DIGITAL TRANSFORMS PHYSICAL

CAD Challenges App

An Informatics Framework for Parametric Modeling Practice and Research Data Collection in Computer-aided Design

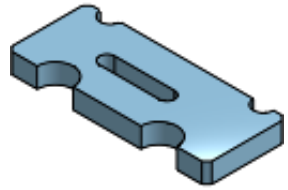
Yuanzhe Deng [1,2]
Dr. Matthew Mueller [1]
Dr. Matt Shields [1]

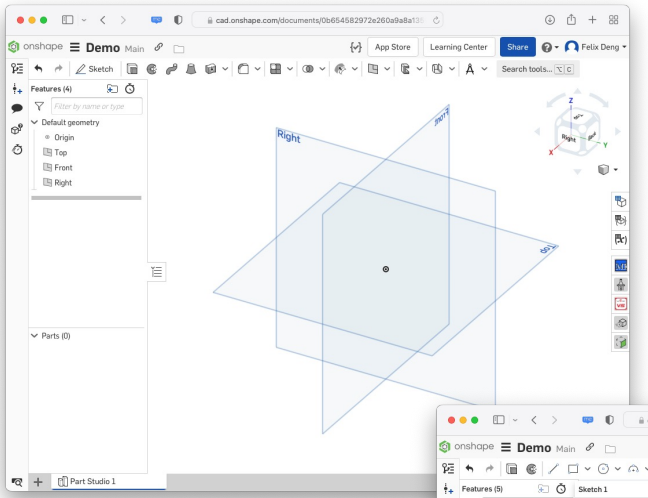
[1] PTC Education, PTC Inc., Boston, MA
[2] University of Toronto, Toronto, ON, Canada

AGENDA

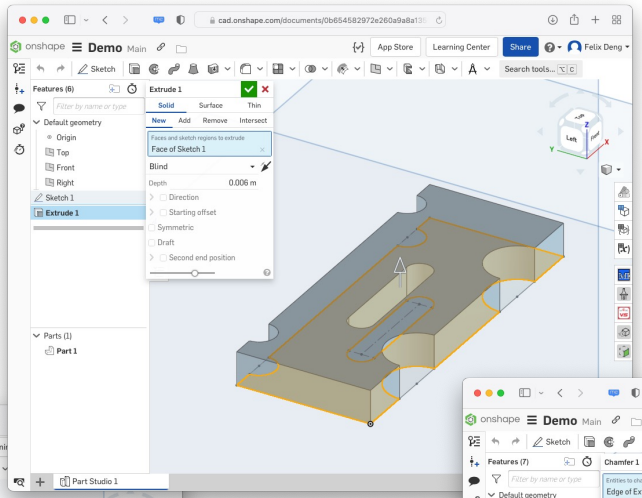
- CAD Research Background
- Our Framework
- Preliminary Analysis
- Conclusions & Future Work

