

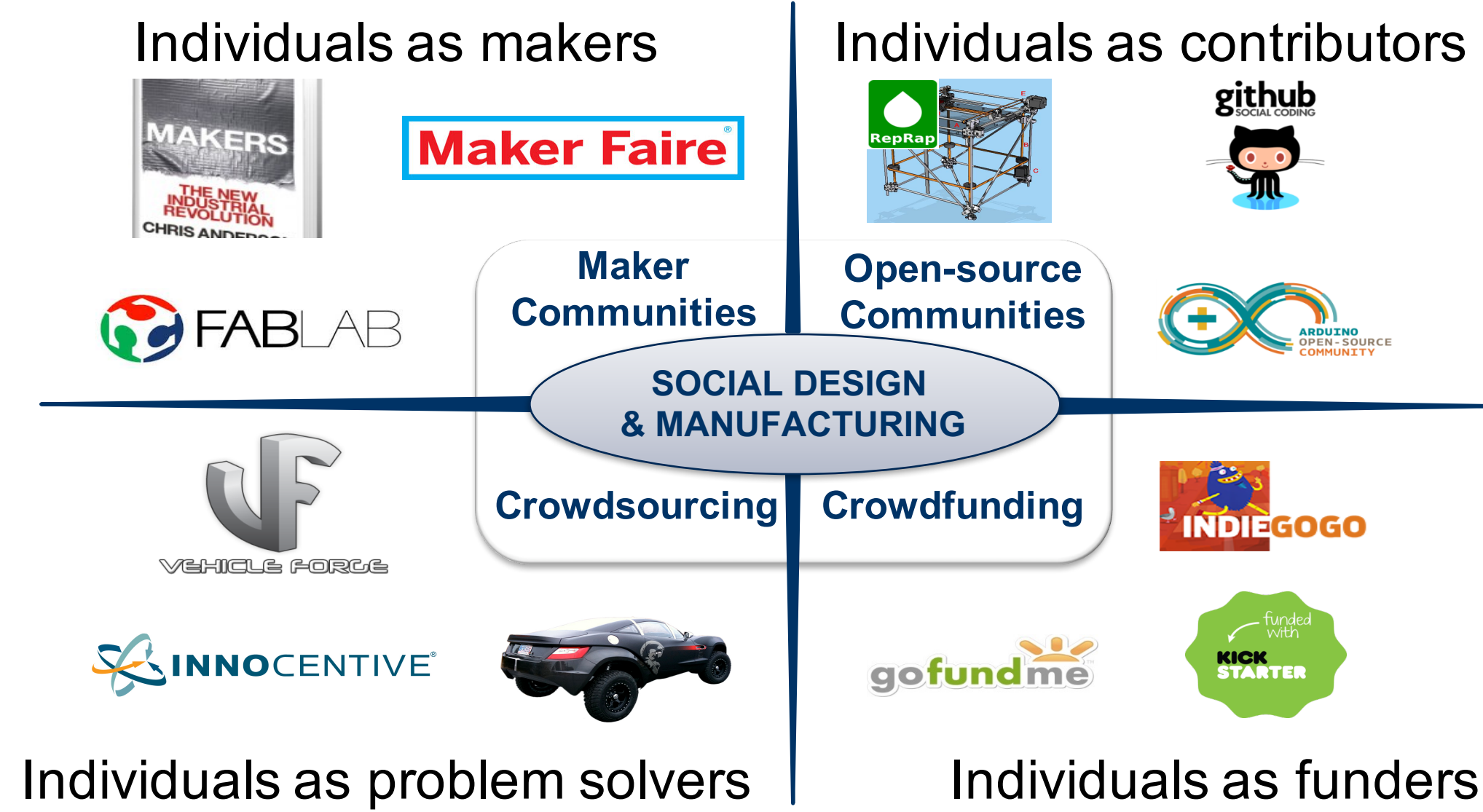


CPS: Synergy: Foundations of Cyber-Physical Infrastructure for Creative Design and Making of Cyber-physical Products

