Reshaping Makerspaces to Learn Frontier Making Practices

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ALL LEARNING IS MODELING

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Makerspaces (MS)

"informal sites for creative production in art, science, and engineering, where people of all ages blend digital and physical technologies, to explore ideas, learn technical skills, and create new products." (Sheridan et al., 2014)

Images: Sri Prakash Vidyaniketan, Atal Innovation Mission

STEM Conceptual Understanding

Broaden STEAM participation

Productive STEM identity

NITI Aayog ATL Program 8000+ tinkering spaces

*Building Innovation capacity;
Solving societal problems*

Needs learning disciplinary practices along with the body of knowledge

How can school-based MS (such as ATL) support the learning of frontier making practices that address societal needs?

1. *Characterize the design process of frontier making cases*
2. *Extract the key engineering design practices*
3. *Discuss the characteristic frontier making practices in the context of MS*

A typical electric centrifuge

Image: Hermle_2_KareljWiki (CC)

Paperfuge (Illustrative case)

Ultra-low cost hand-powered centrifuge;
Inspired by lack of electricity in African clinics

Paperfuge Prakash Lab, Stanford
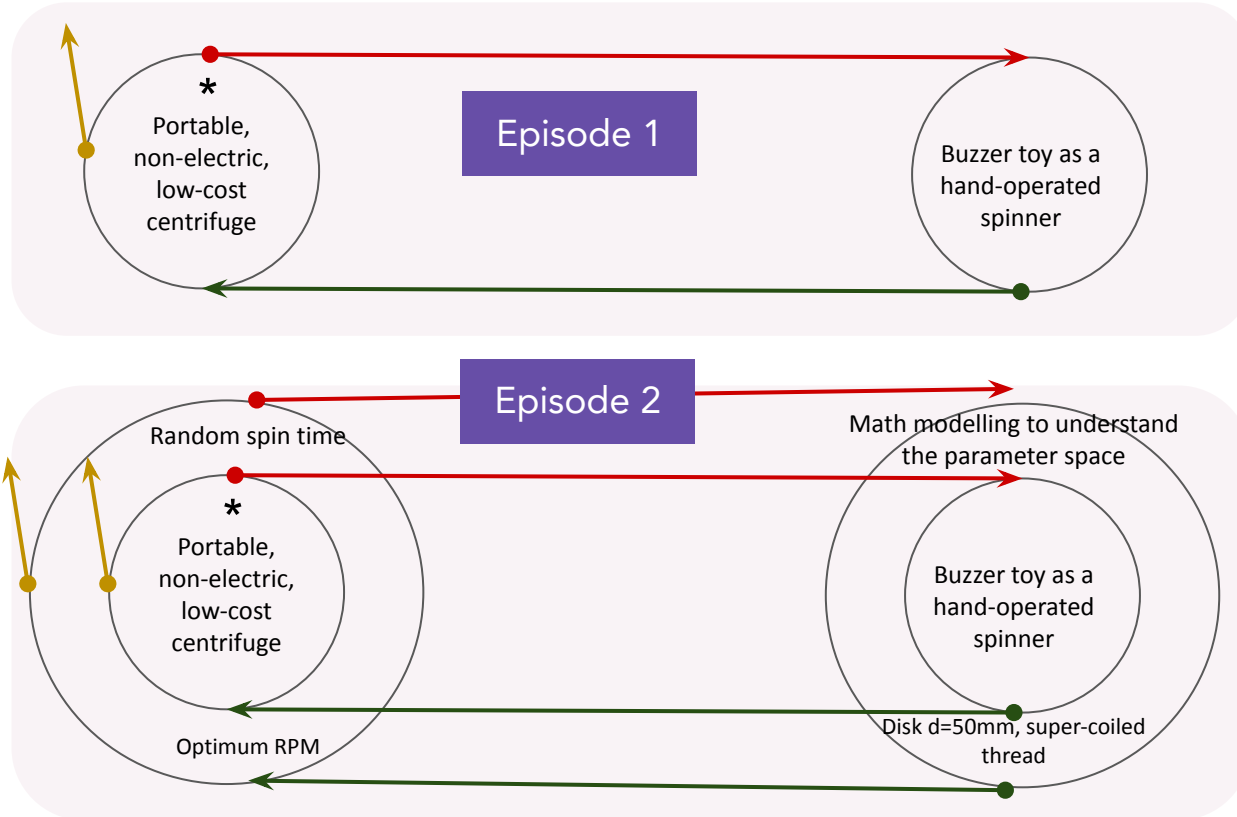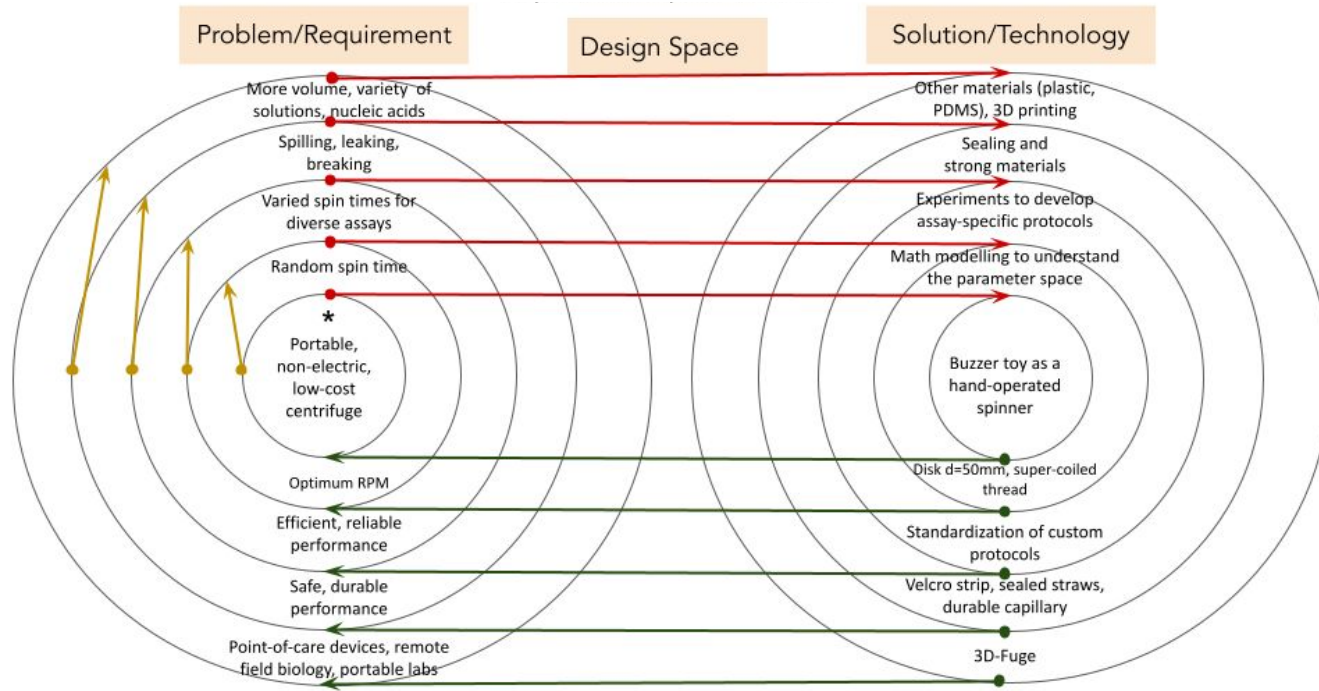
Image: Screenshot from video *by Kurt Hickman*

