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Utilizing Informed Design Pedagogy and Strategies in Creating an Introduction to Engineering Design Module

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Complete Evidence-Based Practice:
Utilizing Informed Design Pedagogy and Teaching Strategies in a Freshman Engineering Design Module

Introduction

This Complete Evidence-Based Practice paper describes an instructional module created and taught by the author that introduced freshman engineering students to the use of informed design thinking [1] when doing design challenges that aimed to serve K-12 wheelchair users. The 10-week module was part of a one-credit, 15-week undergraduate course, Engineering Design offered at CCNY's School of Engineering. Students taking this module met in-person with the author/instructor once a week for a 110-minute recitation and lab sessions. This was followed on Fridays by a 50-minute online synchronous lecture that introduced students to different fields of engineering via invited guest speakers. The module reported in this paper was offered to undergraduates for three consecutive semesters starting in Fall 2022, and was attended each term by 21-22 students.

Project Approach

The main design challenge for this freshman Engineering Design module involved creating a Halloween costume requested by children who were wheelchair users. It needed to attach to a child's wheelchair without marring it, be light in weight, safe to use, be easily assembled by the child's parent or helper, allow easy entrance and exit for the user, and possess sufficient clearance to pass through doorways and halls. Teams worked with a $300 materials budget for PVC pipes and joints, sheathing, glue, paint and electrical components – costs that were covered by the college. Inspiration for the main design challenge came from the work of the Kansas-based non-profit organization, Walkin' & Rollin' Costume [WRC], which annually helps link young wheelchair users who want Halloween costumes with volunteers and school groups around the country who then design, build and deliver requested costumes to children's families, all for free.

In one of the standard WRC models, Halloween costumes have two main parts. The first is an undecorated, interior "master frame" made of PVC pipe, glued PVC joints, and which gets attached to the wheelchair in ways that does not mar the user's equipment (e.g., plastic ties). The second subsystem is a Costume Shell, which also is made up of a PVC-pipe frame that gets covered with PVC sheeting or cardboard and decorated with paint and other materials to meet the child's costume request; e.g., Super Mario Cart, Toy Story 3 Claw Machine, Disney Princess. Tools and materials for planning and fabricating prototype frames and decorating costumes were available for students to use during and after module sessions.

Teams were given the Design Brief (see Figure 1) in Week 1, and learned that each costume needed at least one electrical and/or mechanical "action component," which the child had to be able to manipulate easily and safely. The costume design needed to incorporate safety features, including alerting passers-by or cars of the user's presence during the day or at night. This point was emphasized at the Division of Homeland Security webpage on Halloween Safety, which stated "Children are twice as likely to be injured in a vehicle or pedestrian accident on Halloween compared to any other day of the year" [2].

Halloween in Harlem on Wheels

The Challenge: ENGR 10100.3EF students, working in teams, will design and build costumes that a child who uses a wheelchair has requested for Halloween.
The design must be age appropriate and contain an “action component,” which can be an electrical and/or mechanical, which the child must be able to manipulate easily and safely.
The costume will be made up of a Frame + Shell that must be easy to assemble and take apart with simple tools, and not mar the wheelchair or cause harm to anyone when used. The costume’s frame must fit into connection points in a previously fabricated “master frame” made up of ¾” PVC pipe, glued joints and ties, and securely attached to the wheelchair.

Materials & Budget:
- The costume frame will be made of PVC pipe with glued joints, and fit into the “master frame” that has already been built and fastened to the wheelchair.
- The shell will be covered with cardboard or 3mm PVC sheeting and decorated by team with paint and other budgeted materials.
- The School of Engineering will cover these costs.

Roles *(can rotate, not fixed)*: Team Lead, Engineer/Maker, Researcher/Designer, Tester/Safety; Coordinator, Visualizer/Presenter, Design Minder.

Criteria:
- The Costume’s Frame + Shell needs to be sturdy, stable & safe for Users.
- Users include: the Child, the Guide who helps in getting from place to place, and the nearby Public.
- The Shell must be of modular design so that it can be boxed and shipped to the User’s family for assembly.
- When on the street, the costume must have safety features so that it can be seen by operators of nearby street vehicles and pedestrians.
- The costume must be sturdy enough to withstand a 20 mph wind, and be able to survive a 4-mph collision with a wall.