PARAMETRIC CAD MODELLING

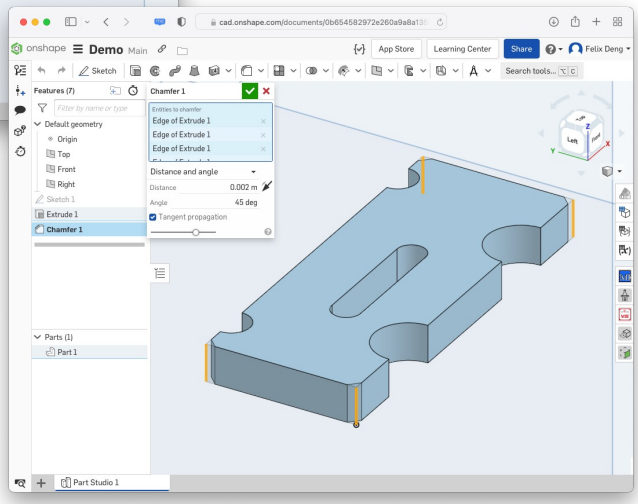


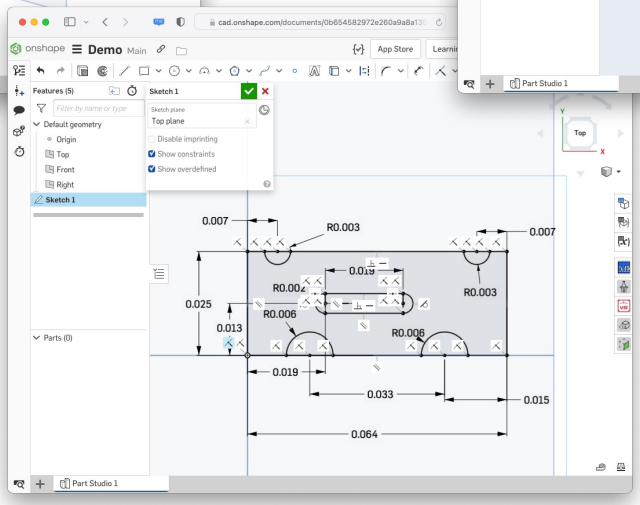


Default Planes



Parametric
3D Features





Constrained
2D Sketches

TEACHING DESIGN IN CAD

Declarative Knowledge

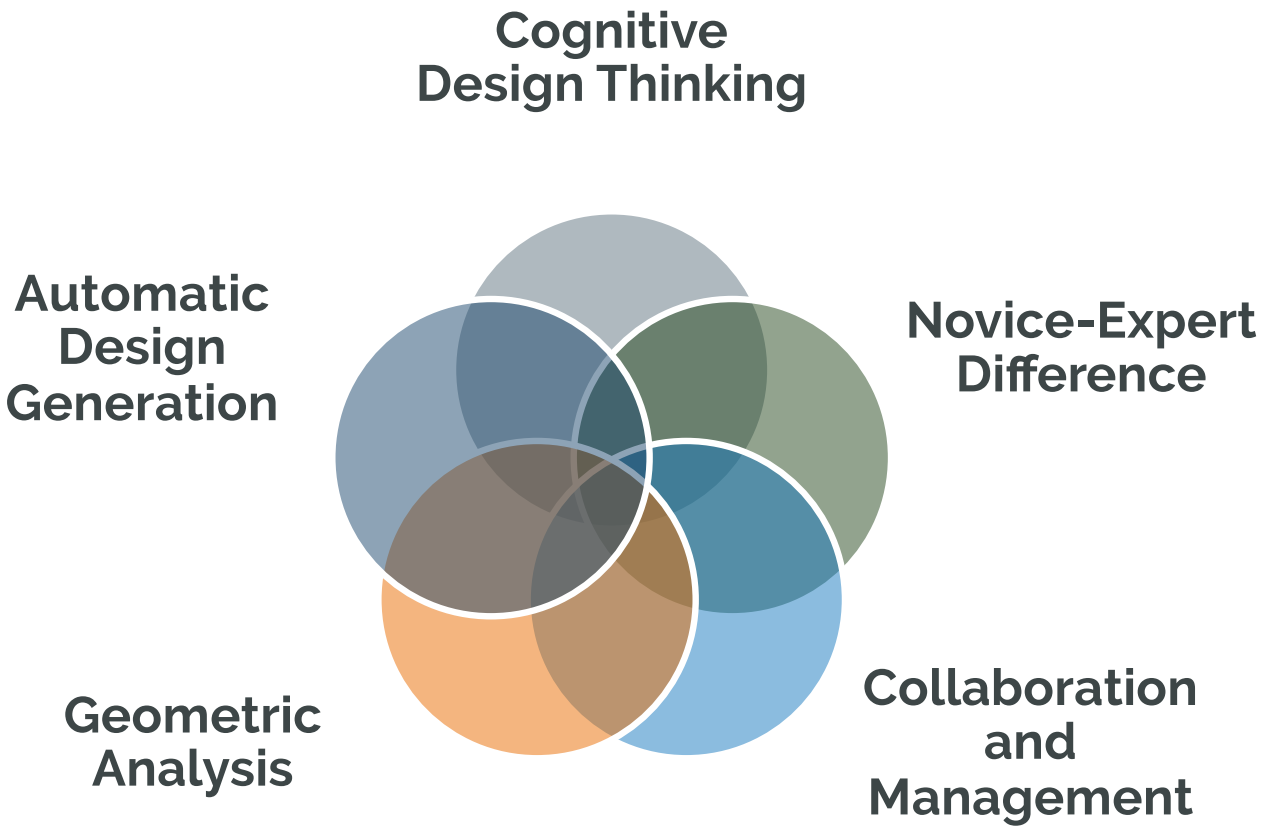
- Mastery of individual parametric features and commands
- Dominant pedagogy in education and industry
- Commonly tested through certification exams

Procedural Knowledge

- Cognitive decision-makings and strategic design process planning
- Requires gradual development through practice and experience
- Main empirical difference between expert and novice designers

Chester, I., 2008, "3D-CAD: Modern Technology--Outdated Pedagogy?," Des Technol Educ, **12**(1).
Chester, I., 2007, "Teaching for CAD Expertise," Int J Technol Des Educ, **17**(1), pp. 23–35.