PIs: Jitesh H. Panchal, Mikhail J. Atallah and Karthik Ramani (Purdue University)
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Emerging Models of Innovation



Motivation

Barriers to participation in design and prototyping:

- Makers may lack complete engineering knowledge
- Makers may not have necessary tools and knowledge for physics-based modeling
- Makers may not be willing to reveal information in the early stages of co-design

Project Overview

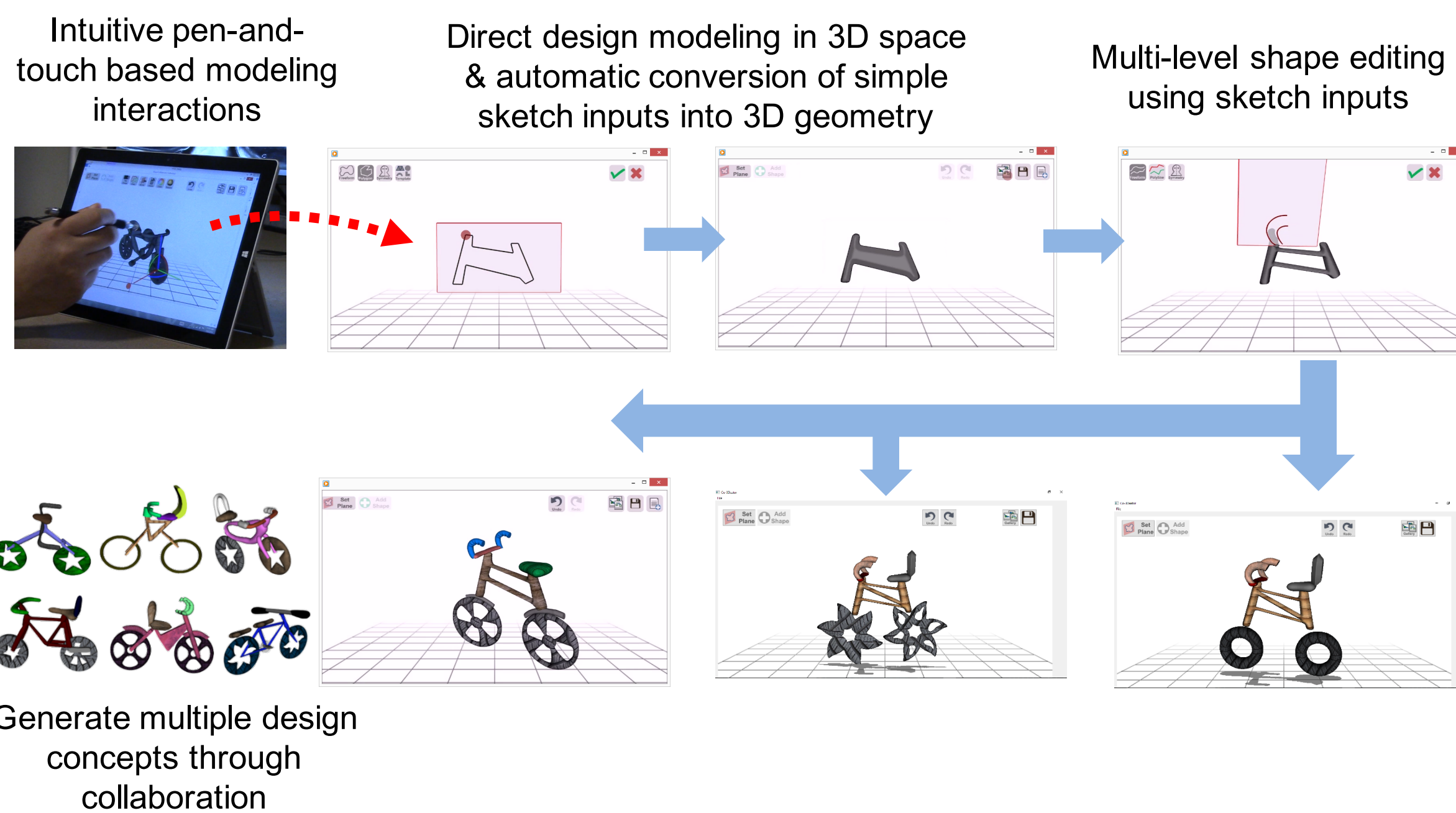
The **primary objective** of this project is to lay the foundations of a cyber-physical infrastructure for creative design and making of realizable products.

