Symposium on *Extraordinary Engineering Impacts on Society*

National Academy of Engineering

August 18-19, 2022

Alice M. Agogino

- Roscoe and Elizabeth Hughes Professor Emeritus of Mechanical Engineering
- Chair of the Graduate Group in Development Engineering
- Education Director of the Blum Center for Developing Economies
- University of California at Berkeley
- CEO of Squishy Robotics , Inc.

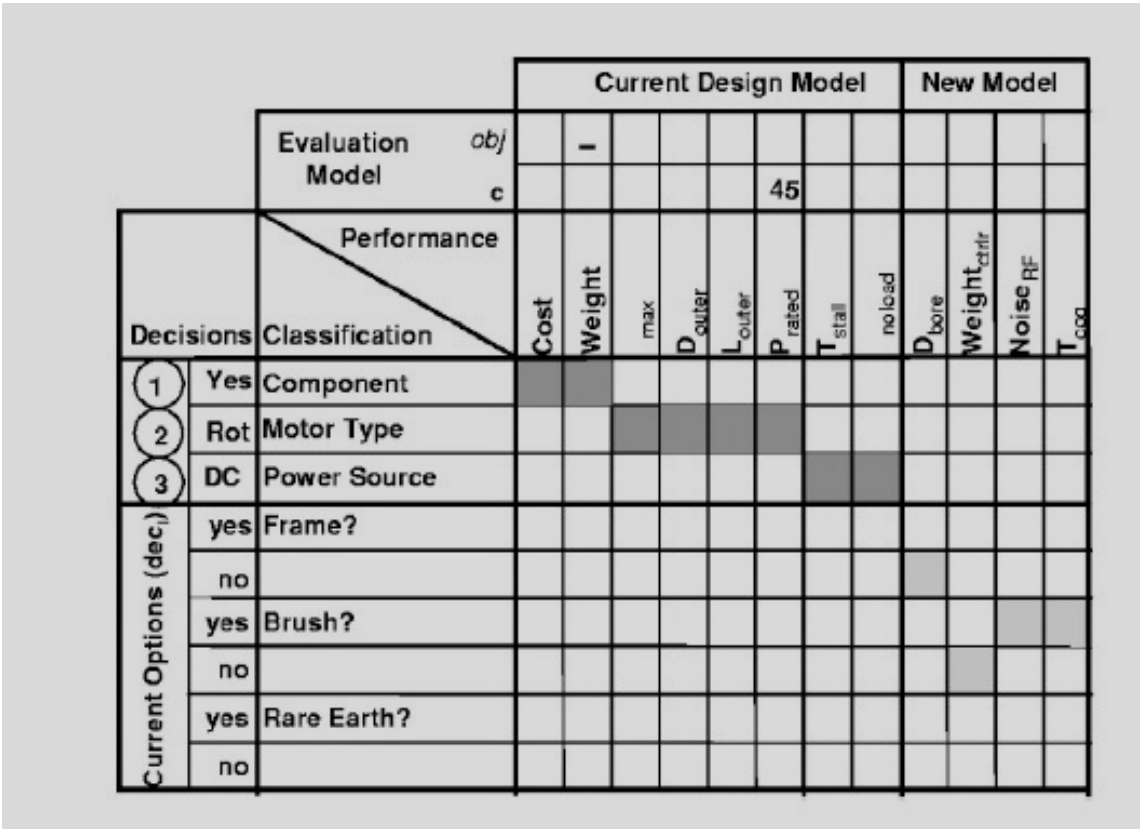
BLUM CENTER FOR DEVELOPING ECONOMIES

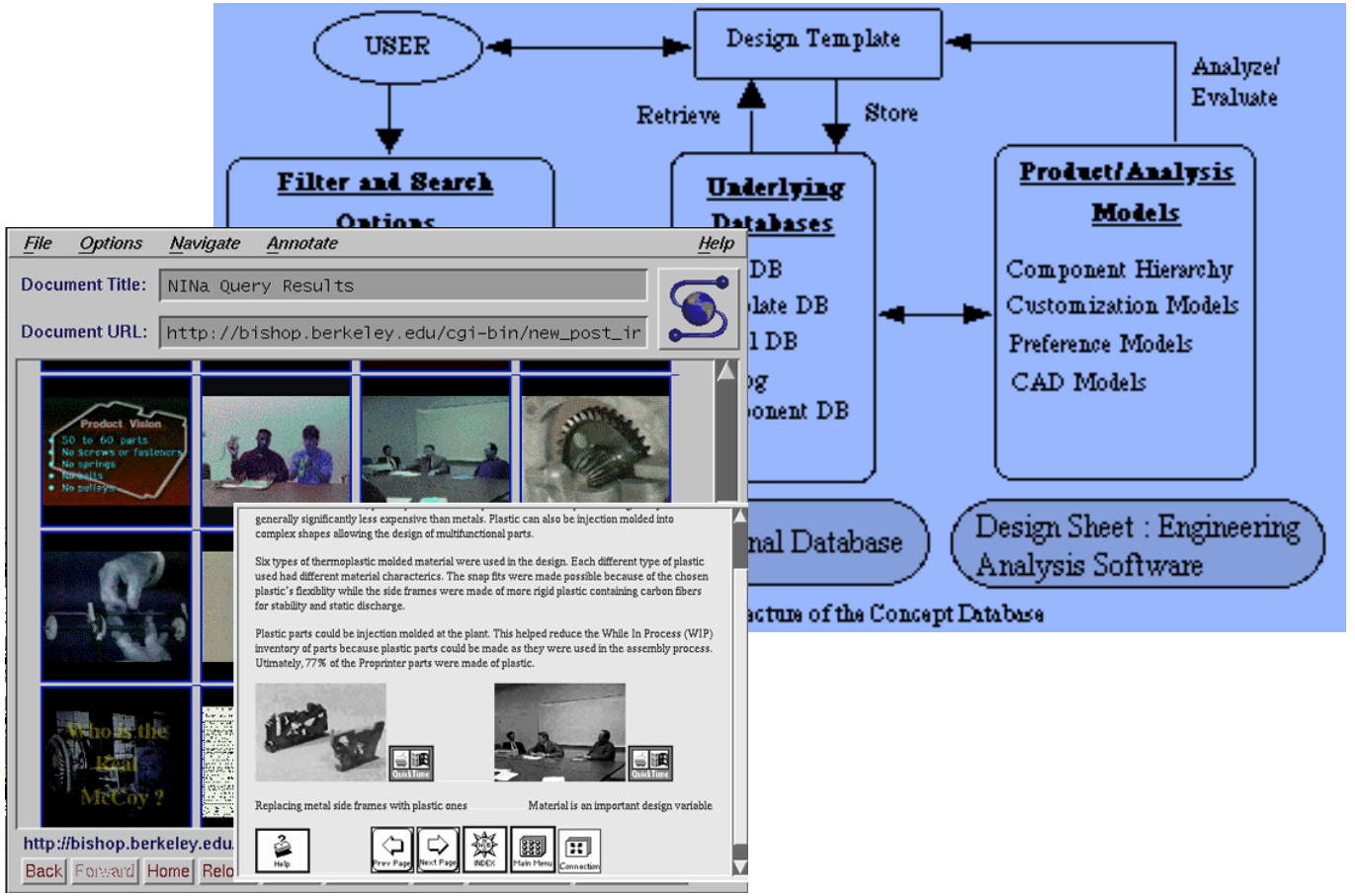
DESIGNATED EMPHASIS
DEVELOPMENT ENGINEERING
UNIVERSITY OF CALIFORNIA, BERKELEY

SQUISHY ROBOTICS

Berkeley
UNIVERSITY OF CALIFORNIA

Concept Database
Started with NSF Presidential Investigator award



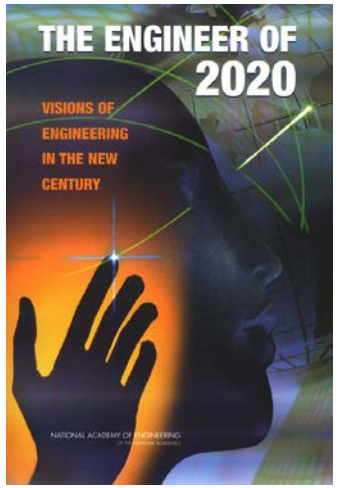


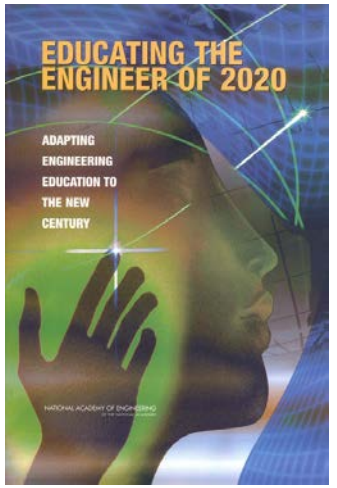
- 8451622 Presidential Young Investigator Award: Research on Expert Systems in Automated Manufacturing, Knowledge Acquisition, and Design Methodologies
- 9300025 Concept Database: A Design Information System for Concurrent Engineering with Application to Mechatronics Design

Synthesis Engineering Education Coalition

NSF-funded Synthesis Coalition was a union of eight diverse institutions funded by the National Science Foundation to design, implement and assess new approaches to undergraduate engineering education that emphasize

- multidisciplinary synthesis, teamwork and communication,
- hands-on and deign, prototyping, and laboratory experiences,
- open-ended problem formulation and solving,
- examples of “best practices” from industry through multimedia case studies.
- Inclusive and diversifying practices.

