

NOVEMBER 2023



2023 EDGE PROJECT ADVISORY BOARD MEETING

Meeting Kickoff

1) Project introduction; 2) Team member introduction; 3) Work plan; 4) Project progress; 5) Research activities; 6) Key outcomes

ZHENGHUI SHA

Assistant Professor, J. Mike Walker Department of Mechanical Engineering, The University of Texas at Austin

Welcome to UT Austin In-Person & Virtually



Project Team Introduction



Zhenghui Sha

Assistant Professor
Walker Department of
Mechanical Engineering
UT Austin



Onan Demirel

Assistant Professor
Department of
Mechanical Engineering
Oregon State University



Molly H. Goldstein

Teaching Assistant Professor
Department of Industrial and
Enterprise Systems
Engineering, UIUC



Charles Xie

Founder, CEO, and
Chief Scientist
Institute for Future
Intelligence (IFI)



Darya L. Zabelina

Associate Professor
Department of
Psychological Science
University of Arkansas

1 PhD and 2
MS Students
Graduated



Xingang Li

PhD Student at
UT Austin



John Clay

Research Scientist
Assistant at UT Austin



Elisa Koolman

PhD Student at
UT Austin

AB Members Introduction



Dan Banach
Senior Technical Manager
Autodesk, Inc.



Lydia Chilton
Assistant Professor
Department of Computer Science
Columbia University



Yan Fu
Senior Manager
Strategy and Enterprise Analytics
Ford Motor Company



John Gero
Research Professor
Department of Computer Science and
Architecture
University of North Carolina at Charlotte



Susan Shaw
Customer Research Lead
Driver-Assistance Systems
Ford Motor Company

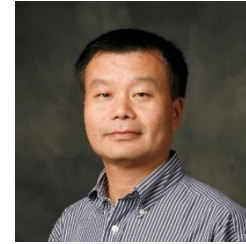


Rachel Switzky
Assistant Professor
Director of Siebel Center
for Design, UIUC

2023 AB Meeting Guests



Maura Borrego, Professor
E.P. Schoch Professorship in Engineering
Director, Center for Engineering Education



Ming Zhang, Professor
Roberta P. Crenshaw Centennial Professorship in Urban
Design and Environmental Planning
Mike Hogg Professorship in Community and Regional Planning
Director, Cooperative Mobility for Competitive Megaregions

Project Background



National Science Foundation (NSF) Accelerating Discovery: Educating the Future STEM Workforce (AD)

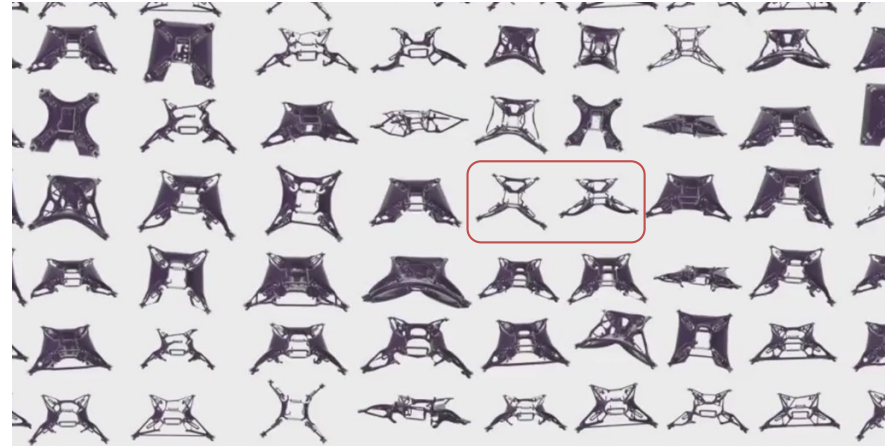
*“A well-prepared, innovative science, technology, engineering, and mathematics (STEM) workforce is crucial to the Nation's prosperity and security. Future generations of STEM professionals are a key sector of this workforce, especially in the critical scientific areas described in the Big Ideas for Future NSF Investments. To accelerate progress in these areas, **the next generation of STEM professionals will need to master new knowledge and skills, collaborate across disciplines, and shape the future of the human-technology interface in the workplace.**”*

Generative Design

“Generative design mimics nature’s evolutionary approach to design.

Designers or engineers input design goals into generative design software, along with parameters such as materials, manufacturing methods, and cost constraints.

Then, using cloud computing, the software explores all the possible permutations of a solution, quickly generating design alternatives.”



Example: A design on a quad rotor UAV and generative design software returned what was almost identical in form to that of a flying squirrel.