3

Design Space

Problem/Requirement

Solution/Technology

Paperfuge
Design Process

Episode 1

*
Portable, non-electric, low-cost centrifuge

Buzzer toy as a hand-operated spinner

Episode 2

Random spin time

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Portable, non-electric, low-cost centrifuge

Optimum RPM

Math modelling to understand the parameter space

Buzzer toy as a hand-operated spinner

Disk d=50mm, super-coiled thread

Paperfuge episode outcomes
1. Identified whirligig as the model for hand-powered centrifuge
2. Defined the material and the tech specs (paperfuge of 50 mm dia)
3. Standardized the spin times for various assays
4. Developed the safety features for the sample capillaries (velcro etc.)
5. Developed a way to mass manufacture (3D fuge)

4

Expanding Spiral Pattern

Within every problem-solving episode:

- a problem was identified and scoped in a particular social context;

- a complete solution was developed for that problem;

- a broader need became explicit due to the prototype;

- the prototype helped imagine a solution to the expanded problem;

- the process continuously expanded the design space, to address both the technical and the social complexities of the need; thus designing a satisficing solution.

Discussion and Implication

Frontier design practices	Potential Makerspace Practices
1) Problem formulation started with identification of unmet need in a particular social context. 2) Problem scoping expanded spirally. The prototype helped imagine the next solution. 3) Design process included both product and manufacturing. 4) Design process contributed to theoretical understanding.	1) Encourage students to first identify societal needs by themselves. 2) Start with the problem, not the tools and techniques. 3) Continue the making process beyond a single iteration. 4) Encourage students to theorize with their making.

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