Access and Clearance:
- The child must be able to enter/exit the costume in case of emergency.
- Costume must be easy to remove.
- Child must have free access to the wheel brakes, armrests & driving rim.
- Assembled costume must be able to pass thru 32” wide doorway, and perform a 90°, 180° and 3-point turn.
- Costume must have 6” clearance with ground to not hit obstacles there, and avoid scraping when going up a 5° slope.

Documentation:
- Teams will design documentation for assembling and using the costume by User’s Family.
- Each team member will keep a Design Playbook describing research conducted, design ideas, modeling investigations and prototype testing.
- An Informed Design Rubric will be done by all and included in Playbook.

3a Humanscale Wheelchair Users

Figure 1. The Design Brief for the HIHOW project described the main challenge and its related criteria and constraints

Discussion and Results

The following is a composite case study based on the teaching of the Interdisciplinary Engineering Design module for three consecutive semesters from Fall 2022 to Fall 2023. It highlights content and selected topics in the module’s 10-lesson sequence, key pedagogical approaches and their impact on student learning, and changes in the module’s design over the three semesters, with rationales behind those decisions. Prominent among the instructional strategies was the use of various formative assessment approaches to adjust instruction while providing evidence of student progress in using design practices and engineering concepts in an informed way. Tasks included: Triad Sorting, proposing and applying Design Rules-of-Thumb, Small Group Discussions, Interviews, using Contrasting Cases and reflecting on design practice using an Informed Design Rubric. These approaches were used in a context where human-centered designing and "design with us, not for us" was emphasized.

Design thinking was introduced and elaborated upon in a variety of ways throughout the module. In the first class meeting, students first watched the 21-min 1999 Nightline episode, "Deep Dive" [3], where members of product design firm, IDEO, redesigned a traditional shopping cart in five days. After watching the video, students discussed design strategies that they saw IDEO team members using, while also pointing to key elements of IDEO's workplace culture that help support and sustain high levels of innovation at IDEO. Creativity heuristics and design mindsets were also introduced that included lateral thinking [4], analogical reasoning and productive thinking [5] as ways to stave off limits to creative thinking like idea fixation [6] [7].

During the first two class meetings, students working in teams of four were tasked with a "Tallest Tower" design challenge. They were given 40 paper straws (7.75", 0.24" OD), a box of smooth trombone paper clips, 25-cm of masking tape, and asked to build a freestanding structure as tall as possible that would fit onto a 1'x1' plastic cardboard platform and support a half-liter bottle of water. The structure had to remain freestanding for 10 seconds after the bottle was placed at least half-way up the total height of the tower. With the second iteration of the tower, during testing the 1'x1' base was tilted 6°, which aimed (very roughly) to model the building experiencing an earthquake. Team members were assigned roles – Project Leader, Maker Leader, Lead Researcher and Design Minder. Teams and were given a two-gallon zip-lock storage bags containing the above materials, and also handouts where students learned from print-based tutorials and videos of experts, reviewed guides to experimenting with straw structures, and looked over case studies of bridges and tower structures. While some team members planned and started fabricating their towers, others in real time used these aides to make a quick study of core ideas related to stability, rigidity and making structures strong-yet-light, buckling forces, and a 4-step troubleshooting process to be used while testing their first prototypes. Before these dramatic tests were conducted to see if their first prototypes would "hold water," the instructor selected three of the untested tower prototypes, placed them in a row next to one another, and asked students to do a **triad sorting** [8] task. Students were instructed to group two of the three prototypes together based on some shared feature or perceived similarity, and then indicate how the third item was different from the other two. This activity gives students an opportunity to work from their initial inchoate impressions to finding words that describe newly noticed features about the designs that they only saw once they compared them.

Students were introduced to **design rules-of-thumb** [9] [10] [11] as practice-based advice that can help designers make informed design decisions. For homework, students reviewed the research materials and articulated advice based on those readings and the building of the first prototypes. Formulating advice such as "Build with a wide base" or "Design structures with triangles, not squares" and have qualitative reasons that explain why those are good recommendations was preferred for freshman engineering students, rather than asking them to apply challenging equations they would learn in future engineering science classes to the designing of their structures.