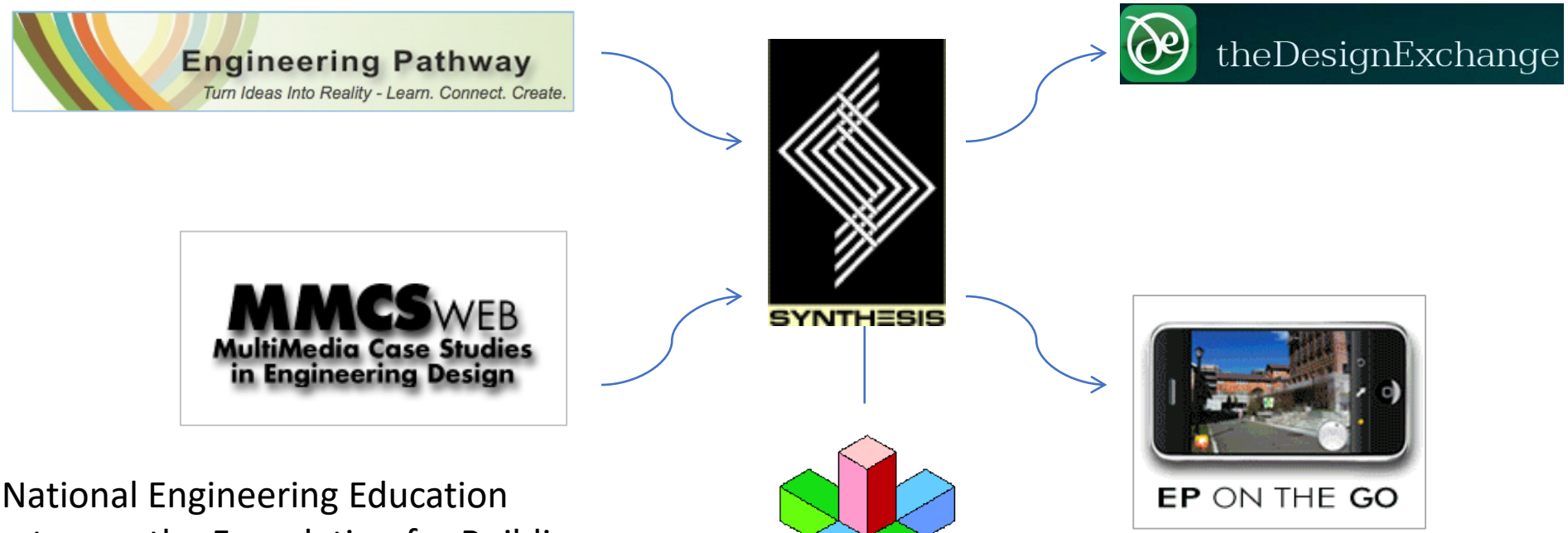




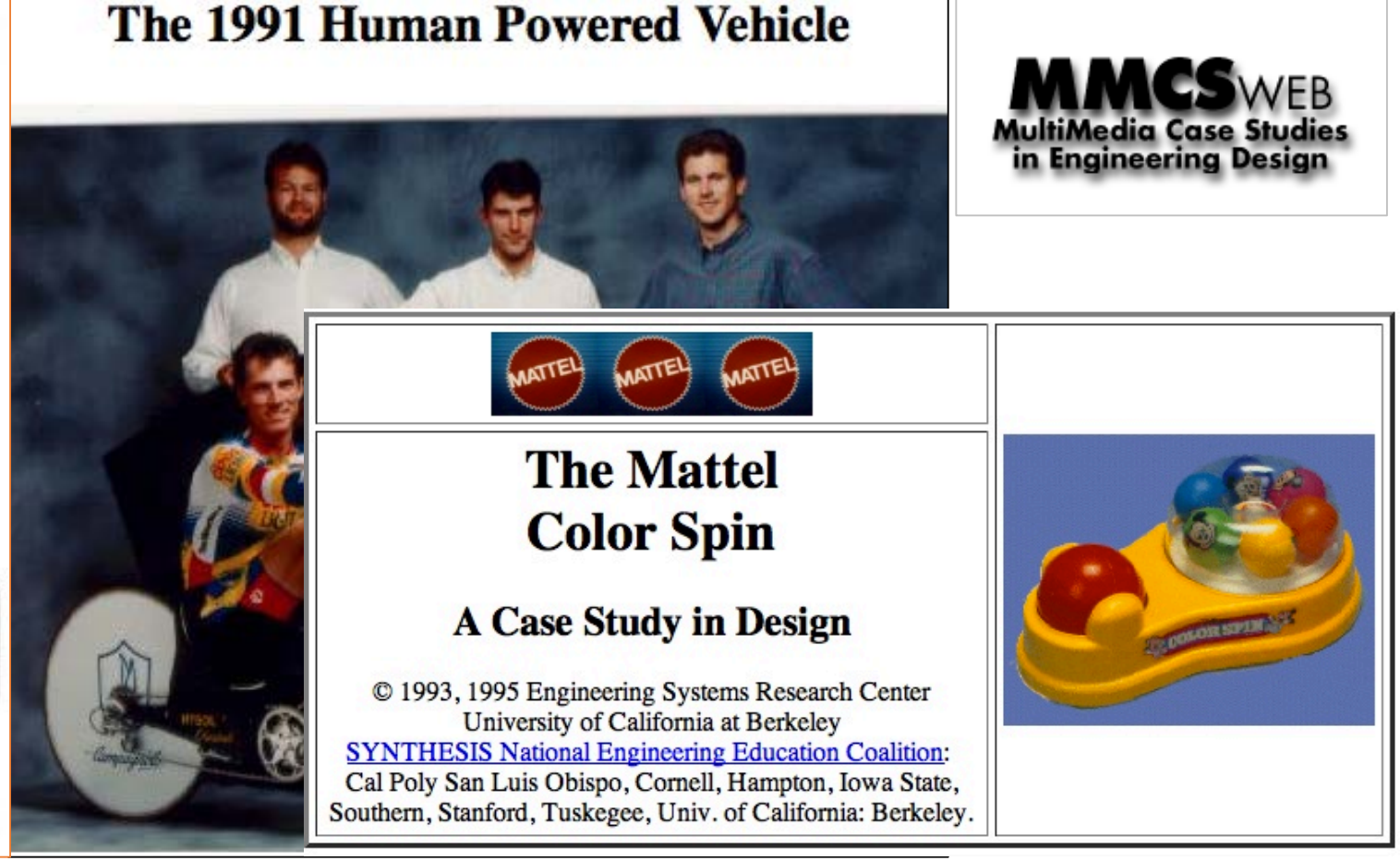
9625456 SYNTHESIS: An NSF Engineering Education Coalition

Engineering Education Multimedia Design Portfolio

Alice M. Agogino



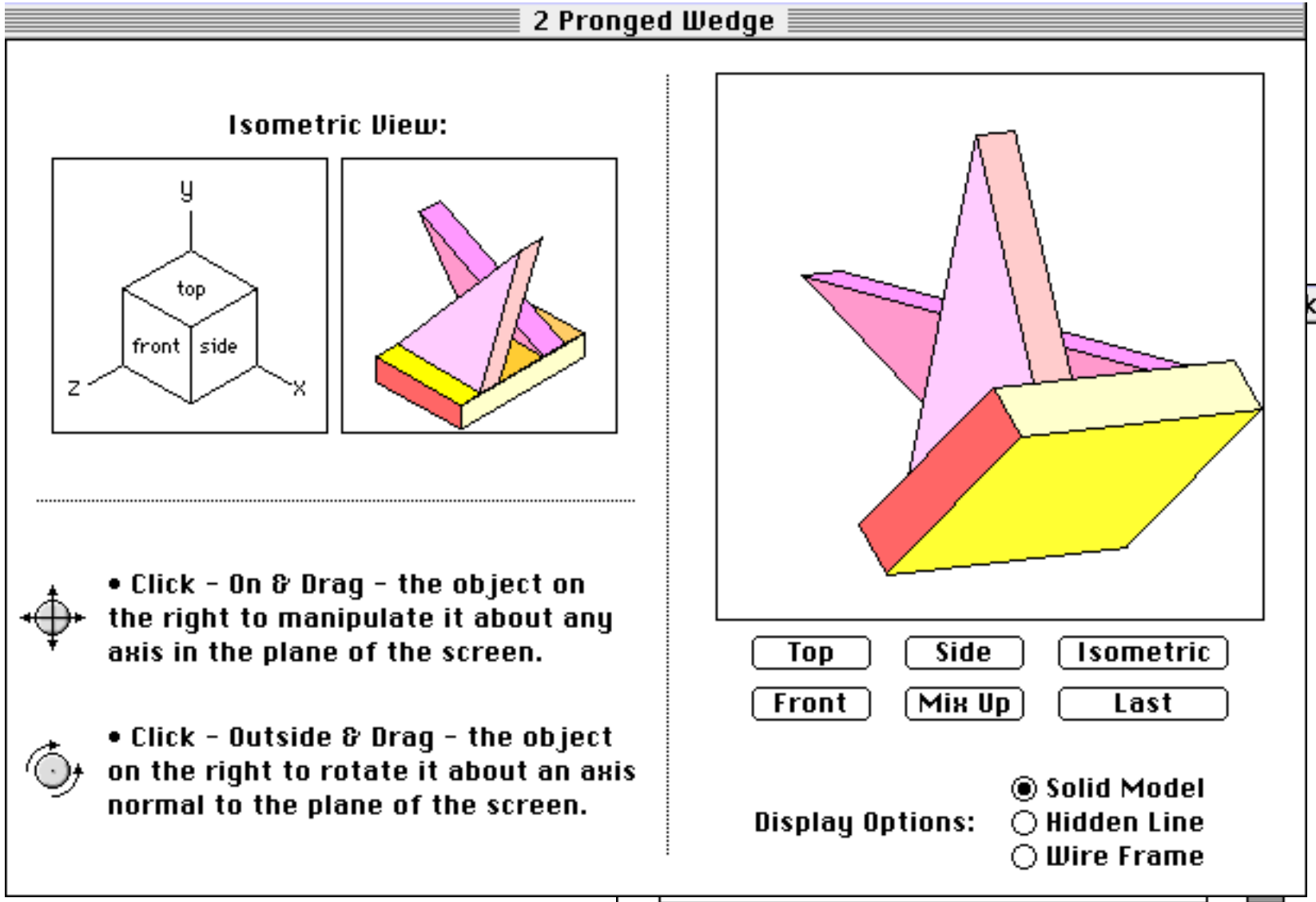
- Using the National Engineering Education Delivery System as the Foundation for Building a Test-Bed Digital Library for Science, Mathematics, Engineering and Technology Education
- 0532808 Collaborative Research: A Comprehensive Pathway for K-Gray Engineering Education

