The Value of Immersive Technologies in Communicating Design Concepts among Student Team Members

Dr. Judy M. Vance
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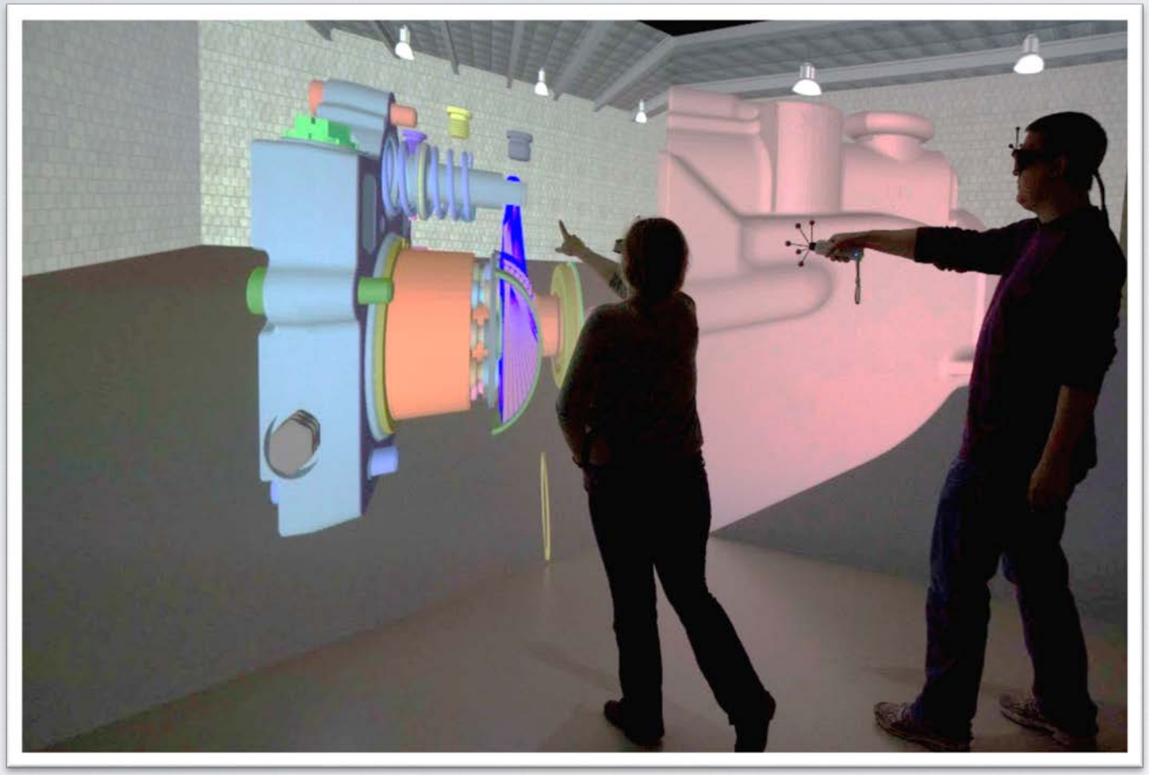
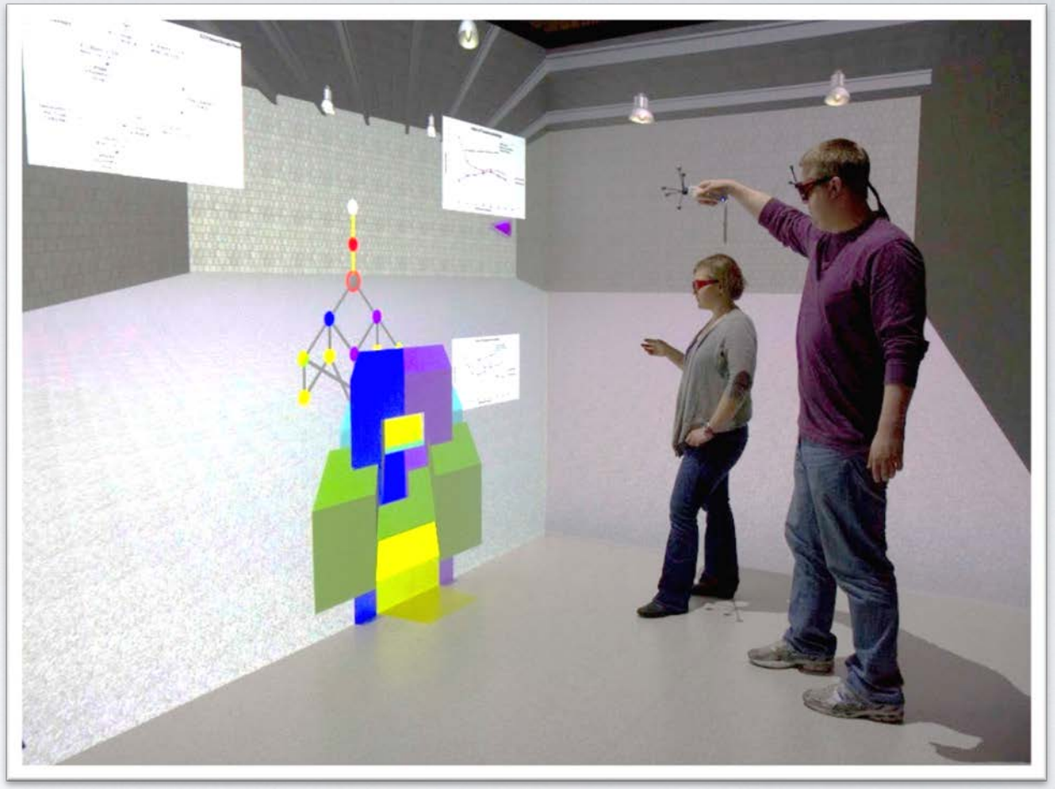
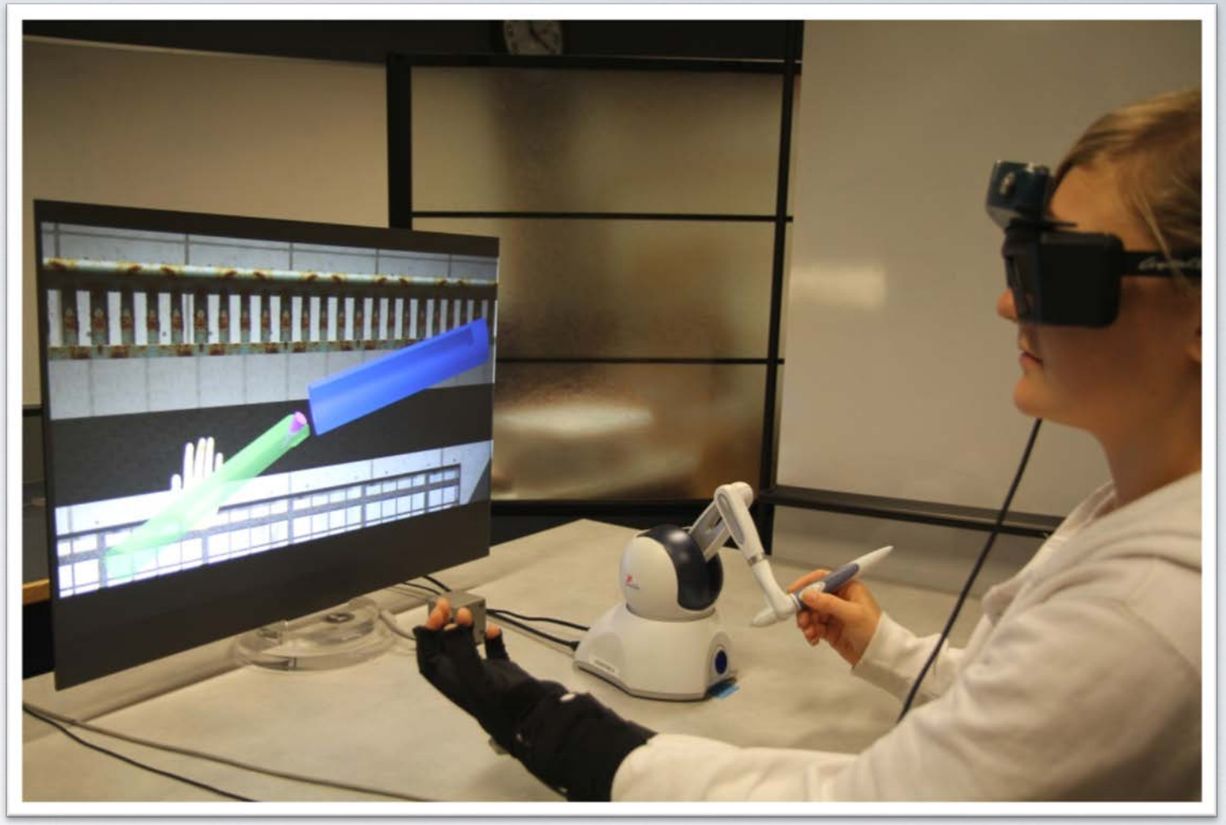
Mechanical Engineering Department
Iowa State University
Ames, IA