[Shaan Hurley, 2016] 7

Research Goal

To define, implement, and disseminate **generative design thinking** to facilitate the teaching and learning of generative design at undergraduate levels

Research Questions

- *RQ1. **Theoretical perspective***: What are the essential elements of generative design thinking that students must acquire in order to work effectively at the human technology frontier in engineering?
- *RQ2. **Practical perspective***: To what extent and in what ways can the project products support the learning of generative design as indicated by students' gains in generative design thinking?
- *RQ3. **Affective perspective***: To what extent and in what ways can AI affect the professional formation of engineers as indicated by the changes of students' interest and self-efficacy in engineering?

Project Work Plan

1. **Define generative design thinking** by assimilating computational thinking to augment and reshape design thinking, thereby setting up 1) a theoretical foundation for research, 2) learning goals for students, and 3) the developmental goals for the project.
2. **Develop the open-source Aladdin software** with the goal to support the learning and teaching of generative design. The focus is on supporting students as they learn basic concepts of generative design, and allowing researchers to find ways to improve this human-AI collaboration.
3. **Develop curriculum modules** in Aladdin using project-based learning. To engage students, we will adopt authentic engineering projects that can be realistically solved using generative design.

Project Work Plan

- 4. Conduct educational research** through collaboration with ten other participating colleges and universities. With these collaborators, we will explore the strategies and methods for integrating instructional modules and embedding the educational research into introductory engineering and CAD courses.
- 5. Collect and analyze student data** using instruments such as demographic surveys, questionnaires, self-efficacy measures, design reports, screencast videos, software logs, classroom observations, and participant interviews.
- 6. Disseminate the products** of this project, including an operational definition of generative design thinking, the Aladdin software, and the instructional modules.
- 7. Collaborate with the Advisory Board to evaluate and advance the project** through the evaluation given by the board members.

