ENGINEER 1P13:
PROJECT FOUR WORKSHEETS (INDIVIDUAL)

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PROJECT FOUR MILESTONE ONE: PROBLEM FRAMING AND TEST PLAN

MILESTONE 1.1 – CLIENT NOTES

Team ID:

Complete this worksheet individually before coming to Lab A for Week 6.

1. Include your client notes from the introductory client visit

Name:	MacID:
-	

PROJECT FOUR MILESTONE TWO: DESIGN EXPLORATION AND DESIGN REVIEW #1

MILESTONE 2.1 – CLIENT NOTES

Team ID: Fri-43

Complete this worksheet individually before coming to Lab A for Week 7.

Include your client notes from the introductory client visit

Name: Shadi El-Fares	MacID: elfaress

Client Notes:

Name: Tiffany

Age: 33

Condition: Spina Bifida

Mobility: Relies on power wheelchair for mobility

Assistance: Supported by a nurse and PSW for daily activities

Occupation: Walmart employee, responsibilities include shelf stocking and customer assistance

Challenges:

- Limited lower body mobility

- Requires aid for everyday tasks

- Encounters difficulties with inaccessible doors

- Wheelchair constraints on uneven surfaces

- Challenges in reaching high shelves at work

- Experiences cold sensitivity due to presence of metal rods in back

Goals:

- Enhance independence in daily activities

- Improve wheelchair accessibility and safety measures

- Seek solutions for reaching high shelves at workplace

- Address cold sensitivity, especially during winter months

MILESTONE 2.2 – RESEARCH ASSIGNMENT

Team ID: Fri-43

Complete this worksheet before Lab A for Week 7.

- State the question you plan to answer through your research
- Summarize your research findings (answer). Your answer should be a coherent, well-written summary of your research, not a "brain dump".
- You may include images, but don't forget to cite them properly.
- Aim for a length of about 500 words
- Properly cite your sources using IEEE formatted references and in-text citations. For information on referencing formats and choosing sources, see Design and Communication Workshop 1.

Name: Shadi El-Fares	MacID: elfaress

What is your question?

How will we use Motor Control in this our design solution?

What is your answer?

Controlling Multiple Motors Simultaneously with Arduino

Controlling multiple motors simultaneously using an Arduino microcontroller offers a wide range of applications, for our design solution. This capability allows for precise coordination of movements, synchronization of operations, and the ability to create complex, multi-degree-of-freedom mechanisms. One common scenario where this is crucial is in systems that involve expansion and retraction mechanisms, such as robotic arms, CNC machines, 3D printers, and more.

Why Control Multiple Motors?

1. Complex Movements: Many applications require multiple motors to work in tandem to achieve complex movements. For instance, a robotic arm might need several motors to control different joints, each contributing to the overall motion.

2. Balancing and Stability: In systems like self-balancing robots or drones, multiple motors are used to control different parts of the system to maintain stability and balance.

3. Increased Load Capacity: When a single motor cannot handle the load requirements, multiple motors can be used together to distribute the load and prevent strain on any single motor.
4. Redundancy and Reliability: Having multiple motors for critical applications provides redundancy. If one motor fails, others can continue to operate, ensuring the system's reliability.
5. Speed and Efficiency: By distributing tasks among multiple motors, the system can operate more efficiently and achieve higher speeds.
We have to:
1. Motor Selection:
- Choose the appropriate motors based on your application requirements (e.g., DC motors, stepper motors, servo motors).
- Consider factors such as torque, speed, power requirements, and control precision.
2. Motor Drivers:
- Since Arduino pins are not designed to provide enough current or voltage for motors, motor drivers are used as intermediary devices.
- Common motor drivers include L298N, L293D, A4988 for stepper motors, and dedicated servo motor controllers.
3. Power Supply:
- Motors often require more power than the Arduino can provide. A separate power supply should be used for the motors.
- Be sure to properly connect the grounds of the Arduino and the motor power supply to avoid noise and interference.
4. Arduino Programming:
- Use Arduino's programming language, which is based on C/C++, to write the code for motor control.
- Libraries such as `AccelStepper` for stepper motors or `Servo` for servo motors can simplify the code.

Controlling multiple motors simultaneously with Arduino opens up a world of possibilities for robotics, automation, and other projects. By selecting the right motors, using appropriate motor drivers, providing adequate power, and writing efficient code, you can create intricate systems

capable of precise and synchronized movements. Whether it's expanding and retracting mechanisms or any other complex motion, Arduino offers a versatile platform for realizing your designs.