For the second iteration of the Tallest Tower challenge, paperclips were replaced by quarter-scale 3-D printed joints as the means for connecting the straws together as a structure. This change helped the teams avoid a convergence on very similar tower solutions, and also enabled speedier fabrication, and resulted in noticeably more rigid prototypes. The gave teams an opportunity to focus on issues of the issue of structural stability, where locating the center of mass within the "footprint" of the 1'x1' platform that supported the tower was critical.

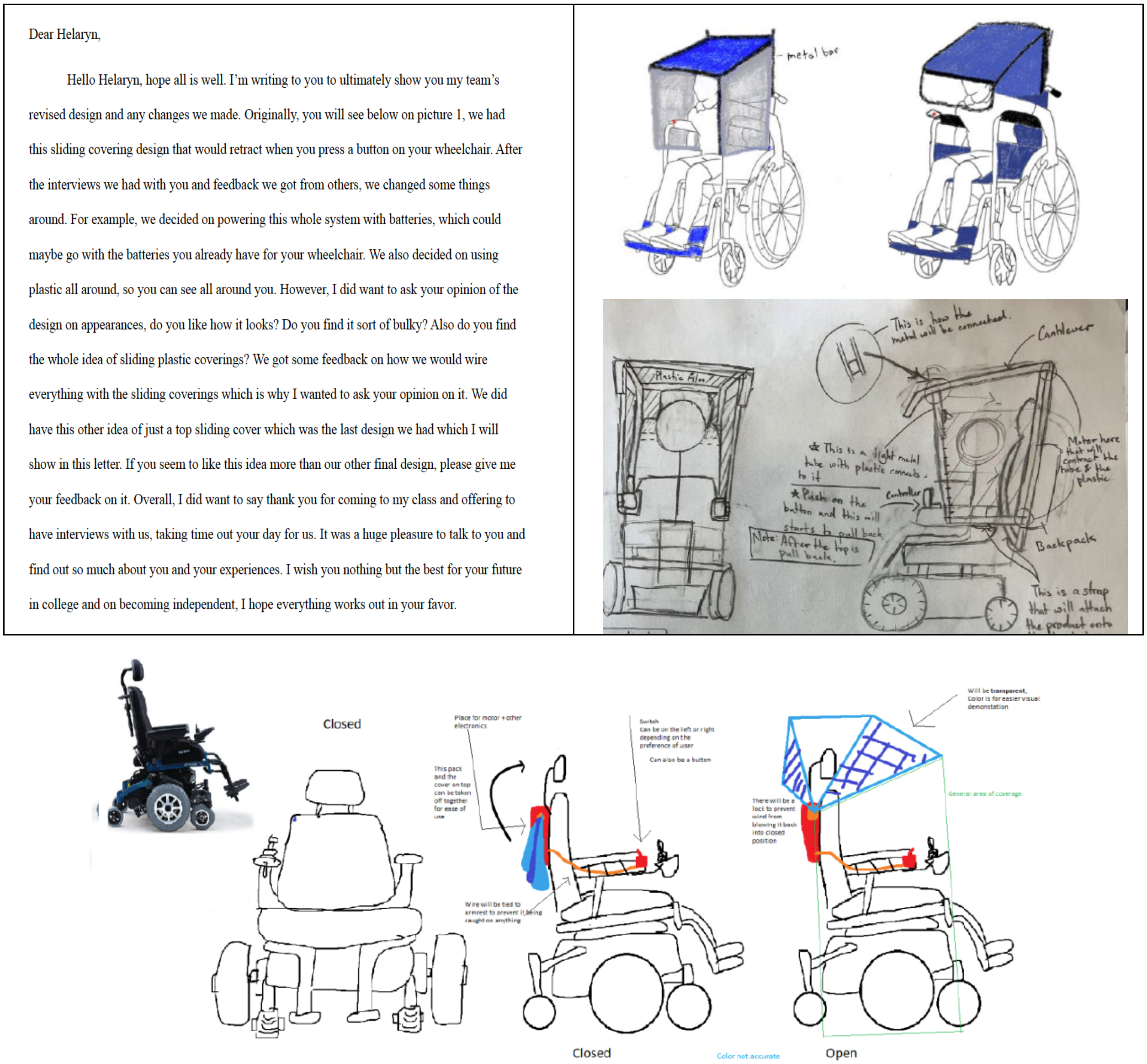
A key learning outcome of the module was to support communication, networking and emergent leadership skills. This was done by having students work regularly in small- and medium-sized groups on various tasks. An especially successful approach in reaching this goal was to assign course readings in batches of four articles per week, which were reviewed during follow-up sessions via **Small-Group Discussions** [SGDs]. With this student-centered pedagogical approach, each team member was responsible for preparing and sharing Leader Notes that they created for their the Small Group. During class meetings, these groups met to discuss the readings, with each member taking charge of conducting a 5-7 minute discussion about one of the four weekly readings. Teams recorded these SGD sessions using Zoom and a laptop, which they were later shared with instructor for review. Each student then posted to Blackboard by week's end a short written reflection on how the discussion that they led went, and how it might be improved the next time. Many students in their subsequent reflections on how things went described how their performances in facilitating a discussion with their peers improved significantly. This was most noticeable during the second SGD session, which followed soon after the missteps and growing pains encountered in the first group talk.