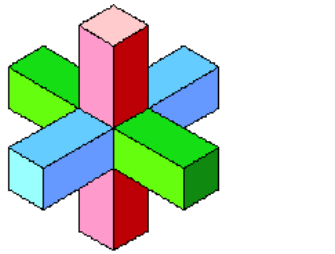


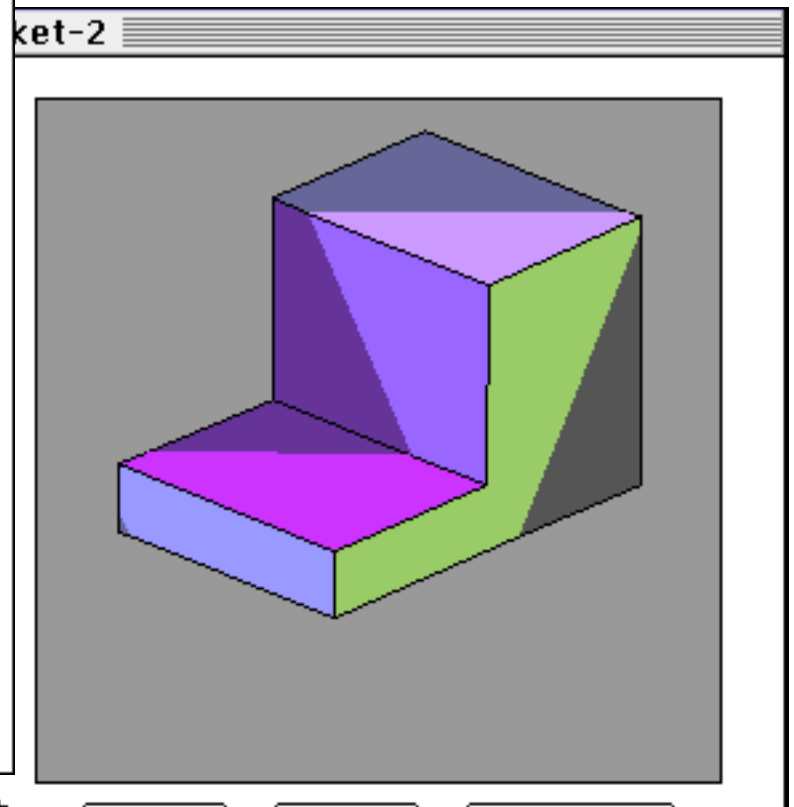
Multimedia cases of engineering design, including industrial design, design for assembly, design for manufacture, customer-driven design, design trade-offs, design for environment service & ergonomics, social implications of design, history of technology.

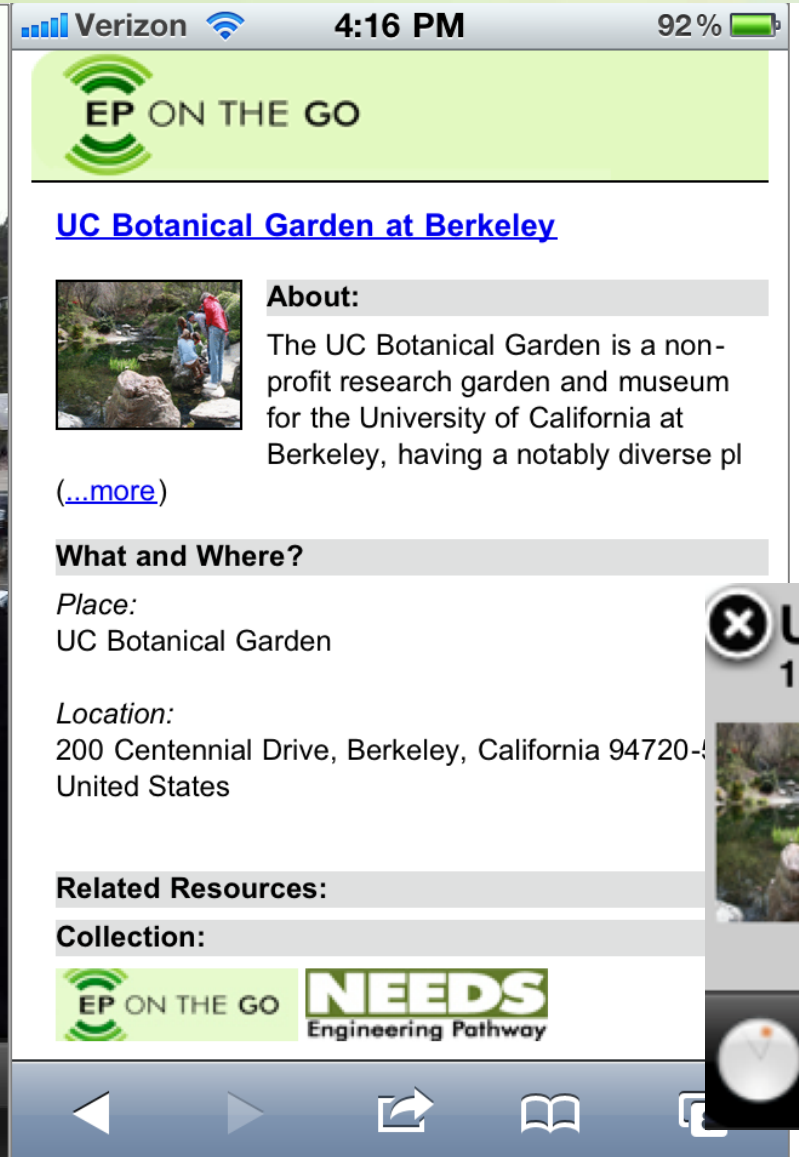
The multimedia cases were used for K-12 outreach, as well as introduction to engineering, freshman design and senior design classes.