Virtual Reality Applications Center

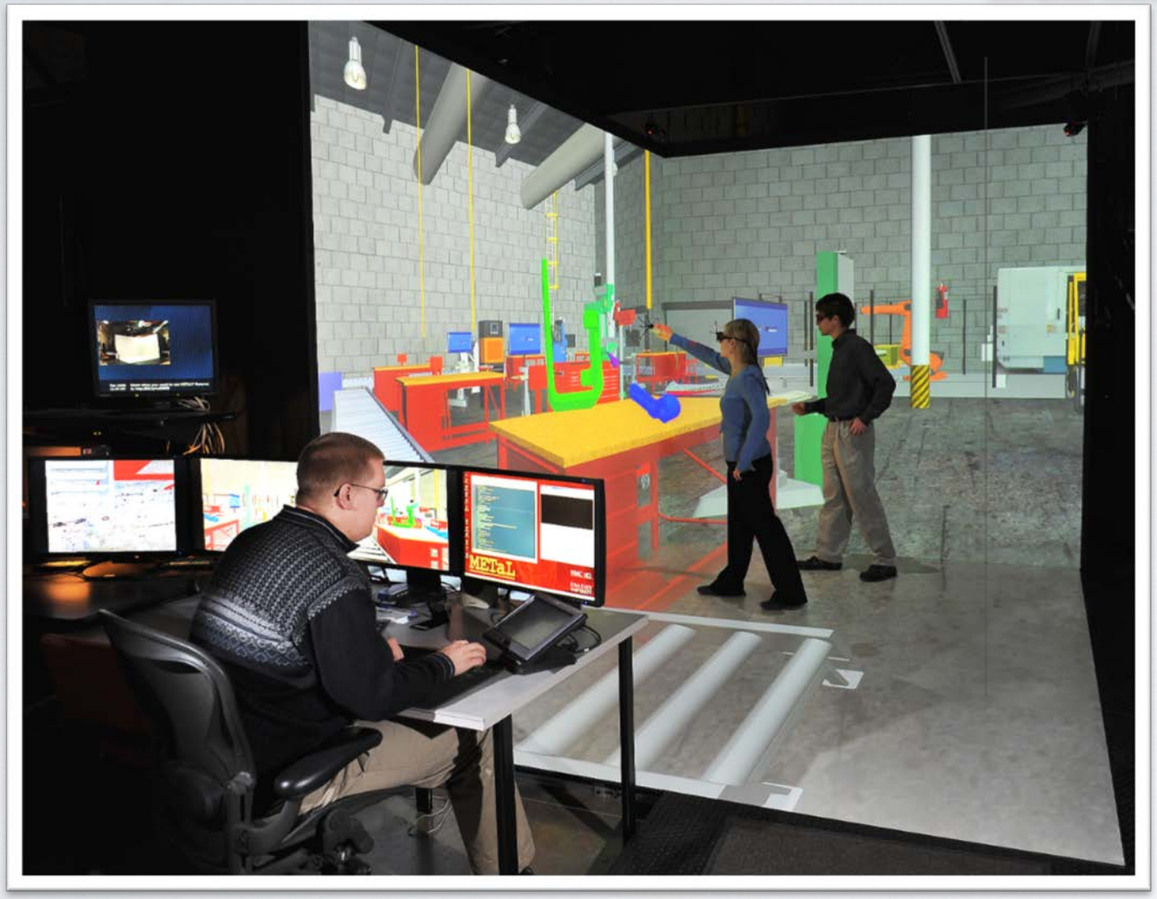






Multi-Model Experimental Testbed and Laboratory

METaL
MULTIMODAL EXPERIENCE TESTBED AND LABORATORY



2 walls, 1 floor

3 Digital Projection
TiTAN WUXGA-3D projectors

ART Track Pack 4 infrared optical tracking system

Wii remote with infrared markers

Exploring the Role of Large-Scale Immersive Computing Environments in Collaboration Between Engineering and Design Students

Meisha Berg
Masters of Science (Mechanical Engineering)
Masters of Science (Human Computer Interaction)
April 13, 2015

Design Thinking

A method of creative action.

In the simplest terms, Design Thinking is “a formal method for practical, creative resolution of problems or issues, with the intent of an improved future result”.

Rolfe Faste

Study 1: Research Question

What are the perceived effects of using Large Scale Immersive Computing Environments (LSICE) as a tool during the design process ?

- Creativity
- Ideation
- Communication

- Mechanical Engineering Students
- Design Students

ME Sophomore Design/Build Class

Mechanical Engineering 270 – Introduction to Mechanical Engineering

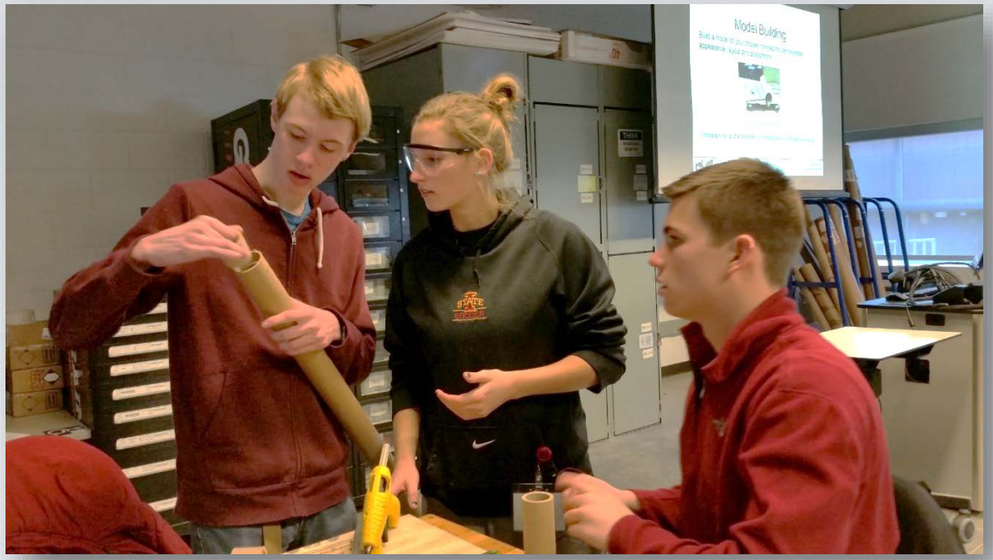
This course is intended as an introduction to the fundamentals of the mechanical engineering design process. Team-based projects with open-ended problems and prototyping of designs will be worked. Applications of engineering tools and principals will be studied and implemented. Oral and written reports will be required for this course.