List of sources:

[1] A guide to designing robust robot arms - technical - chief delphi, https://www.chiefdelphi.com/t/a-guide-to-designing-robust-robot-arms/425684 (accessed Feb. 26, 2024).

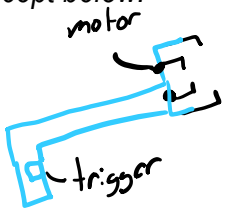
[2] "Controlling a DC motor with Motor Shield REV3," docs.arduino.cc, https://docs.arduino.cc/tutorials/motor-shield-rev3/msr3-controlling-dc-motor (accessed Feb. 26, 2024).

MILESTONE 2.2 – INITIAL CONCEPT EXPLORATION

Team ID: Fri-43

Complete this worksheet before Lab A for Week 7.

1. Include multiple images of your **initial** concept exploration, if needed
   → Include necessary annotations to help in the communication of your ideas
   → These can be photos of hand sketches, photos of initial prototypes, screen grabs of basic CAD models
   → Include your Team Number, Name and MacID on *each* concept image
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **Do not include more than *two* concept images per page**

Name: Shadi El-Fares	MacID: elfaress
Insert screenshot(s) of your concept below. 	

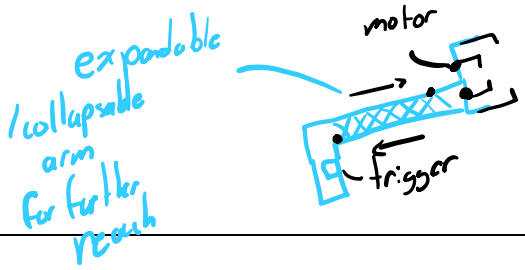
MILESTONE 2.4 – REFINED CONCEPT EXPLORATION

Team ID: Fri-43

Complete this worksheet during Lab A for Week 7.

4. Include multiple images of your **refined** concept exploration, if needed
   → Include 2 distinct concepts based on the functional analysis
   → Include necessary annotations to help in the communication of your ideas
   → These can be photos of hand sketches, photos of initial prototypes, screen grabs of basic CAD models
   → Include your Team Number, Name and MacID on *each* concept image
5. Insert your photo(s) as a Picture (Insert > Picture > This Device)
6. **Do not include more than *two* concept images per page**

Concept 1:

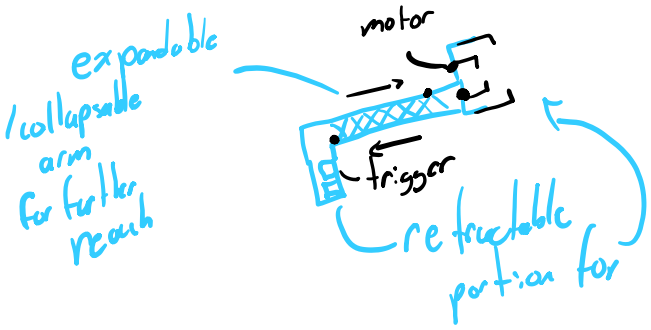
Name: Shadi El-Fares	MacID: elfaress
Insert screenshot(s) of your concept below. 	

Team ID: Fri-43

Concept 2:

Name: Shadi El-Fares	MacID: elfaress

Insert screenshot(s) of your concept below.



PROJECT FOUR MILESTONE THREE: PROTOTYPING, DECISION MAKING AND DESIGN REVIEW #2

MILESTONE 3.1 – REFINED CONCEPT: INITIAL PROTOTYPE

Team ID: Fri-43

Complete this worksheet individually before coming to Design Studio/Lab A for Week 8.

