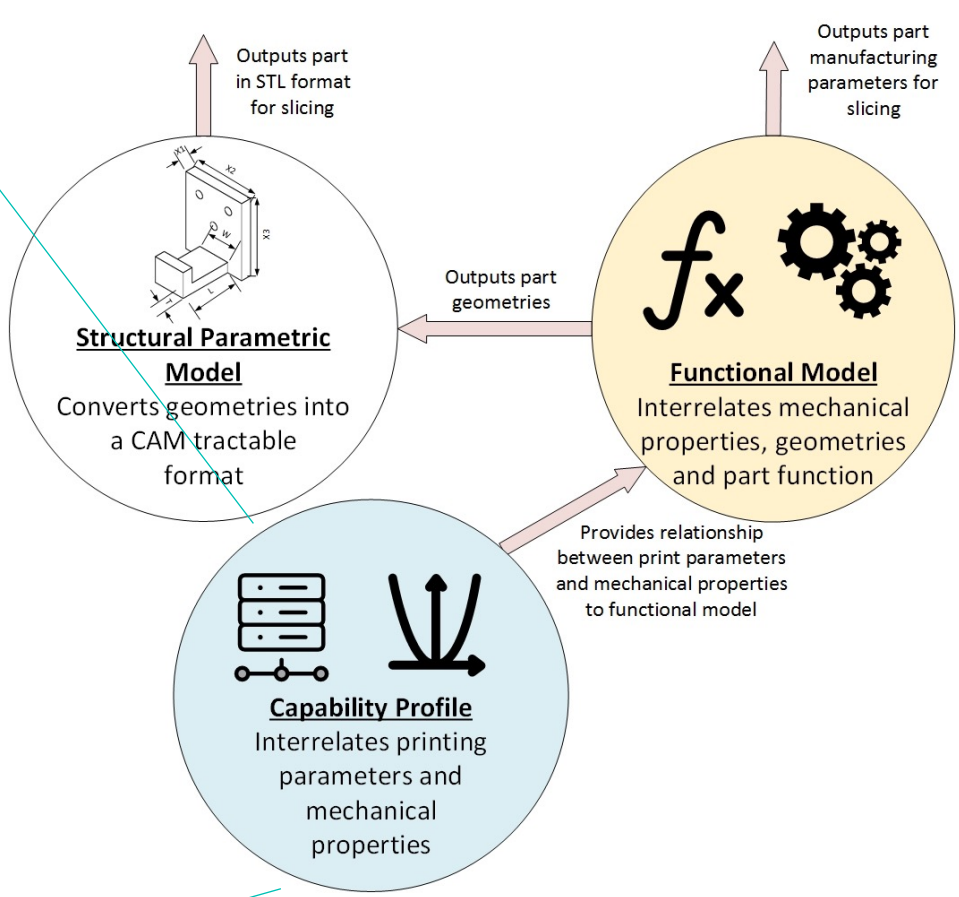
4 Manufacture and test

3 Generative design to find a solution









La metodología y sus modelos

1. User selects model from design library.

2. User inputs their requirements, manufacturing capability & constraints.

3. Solutions generated via PSO

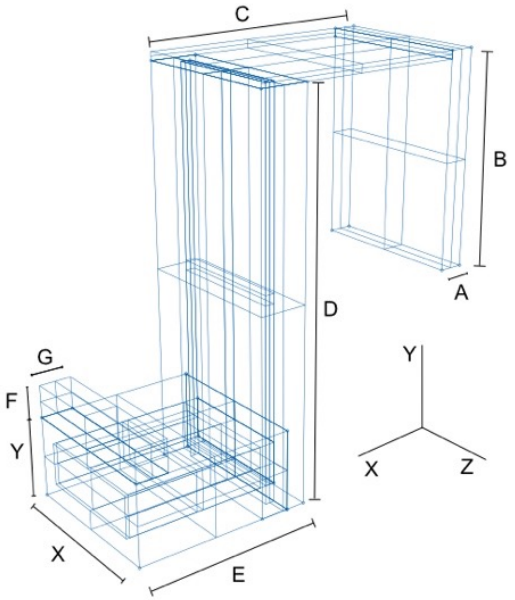
4. Part is manufactured via FDM.

