Design Process Models & Re-Designing Engineers' Design Education

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Background & Motivations

Historical Context: Cold War Roots

- Design processes created to streamline designs and motivate creativity in the Cold War [1]
  - Stemmed from schools within the UK – moved to the US for its utility [1]
  - Influenced by digital logic & computer programming [2] – thus very procedural methods

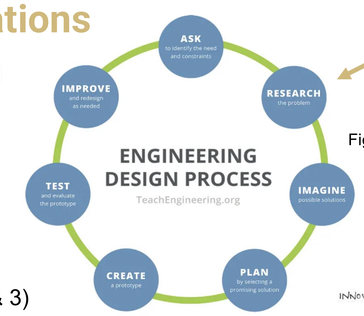
Modern Day Outgrowth

- Today, "The Design Process" commonly references procedural models similar to Fig. 1
  - Often used to introduce engineering & design in K-12 & higher education
- However, research indicates there is no "consensus model" of the design process [4,5]
  - Some literature has been starting to create "analog" or "lived" models of design (Fig. 2 & 3)
  - As indicated by Gericke & Blessing (Fig. 4), disciplines vary in their design process conceptualization – noticeably absent from defined design processes are Use & Closeout

Educational Example: Teaching Design at University of Colorado at Boulder

- Design is introduced in projects courses (like GEEN 1400) – often in context of planning, building, and designing a project
  - Design process models used in these courses are frequently procedural (Fig. 1)
  - Although they are often circular, it is still a formulaic approach to design

Applying the concept of "design fixation" [7] to the practice of teaching procedural design process models, we argue that students may be subconsciously fixating on only a procedural model of design.



"Procedural" Design Process Model
circular, formulaic, rigid

Fig. 1: Model from TeachEngineering's "design process curriculum" [3]

"Lived" Models of Design
personalized, non-formulaic, flexible

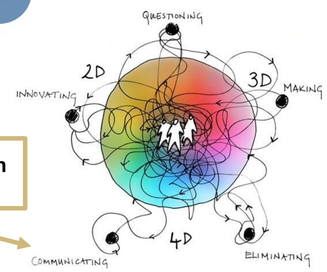


Fig. 2: Furniss's model of design created with models from designer interviews [4]

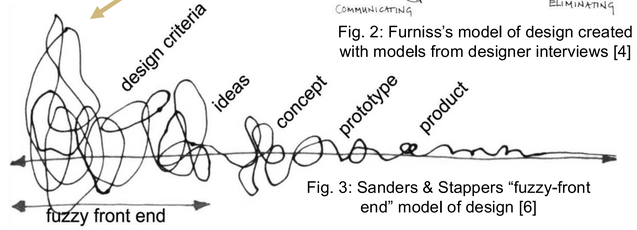


Fig. 3: Sanders & Stappers "fuzzy-front end" model of design [6]

Designer Bias & Global Context

- Procedural design processes prescribe designer actions through formulas & are rooted in Western thought
  - This bias may be invisible to Western students, but it still impacts their design process & designed artifacts
- An example of this invisible bias can be seen with the absence of "Use" & "Closeout" steps as shown by Fig. 4
  - Note that this absence is also present in Fig. 1
  - Without "Use" or "Closeout" – design becomes an isolated activity, separate from the context
  - This may cause students to limit their definitions of design & their perceived responsibility as designers

If students are unaware of procedural design processes' invisible biases, they may not consider how such biases impact their designs in global or cultural contexts.

Discipline	Establish a Need	Analyze Task	Conceptual Design	Embodiment Design	Detailed Design	Implementation	Use	Closeout
Mechanical Engineering (n=31)								
Industrial Design (n=1)								
Systems Engineering (n=5)								
Building Design/ Architecture (n=5)								
Software Design (n=5)								
Service Design (n=5)								
Mechatronics(n=3)								

Fig. 4: Comparison of design process models across disciplines as discussed by Gericke & Blessing [5]