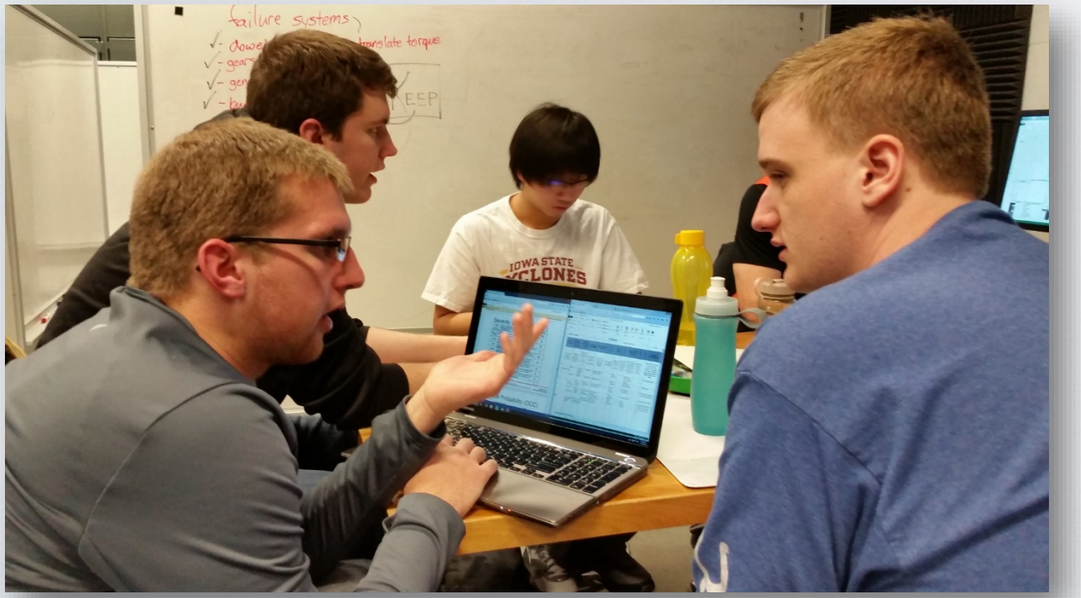
College of Design Course

Design Studies 332x – Multi-Dimensional Digital Design Communication

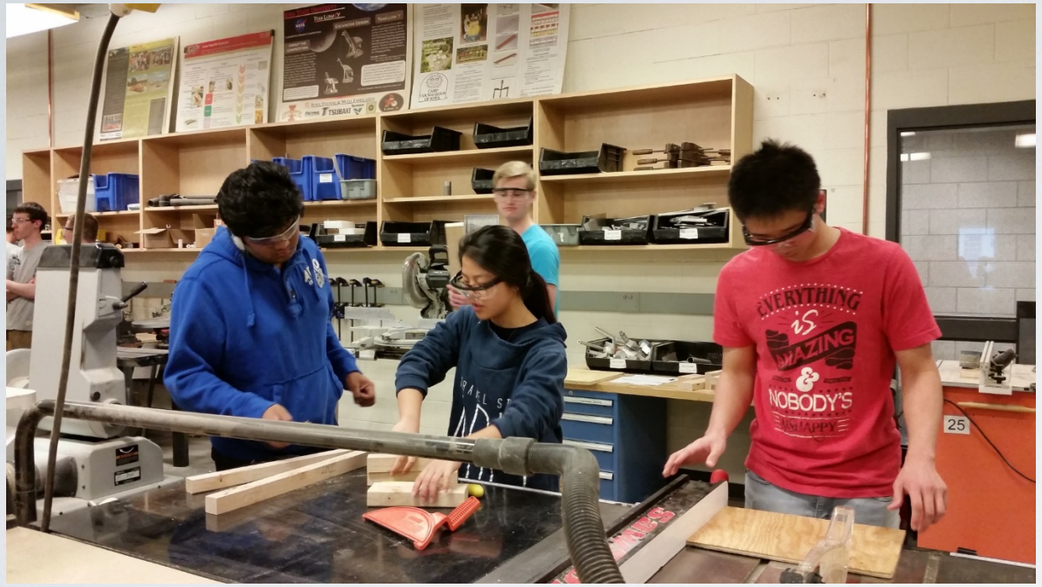
Investigations of interoperable digital design tools, technics and methods directed at human scale interactive hybrid design from ideation to visualization, synthesis to analysis, and realization to fabrication.