DESIGN RESEARCH IN CAD



RESEARCH QUESTIONS

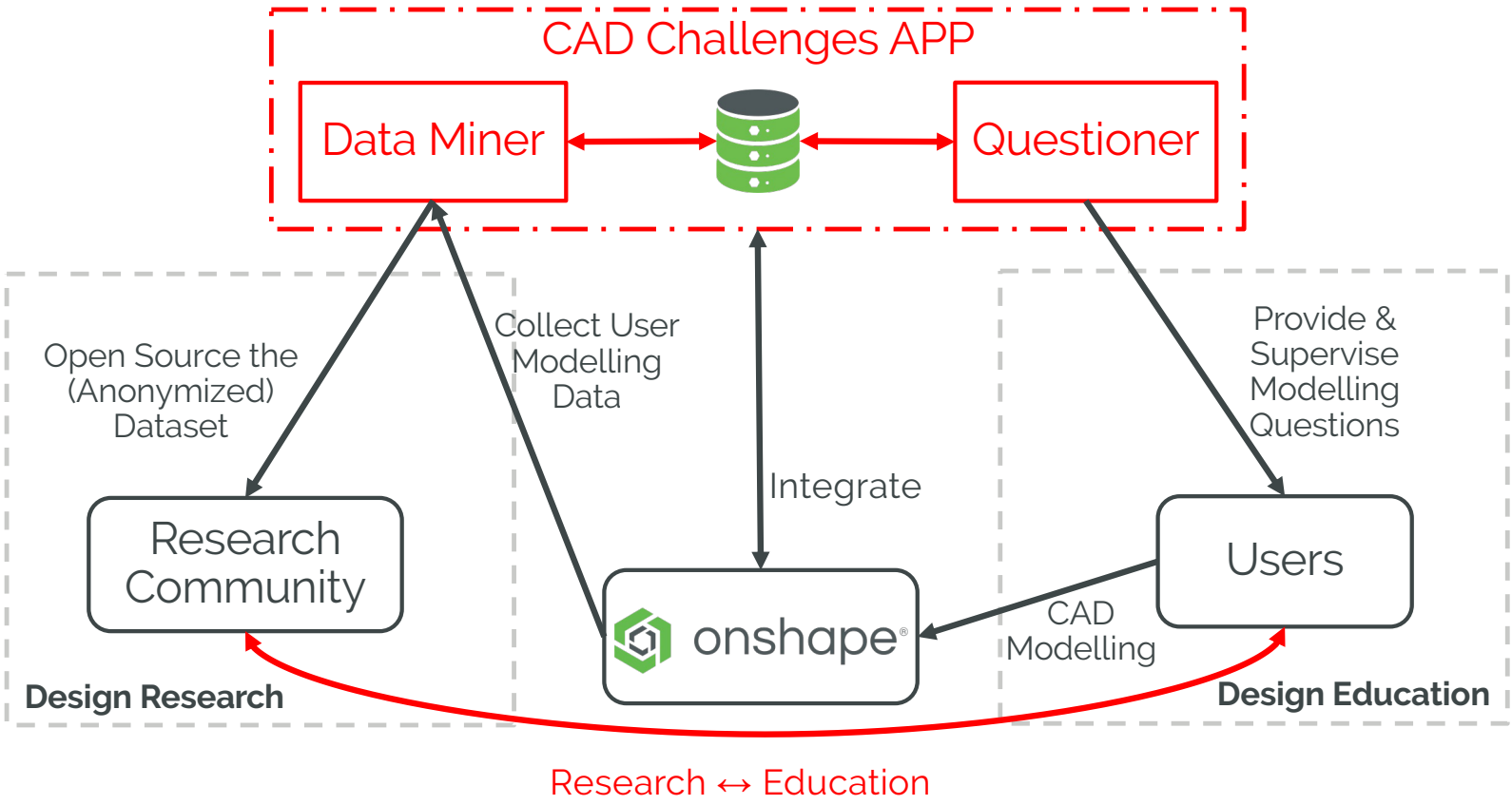
Education Research

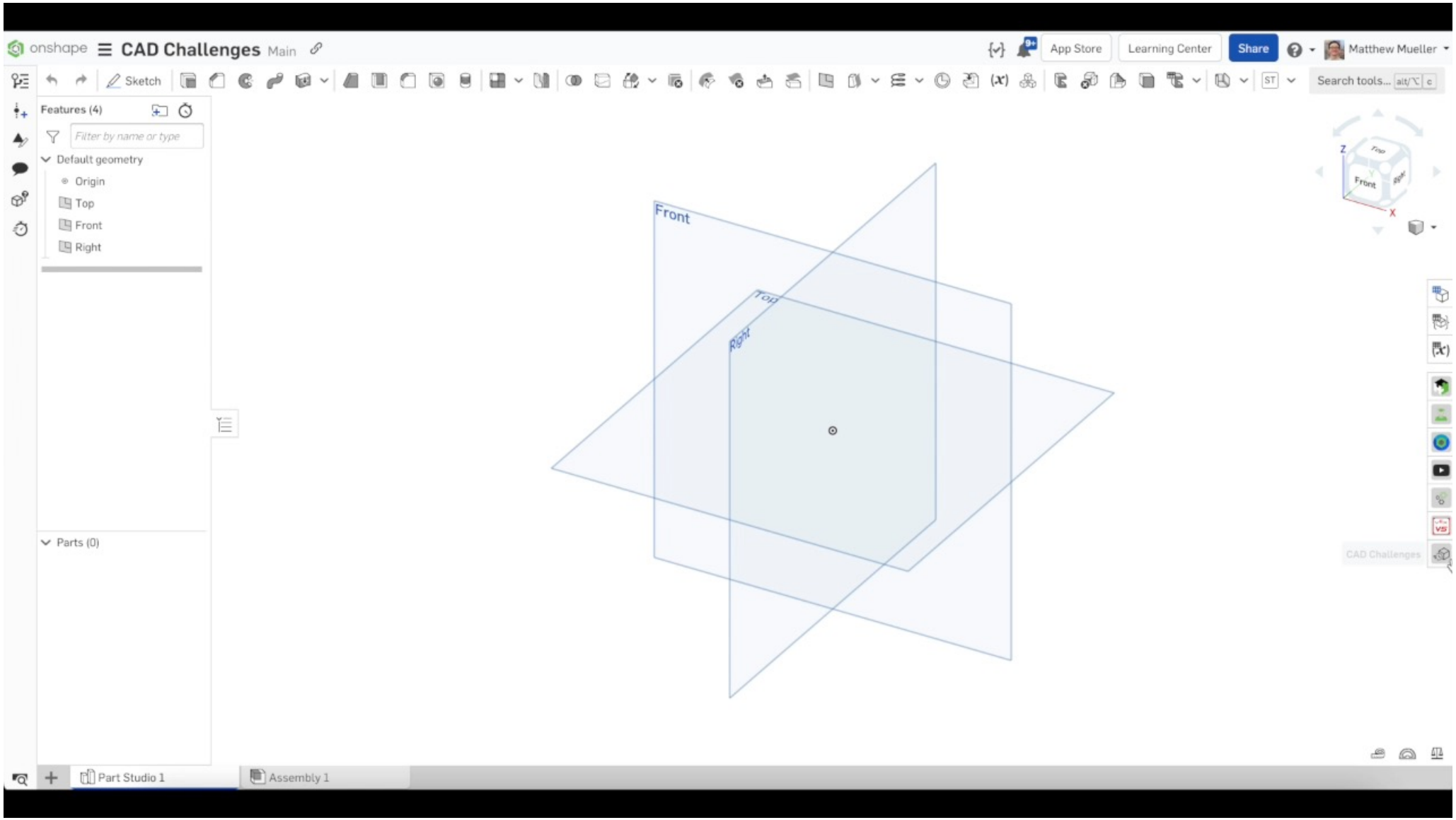
- How can we facilitate and incentivize asynchronous practicing of CAD to help learners gain procedural knowledge?