Personal Models of Design

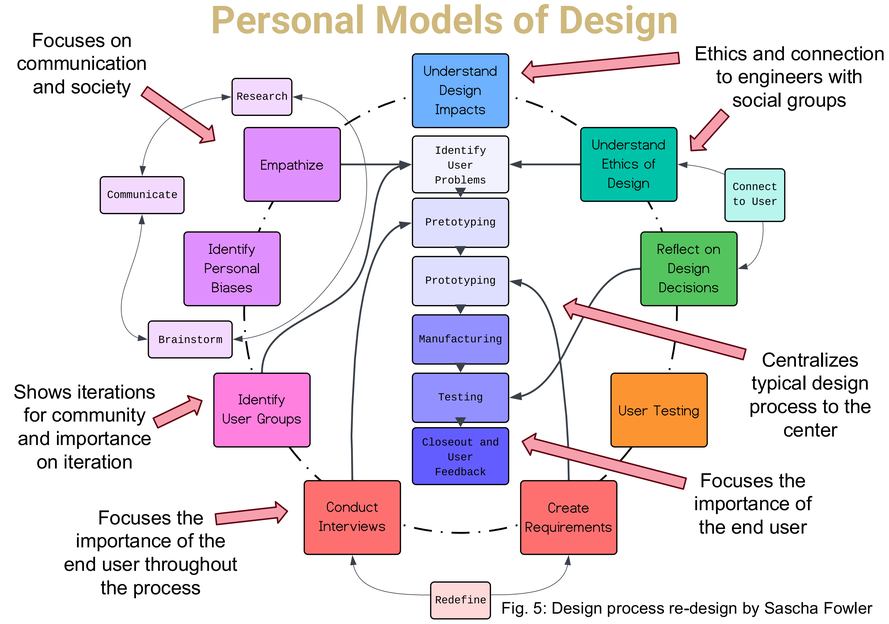


Fig. 5: Design process re-design by Sascha Fowler

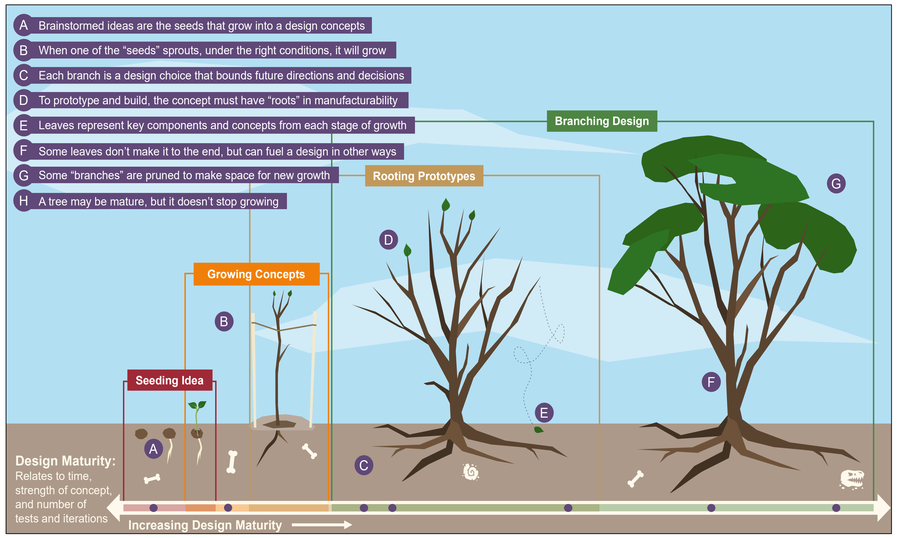


Fig. 6: Design process re-design by Percy Smith

Proposed Implementation for Revised Curriculum

Changes to curriculum should:

1. Foster students' conceptualization of design processes by challenging them to conceptualize and communicate their own design process models
2. Encourage nuanced understanding of design among young engineers through self-reflection, discussion and visualization of diverging perspectives

Wk.	Tasks or Lesson Plan	Goals and Social Impact
1	• Place students into teams • Introduction of a small design project that requires minimal engineering knowledge	• Students experience what it is like to design something from scratch • Allows them to understand their personal design processes without other design processes affecting perspective
2	• Students work on & finish design projects	• Gives time for students to explore how their team designs
3	• Students reflect on their design project and represent their view of the design process • Introduction of common process models	• Students will characterize their understanding of design processes • Allows students to visualize differences between individual and commonly-used process models
4	• Introduction of personal identities & bias • Drawing connections between bias and individuals' design process models • Discussion of stakeholder and user impacts	• Students will identify how biases informed their process models • Encourages students to determine what design means for them without enforcing a 'formula' of the design process • Fosters connections between design practice and social impacts

Table 1: Example of addition to an engineering design course curriculum

Prospective Impact

- Provides students with tools to understand & discuss:
  - Structural & Personal Biases
  - Designer Responsibility
  - Global & Cultural Contexts
  - Western Hegemonic Values in Engineering
- Addresses problems with procedural design process models before they are internalized by students
- Mitigates students' "design fixation" through reflection

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References

[1] N. Cross, "A History of Design Methodology," in Design Methodology and Relationships with Science, M. J. de Vries, N. Cross, and D. P. Grant, Eds., Dordrecht: Springer Netherlands, 1993, pp. 15–27. doi: 10.1007/978-94-015-8220-9_2.

[2] J. C. Jones, "Method of Systematic Design," presented at the Conference on Design Methods, 1962, pp. 54–73. [Online]. Available: https://dl.designresearchsociety.org/cgi/viewcontent.cgi?article=1000&context=design_meth ods_conference_1962

[3] TeachEngineering. (n.d.). *Engineering Design Process*. TeachEngineering.Org. Retrieved October 16, 2025, from designprocess://www.teachengineering.org/populartopics/designprocess

[4]L. Furniss, L. Deeg, T. Metz, and R. Tursky, "Beyond Discipline: Evolving Design Practice and Design Education in the Twenty-First Century," Architecture_MPS, vol. 18, no. 1, 2020, doi: 10.14324/111.444.amps.2020v18i1.004.

[5] K. Gericke and L. Blessing, "An Analysis of Design Process Models Across Disciplines," in International Design Conference, Dubrovnik, Croatia: Design Processes, May 2012, pp. 170–180.

[6] E. Sanders and P. Stappers, "Co-creation and the new landscapes of design," Co-Design, vol. 4, no. 1, pp. 5–18, Mar. 2008, doi: 10.1080/15710880701875068.

[7] Jansson, D., & Smith, S. (1991). Design fixation. *Design Studies*, *12*.