EDU500039

SJSU Case Study: Industrial Design + Mechanical engineering Collaboration

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Learning Objectives

- **Define** the role and the value of cross-discipline collaboration between design, business, and engineering perspectives.
- **Identify** the three different collaborations that took place at SJSU between engineering and design over the past year
- **Explore** the use of Fusion 360 in sustainability design, advanced material projects, and the Kreative Kitchen
- **Introduce** an experimental collaborative classroom space called, the Kreative Kitchen

Description

The world is changing and becoming more collaborative, and the lines between fields are constantly blurring. Design, business, and engineering in industry do not happen in a vacuum independent of each other. So why would we approach education in these fields as if they do? How do you introduce innovative software features and technologies into a product development process without stifling creativity and innovation? How can we maximize the power of AI and feature-rich software such as Fusion 360 software to help solve problems in design? We explore these questions and more in the San Jose State University classrooms, as we experiment in the SJSU/Autodesk Kreative Kitchen. The Kreative Kitchen is an innovative, multidisciplinary, educational pilot model dedicated to exploring how we can maximize the benefits of diverse fields in a collaborative academic environment that mimics industry.

Speaker(s)

Kohar Scott started a full-time role as Assistant Professor at SJSU in the Fall of 2020 after teaching as an Adjunct Professor in the Industrial Design Program since 2015. Having grown up in Cupertino, she graduated Magna Cum Laude from De Anza College, left to attend UCLA where she was inducted into the Phi Theta Kappa Honor Society, and graduated from Art Center College of Design in Southern California in 2000 with a BS in Product Design. In 2019 she completed her Masters in Design at SF State where she was inducted into Epsilon Pi Tau and awarded the Warner Award for her research project in design education. Kohar's industry experience ranges from boutique design firms, large consultancies, mid and large size corporations, and eventually even consulting on her own. Her background includes a focus on Color, Material, and Finish (CMF) and Industrial Design. She holds multiple patents, and her client list includes industry leaders in consumer electronics, pro-audio, toy manufacturing, personal care, and soft goods. Her current research revolves around the use of color, materials,

and technologies such as AI, VR, and AR to solve problems in the design. Her teaching philosophy focuses on bridging the gap between industry and education and breaking the silos of education through cross-discipline collaboration. After an adventurous sojourn around the world in career, parenting, and in travel, she is enjoying giving back to her community through teaching the next generation of designers and raising her two daughters here in the South Bay.

Amir Armani is an Assistant Professor of Mechanical Engineering at San Jose State University. He obtained his Ph.D. degree in 2017 from Missouri University of Science and Technology (formerly known as the University of Missouri, Rolla), and his M.S. and B.S. degrees in 2012 and 2009 from Sharif University of Technology, all in Mechanical Engineering. Dr. Armani's research has been centered on Additive Manufacturing, Structural Ceramics, Functionally Graded Materials, Smart Structures, and Sheet Metal Forming. He is the author/co-author of two books, one US patent, and 35 peer-reviewed papers (19 journal articles and 16 conference papers). These publications have received more than 500 citations thus far (according to Google Scholar).

Introduction

For over 40 years, SJSU has offered a solid industrial design education with a lot of student time spent in our central shop and classrooms where they are able to build and mockup their ideas. During lockdown, SJSU was one of the first institutions to respond to the pandemic by shutting down or severely limiting access to our hands-on learning facilities and on-campus activities. As a result, our students returned back to their homes of origin, sometimes across the world. This challenged us to find creative ways to pivot our instruction and curriculum to teach remotely and virtually.

The Silos of Education

The world is changing, becoming more collaborative, and the lines between fields are constantly blurring. Design and engineering in industry do not happen in a vacuum independent of each other. So why would we approach education in these fields as if they do?