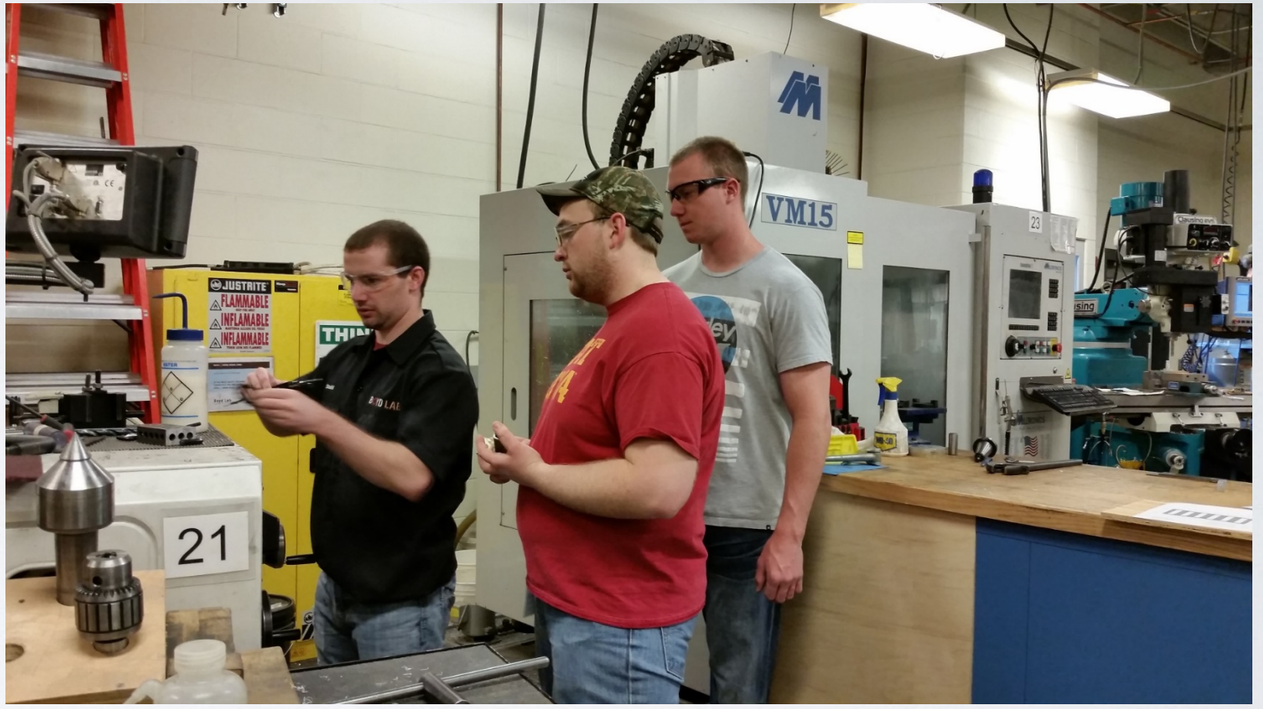
ME 270


Model Building

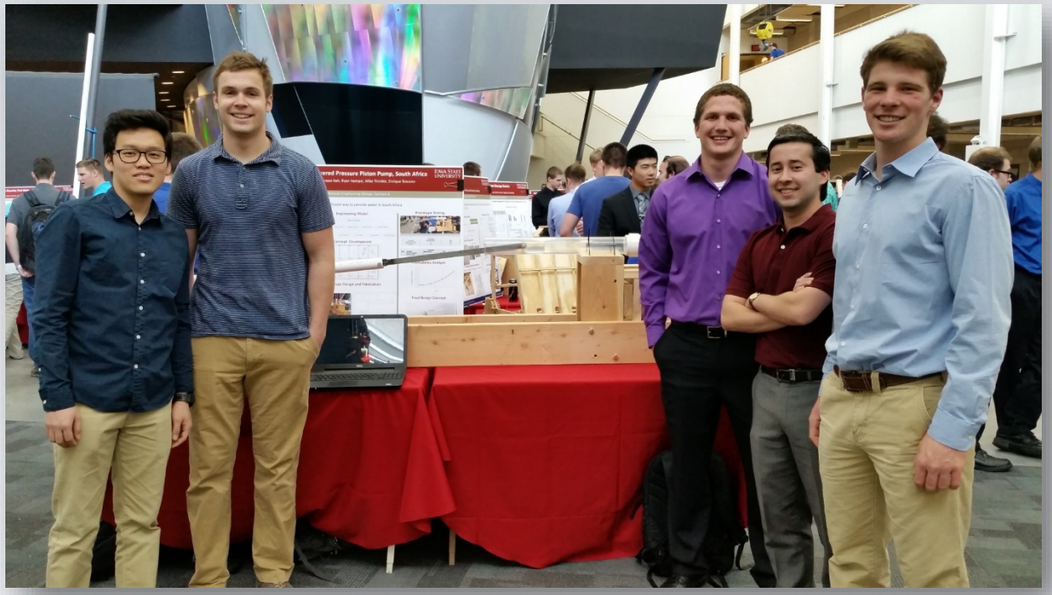

failure systems
translate torque
IOWA STATE
CYCLONES

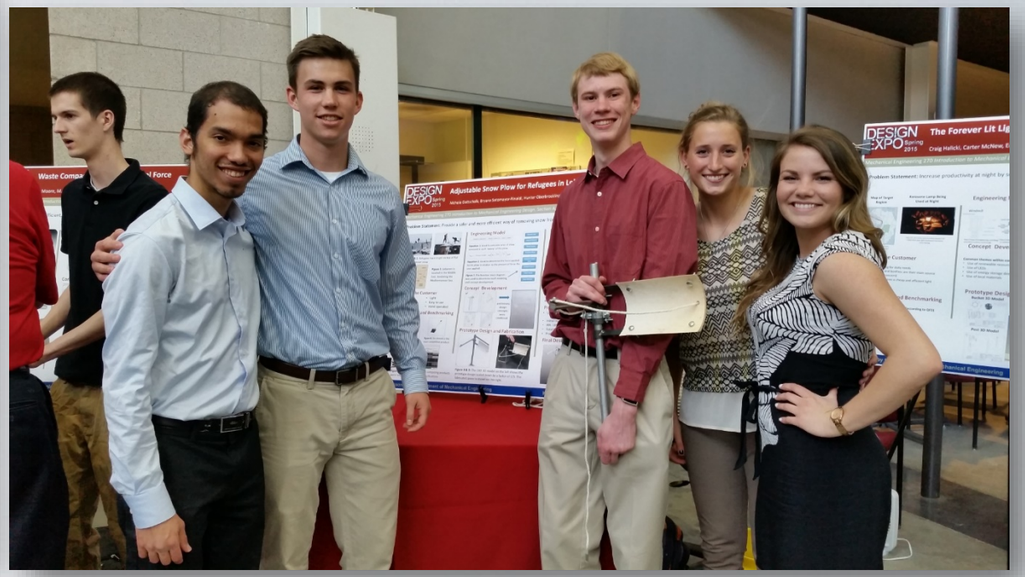
ME 270

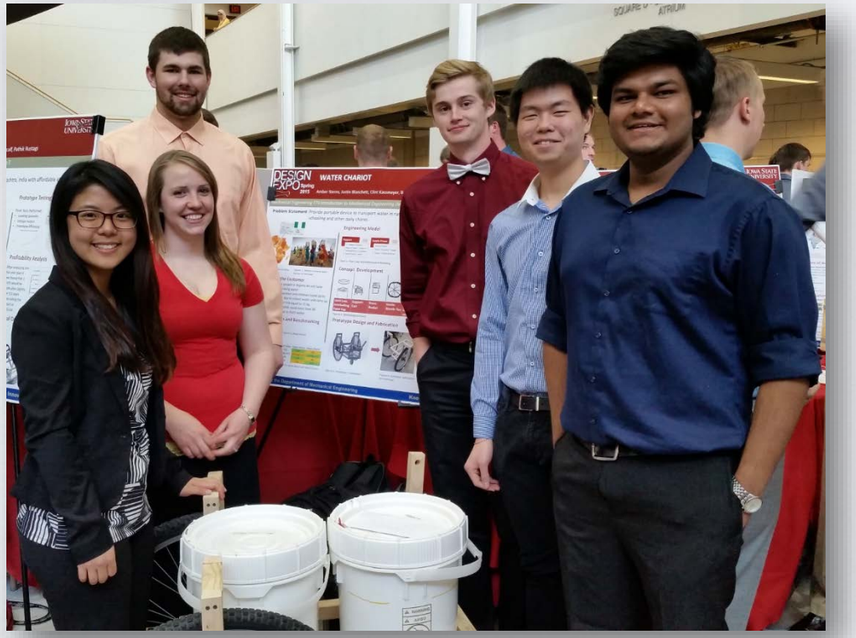

EVERYTHING
IS
AMAZING
&
NOBODY'S
25

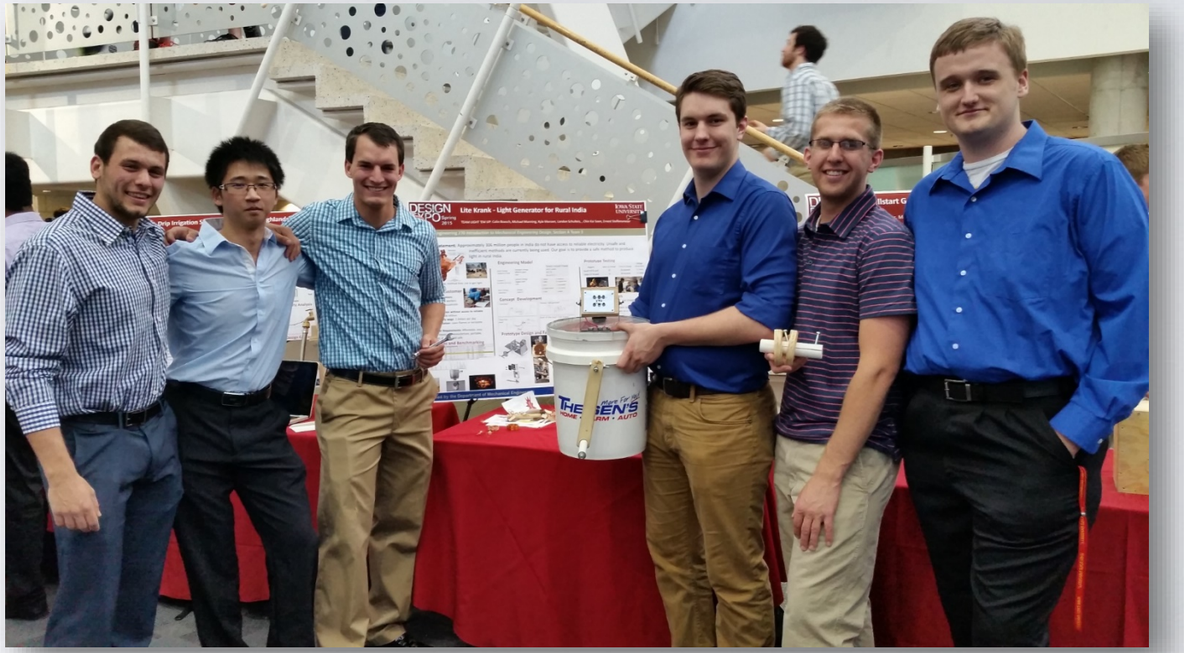

JUSTRITE
FLAMMABLE
INFLAMABLE
INFLAMMABLE
VM15
21

ME 270




DESIGN EXPO
Spring 2015
Adjustable Snow Plow for Refugees in
The Forever Lit Li


DESIGN EXPO
Spring 2015
WATER CHARIOT


DESIGN EXPO
Spring 2015
Lite Krank - Light Generator for Rural India

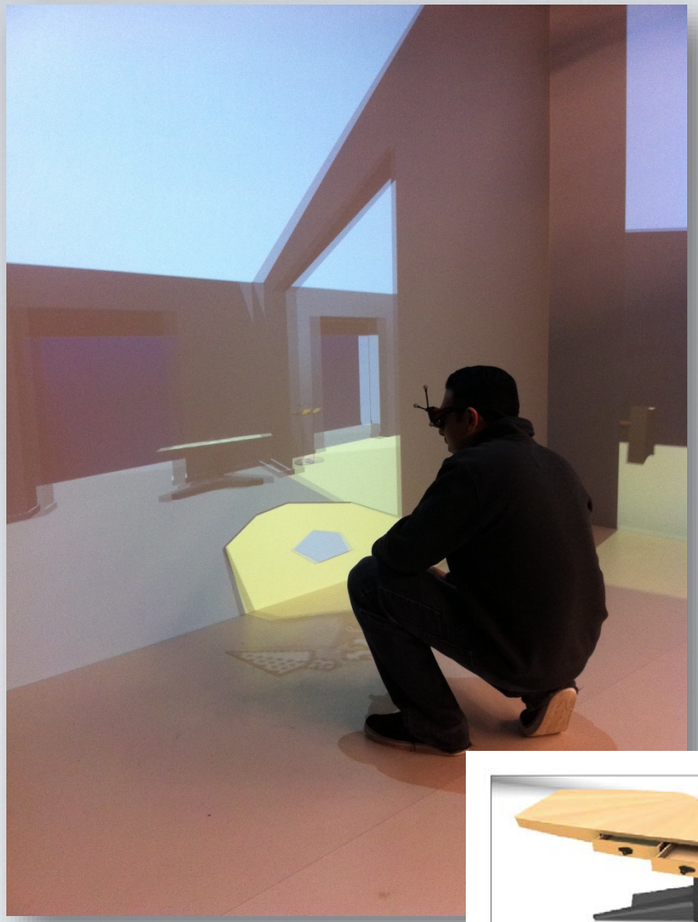
Design Students

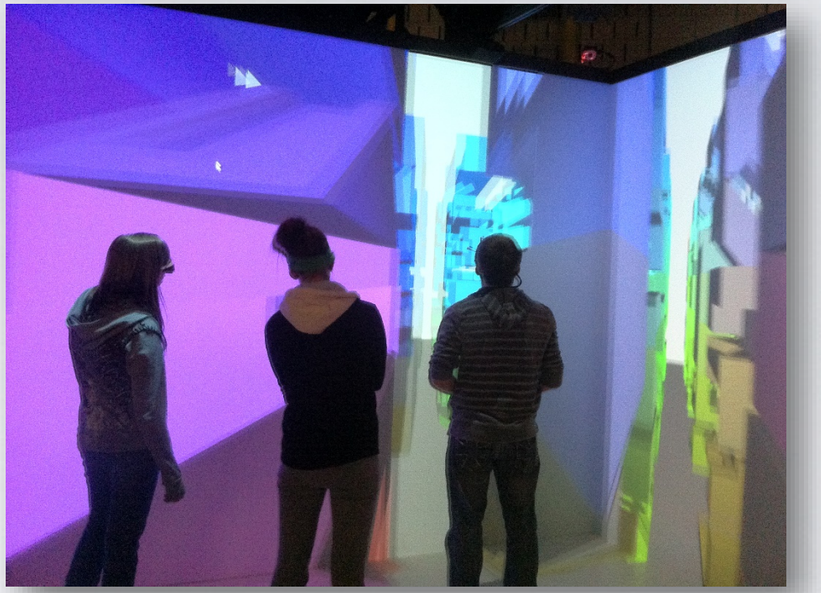
Three different projects throughout the semester.