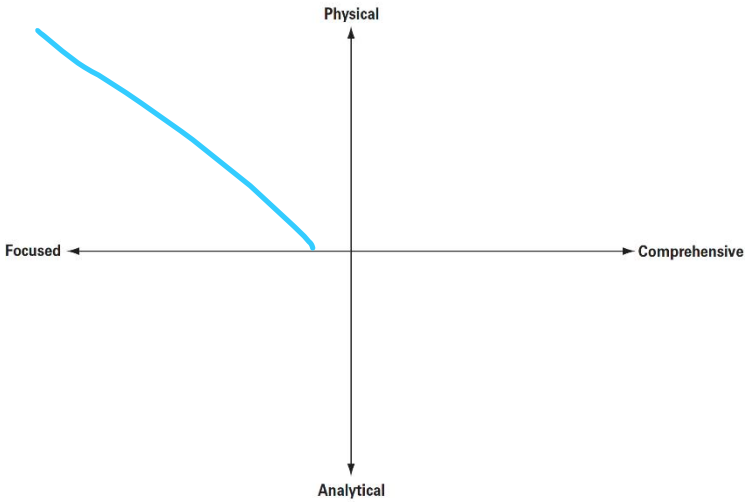
1. Write a small description of your initial prototype. Be sure to include what problem it aims to solve, how your initial prototype will be fabricated, and what functionality will be included and omitted in this initial prototype.
2. Classify whether your prototype is Physical or Analytical, and Focused or Comprehensive. Include the purpose of this prototype in the context of project 4 and the level of fidelity (low, medium, or high fidelity)
   - → **Physical vs. Analytical:** Physical prototypes are tangible artifacts that are created to approximate the final product. Analytical prototypes are non-tangible and represent the product using usually visual or mathematical models.
   - → **Focused vs. Comprehensive:** Focused prototypes implement only one or a few of the attributes of the final product. Comprehensive prototypes aim to implement most, if not all of the attributes of the final product.
3. Create a list of objectives and metrics for your initial prototype. There is no required amount of objectives or metrics, so long as the list is comprehensive.
4. Create a rough experimental plan for how you might test your prototype. Consider the methods you might use to test various objectives, how you will measure how effective each test proves to be and how realistic it would be to implement. This does not need to be detailed plan but should consider several of your objectives for the prototype.
5. Take picture(s) of your refined concept (initial prototype)
   - → Insert your photo(s) as a Picture (Insert > Picture > This Device)
   - → **Do not include more than *two* refined concept pictures per page**
   - → Include details on how concept was refined (what feedback was incorporated, what features are different than previous concept exploration, etc.)
   - → You can continue this process within the allocated time of the LabA/DS and seek feedback and discussions from your team members and/or the instructional team (IAIs, TAs, etc.).

Name: Shadi	MacID: elfaress

Write a short description of your initial prototype below.

My initial prototype is a miniature version of the snow remover add-on to Tiffany's wheels.

Indicate where your prototype falls on the scale below.



Kind of Prototype:

☐ Physical or ☐ Analytical

☐ Focussed or ☐ Comprehensive

Purpose of Prototype:

The purpose of this prototype is to test the snow-plowing ability and mechanical feasibility of the product.

Level of Fidelity:

Extremely low

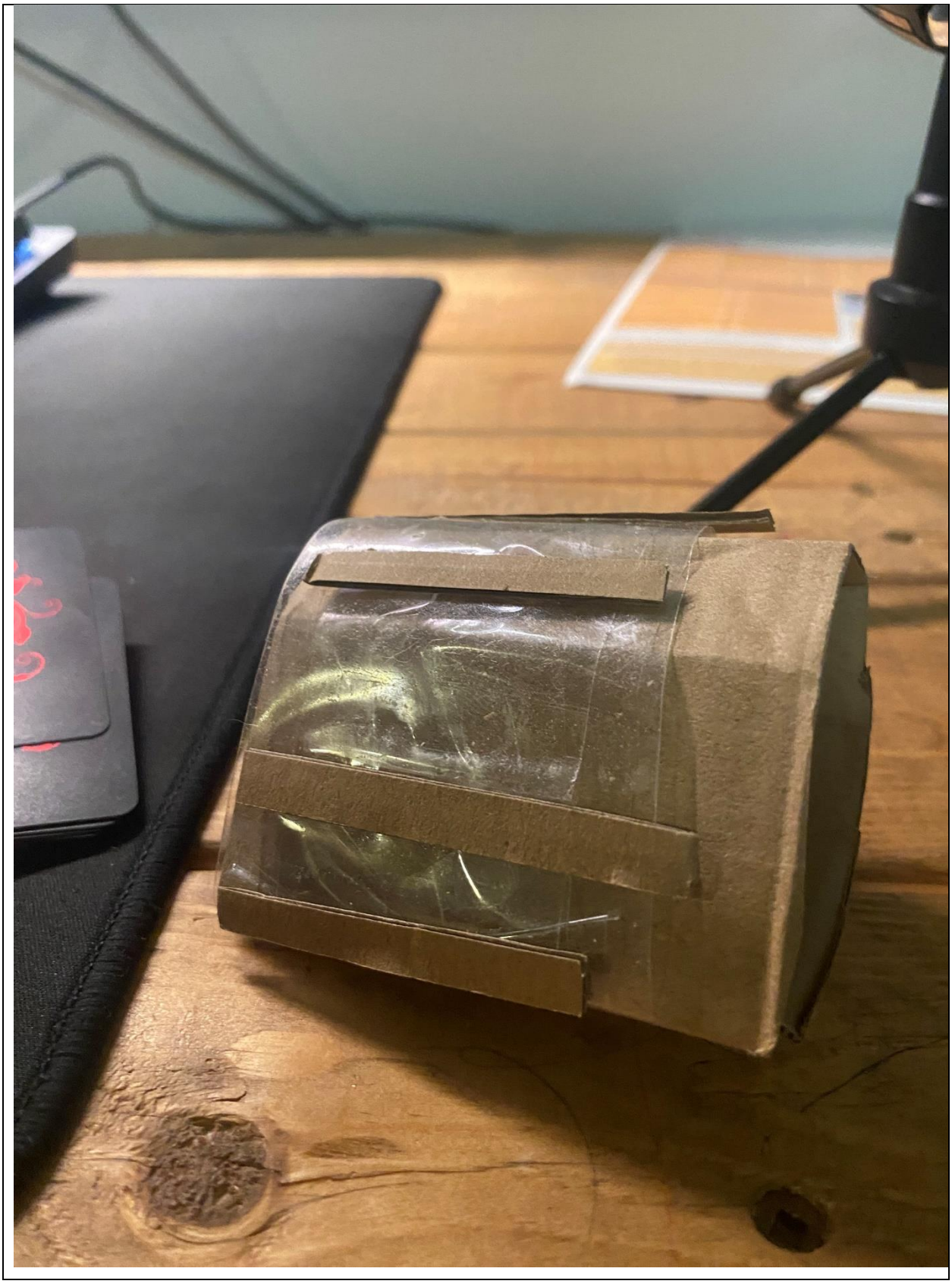
Include a list of objectives and metrics for your prototype below.