Design Research

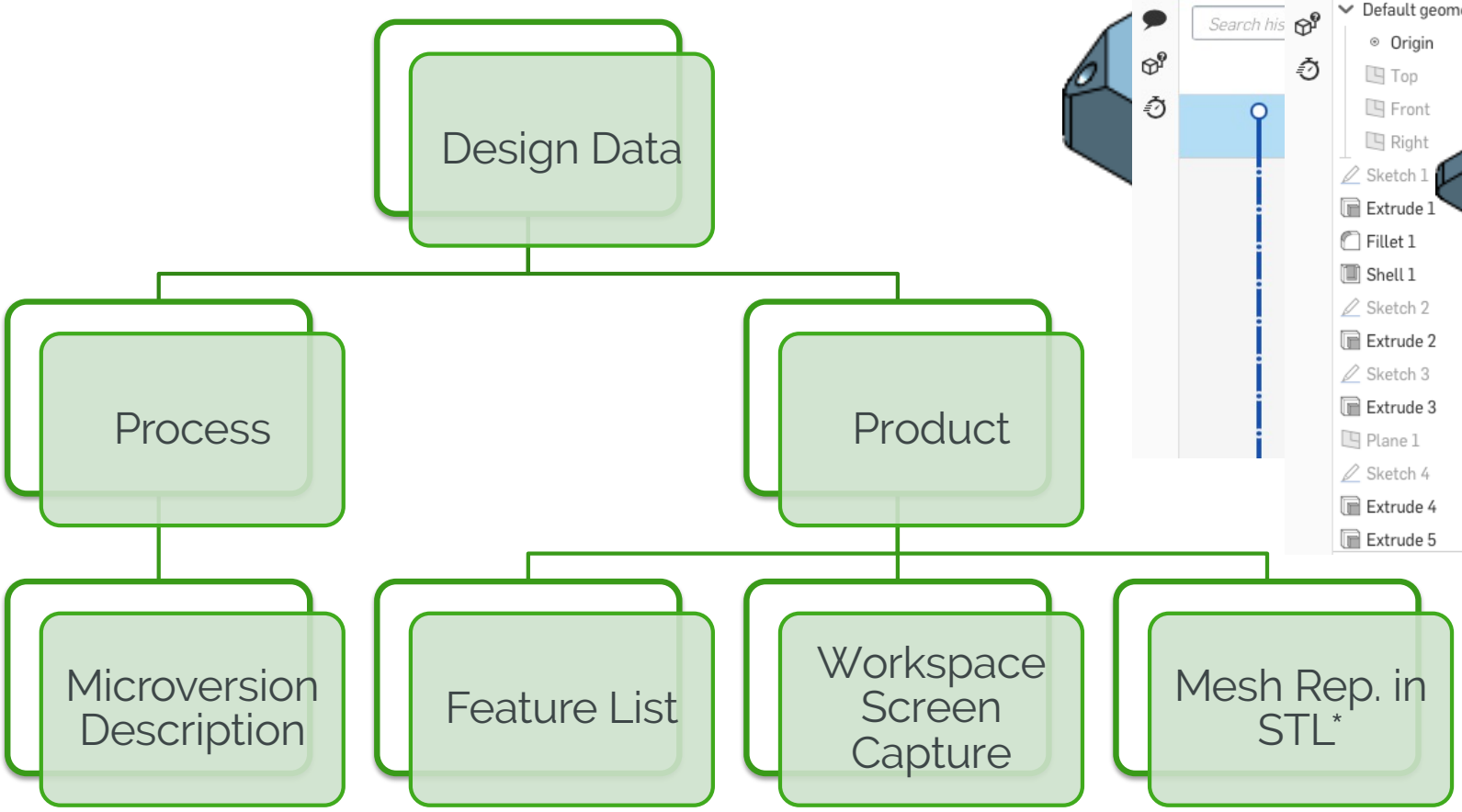
- How can we easily collect large amounts of data about modeling strategies to better understand CAD best practices?