Design groups changed with each project.

Focus on digital tools.

Application area was primarily furniture design.





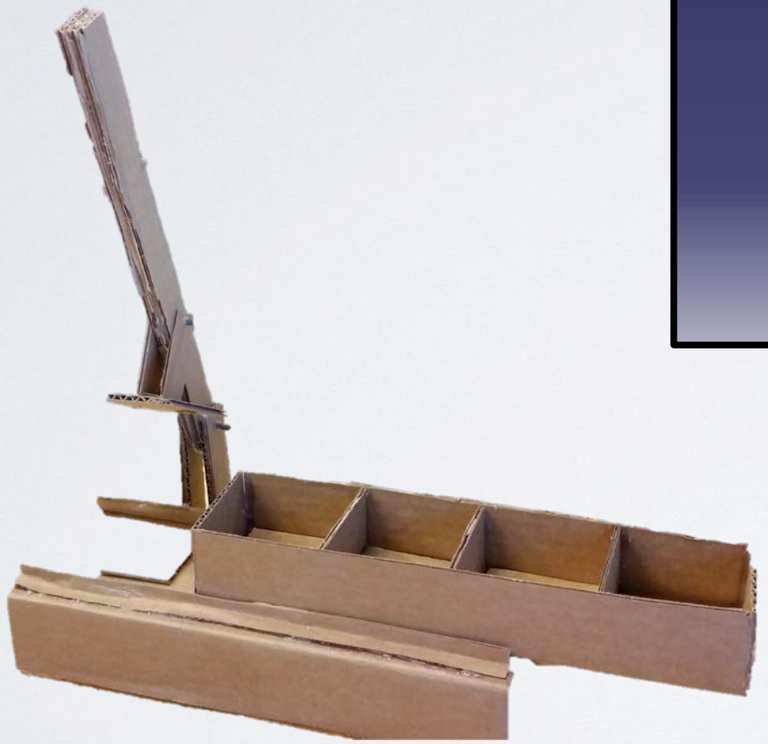

POWER PLANTS
THE ULTIMATE SYNTHESIS OF TECHNOLOGY AND BIOLOGY
Power Plants consume non-biodegradeable materials and produce efficient, clean burning fuels compatible with all modern combustion engines

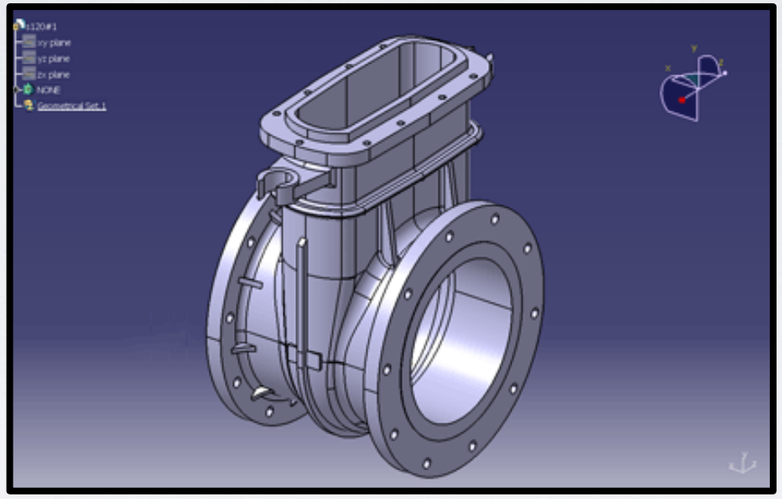

Kubizmus
Czech Cubist Style Desk
3D Model of Chris Martin Furniture by Austin Minnthan
The Kubizmus desk in the style of Czech Cubism was designed and built by Chris Martin and modeled using FormZ software. The Kubizmus desk has multiple angles forming a variety of planes, as the cubist style would exhibit. The backbone of the desk is a steel column with protruding supports that follow the angular pattern inspired by mineral crystals forming. The top plane of the desk is European beechwood with a leather wrapped underside. Two drawers are built into the front of the desk with crystal-inspired drawer pulls made of brass.
Model View
Original Overall View
Drawer Model View
Alternate Model View
Original Drawer View
Drawer Pull Model View
Top Model View