Design education history

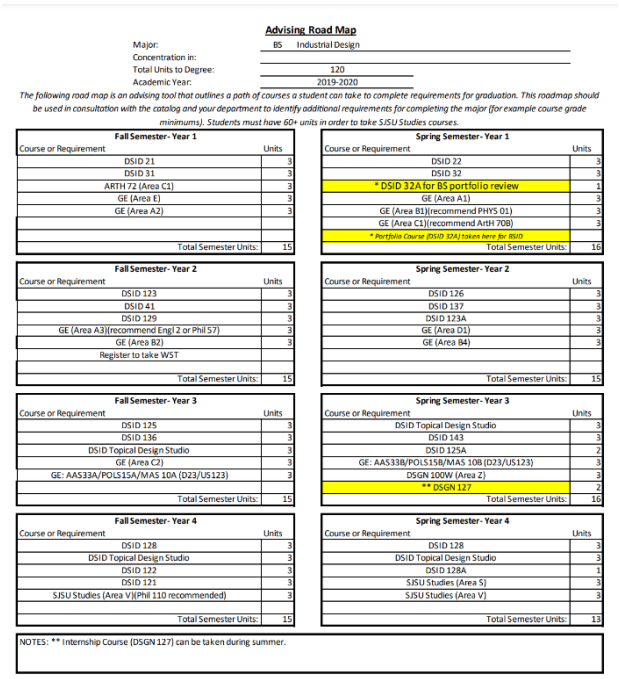
The history of design education roots back to 17th century Europe. Students were treated like pre-apprentices and still today, design is taught through design projects whereas a chemistry student must first learn the periodic table and mathematics before applying it to chemistry.

Design and engineering education at SJSU

Designers are not engineers. Our curriculum roadmaps require us to focus on the skills needed to be successful in our subsequent fields, such as **visual communication**, **championing the end-user**, and **function**. When it comes to engineering, technology, materials and manufacturing knowledge, design students need a way to synthesize complex, technical material and process content in a way that inspires creativity, curiosity, and continued inquiry.

The engineering roadmap necessitates mostly engineering based studies and while both design and engineering approach problem solving from a perspective of function, the approach is more analytical and the curriculum doesn't include as much drawing and visual communication instruction as the design program.

At the education level, we have very little knowledge about what the other discipline teaches. Part of my commitment in education is breaking these silos by introducing cross-discipline collaboration in higher education. Partnering with Autodesk and using Fusion 360 has been a great platform to help make this happen.



Advising Road Map

Major: BS Industrial Design
Concentration in:
Total Units to Degree: 120
Academic Year: 2019-2020

The following road map is an advising tool that outlines a path of courses a student can take to complete requirements for graduation. This roadmap should be used in consultation with the catalog and your department to identify additional requirements for completing the major (for example course grade minimums). Students must have 60+ units in order to take SJSU Studies courses.

Fall Semester- Year 1	
Course or Requirement	Units
DSID 21	3
DSID 31	3
ARTH 72 (Area C1)	3
GE (Area E)	3
GE (Area A2)	3
Total Semester Units:	15

Spring Semester- Year 1	
Course or Requirement	Units
DSID 22	3
DSID 32	3
* DSID 32A for BS portfolio review	1
GE (Area A1)	3
GE (Area B1)(recommend PHYS 01)	3
GE (Area C1)(recommend ArtH 70B)	3
* Portfolio Course (DSID 32A) taken here for BSID	
Total Semester Units:	16

Fall Semester- Year 2	
Course or Requirement	Units
DSID 123	3
DSID 41	3
DSID 129	3
GE (Area A3)(recommend Engl 2 or Phil 57)	3
GE (Area B2)	3
Register to take WST	
Total Semester Units:	15

Spring Semester- Year 2	
Course or Requirement	Units
DSID 126	3
DSID 137	3
DSID 123A	3
GE (Area D1)	3
GE (Area B4)	3
Total Semester Units:	15

Fall Semester- Year 3	
Course or Requirement	Units
DSID 125	3
DSID 136	3
DSID Topical Design Studio	3
GE (Area C2)	3
GE: AAS33A/POLS15A/MAS 10A (D23/US123)	3
Total Semester Units:	15