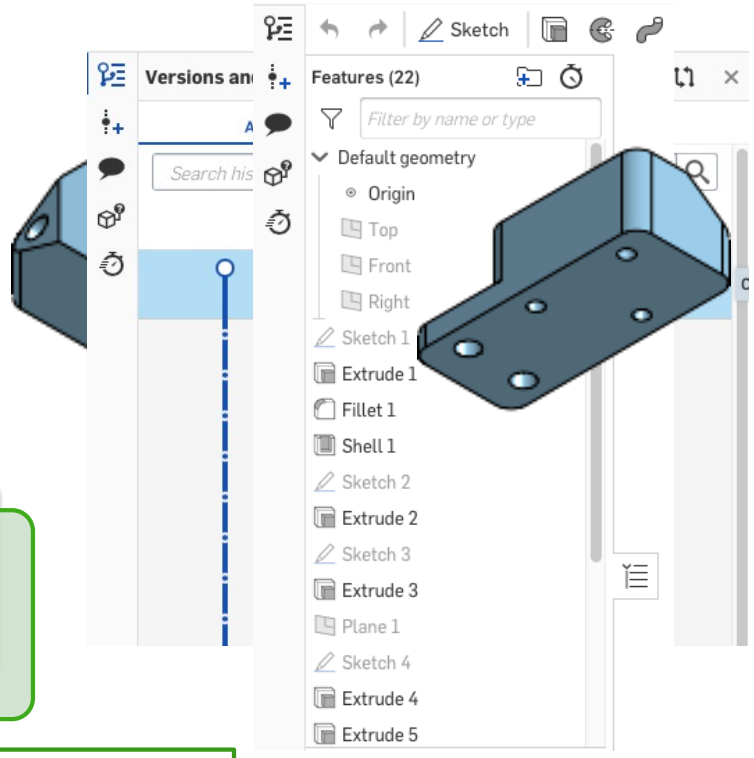
OUR FRAMEWORK




onshape
CAD Challenges
Main
App Store
Learning Center
Share
Matthew Mueller
Sketch
Search tools...
Features (4)
Filter by name or type
Default geometry
Origin
Top
Front
Right
Parts (0)
Front
Top
Right
Part Studio 1
Assembly 1