Specific aims:

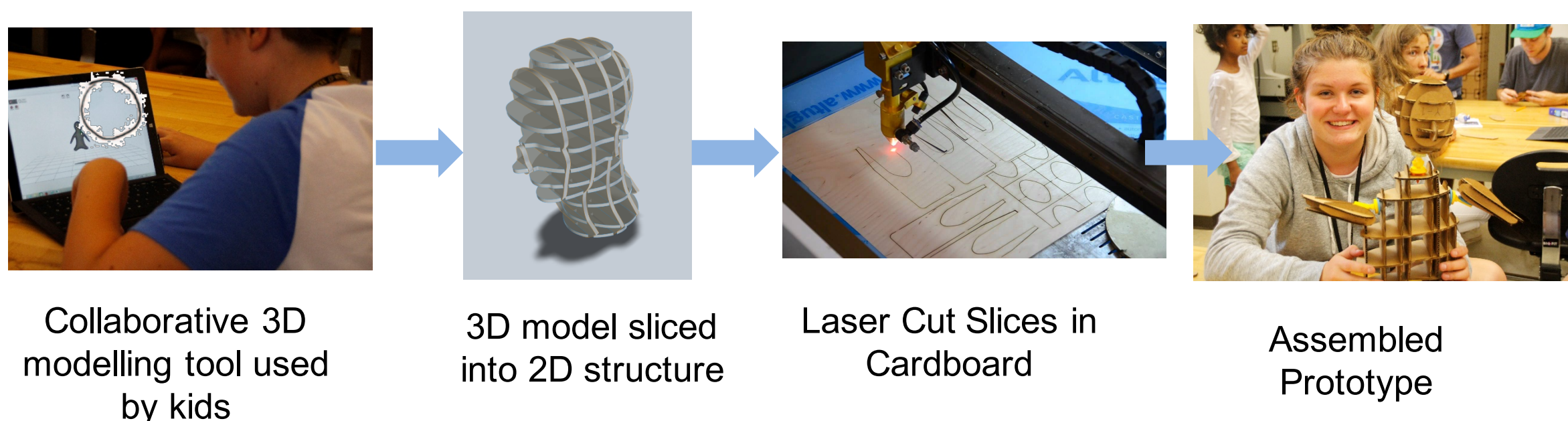
- Aim 1: Reducing barriers to participation through NUIs.
- Aim 2: Reducing barriers to model-based engineering.
- Aim 3: Overcoming information-related impediments to co-design.