Spatial Reasoning Software Removed Gender Differences

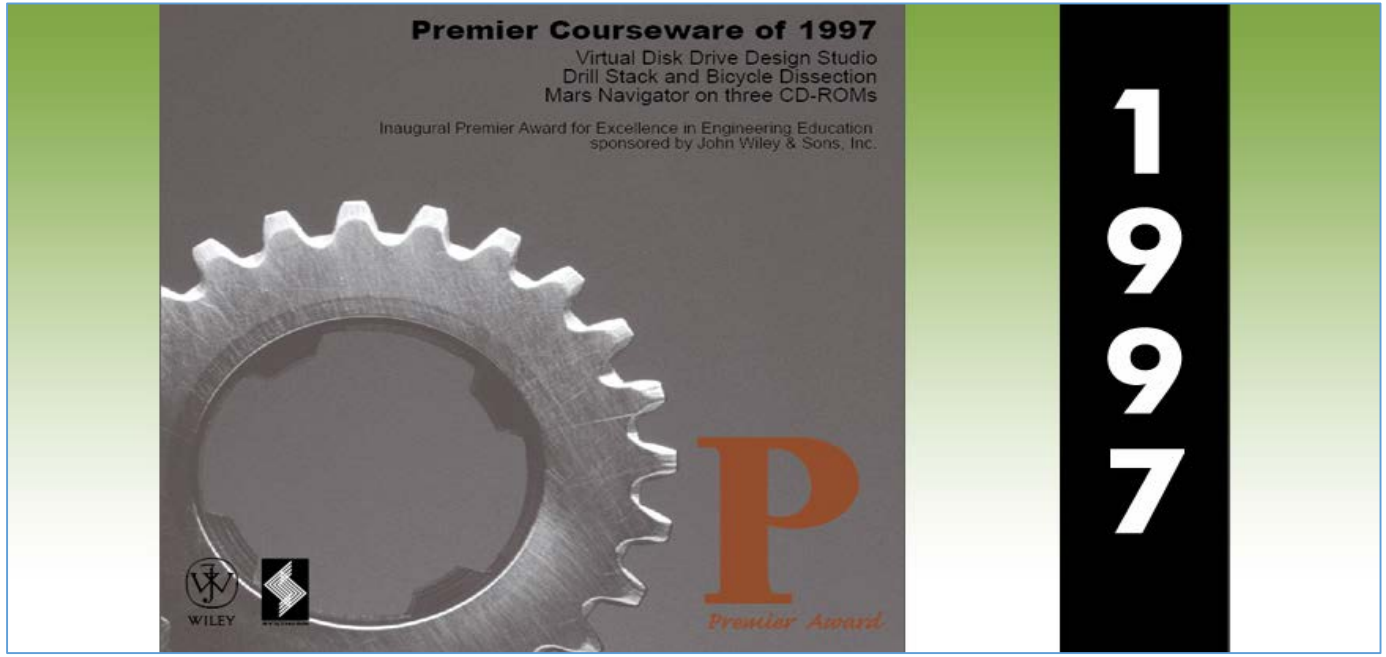




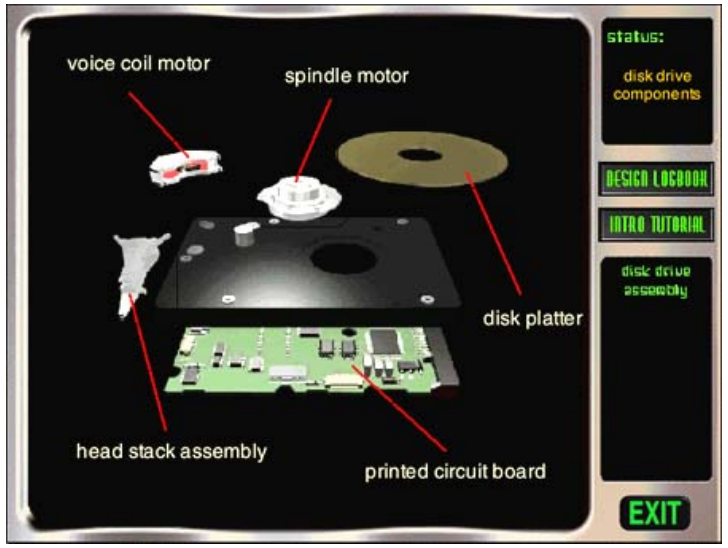




EP on the Goal: Mobile Learning with Augmented Reality



SYNTHESIS



MMCSWEB
MultiMedia Case Studies in Engineering Design

The Virtual Disk Drive Design Studio is an educational game using interactive multimedia to introduce students to the world of mechatronics design. It won the Premier Award for Excellence in Engineering Courseware in 1997.