DATA MINER



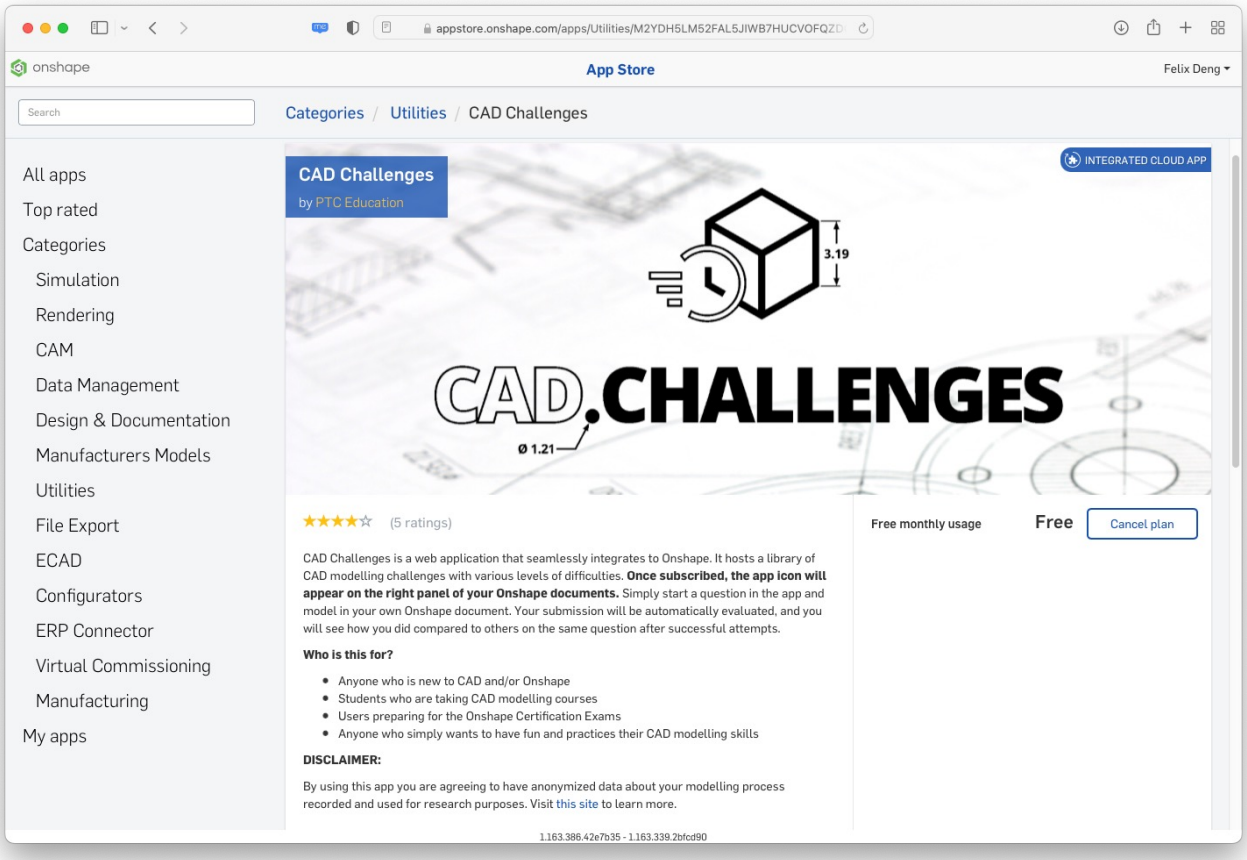


* STL: stereolithography

BENEFITS OF THE FRAMEWORK

- **Education**
  - Asynchronous learning
  - Competitive incentives for modelling practice
  - Teach procedural (strategic) knowledge with careful question design
- **Research**
  - Unobtrusive data collection
  - Big data research approach
  - Flexibility in experimental design