Interviews was another strategy employed in teaching this module that highlighted human-centered design, empathizing with the user, and helping students move towards what Ricardo Gomes calls a "design with us, not for us" mindset. Students' efforts were powerfully supported by the class having both virtual and face-to-face interviews with two teenage wheelchair users, both of whom acted as informal consultants to the teams. The first was the son of the founder of WRC, and had over the years been on the receiving end of numerous WRC costumes. More recently, he had helped dozens of volunteer groups in creating Halloween costume systems for children. The second was a 17 year-old female student who lived close to CCNY and was taking classes on campus while completing her high school degree, and visited the classes on numerous occasions.

The male teenager with extensive costume design experience acted as one of the four outside design advisors (the other three were engineering educators) to the design teams. Teams met with him virtually during the semester to ask specific questions regarding problem framing, young users' needs, including his own perceptions, perspectives and needs as a former user of Halloween costumes, and practical suggestions and approaches to fabricating their master and costume frames. Teams reported valuing these suggestions very highly, given his extensive knowledge about problems typically encountered by rookie costume maker teams, the current availability of hardware options, and insights into the perceptions of young wheelchair users.

The interview sessions with the female high school wheelchair user were face-to-face, and had a powerful impact on the engineering students. During each of three semesters that this module was offered, this guest speaker visited the class twice, noting how she was happy to give feedback to the teams because "I would like our kids to have a great experience." In her first presentations, she described her experiences living in Harlem with muscular dystrophy, and gave details about her limits of strength and range of motion – facts that were seen as important by the design students. She offered feedback about design ideas that teams proposed. She spoke about her experiences as a sixth grader she dressed up as Wonder Woman and going trick-or-treating for a 25-block stretch of Broadway on the Upper West Side of Manhattan. She spoke compellingly of her difficulties navigating crowded streets, the dangers of crossing the street, her need to take care not to get her costume entangled in the wheels of her chair, how elevator buttons would be out of her reach, and how she could not open certain doors without help from another: "Just for me to go outside, I feel kind of defenseless."

To prepare for these meetings, students read the opening chapters of *Rolling Warrior* [12], Judy Heumann's memoir about her experiences as a wheelchair user and dedicated work supporting disability rights legislation that was eventually made into law. During her visits, the engineering students were clearly engaged and moved by the experience, and wrote follow-up thank you letters to her (see Figure 2) where they wished her well while sharing conceptual design ideas they had developed for a problem she had described earlier – of needing protective gear for when she uses her wheelchair to travel outside on the city streets in the rain.



Dear Helaryn,

Hello Helaryn, hope all is well. I'm writing to you to ultimately show you my team's revised design and any changes we made. Originally, you will see below on picture 1, we had this sliding covering design that would retract when you press a button on your wheelchair. After the interviews we had with you and feedback we got from others, we changed some things around. For example, we decided on powering this whole system with batteries, which could maybe go with the batteries you already have for your wheelchair. We also decided on using plastic all around, so you can see all around you. However, I did want to ask your opinion of the design on appearances, do you like how it looks? Do you find it sort of bulky? Also do you find the whole idea of sliding plastic coverings? We got some feedback on how we would wire everything with the sliding coverings which is why I wanted to ask your opinion on it. We did have this other idea of just a top sliding cover which was the last design we had which I will show in this letter. If you seem to like this idea more than our other final design, please give me your feedback on it. Overall, I did want to say thank you for coming to my class and offering to have interviews with us, taking time out your day for us. It was a huge pleasure to talk to you and find out so much about you and your experiences. I wish you nothing but the best for your future in college and on becoming independent, I hope everything works out in your favor.