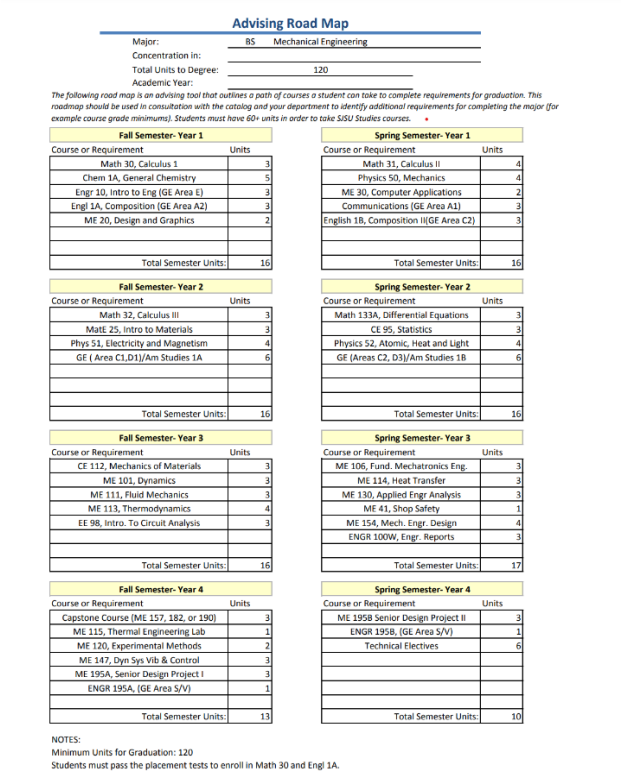
Spring Semester- Year 3	
Course or Requirement	Units
DSID Topical Design Studio	3
DSID 143	3
DSID 125A	2
GE: AAS33B/POLS15B/MAS 10B (D23/US123)	3
DSGN 100W (Area Z)	3
** DSGN 127	2
Total Semester Units:	16

Fall Semester- Year 4	
Course or Requirement	Units
DSID 128	3
DSID Topical Design Studio	3
DSID 122	3
DSID 121	3
SJSU Studies (Area V)(Phil 110 recommended)	3
Total Semester Units:	15

Spring Semester- Year 4	
Course or Requirement	Units
DSID 128	3
DSID Topical Design Studio	3
DSID 128A	1
SJSU Studies (Area S)	3
SJSU Studies (Area V)	3
Total Semester Units:	13

NOTES: ** Internship Course (DSGN 127) can be taken during summer.

Fig. 1 The curriculum roadmap of Design and Engineering



Advising Road Map

Major: BS Mechanical Engineering
Concentration in:
Total Units to Degree: 120
Academic Year:

The following road map is an advising tool that outlines a path of courses a student can take to complete requirements for graduation. This roadmap should be used in consultation with the catalog and your department to identify additional requirements for completing the major (for example course grade minimums). Students must have 60+ units in order to take SJSU Studies courses.

Fall Semester- Year 1	
Course or Requirement	Units
Math 30, Calculus 1	3
Chem 1A, General Chemistry	5
Engr 10, Intro to Eng (GE Area E)	3
Engl 1A, Composition (GE Area A2)	3
ME 20, Design and Graphics	2
Total Semester Units:	16

Spring Semester- Year 1	
Course or Requirement	Units
Math 31, Calculus II	4
Physics 50, Mechanics	4
ME 30, Computer Applications	2
Communications (GE Area A1)	3
English 1B, Composition II(GE Area C2)	3
Total Semester Units:	16

Fall Semester- Year 2	
Course or Requirement	Units
Math 32, Calculus III	3
MatE 25, Intro to Materials	3
Phys 51, Electricity and Magnetism	4
GE (Area C1,D1)/Am Studies 1A	6
Total Semester Units:	16

Spring Semester- Year 2	
Course or Requirement	Units
Math 133A, Differential Equations	3
CE 95, Statistics	3
Physics 52, Atomic, Heat and Light	4
GE (Areas C2, D3)/Am Studies 1B	6
Total Semester Units:	16

Fall Semester- Year 3	
Course or Requirement	Units
CE 112, Mechanics of Materials	3
ME 101, Dynamics	3
ME 111, Fluid Mechanics	3
ME 113, Thermodynamics	4
EE 98, Intro. To Circuit Analysis	3
Total Semester Units:	16

Spring Semester- Year 3	
Course or Requirement	Units
ME 106, Fund. Mechatronics Eng.	3
ME 114, Heat Transfer	3
ME 130, Applied Engr Analysis	3
ME 41, Shop Safety	1
ME 154, Mech. Engr. Design	4
ENGR 100W, Engr. Reports	3
Total Semester Units:	17

Fall Semester- Year 4	
Course or Requirement	Units
Capstone Course (ME 157, 182, or 190)	3
ME 115, Thermal Engineering Lab	1
ME 120, Experimental Methods	2
ME 147, Dyn Sys Vib & Control	3
ME 195A, Senior Design Project I	3
ENGR 195A, (GE Area S/V)	1
Total Semester Units:	13

Spring Semester- Year 4	
Course or Requirement	Units
ME 195B Senior Design Project II	3
ENGR 195B, (GE Area S/V)	1
Technical Electives	6
Total Semester Units:	10

NOTES:
Minimum Units for Graduation: 120
Students must pass the placement tests to enroll in Math 30 and Engl 1A.