PRELIMINARY ANALYSIS



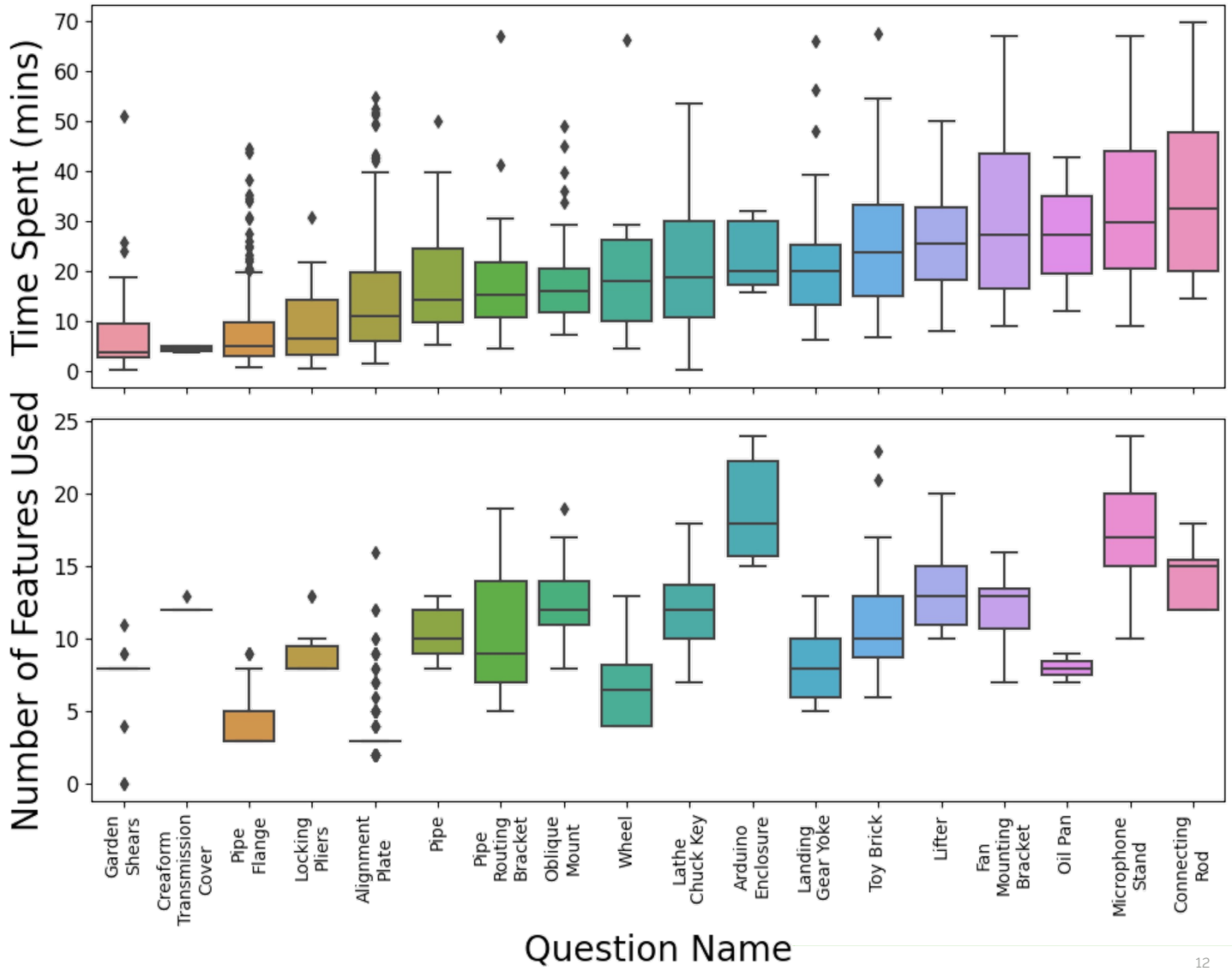
Publicly Launched on March 6, 2023

Unique Users: 303

Total Question Attempts: 1055

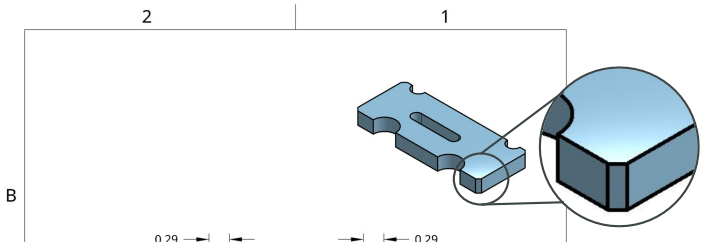
* Data as of August 18, 2023

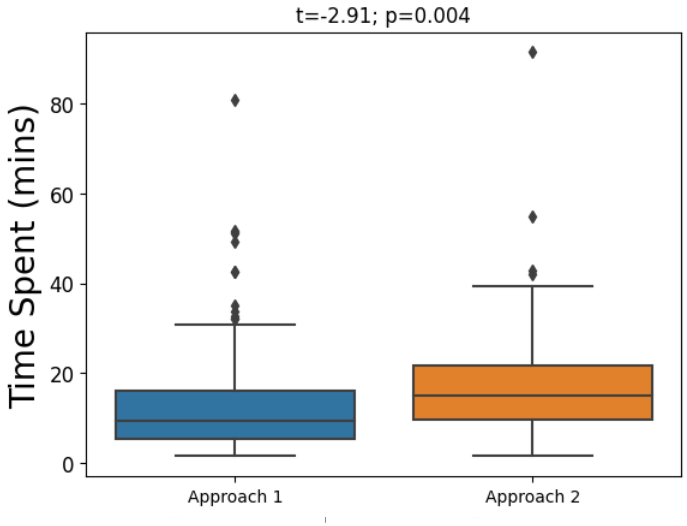
PRELIMINARY ANALYSIS



*** Data as of August 18, 2023**

HOW DID USERS MODEL?

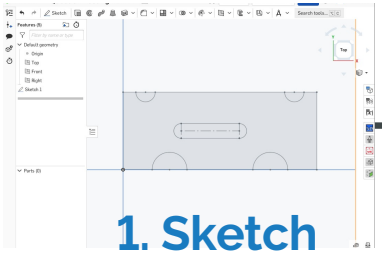




Approach 1:

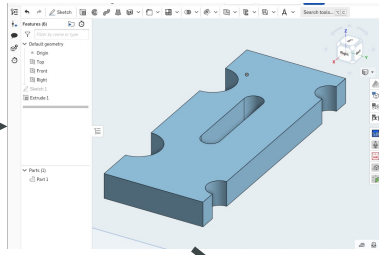
$n = 163$ attempts

Avg. Time: 13 mins

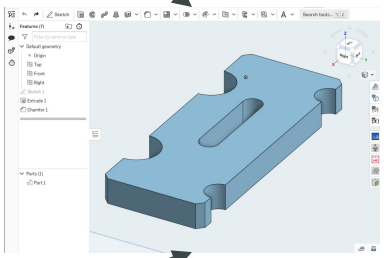


1. Sketch

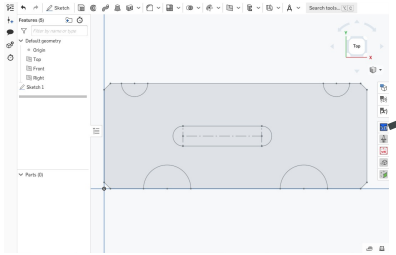
2. Extrude



3. Chamfer



1. Sketch



2. Extrude

Approach 2:

$n = 35$ attempts

Avg. Time: 20 mins

* Data as of August 18, 2023

CONCLUSIONS, LIMITATIONS, & FUTURE WORK

- Education-research connection
  - Education users generate big data for research
  - Research findings benefit education
- Extensibility of app framework
- Limitations
  - Anonymity vs. user background
  - Capture of other cognitive activities
- Future work
  - More challenges
  - Connection to real-world CAD design data
  - Build functionality to check for best practices

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THANK YOU

edutech@ptc.com

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