Figure 2. Teams proposed conceptual designs for a rain-protection system for a guest wheelchair user, after learning of the challenges she faced in the city streets when it rains

To build an understanding of how wheelchairs work and how it feels to use them students used one of the two wheelchairs that the instructor brought to the class to explore various floors of the building where class was held. Students also watched videos of WRC design teams working on and talking about their own Halloween costume projects and challenges. Working in pairs, student did hands-on investigations related to the mechanical advantage provided by various devices (e.g., upright derailleur and recumbent [BikeE] bicycles, Irwin Quick-Grip clamps [13], nutcrackers [11], and pipe cutters. In one hands-on classroom activity, students qualitatively rank ordered and then took measurements and quantified the mechanical advantage provided by these devices [11], and then discussed the force vs. distance tradeoffs from which the mechanical devices they investigated operated. Selected teams also did a crane activity reported on by Miller [14] when some teams' early designs included cantilevered structures that extended out from the main costume frame.

Contrasting cases [15] were used to help make students aware of where their own growth in design capability during the semester might go. Students read descriptions and scenarios that compared how beginning versus informed designers do nine design thinking strategies [1] that include skipping vs doing research, idea scarcity vs fluency, and unfocused vs diagnostic troubleshooting. Students were also introduced to different design process models [16] [17] [18], and discussed what aspects of design thinking each design model emphasized or ignored, citing the pros and cons of each model for different design situations.

Building understandings in freshmen engineering students of what beginning versus informed designers think and do in a variety of contexts was another learning goal for this module. Towards this end, students read a graphic novel about six college students doing a capstone design challenge for their senior product design course at MIT [19]. For a homework, the CCNY freshmen used an Informed Design Rubric to rate how the six team members at MIT performed different design strategies. They rated each person's performance on a scale of 1 to 6, and importantly pointed to evidence from the story for their ratings. At the semester's end, the freshmen assessed their own design work and thinking during the semester using the same Informed Design Rubric (See Figure 3). As a formative assessment tool, the final 1-6 rating that students assigned themselves was less important than the concrete references they made to what they had done during the semester that supported their ratings.

Informed Design Rubric*

Use this rubric to assess others' or your abilities to do design practices in an "informed" way. First, review the contrasting descriptions of beginner designers and informed designers in columns 2 and 3. Then recall things done or said that are evidence that a design strategy was used. In the right-hand column, circle a score of "1" for each practice where you work and think as beginning designers, or as an informed designers (6), or somewhere in between (2-3-4-5). Support each rating with a short description of how the strategy was done. Page numbers from ---- paper provided to fuller descriptions of these patterns and behaviors of designers.