Fig. 2 The curriculum roadmap of Engineering

Why is this important?

Learning styles have changed over the years and our current generation of students need collaborative learning to put concepts into context in a social setting in order to store content in a meaningful way.

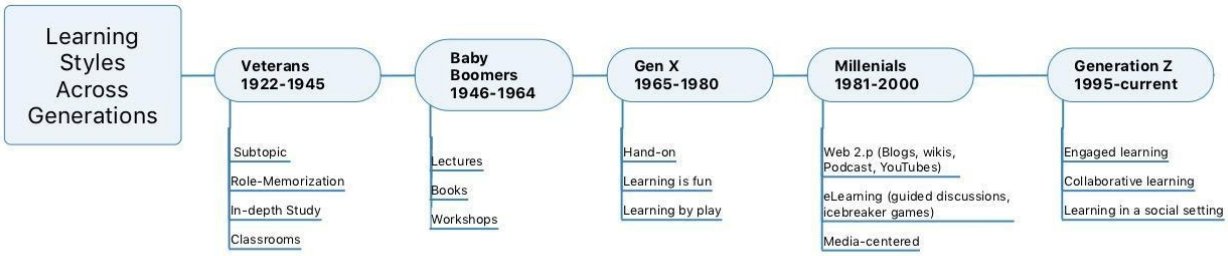


Fig. 3 First four generations identified by Dr. Clayton Austin

Collaboration is key

Early brainstorming with multi-discipline collaboration:

- Leverages the skillsets of each discipline from a different angle and thus,
- Optimizes workflows early,
- Identifies product challenges and limitations,
- Reduces time to market

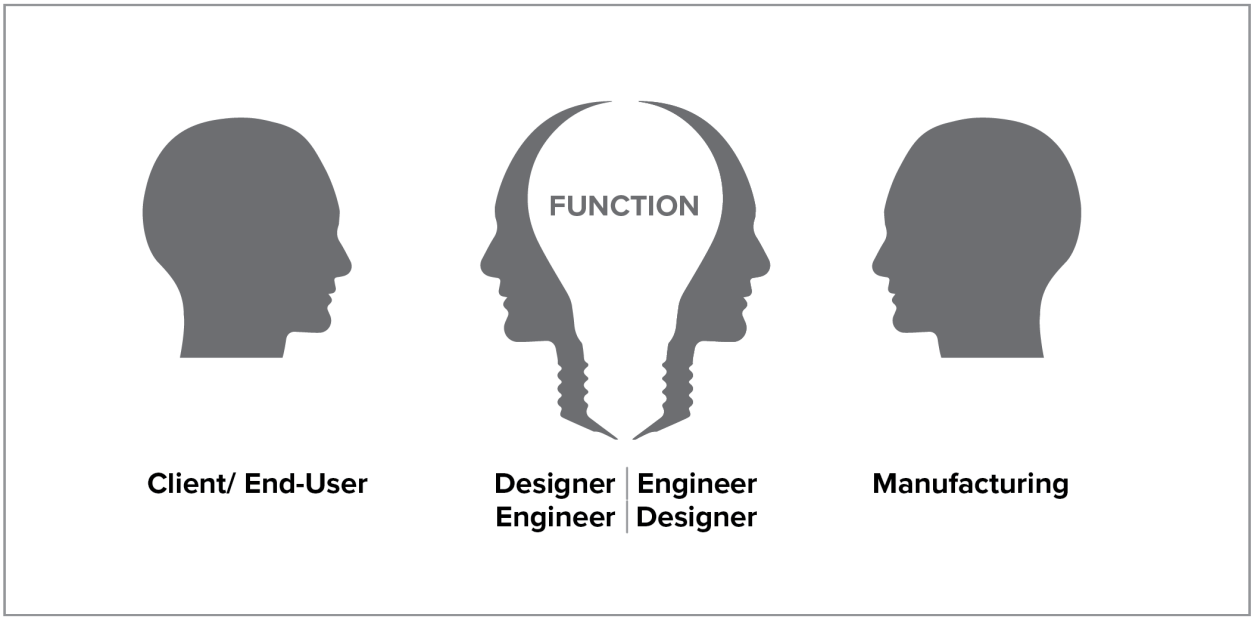


Fig. 4 Both design and engineering are working to solve problems, but the approach is different, engineers are typically manufacturing-facing and design is typically client-facing, but if we collaborate interdisciplinarily, then both can be interchangeable and expanded.