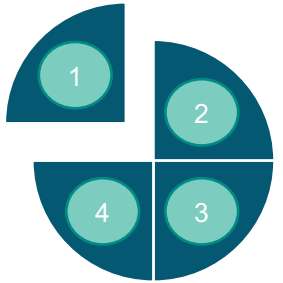
5. User tests part

6. User determines if the part meets their requirements.

7. If unsuccessful, cycle is repeated incorporating the physical testing results.

8. Solution Generation and physical testing repeated until a satisfactory part is made.





$$F_{MaxBend} = \frac{UTS.I_{xxShell}}{y_{shell}.d} + \frac{UTS_{infill}.\%Infill.I_{xxInfill}}{y_{infill}.d}$$

Requirements:
Load
Fitting size

Capability:
Material Properties
Printer Capability

Constraints:
Time
Material

1. User selects model from design library.

2. User inputs their requirements, manufacturing capability & constraints.

3. Solutions generated via generative design

4. Part is manufactured via FDM.

5. User tests part

6. User determines if the part meets their requirements.

7. If unsuccessful, cycle is repeated incorporating the physical testing results.

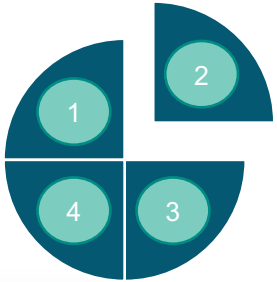
8. Solution Generation and physical testing repeated until a satisfactory part is made.

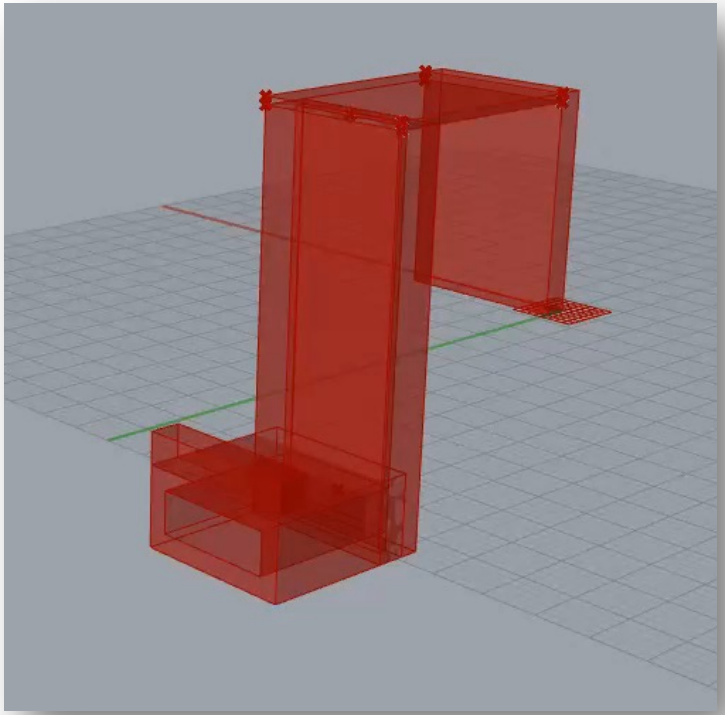
$$Fitness = C_1.C_2.\frac{Load}{Area_{Cross\ section}}$$

$$Where\ C_1 = 0.1\ if\ Fmax < Frequired\ else\ C_2 = 1$$

$$C_2 = 0.1\ if\ Infill \leq .1, else\ C_2 = 1$$

$$and\ Load = Min(F_{MaxBend}, F_{required})$$





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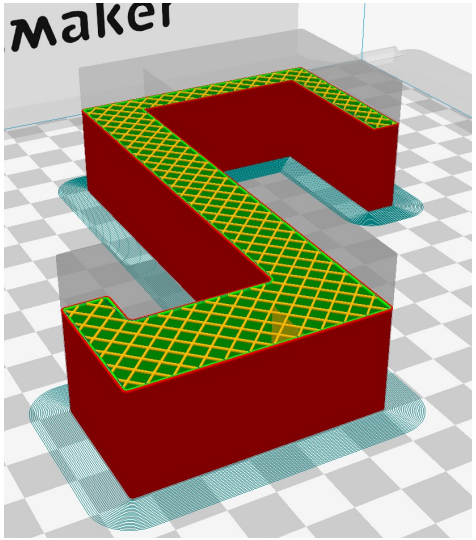