Design Strategies	Beginning vs. Informed Designer Patterns: What Beginning Designers Do	Beginning vs. Informed Designer Patterns: What Informed Designers Do	Beginning - Informed Design Rating (1-6) & Describe Evidence
	Pattern A. Problem Solving vs. Problem Framing [747]		Rating (circle): Beginner 1 – 2 – 3 – 4 – **5** – 6 Informed Designer
Understand the Challenge	Treat design task as a well-defined, straightforward problem that they prematurely attempt to solve. Never return to problem to see if grasp of the challenge has changed.	Delay design decisions until criteria & constraints of challenge and how prototype should function and behave can be defined. Return to problem to check on goals and reframe problem if needed. [751]	Page # and Short Description of Strategy Being Used: *For the week that the idea was presented, I came up with many questions about how this wheelchair building was going to go. I wondered about how a costume could be attached to a wheelchair, how big the costume can be to not interrupt other trick-or-treaters, and what materials would be needed. We shared our ideas with our classmates next to us during this time as well.*
	Pattern B. Skipping vs. Doing Research [752]		Rating (circle): Beginner 1 – 2 – 3 – 4 – **5** – 6 Informed Designer
Build Knowledge	Skip doing research and instead pose or build solutions immediately.	Investigate and research to learn about problem, what users' needs are, how systems work. Study relevant case studies and prior art. Reverse engineer existing products. Do product dissections. [753-5]	Page # and Short Description of Strategy Being Used: *Throughout the first few weeks, I did research on the user and the problems that occur when using a wheelchair. Before even working on generating ideas and models, I had to search up what the user has to go through and think about the parameters on how the costume should be to keep the user happy and comfortable. This was done in EN7.*
	Pattern C. Idea Scarcity vs. Idea Fluency [755]		Rating (circle): Beginner 1 – 2 – 3 – 4 – 5 – **6** Informed Designer
Generate Ideas	Work with few or just one idea, which they can get fixated or stuck on, may not want to discard, add to, or revise.	Generate range of design ideas to avoid fixation. Do brainstorming, generative database searches, and other divergent thinking techniques to achieve idea fluency. [756-8]	Page # and Short Description of Strategy Being Used: *For one of the assignments we looked at disruptive innovations which are innovations that challenge the normal idea of whatever topic it's based on. I looked up different wheelchairs that went above and beyond what a wheelchair costume was supposed to be like and took notes and created ideas for what costume idea my team and I could do. With the inspiration, I came up with the Minecraft Pig.*
	Pattern D. Surface vs. Deep Drawing & Modeling [758]		Rating (circle): Beginner 1 – 2 – 3 – 4 – 5 – **6** Informed Designer
Draw & Model	Propose superficial ideas that do not support deep inquiry, and which would not work if built.	Explore and investigate design ideas via sketching, gesturing, and describing possible solutions. Do rapid prototyping with simple materials to make simple prototypes that support deeper inquiry into how system works. [759-761	Page # and Short Description of Strategy Being Used: *I created models of what my Minecraft pig would look like and how its mechanical and electrical elements would work. I created a 3d model of how I wanted the costume to look by using solid works. In addition, I created little Lego mini contraptions that simulated the movements of wings if the team were to have gone with the ender dragon, and a simulation of the legs for the pig. The D&B sessions would also count towards this because I helped build the first model of the master frame.*
	Pattern E. Ignore vs. Balance Benefits & Tradeoffs [761]		Rating (circle): Beginner 1 – 2 – 3 – **4** – 5 – 6 Informed Designer
Weigh Options & Make Decisions	Make design decisions without weighing all options. Attend only to strengths (pros) of favored ideas, and drawbacks (cons) of less favored ones.	Consider both the benefits and tradeoffs of all ideas, using words and graphics, Design Rules of Thumb & Values (e.g., Keep It Super Simple, human-centered design) [762-5] before making design decisions.	Page # and Short Description of Strategy Being Used: *I thought I was good at weighing options and considering benefits and tradeoffs of different ideas. Such as the different pros and cons of using an umbrella vs a stroller hood. The only idea we had to dismiss immediately was using a raincoat since Hellaryn essentially imposed that on us as a design constraint because of her bad experience. However, it wasn't until our last meeting with Matt that I considered making the rain protection usable by Hellaryn without the need of an assistant.*
	Pattern F. Confounded vs. Valid Tests & Experiments [765]		Rating (circle): Beginner 1 – 2 – 3 – **4** – 5 – **6** Informed Designer
Conduct Experiments	Do few or no tests on prototypes, or run confounded tests by changing multiple variables in single experiment.	Conduct both "quick-and-dirty" and valid fair-test experiments to learn about materials, key design variables, how system works and to optimize performance. [765-6]	Page # and Short Description of Strategy Being Used: *Throughout the three D&B sessions I attended, I conducted many experiments. I tested the first design many times by riding the wheelchair through tight spaces and seeing if the master frame would be able to go through. I also did experiments with different designs of master frames builds. Furthermore, I did experiments on adding connectors to the master frame that would allow it to be detachable from the wheelchair.* *This was perhaps one of my favorite steps because after we would build a dry-fitted frame or part of the frame, we would then move around with it to see it will provide a limitation to the user or if it doesn't interfere at all with the comfort of the user. We did this a lot, and this is why I give it a 4.*
	Pattern G. Unfocused vs. Diagnostic Troubleshooting [766]		Rating (circle): Beginner 1 – 2 – 3 – 4 – **5** – 6 Informed Designer
Troubleshoot	Use an unfocused, non-analytical way to view prototypes during testing and troubleshoot ideas.	Focus attention on problematic areas when troubleshooting devices (observe, name, explain, propose ways to fix them). [768-9]	Page # and Short Description of Strategy Being Used: *During my third session, the team and I discussed the problems of the current build and how to fix them. We talked about the difficulty for the user to set up this wheelchair in which the idea of a connector was brought up and looked further into. I thought about using Velcro instead of zip ties since they can be undone and would be strong enough to keep the frame and costume together.*
	Pattern H. Haphazard or Linear vs. Managed & Iterative Designing [769]		Rating (circle): Beginner 1 – 2 – 3 – 4 – **5** – 6 Informed Designer
Revise & Iterate	Design in haphazard ways where little learning gets done, design steps are done once or in linear order, project resources or time are not managed well.	Do design in a managed way, where ideas are improved iteratively via feedback, strategies are used multiple times as needed, in any order, and time and materials are used effectively. [771]	Page # and Short Description of Strategy Being Used: *I think everyone did a great job at this. Thanks to Prof, we always asked ourselves questions about the stability of the master frame, mechanical advantage, and other relevant subjects, and we would always revise accordingly. For example, we had a concern regarding the horizontal force exerted on the front connection point and we were able to first use ties and then screws to make the connection point more stable. Everyone had interesting ideas. We would all share what we had and try to incorporate pieces of everyone's ideas, helping revise the frame rather than stay fixed on one.*
	Pattern I. Tacit vs. Reflective Design Thinking [772]		Rating (circle): Beginner 1 – 2 – 3 – 4 – 5 – **6** Informed Designer
Reflect on Process	Do tacit designing with little self-monitoring while working on tasks, or reflecting on design thinking process, teamwork and product performance once done.	Keep design diaries and portfolios. Periodically review team dynamics and keep tabs on strategies used. Check how well solution met goals. Reflect on design strategies and team dynamics while working and after finished.	Page # and Short Description of Strategy Being Used: *Throughout the semester, I have kept the book entries about the processes and strategies I have learned. In case I needed to remember certain things I would actively view the previous entries to make sure Inc. them into my new goals. For example, Inc. geometry from the tower activity into the frame for the costume.*