Three collaborations

- Sustainable Design
  - Involved design + chemical and material engineering undergraduate students
  - WOIN exhibit at History San Jose Park
  - Interactive AR models from Fusion 360
- Kiosk Display Project
  - Involved (1) design + (1) mechanical engineering graduate student
  - Design for fabrication
- Kreative Kitchen
  - Involves (2) design + (2) mechanical engineering undergraduate students
  - Sponsored project with the Aerospace Museum of California

Lessons Learned

It is my hope that as we continue to layer in new engineering concepts, the connection between the load bearing vertices and polygon geometry will help designers develop products with longer life-spans and using less raw materials, which ultimately leads to less part failure, decreased part cost, and more sustainable practices.

Topology Optimization as a bridge

Before attempting generative design in the classroom, which happens invisibly in the cloud using AI, I will try introducing topology optimization in a simple case study first. Topology optimization offers an activity where students can manipulate the constraints in 'real-time' to make a connection between the constrain values and what is being calculated and effected in the end geometry.

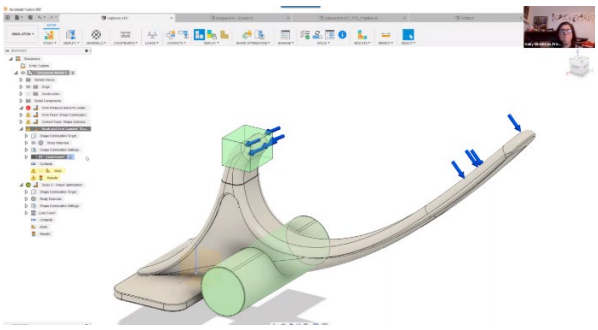


Fig. 5 Workshop by Gaby Waldman-Fried.
Showing topology optimization 'real-time' constraints

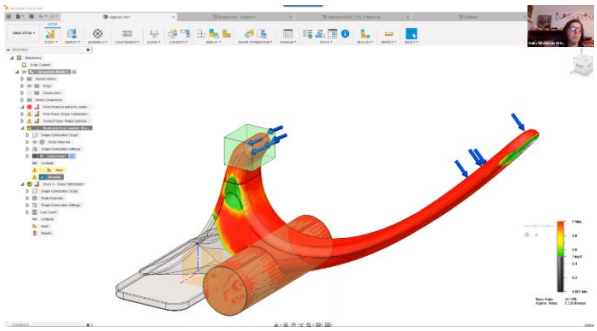


Fig.6 Workshop by Gaby Waldman-Fried.
Topology optimization 'real-time' visuals of constrain results

Enter the Kreative Kitchen

What is it?

The Kreative Kitchen is a neutral ground to come together, collaborate, exchange ideas, innovate workflows, explore new technologies such as AI, AR, and VR.

In the Kreative Kitchen, sponsored by Autodesk, we are:

- Combining learning outcomes to align with activities that leverage each discipline equally and to it's strength, but overlapped to expose one to the other.
- Sharing lectures that expose students in mechanical engineering and design to the language, terminology, and values of each discipline.
- Leveraging skillsets to augment and compliment each other in deliverables
- Learning from one another about ways to improve our best practices and carve out new territory
- Unschooling students by giving them agency to explore the master paths of interest to them
- Changing the way we approach higher education through a collaborative study environment

3D Scanning workflow

This document includes notes on scanning the model and then cleaning it up in Mesh Mixer. It is not optimized for best practices yet, just raw experiment with a foundation 'speed form' project:
https://docs.google.com/document/d/1l3DH1miq7rDKwt9Rz3F2Q8jZuy0dm2sws0Ibv6h68KA/edit

Conclusion

These collaborative explorations wouldn't have been possible without the monumental support from Autodesk, the education team led by Di Jin, Tim Paul, Gaby Waldman-Fried, and the Autodesk Ambassador program. I'm excited about the collaborative possibilities and potentials as we continue to explore, experiment, and bridge the gap between disciplines and industry. Feel free to reach out with questions or to connect.

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