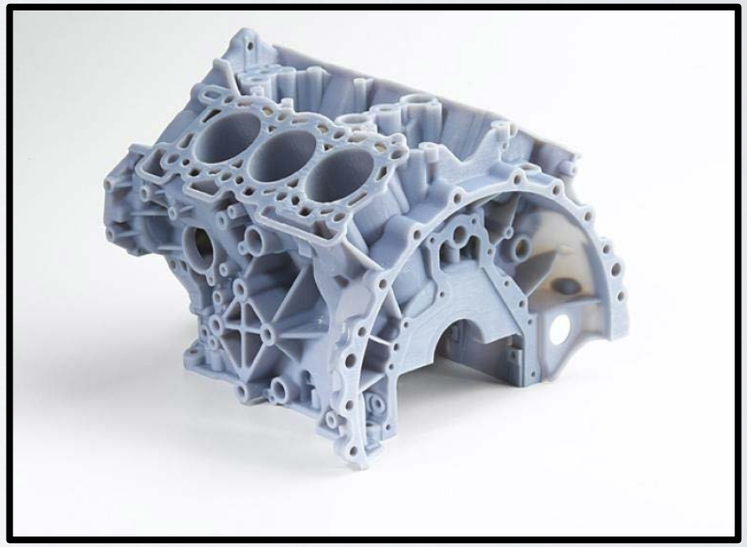
DeS 332x

Project Based Learning

Prototyping

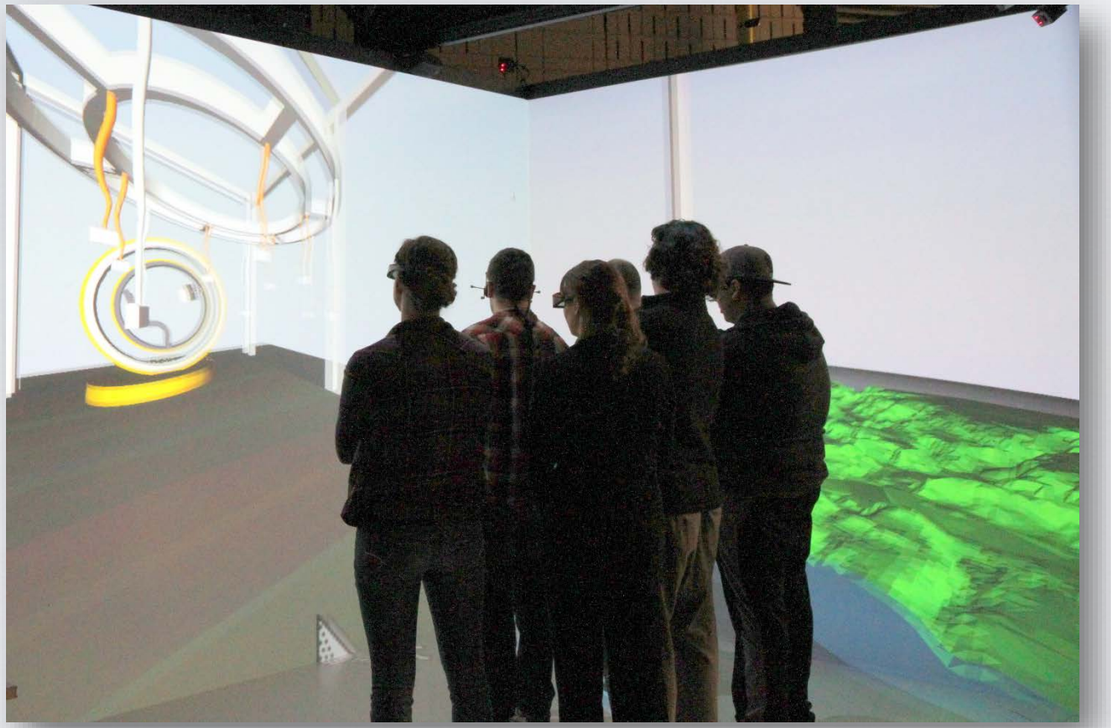






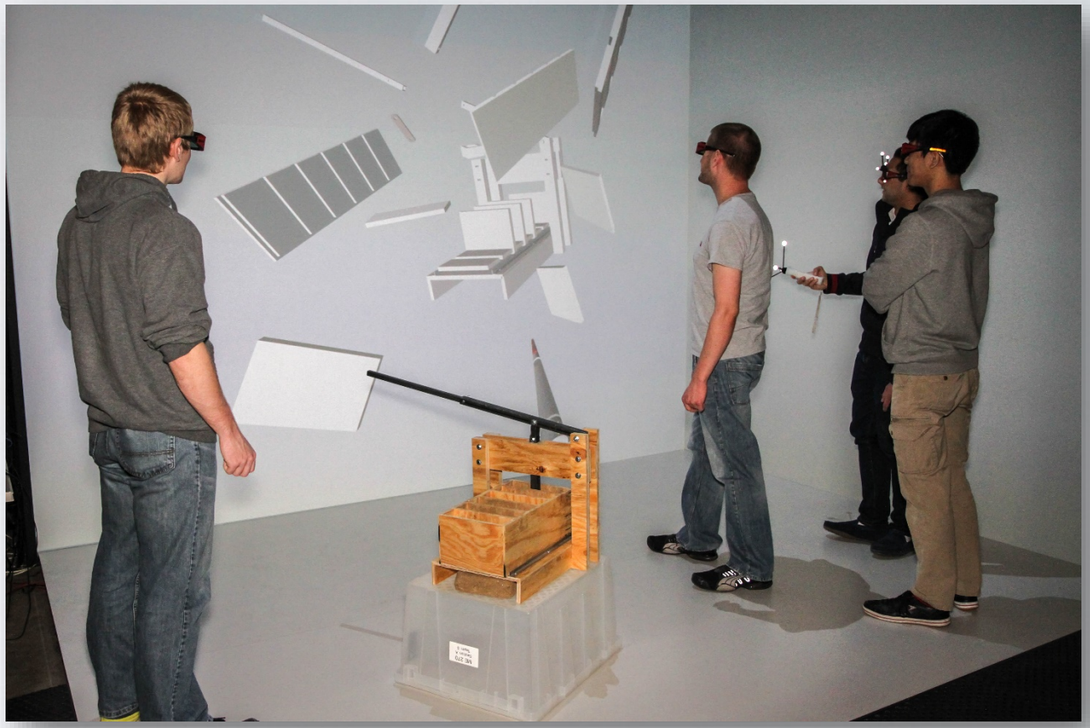
Design 332X

30 students
Average Age: 21.5
21 men, 9 women
8 teams of 3-4 students



ME 270

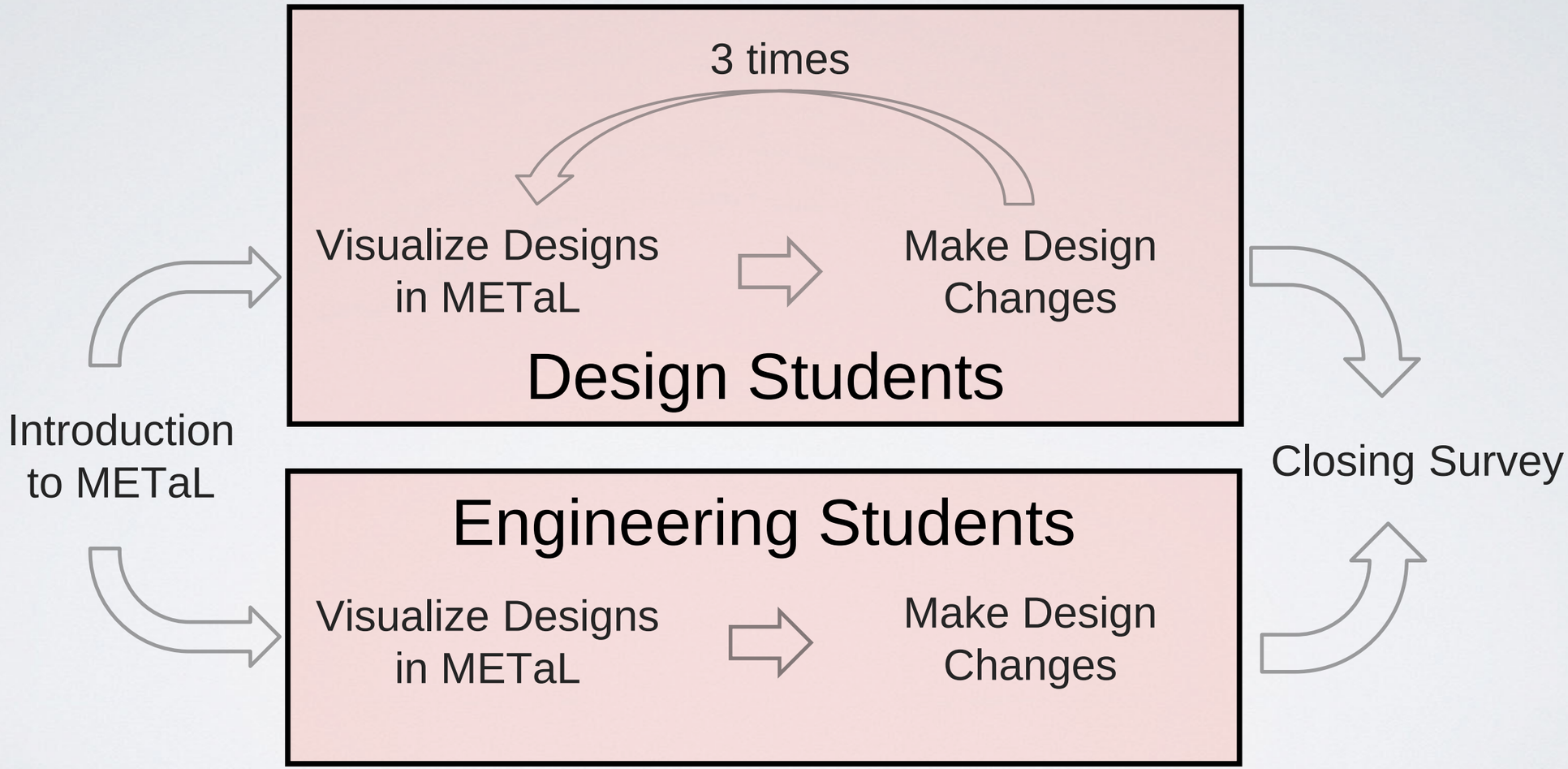
25 students
Average Age: 20.5
23 men, 2 women
5 teams of 5-6 students



Movie 1

Movie 1

Procedure


3 times
Visualize Designs in METaL
Make Design Changes
Design Students
Introduction to METaL
Engineering Students
Visualize Designs in METaL
Make Design Changes
Closing Survey

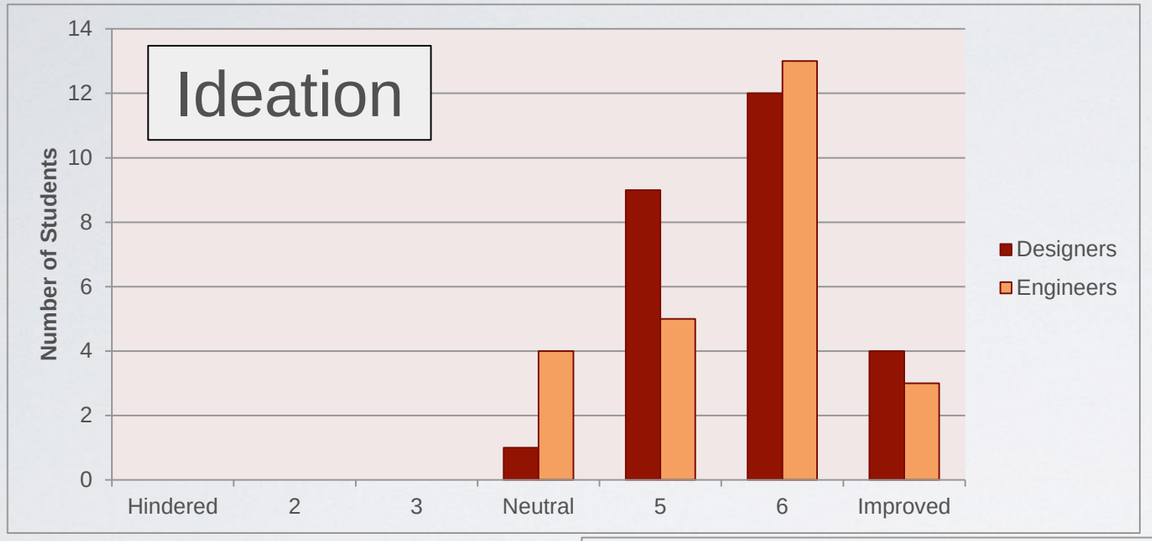
Survey Questions

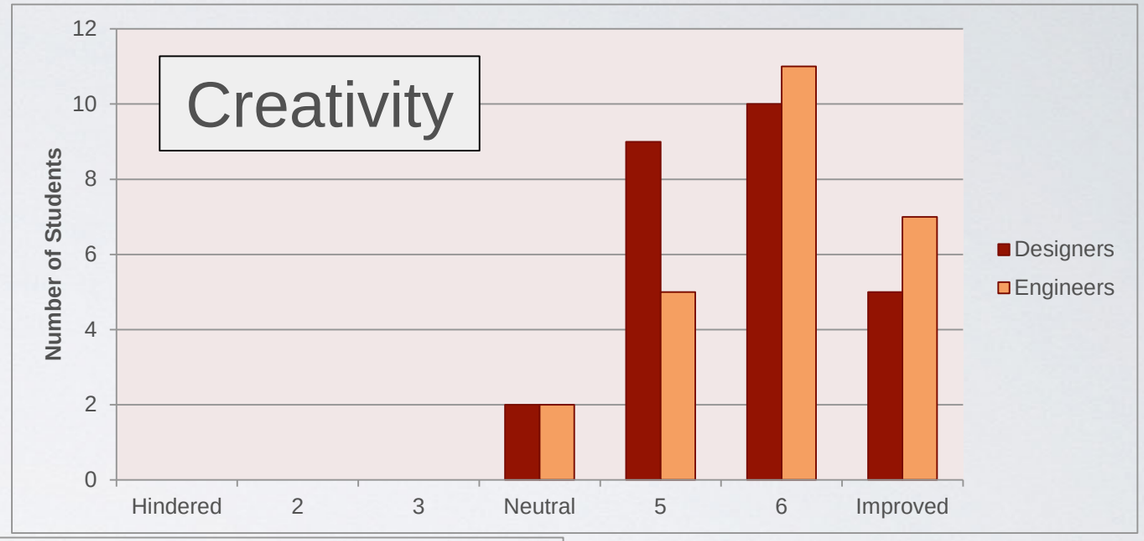
How much did the environment hinder or improve your ideation?