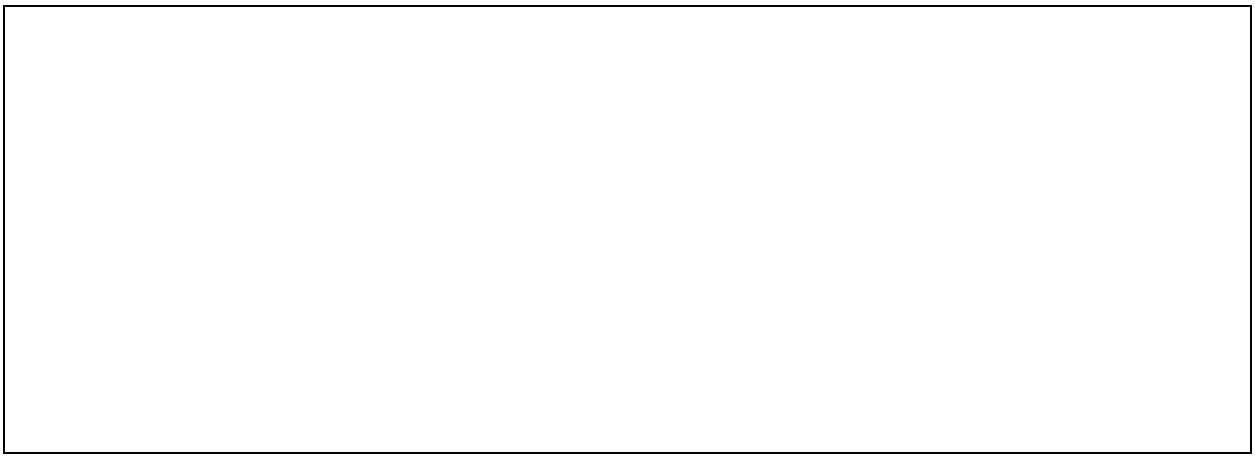
Objectives	Metrics
• **Roll**	• **Stiffness**
• **Structurally strong**	• **kg**
• **Move snow back**	• **Pieces of snow**
•	•
•	•

Include a rough experimental plan on how you might test your prototype below.

Scrunching paper up in small pieces and have it roll-over to see if the small pieces fly backwards to mimic snow.

Insert picture(s) of your refined concept (initial prototype) below.





PROJECT FOUR FINAL DELIVERABLE: PROJECT REFLECTION

The activities in this handout are intended to be completed by the end of the project 4. You will apply what you learn in Design Communication Workshop 4 to complete this task.

Submission Details

Each Team Member: upload your reflection essay as a PDF to the Avenue Dropbox titled P4 Reflection using the MacID_P4_Reflection.pdf as naming convention

Grading of Reflection

Your reflection assignment is worth 1 mark of your total Project-4 grade (12.5%). Rubric is provided on Avenue to Learn.