Project Progress By 09/2022

WP1: Define GDT

WP2: Develop GD techniques

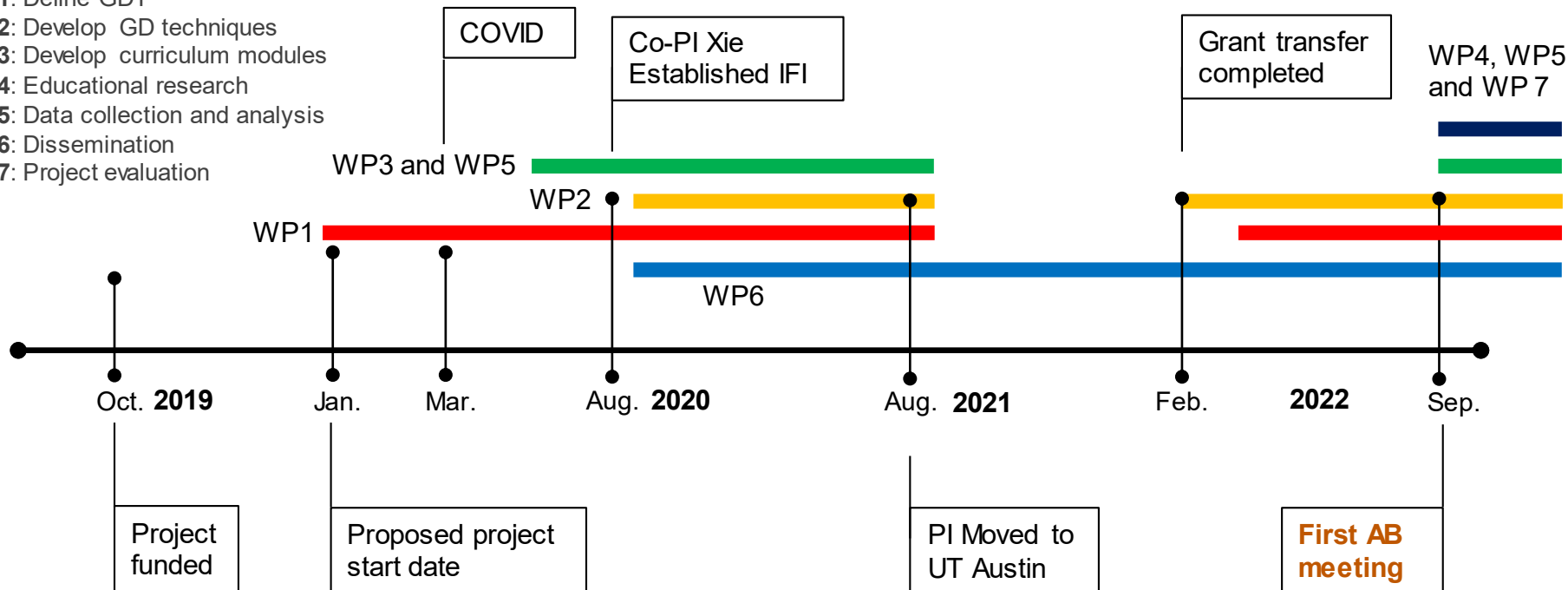
WP3: Develop curriculum modules

WP4: Educational research

WP5: Data collection and analysis

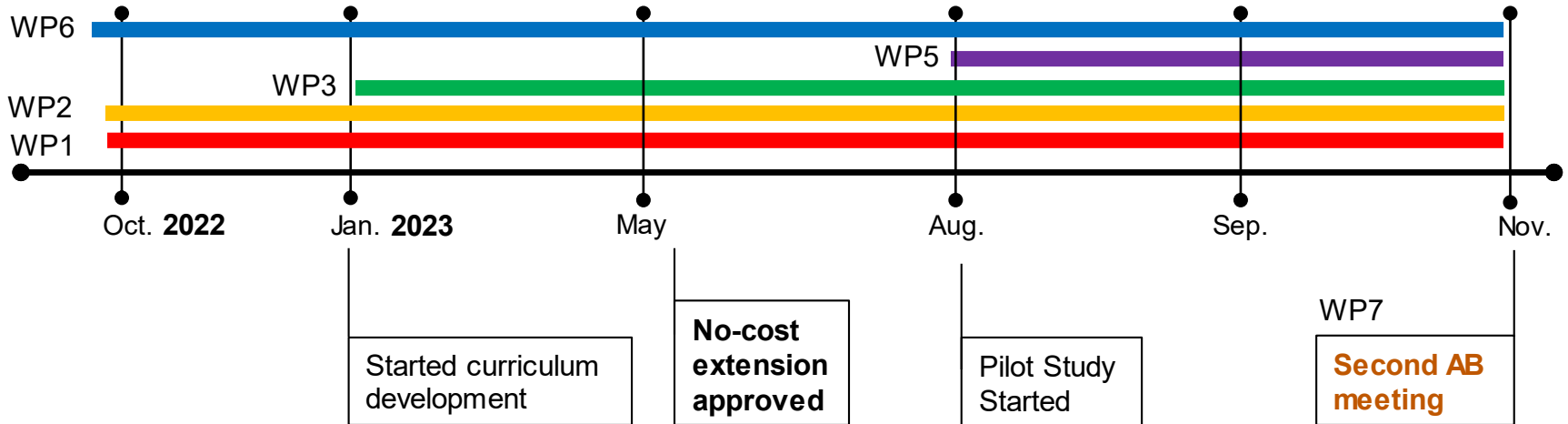
WP6: Dissemination

WP7: Project evaluation



Project Progress Since Last Meeting

- WP1: Define GDT
- WP2: Develop GD techniques
- WP3: Develop curriculum modules
- WP4: Educational research
- WP5: Data collection and analysis
- WP6: Dissemination
- WP7: Project evaluation



Research Activities

1. Exploration of **data-driven generative design (GD) methods** in support of GD technology and software development.
2. The **design and development of Aladdin**, an open-source computer-aided generative design and engineering software.
3. Investigation on the relationship between engineering systems thinking, parametric design thinking, computational thinking, and engineering design thinking in seeking an **operational definition of generative design thinking**.
4. Preliminary **design of curriculum modules** based on Aladdin and existing generative design technologies.

Key Outcomes and Dissemination

1. Created a set of new **GD curriculum** materials
2. Aladdin – **Cloud-based, AI-powered GD software** with improved functions
3. New **data-driven generative design** approaches
4. **Human-centered** generative design framework
5. Refined **Evolving Design Thinking** model and **systematic review on GDT**
6. Improved **instructional materials** based on Fusion 360
7. **Broadened dissemination** of research outcomes

4 journal articles, **2** refereed conference papers, **1** conference abstract and poster presentations, **1** Master's thesis

Research Presentations

- Presentation 1 – John Clay & Elisa Koolman
- Presentation 2 – Dr. Onan Demirel & Dr. Molly Goldstein
- Presentation 3 – Xingang Li & Yuewan Sun
- Presentation 4 – Dr. Charles Xie
- Roundtable Discussion

Future Work

1. **Software Development:** Aladdin (Open Source)
2. **Approach Development:** Generative Design
3. **Curriculum Development:** Project-Based Learning Modules
4. **Education Research**
5. **Research Dissemination:** Teacher Workshop in Maine and Research Workshop at IDETC/CIE 2024

This project is expected to equip students with **essential skills and mindsets** needed to master using **AI approaches in contemporary engineering practices.**

Evaluation Report

Link: <https://forms.gle/73tbXyDyEtiAUqQG6>

Deadline: December 8, 2023