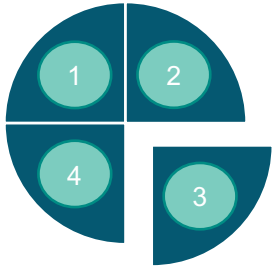

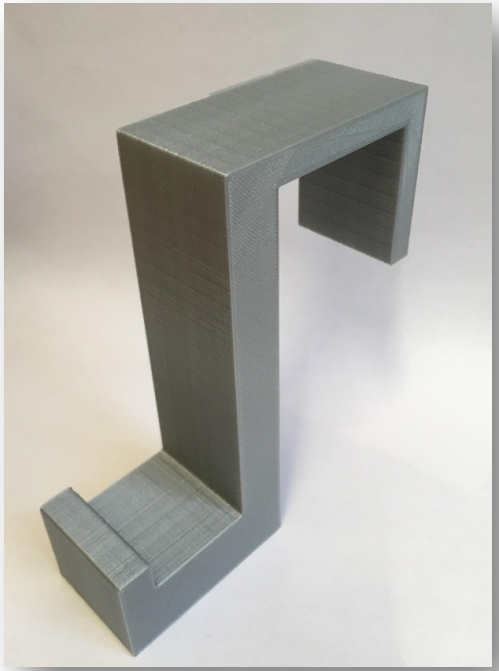

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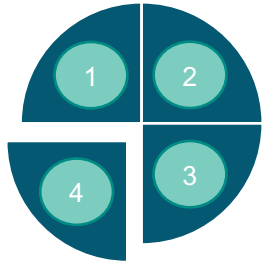
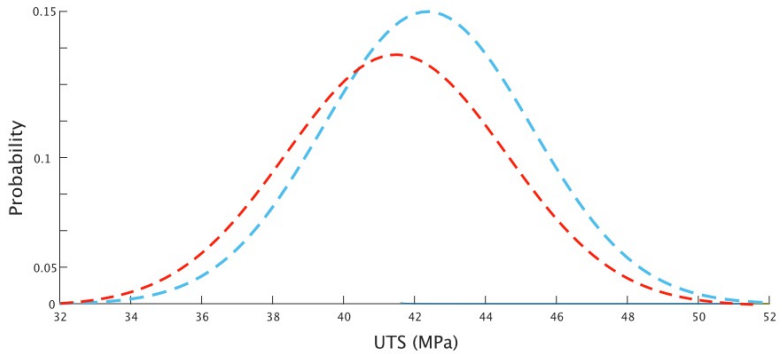
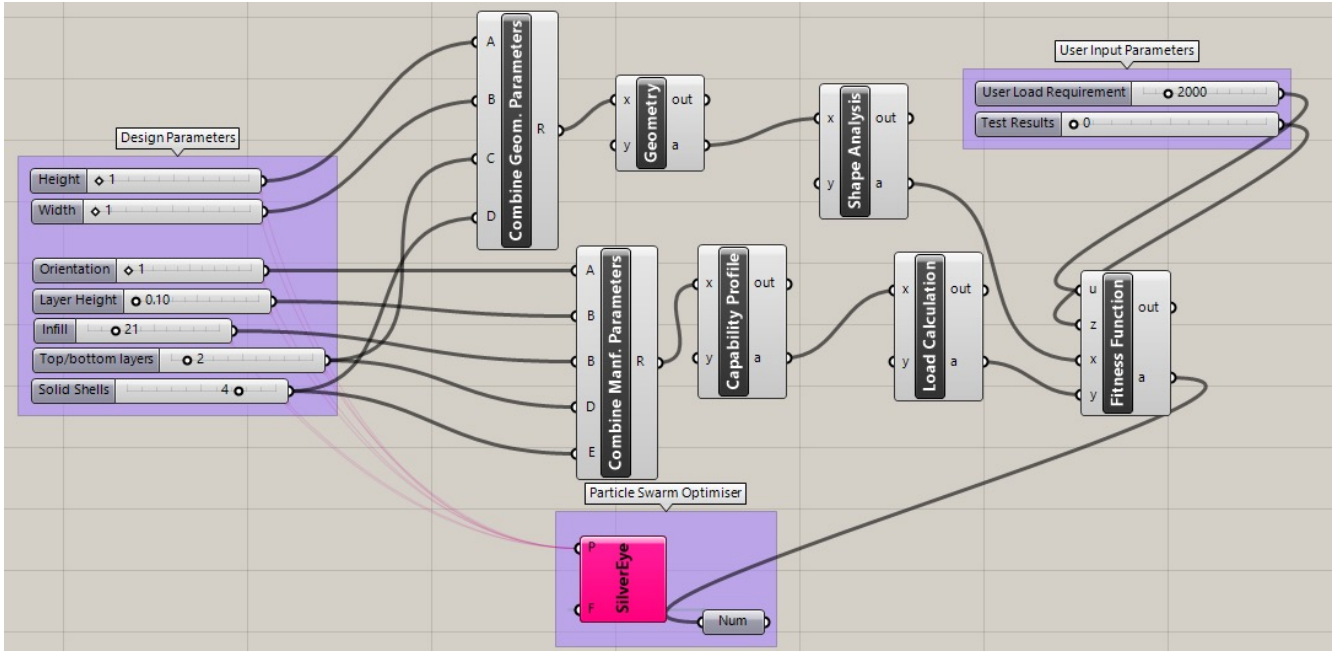