NUI-based Collaborative Design and Making

Collaborative Sketch-based 3D Modeling for Early Stage Design

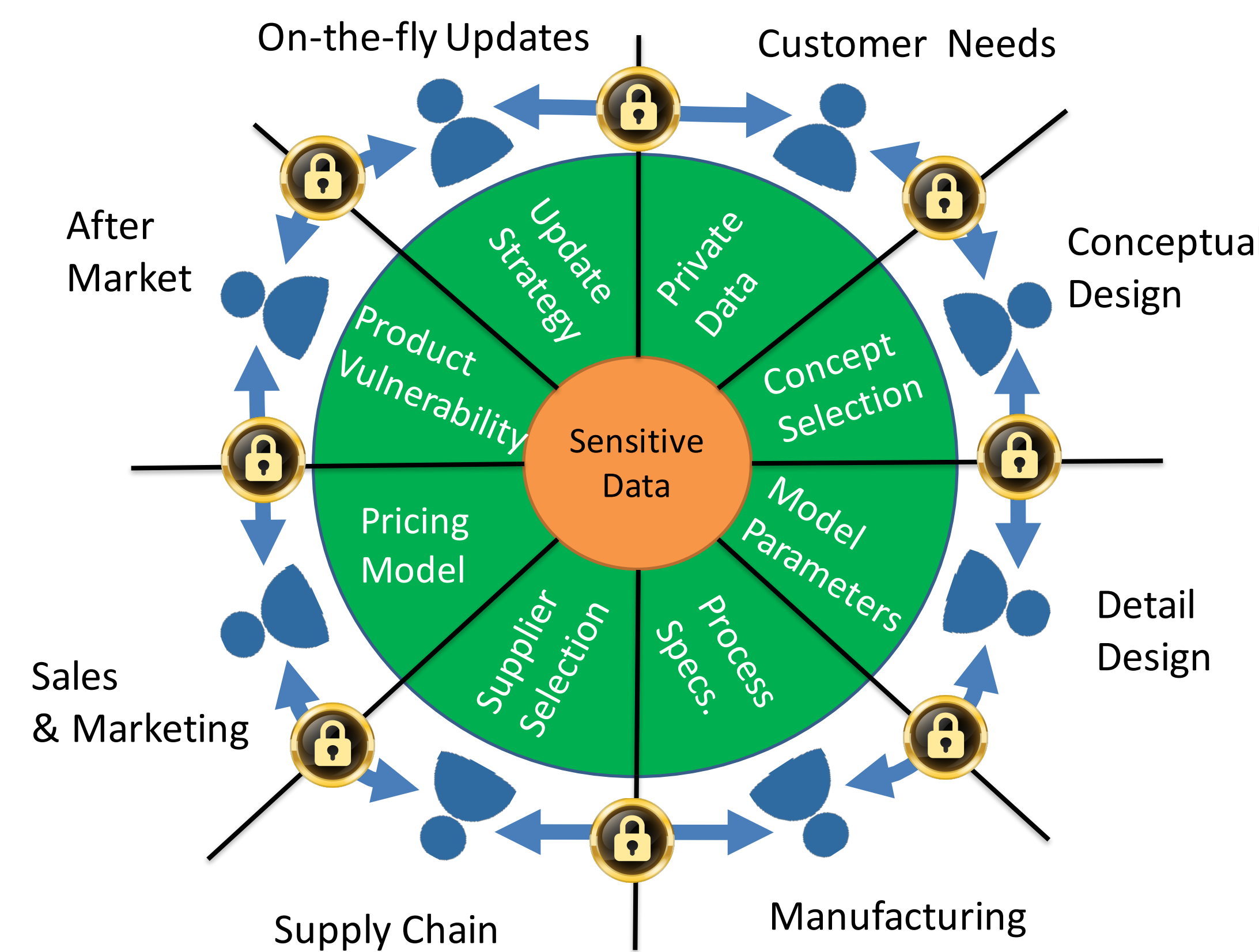


Gifted Education Resource Institute (GERI) Program



- Group of 40, 7-8th grade kids participated in a two week design workshop through the GERI program at Purdue.
- Simplicity of sketching tool enabled kids to collaboratively design and quickly fabricate prototypes.
- Automatic design segmentation & generation of component fabrication plan
- Low cost and quick fabrication of physical prototype

Product Realization Process



Synergy among different stakeholders is the key for product realization process

Significance

- NUI-based design framework enhances visualization and ease of prototyping among collaborators
- Preserving ownership of product data facilitates win-win situation to all the collaborators

Applications beyond co-design

- Realized the use of proposed secret sharing protocols help in maximizing the doctor-patient fit through NSF I-Corp program