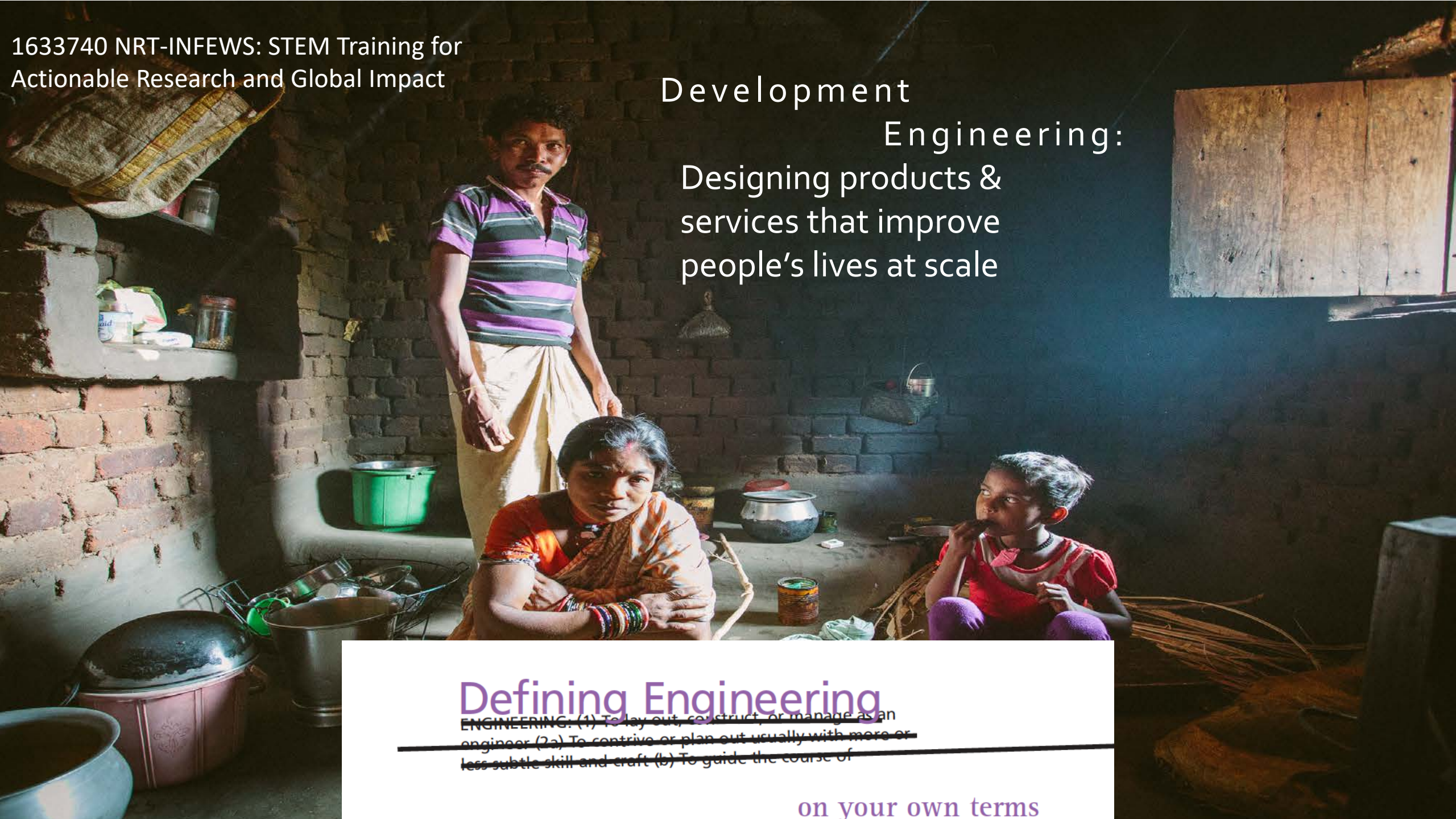
Community-Based Design: Girls, Inc. Pinoleville Pomo Nation

0428935 DISTINGUISHED TEACHING SCHOLAR, Designing for Diversity

1633740 NRT-INFEWS: STEM Training for Actionable Research and Global Impact

Development Engineering:

Designing products & services that improve people's lives at scale



Defining Engineering

~~ENGINEERING: (1) To lay out, construct, or manage as an engineer (2a) To contrive or plan out usually with more or less subtle skill and craft (b) To guide the course of~~

on your own terms

Fostering innovation solutions to global problems?

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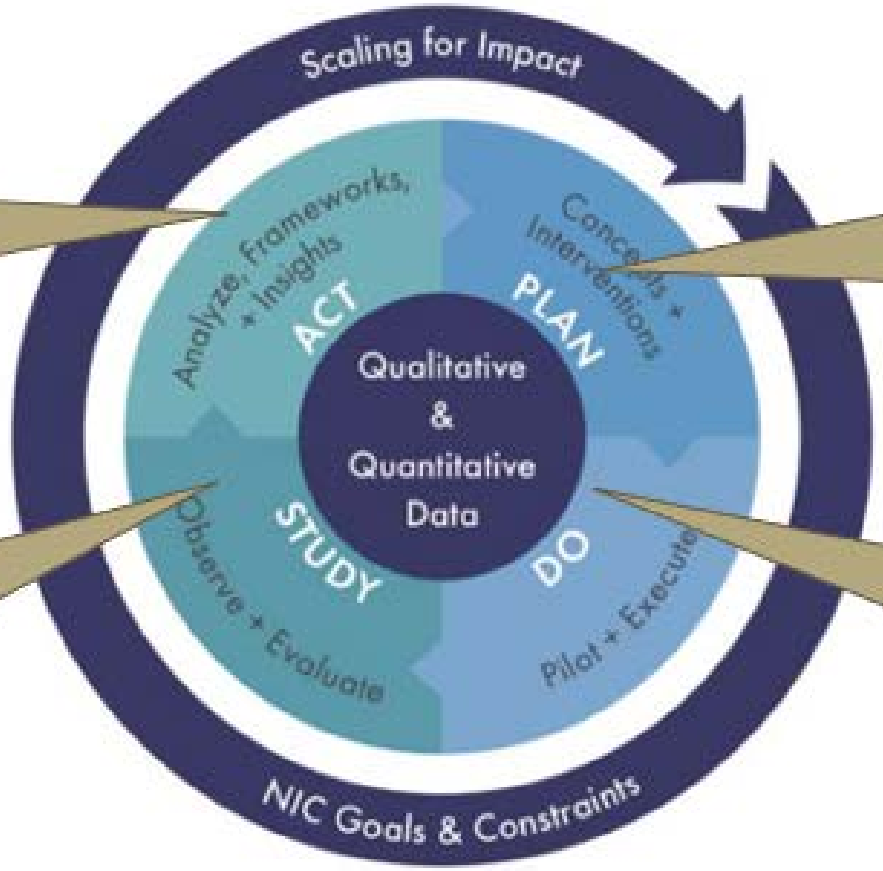
How do I change from a standard tech job to a transformative one?

Find out about UC Berkeley's Master of Development Engineering

Native Foods, Energy, Water Systems Alliance

Gathering:
Creating an action plan



Preparing the ground:
Learning about each of the wise practices

Evaluation team meetings with each of the stepping stone
Collecting benchmark data

Who,
Seed, water,
Planting:
Building the network
Establishing connection

1633740 NRT-INFEWS: STEM Training for Actionable Research and Global Impact

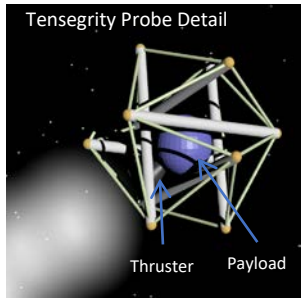
ANNUAL SUMMARY SLIDE – YEAR 4

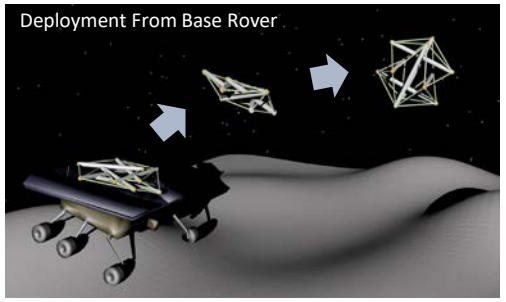
NASA Early Stage Innovations (ESI14) – Grant NNX15AD74G