If you need to review the content, go back to Design Communication Workshop 4 and/or go through the online reflecti0on module. Here is the link:
https://ecampusontario.pressbooks.pub/engineeringreflectiontoolkit/

Reflection Activity

Consider your experience with the design process as a first-year engineering student working on Project 4 over the past couple of months in ENG 1P13. After exploring the client's challenges and gaining insights, your team, decided to focus on one area to improve our client's daily life. You have defined the problem in a problem statement that included objectives, constraints, etc. Through this exploration, you performed a functional analysis that was used to come up with different alternative ways to solve the problem. Your team needed to make a decision between the different alternatives, and you tested your ideas for feasibility. You have been encouraged to iterate as you gained deeper insight and developed empathy for the client. Through the process of iteration, you have had the opportunity to improve upon your ideas. Engineers are continually iterating through the design process. Informed designers are involved in continual learning: learning by doing, learning from brainstorming and prototyping, learning by iteration and from feedback and failure, learning by noticing and troubleshooting, learning by drawing and dialoging about ideas, materials, and people. While iteration is an informal form of reflection, you will deepen your understanding of what you have learned through formal reflection. All of these emphasize the metacognitive and reflective practice aspects of learning through design (Lawson & Dorst, 2009; Crismond & Adams, 2012).

Part 1: What?

In this section you will describe a critical incident that you will be reflecting on as related to the "Generating/Testing ideas" and "Decision-making". For each of these steps of the design process:

In three to five sentences, identify and describe ONE critical incident, breakthrough or big thought-provoking moment that either challenged your assumptions, had a positive impact on you or validated your understanding of the design process. Here are some questions to consider.

Generating & Testing Ideas:

- How did you go about exploring ideas?
- How deeply did you explore your design options?
  - How much research?
  - Did you look into Biomimicry tools?
  - Did you consider any "What if?" questions in your explorations?
- Did you test your ideas?
- If yes, how did you test your ideas?
  - What were you trying to test (e.g., desirability, feasibility, etc.)?
  - What tool/ method did you use? (physical prototype, CAD model, etc.)
  - How much time did you spend on testing each idea?
  - How many ideas did you test?
  - How many prototypes did you make for testing each idea?
  - Did you test your ideas early on or waited until you had more details of the ideas?
- What was one challenge that you faced in the testing process of the design? (we encourage you to write more than one challenge). And What did you do to solve that challenge? (you can attach photos to explain your attempted solutions)
- From the results of our testing, one change we made to improve our design solution was … (add your response) and this change made our design solution better because … (add your response).

Response:

Decision Making:

- What happened during decision-making?
  - Where in the process, relative to the design process steps, did you make decisions?
  - What were the decisions about? Decisions could be about the process (e.g., how much searching of the design space was enough?) or about the design (e.g., which alternative to prototype).
  - How many options did you have to choose from?
  - How many criteria did you have to compare the options? How did you choose those criteria?
  - What tools did you use to make a decision?
- At what stage did you make a decision?
- When did this experience take place? Did you already have one final solution in mind or you were still exploring the ideas?
- What challenges did you face during decision-making process?

Response:

Part 2: "So What?"

In this section you will explore what you learned and describe why this incident matters to you.

In three to five sentences, discuss what you learned from this incident about idea generation, testing ideas, and decision making and that either surprised you, made you confront a misconception, or improved your understanding of the design process.

To help you think about this, consider the following:

- What was the outcome of early or late testing processes?
- Do you think delaying any of your decision-making may have improved the design?
- Could you have collected better observations or data that would have led to better decisions?
- Did you repeat your decision-making process at any other stage?

Response:

In two to three sentences, explain why these new insights are important to you.

Response:

Part 3: "Now What?"

In two to three sentences, discuss how you will integrate this new insight into future design projects, including next week prototyping and design review 2 where you still have a chance to improve your design. To help you think about this, consider the following:

- I learned that... (Express and important learning, not a statement of fact)
- This learning matters because... (Consider how this learning has value to you as an engineer)
- How will I apply my learning?
- How will I design differently next time?
- How will I deal with a similar situation in the future?
- Considering this learning, I will... (Set specific, assessable goals; consider benefits and challenges involved in this plan)

Response:

In two to three sentences, describe the possible benefits and challenges involved in your plan.

Response:

References:

Lawson, B., & Dorst, K. (2009). Design expertise. Oxford, UK: Architectural Press.

Crismond, D. P., & Adams, R. S. (2012). The informed design teaching and learning matrix. Journal of Engineering Education, 101 (4), 738-797.