# EEGRC Poster: Characterizing Trade-off Decisions in Student Designers

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Molly Goldstein is a Ph.D. candidate in the School of Engineering Education at Purdue University, West Lafayette with a research focus on characterizing behaviors in student designers. She previously worked as an environmental engineer specializing in air quality influencing her focus in engineering design with environmental concerns. She earned her B.S. in General Engineering (Systems Engineering & Design) and M.S. in Systems and Entrepreneurial Engineering from the University of Illinois in Urbana-Champaign.

PURDUE ENGINEERING

ENGINEERING EDUCATION

# CHARACTERIZING TRADE-OFF DECISIONS IN STUDENT DESIGNERS

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## BACKGROUND

Although design and decision-making are intertwined for practicing engineers, students from elementary school through college are not taught to think through uncertain situations in which information is limited or outcomes are not guaranteed. Trade-offs are a complex element of decisions, as the decision-maker weighs possible outcomes against their respective costs. Understanding how students characterize their design tradeoffs would allow educators a better glimpse into students' systems design thinking. Without such knowledge at the K-16 level, we cannot create suitable design activities for students to improve on their decision-making skills, inhibiting their effectiveness as future engineers.

## OBJECTIVES

The purpose of this poster presentation is to provide a brief overview of my dissertation work to date on an NSF-funded research project, Collaborative Research: Large-Scale Research on Engineering Design Based on Big Learner Data Logged by a CAD tool. In particular, I will briefly summarize my pilot work that guided my research questions and discuss my ongoing work and next steps.

## PARTICIPANTS

| # Students | Grade |
|---|---|
| 463 | 7th Grade |
| 152 | 8th Grade |
| 140 | Mixed High School |
| 23 | Mixed High School |

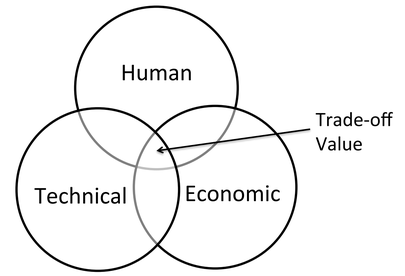
## GOALS

**RQ1: What is the relationship between design artifact trade-off values and profiles of design behaviors that differentiate students?**

**RQ2: What do student reflections tell us about how students characterize their design decisions?**

**RQ3: What is the relationship between student changing conceptions of the importance of making trade-offs and profiles of design behaviors that differentiate students?**


## FRAMEWORK




*Trade-off value conceptual framework, based on Asimow (1962)*

- Assesses solution quality for both objective & subjective design criteria
- Surrogate for how experts assess solutions

Goldstein, MH., Meji, CV., Adams, RS, Purzer, S. (2016). Developing a measure of quality for engineering design artifacts. *Proceedings of the ASEE/IEEE Frontiers in Education Conference*, October 2016, Erie, PA.

## REFLECTIVITY & UNDERSTANDING

Student reflectivity & their understanding of informed design (pilot)

- Developed a protocol to assess students' level of reflectivity
- Conceptions of Design Test to assess students' changing conceptions of design, and of "making trade-offs" in particular



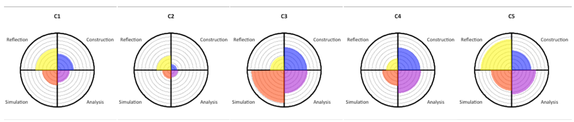

Goldstein, MH., Purzer, S., & Adams, RS., Chao, J., Xie, C. (In Review). *The Relationship between design reflexivity and conceptions of informed design among high school students.*

## PILOT STUDY

### Profiles of student designers

High school students (n=107)

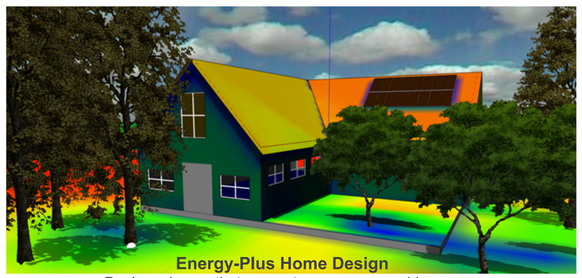
4 design features: construction, analysis, simulation & reflection



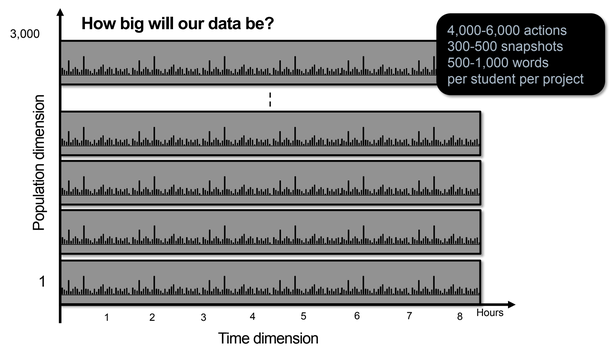

- Cumulative count of all actions across design project
- Hierarchical agglomerative clustering resulted in 5 groups

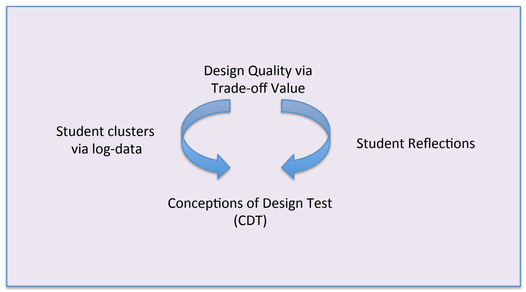
## METHODS

- I collected data from over 700 middle and high school students as they designed energy-efficient buildings in a CAD platform, Energy3D.
- Fine-grained data information of student actions, experimentation results, electronic notes (i.e. reflections), and design artifacts are collected through automatic, unobtrusive logging as students design.
- Per student, this log data sums 4,000 to 6,000 actions that are used to reconstruct her design process.
- A mixed methods approach will be used to investigate designer student trade-off behavior using process data, artifact trade-off value, and student reflections.




Design a house that generates more renewable energy than it consumes over the course of a year




## CONCEPTIONS OF DESIGN

(adapted from Adams & Fralick, 2010)

Of the design activities below, which 5 would you consider as the **MOST** important in terms of producing a high quality design? For one of the selected terms, explain why.

| | | |
|---|---|---|
| Analyzing data | Gathering Information | Planning |
| Brainstorming | Identifying constraints | Prototyping |
| Building | Iterating | Reflecting |
| Communicating | Making decisions | Setting goals |
| Conducting Tests | **Making trade-offs** | Sketching |
| Evaluating | Modeling | Using Creativity |

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