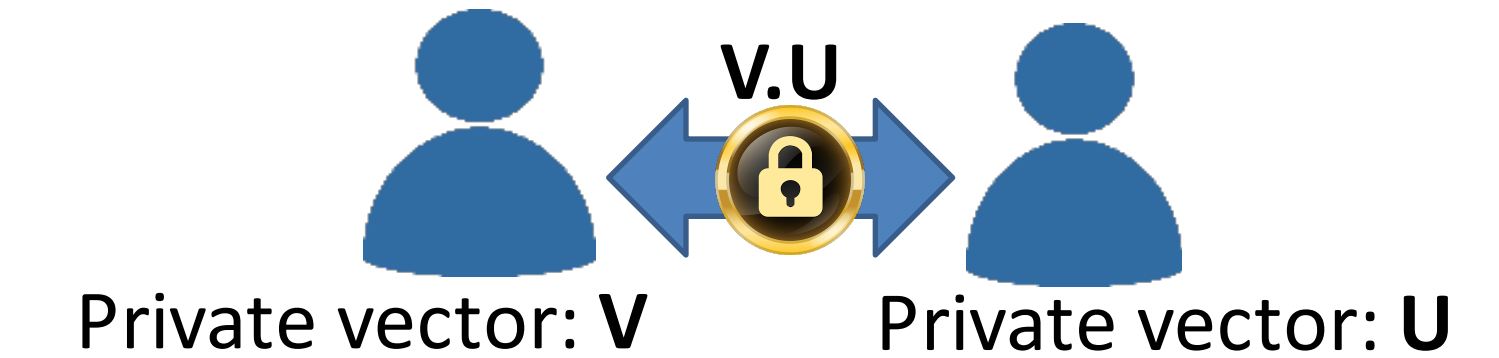
References

- Dachowicz, Adam, Siva Chaitanya Chaduvula, Mikhail Atallah, and Jitesh H. Panchal. "Microstructure-Based Counterfeit Detection in Metal Part Manufacturing." *JOM* 69, no. 11 (2017): 2390-2396.
- Piya, Cecil, Senthil Chandrasegaran, Niklas Elmqvist, and Karthik Ramani. "Co-3Deator: A Team-First Collaborative 3D Design Ideation Tool." In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, pp. 6581-6592. ACM, 2017.

"Raw" Data Leak Prevention in Engineering Collaborations

Question: How to retain data ownership on digital raw data in engineering collaborations?

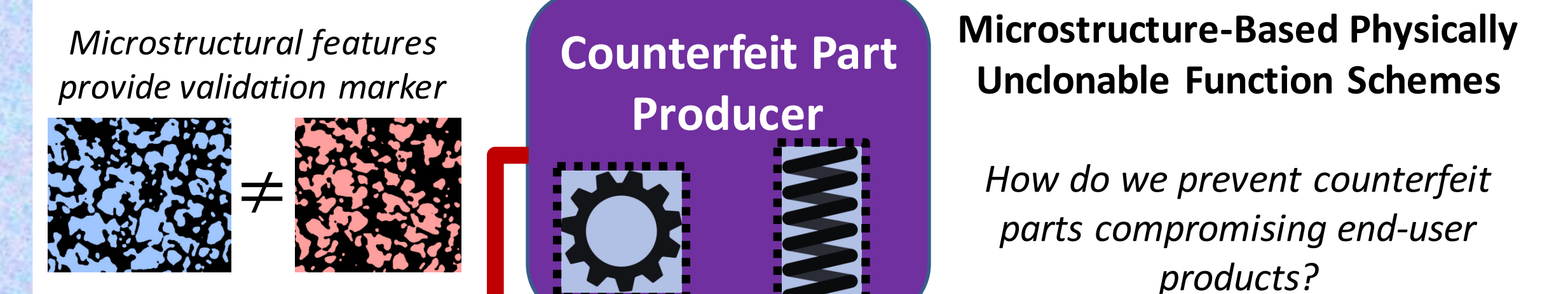
Approach: Development of computationally lightweight secret sharing protocols that process private "raw" data to meet mutually-desired purposes



Counterfeiting Prevention in Manufacturing Supply Chains

Question: How may confidence in the authenticity of procured parts be verified securely and economically?

Approach: Leverage hardware-intrinsic randomness for instance-specific verification.



- Instance-specific enrollment
 - PUF challenge definition
 - Instance-specific validation
 - PUF challenge application
- Counterfeit Detection Methodology**