* Based on "Informed Design Teaching & Learning Matrix Table" from [1]

Figure 3. Composite self-ratings with evidence of beginner vs informed design thinking

The use of design thinking in career planning (see [20]) was emphasized at various points of the course, and used as a transfer task [15] where students used similar practices to solve another ill-defined, open-ended problem. For instance, problem framing was likened to choosing a major in engineering or other field in college. Connections were made to the Friday lectures when they focused on different engineering careers and academic pathways. Students were required to post two 1-page Career Exploration reports of campus events that interested them and which they attended during the semester. Such events included attending an on-campus club meeting, brownbag lecture on a STEM topic, doing a tool training session at a Maker Space, or finding out about an annual entrepreneurial design competition. Topics did not need to relate directly to things discussed in the course, but were to connect to students' interests and help them explore possible roles and careers in their future.

In one homework assignment, students reviewed a handout that listed its "Top 10 Employability Skills" [21], which fall into three categories: how the person works, works with others, and thinks. Students were asked to self-rate, 1-to-10, their own employability skills, and then identified their two strongest and weakest skills. In the following class, aggregated data was shared with the class. During discussion, students commented on trends they noticed, using data to support their views. They noticed that the lowest ranked skill for the group was negotiation, and that the class members were confident in their ability to learn and adapt. Students spoke about how these different capacities might work well or poorly when doing design work in teams. Others reflected on what they might do while at college to utilize their own strengths and also strengthen skills that needed improvement.

Future Work

The current plan is for this module to be taught as a 15- instead of a 10-week module in Fall 2025. The additional meeting time will allow students to build and finish their costumes — estimated at 200 person hours per costume — before Halloween without having to attend after-class sessions. Once the Halloween costume is delivered, the remaining time during the semester will allow a more thorough comparison of beginner vs informed designers through doing readings [1] and watching videos of naive-novice-expert designers redesigning simple mechanical devices [11]. Descriptions of final and future Halloween prototypes, and follow-up exchanges with users and the to freshmen designers will be shared in a later ASEE annual meeting.

Organizations such as WRC serve a valuable function in connecting children in need and their requests with volunteer groups willing to do the work of designing, building and delivering children's requested costumes. Recruiting K-6 wheelchair users who are general education students can be challenging in school districts that do not maintain databases identifying students who are wheelchair-bound and the schools they attend.

The use of the informed design framework was seen as useful in raising students' awareness of their own and others' design processes, and will continue to be an important driving force that will help give shape to future editions of this module.

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