$$F_{MaxBend} = C_1 \frac{UTS.I_{xxShell}}{y_{shell}.d} + C_2 \frac{UTS_{infill}.\%Infill.I_{xxInfill}}{y_{infill}.d}$$

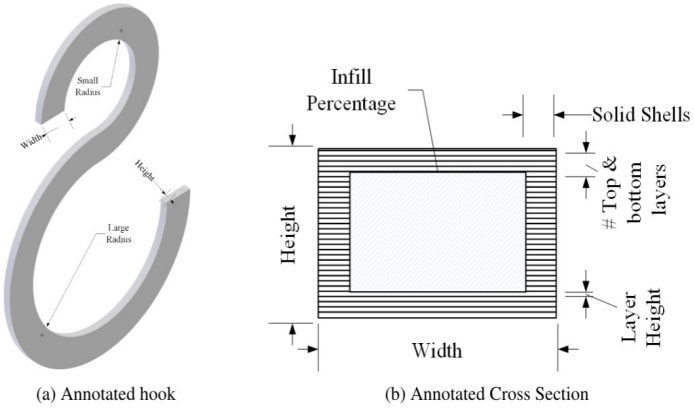
Implementación

- Rhino 6
- Grasshopper



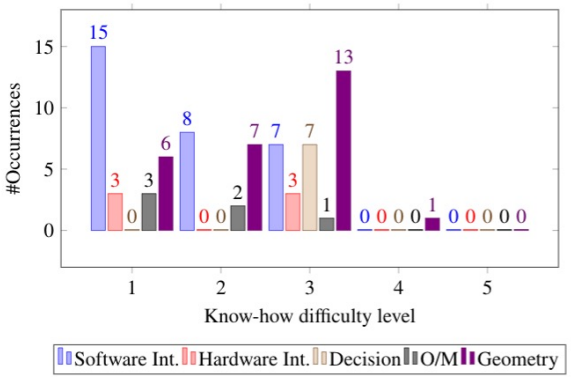
Verificación I

- Parte estructural sencillo
- Espacio de diseño de siete dimensiones
- Optimizándolo no es trivial!
- Parte que satisfice los requerimientos esta generado en dos iteraciones