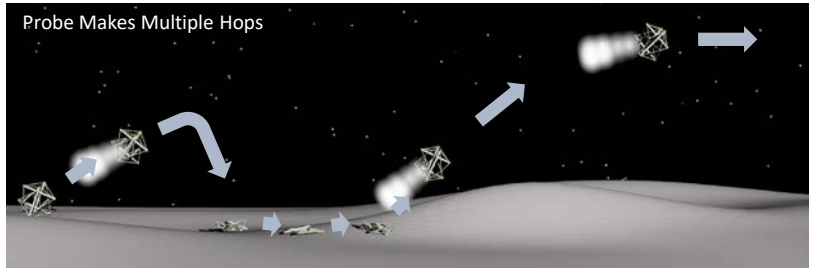
TITLE	Precision Hopping/Rolling Robotic Surface Probe Based on Tensegrity Structures		
PI	Alice M. Agogino (PI)	**UNIVERSITY**	UC Berkeley

RESEARCH OBJECTIVES AND RELEVANCE TO NASA

- Develop tensegrity probe capable of rolling and hopping
- Enables low cost, highly reliable, highly capable ground probes
- Enables mobility through sandy surfaces, hilly terrain, caves
- Enables fast traversal for short missions
- Enables compact storage as secondary payload





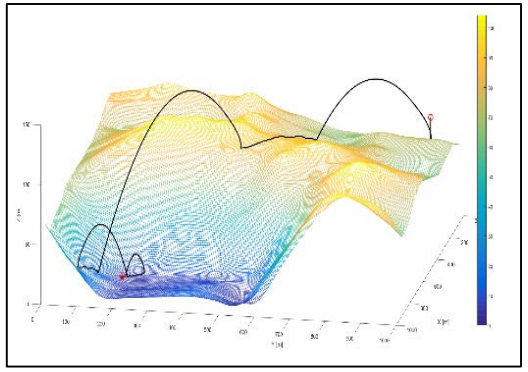


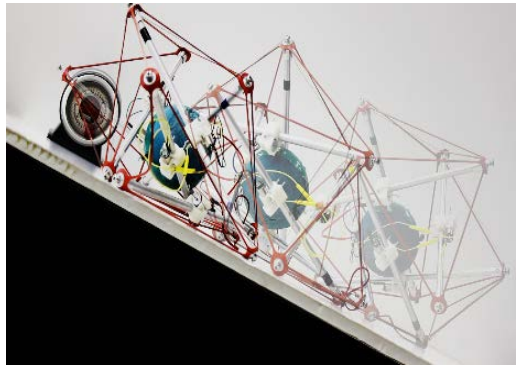
TECHNICAL APPROACH

- Add thruster to ball-shaped tensegrity robot
- Make multiple flying hops towards destination
- Robot then rolls to precise destination
- Tensegrity structure protects payload
- Tensegrity ball enables locomotion through:
  - Sandy surfaces
  - Down steep craters

TEAM MEMBERS AND AFFILIATIONS

- PI: Alice Agogino – University of California Berkeley
- Collaborator: Terry Fong, NASA Ames Research Center