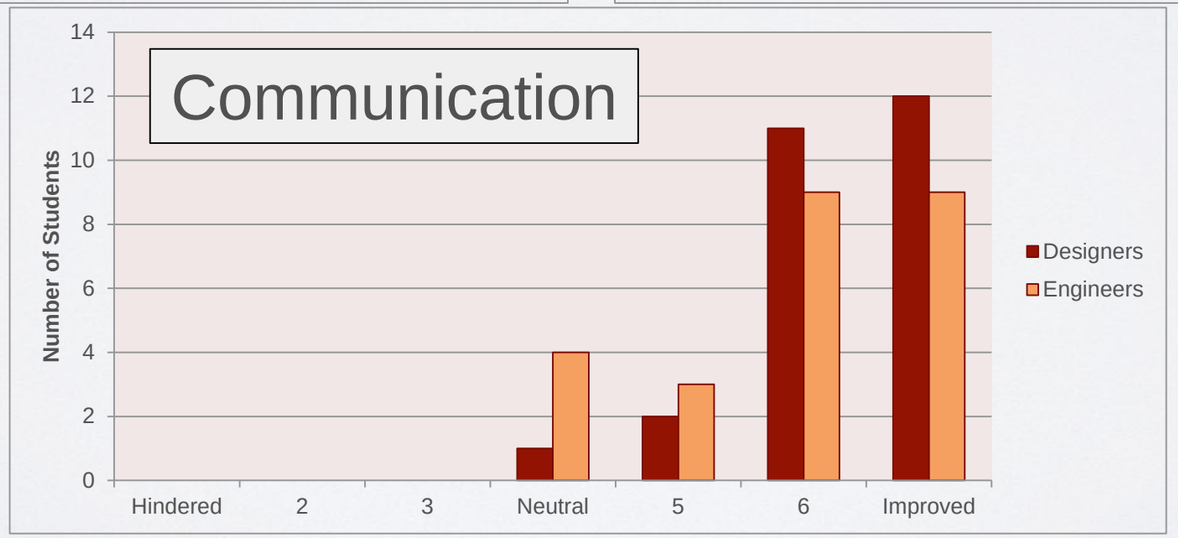
How much did the environment hinder or improve your creativity?

How much did the environment hinder or improve your communication?

Results


Ideation
Number of Students
0
2
4
6
8
10
12
14
Hindered
2
3
Neutral
5
6
Improved
Designers
Engineers


Creativity
Number of Students
0
2
4
6
8
10
12
Hindered
2
3
Neutral
5
6
Improved
Designers
Engineers


Communication
Number of Students
0
2
4
6
8
10
12
14
Hindered
2
3
Neutral
5
6
Improved
Designers
Engineers

Results

Ideation

Group	Mean	Standard Deviation	N
Engineers	5.60	0.91	25
Designers	5.73	0.78	26

$t(47) = 0.5497$
$p = 0.5851$

Creativity

Group	Mean	Standard Deviation	N
Engineers	5.92	0.91	25
Designers	5.69	0.88	26

$t(48) = 0.9062$
$p = 0.3693$

Communication

Group	Mean	Standard Deviation	N
Engineers	5.92	1.08	25
Designers	6.31	0.79	26

$t(43) = 1.4622$
$p = 0.1510$

Survey Questions

What would you improve about the system if you could?

What was your favorite aspect of using METaL to visualize your designs?

Responses

It was very helpful to be able to view the projects at full-scale. By viewing them at full-scale, you could determine if elements of the design were sized correctly or if they needed to be altered.

Design Student

The life-size rendering. It gives you more accurate feel than you would through the screen on a computer. It helped make alterations because sometimes what you thought was a good size for a component was in reality too big or vice versa. Sometimes you tend to lose track of scale in relation to your object and this helps a lot.

Engineering Student

Responses

My favorite aspect is how it bridges the gap from design intent to representation and communication. One large issue I see brought up again and again in design is the limited ways to communicate the intention and design to the viewer. The METaL lab allows a representation style unlike anything before.

Design Student

My favorite aspect of using METaL was being able to 'experience' our design and interact with it before fabricating it. I enjoyed the control over the design and the freedom to move parts around the environment to see how the parts are integrated in the design.

Engineering Student

Responses

It is a whole new experience to be able to just look around a certain object rather than rotating it on the screen. I think because it is more intuitive to human nature, this system and others like it will be very successful in the future.

Design Student

It was really cool. I only noticed so many things from SolidWorks. We realized that a few crucial parts were oriented incorrectly. This was helpful.

Engineering Student

METaL is fantastic for allowing other designers and/or clients to understand aspects of a design they could not gather from oral or 2D representations. It is great to have the vision, which was once restricted to your imagination alone, presented so completely.

Design Student

Study 2: Interdisciplinary Collaboration

Study 2: Research Question

How do LSICEs affect students' perceived abilities to collaborate across disciplines?

Specifically

- *Does the LSICE improve the students' perceived ability to communicate with a team?*
- *Do the students feel a sense of presence in the virtual environment?*
- *Does the LSICE improve the students' perceived ability to visualize designs?*

Interdisciplinary Collaboration

20 Participants

5 Teams of 4 students

2 designers, 2 engineers

1 hour

10 men, 10 women

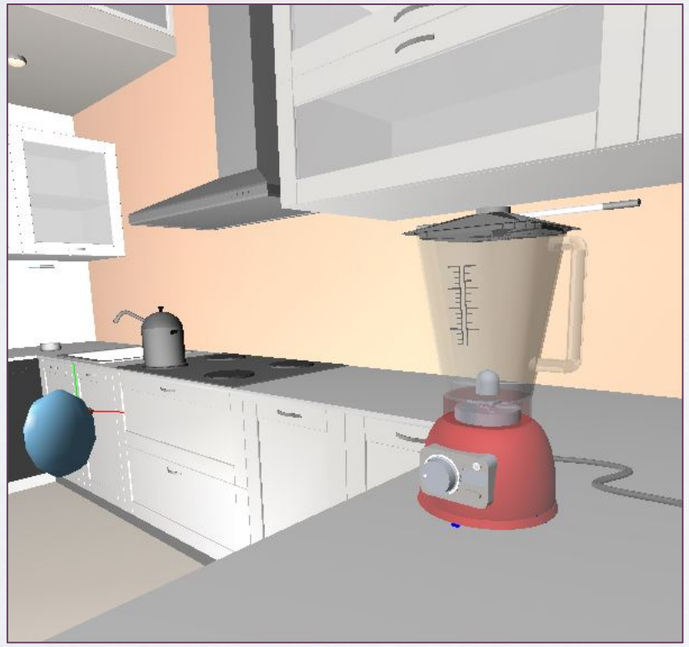
10 undergraduates, 10 graduates

Average age: 22.7

Little to no previous VR experience

Procedure

Pre-Survey → 5 min Acclimation Period → 20 min Design Review → 15 min Team Review → Closing Survey