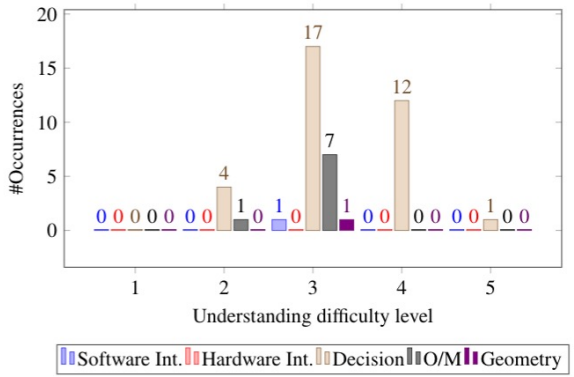


(a) Annotated hook (b) Annotated Cross Section

Figure 4: Generative hook parameters and physical validation

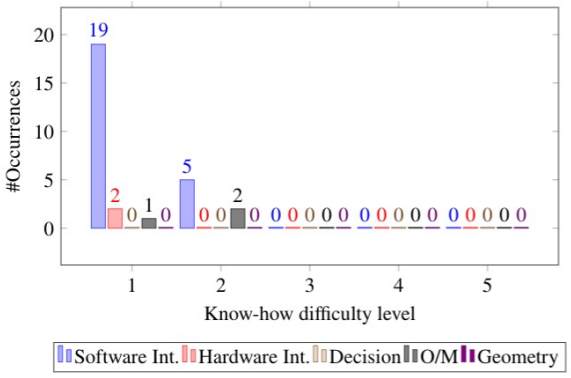


(a) Trad. CAD Know-how

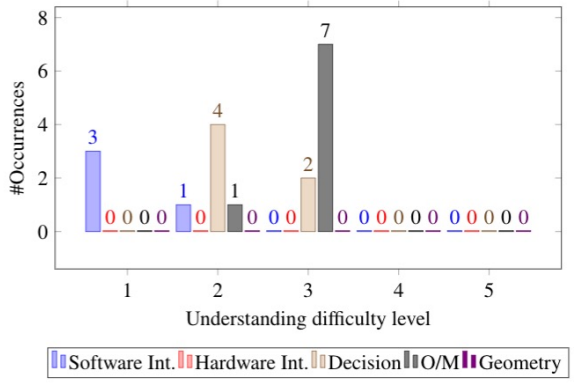


(b) Trad. CAD Understanding

CAD Process



(c) Generative Based Democratised know-how

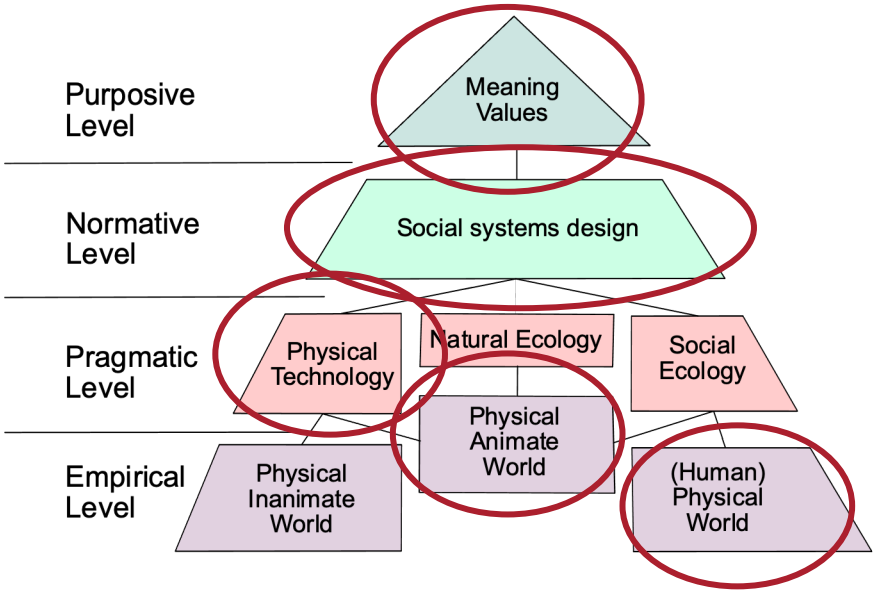


(d) Generative Based Democratised understanding

Generative Approach

Verificación II

Contextualizandolo en Jantsch



Contribuciones al conocimiento

- El desarrollo de una nueva metodología que facilite la democratización de diseño
- La elucidación de los requerimientos de la democratización de diseño
- La creación de nuevo conocimiento sobre el proceso de manufactura FDM
- El desarrollo y uso de un perfil de capacidad para FDM.

Discussion

- What I presented today is what did work, not what didn’t!
- 3D printing technologies require further development
  - This is happening!
- Democratising design is a broad and complex topic
  - Lots of examples (DMF lab?) and outside

Gracias por su atención!

- ¿Tienen alguna pregunta?

Recursos

- Democratsiation and escalation of creativity
  - https://medium.com/@creativeai/creativeai-9d4b2346faf3
- Some of my works
  - Thesis link: https://research-information.bris.ac.uk/en/studentTheses/a-hybrid-virtual-physical-design-methodology-to-enable-the-democr
  - Capability profiling journal paper: https://link.springer.com/article/10.1007/s00170-021-06770-8
  - Approaches to democratising design: https://research-information.bris.ac.uk/ws/portalfiles/portal/205917677/different_approaches_to_democratise_design_are_they_equal.pdf
- Herbert Simon's Science of the artificial
  - https://monoskop.org/images/9/9c/Simon_Herbert_A_The_Sciences_of_the_Artificial_3rd_ed.pdf
- Andrew Feenberg's critical theory of technology
  - https://www.sfu.ca/~andrewf/books/critbio.pdf
- Fundamentos de diseño generativo
  - https://medium.com/generative-design