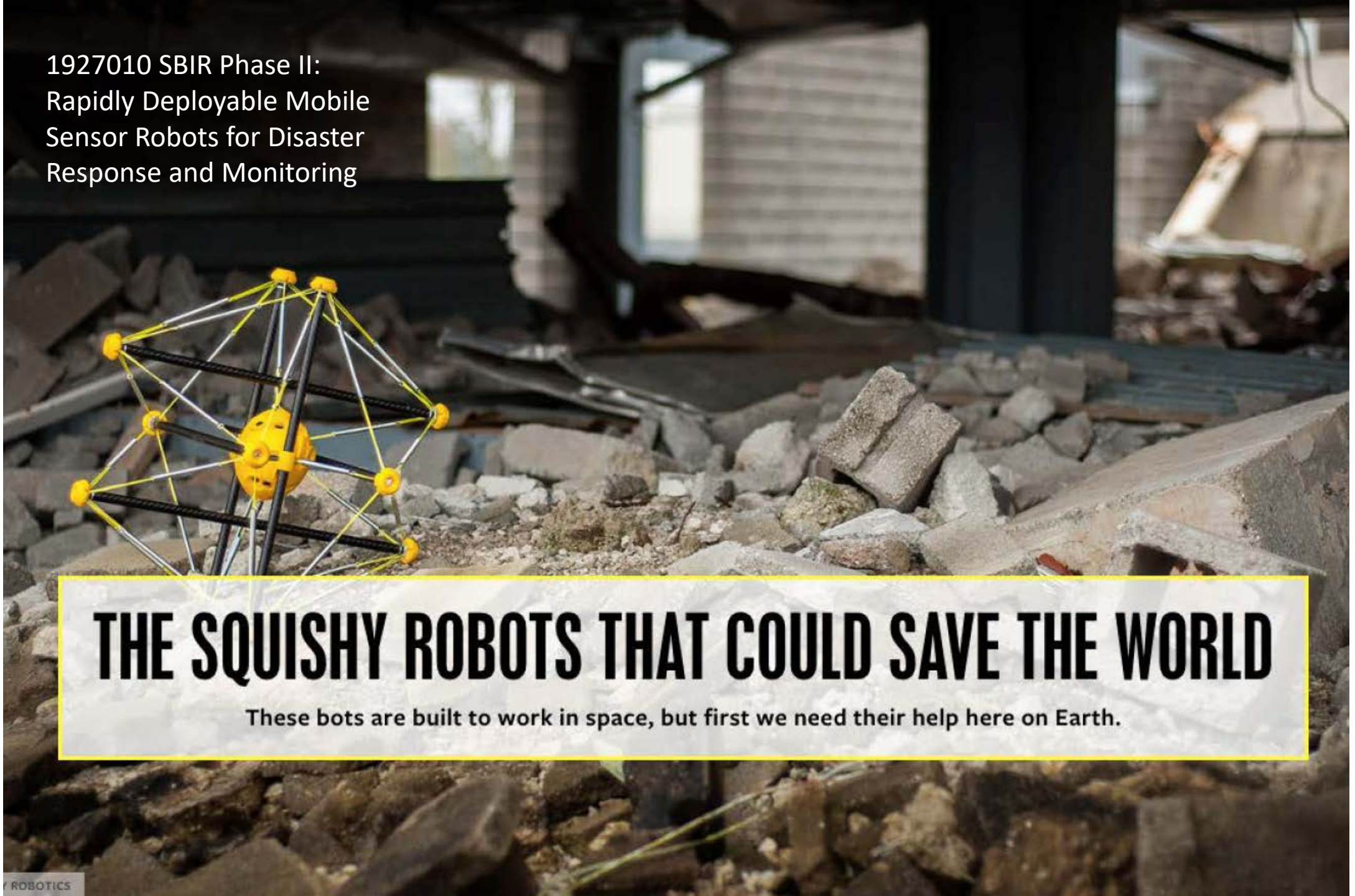


SIGNIFICANT ACCOMPLISHMENTS

- Developed hopping & rolling mission profile that:
  - Allows for low-cost cold gas thruster
  - Minimizes shock to payload within tensegrity structure
  - Validated thru simulation in flat and hilly terrain
- Designed & simulated gimballed thrust control assuming noisy vector control
- Developed lattice platform for flexibility & rapid prototyping
- Developed hardware prototype for testing & validation: TT-3, TT-4, $TT\text{-}4_{mini}$, TT-5, $TT\text{-}5_{Meso}$
- Developed circuit board & sensor systems needed for ground mobility
- Simulation with hopping-bouncing restitution for path-planning missions
- Performed uphill “walking” on 24 degree slopes
- Demonstrated successful drop tests from 122 m from aerial drone
- Developed, analyzed, and tested different control strategies for dynamic rolling locomotion

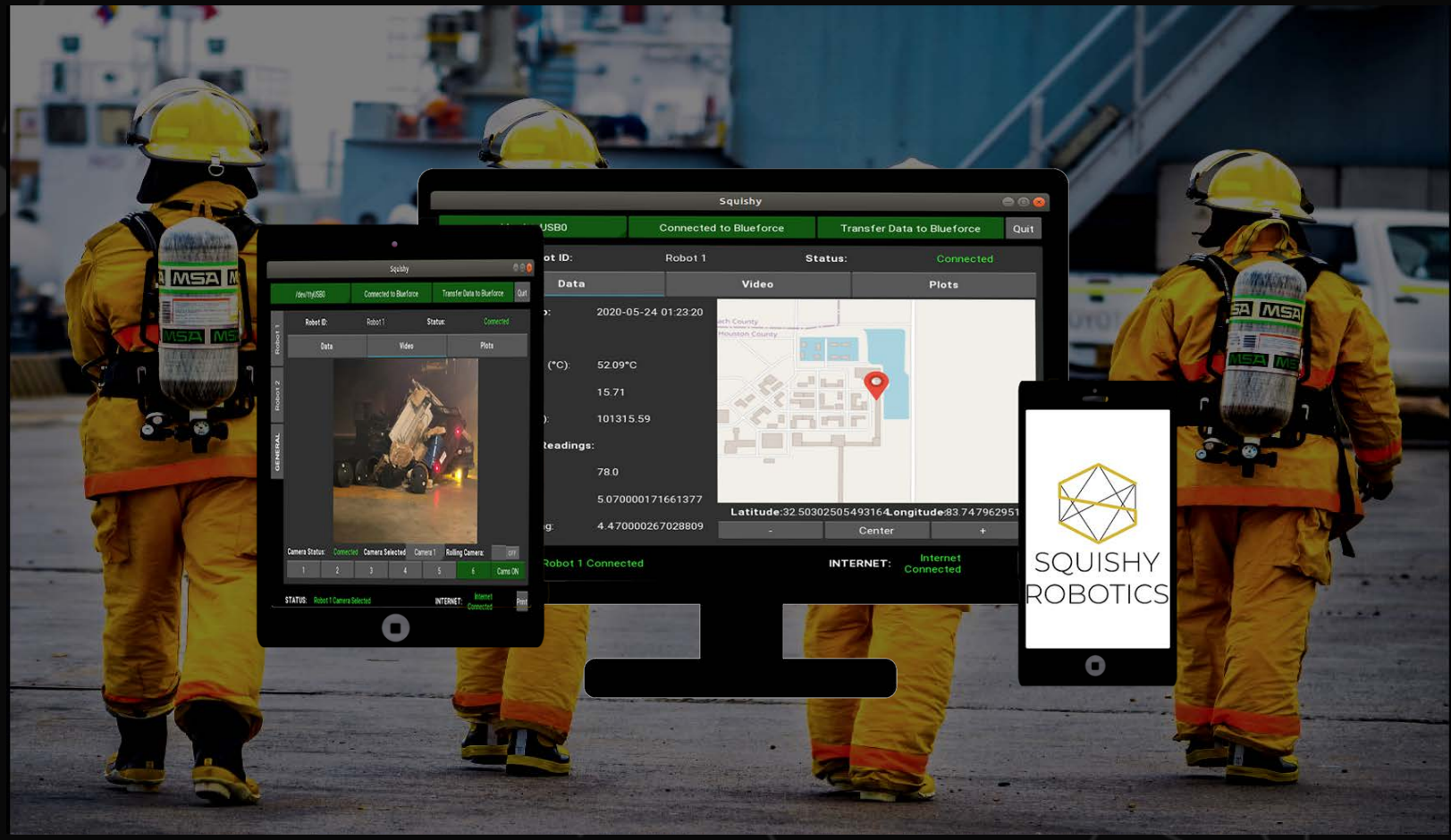
- NSF I-Corp and NASA NNX15AD74G-Agogino Precision Hopping/Rolling Robotic Surface Probe Based on Tensegrity Structures
- 1927010 SBIR Phase II: Rapidly Deployable Mobile Sensor Robots for Disaster Response and Monitoring

1927010 SBIR Phase II:
Rapidly Deployable Mobile Sensor Robots for Disaster Response and Monitoring



SQUISHY ROBOTICS

When every second counts...



Life-saving, Cost-saving Information in Real Time

SQUISHY ROBOTICS

When every second counts...

Early Detection & Prevention of Wildland Fires


Thanks to Extraordinary Impactful Students

NSF (and one NASA)Awards

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- 0532808 Collaborative Research: A Comprehensive Pathway for K-Gray Engineering Education
- 0428935 OFFICE OF MULTIDISCIPLINARY AC, EngEd-Engineering Education, DISTINGUISHED TEACHING SCHOLAR, Designing for Diversity
- 1633740 NRT-INFEWS: STEM Training for Actionable Research and Global Impact
- 2120001 NSF INCLUDES Alliance: Broadening Career Pathways in Food, Energy, and Water Systems with and within Native American Communities (Native FEWS Alliance)
- NSF I-Corp and NASA NNX15AD74G-Agogino Precision Hopping/Rolling Robotic Surface Probe Based on Tensegrity Structures
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