Conduct a design review

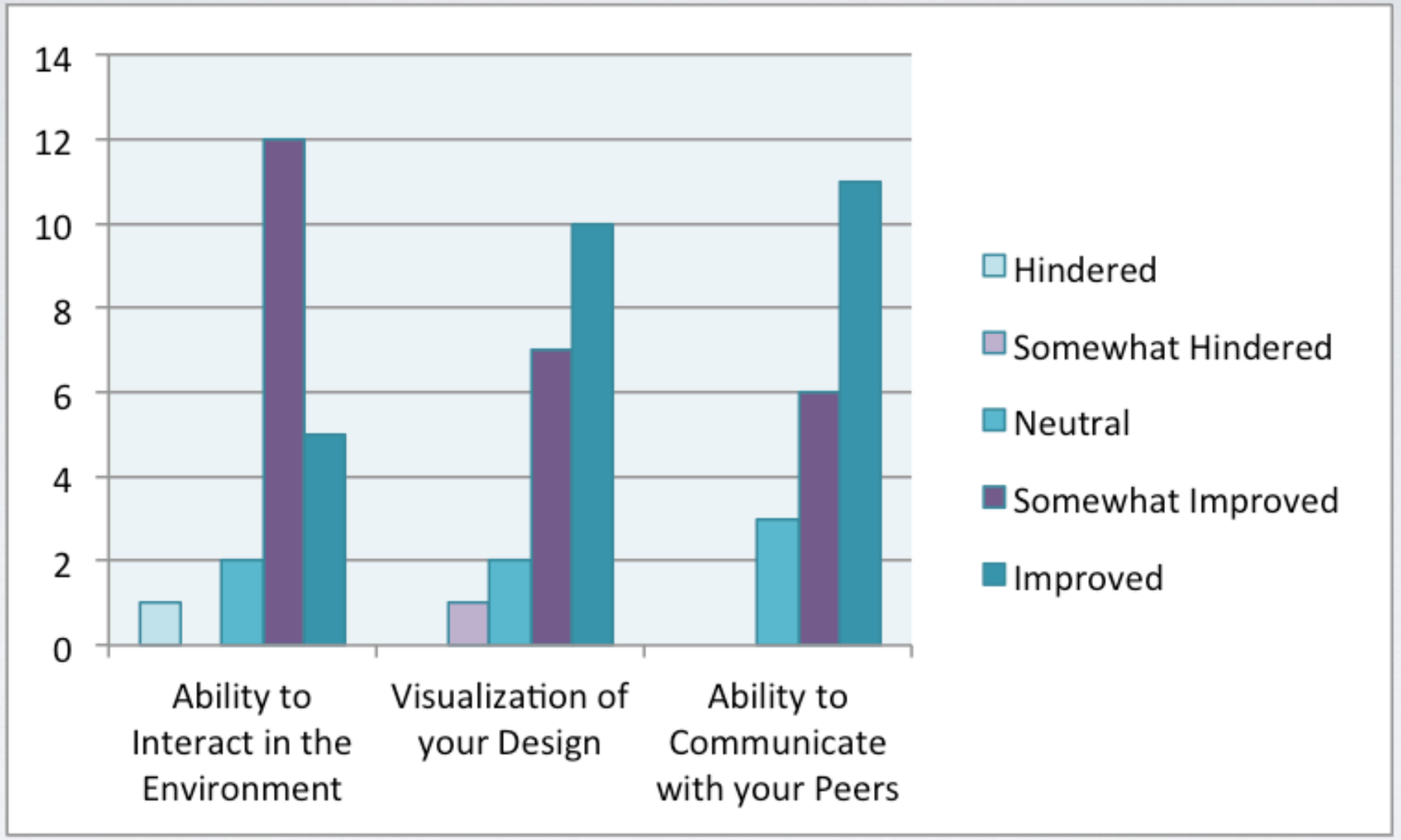
Survey Questions

How much did the environment hinder or improve your ability to interact in the environment?

How much did the environment hinder or improve your ability to visualize designs?

How much did the environment hinder or improve your ability to communicate with your peers?

Responses


14
12
10
8
6
4
2
0
Ability to Interact in the Environment
Visualization of your Design
Ability to Communicate with your Peers
Hindered
Somewhat Hindered
Neutral
Somewhat Improved
Improved

Survey Questions

What improvements would you make to the system?
What were your favorite features of the METaL virtual environment?
What were the biggest drawbacks to the virtual environment?

Responses

The scene was really neat and interactive; you could walk around the kitchen with the mixer and ”pour” into the glasses or bowls or put the mixer in the sink.

Engineering Student

You could manipulate the different features to different angles. A lot of times even in engineering drawings there are 3 views. Here, there are infinite.

Engineering Student

It allowed you to look at every angle of the product as well as allowing you to disassemble pieces and look at them separately.

Engineering Student

Responses

When walking around, it adjusted to the perspective of the user. The 3D was very smooth and became very immersive after a short period of time.

Design Student

I like that when the primary user walked forward it zoomed in rather than using the remote, I actually felt like I was in the kitchen and as if I could hold the object.

Design Student

Responses

I liked that we all had to figure it out together and we were all looking at the same thing. I felt that everyone was very present and engaged, which is different from a typical design critique.

Design Student

You could manipulate the different features to different angles. A lot of times even in engineering drawings there are 3 views. Here, there are infinite.

Engineering Student

Future Work

What is the effect that these environments have on the *performance* of engineering design students?

How do teams with an established relationship interact *differently* in these environments?

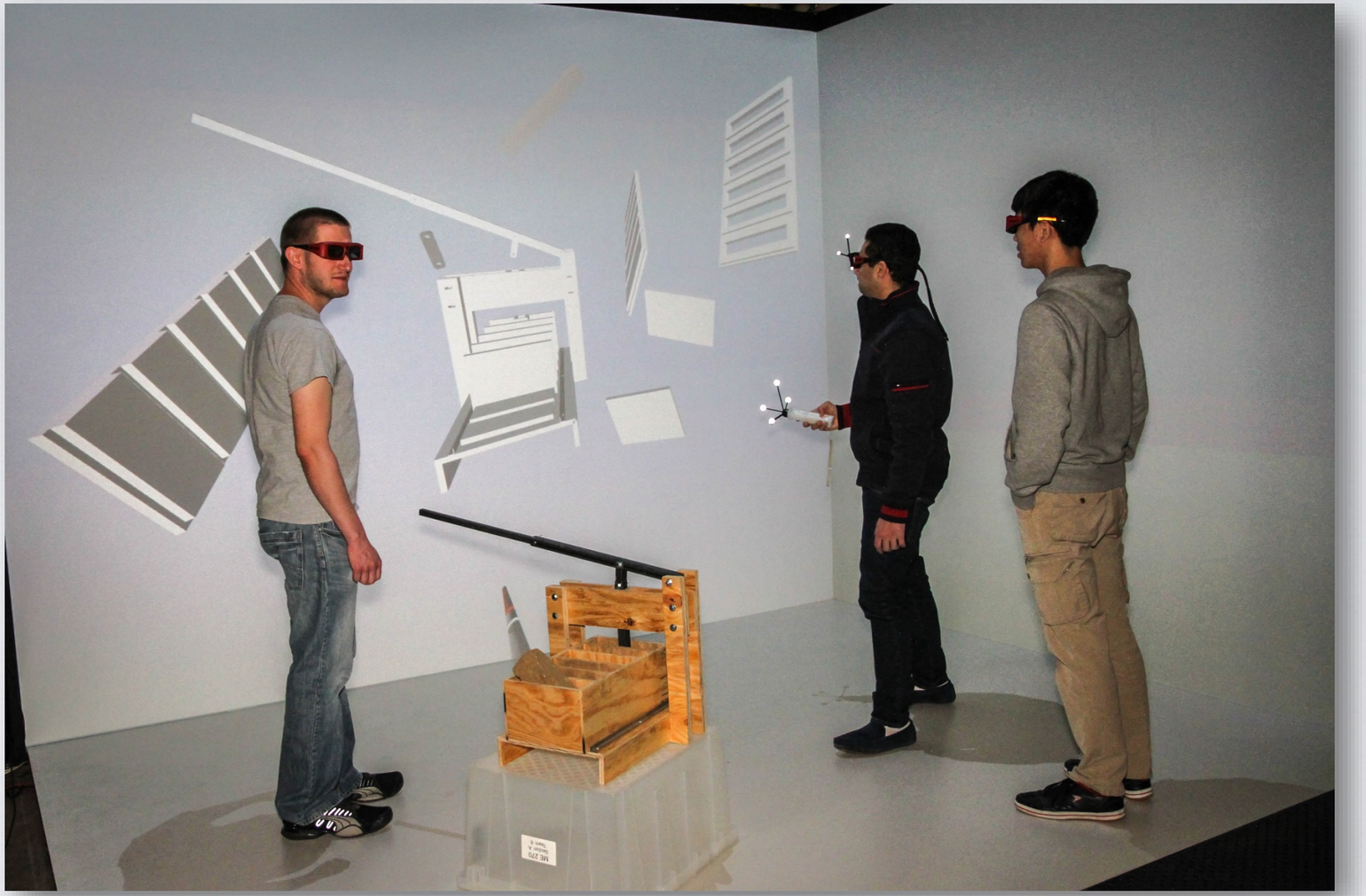
In what *disciplines* and educational *settings* are LSICEs most effective?

How will advancements in technology make these tools more *accessible* to students?

What effect does *novelty* play in collaboration in this setting?

Software - VRJuggLua

Software – Siemen's Teamcenter Visualization



Thank you!

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