THE JAMES DYSON AWARD

Curriculum guide for educators

Integrating the James Dyson Award into your university course

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In collaboration with the James Dyson Foundation

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Overview

The James Dyson Award curriculum guide was written by Dr. Elizabeth Hassan to help other educators globally use the award as a tool for teaching design. Dr. Elizabeth Hassan has successfully integrated the award into her coursework to support the development of students' problem-solving ideas.

The following is an outline of Dr. Hassan's mechanical engineering course with additional instructing resources. This is one example of how educators are utilizing the global award, and how it can be adapted to best fit your students.

The James Dyson Award is an international design, engineering, and sustainability competition for young inventors. It is run the James Dyson Foundation, a charity that exists to inspire the next generation of engineers. Winners of the Award receive prize money and global media exposure, providing a platform for young inventors to change the world.

Learn more about the James Dyson Award here and find out more on pages 13–16.

1.0 Introduction

I use the James Dyson Award in my class because it aligns perfectly with the kind of work I want my students to be doing: thoughtful, well-iterated, and impactful. It's a perfect tool to communicate how strongly I believe in the quality of their ideas.

Dr. Elizabeth Hassan

1.1 Dr. Elizabeth Hassan

Dr. Elizabeth Hassan teaches engineering design at McMaster University. In 2023, she was awarded the University's President's Award for Outstanding Contributions to Teaching and Learning for her work in MECHENG 4B03. Dr. Hassan has been using the James Dyson Award in her class since 2019 and two groups of her former students went on to win in the Award in 2022: Taco, Canada's National Winner and Polyformer, Global Sustainability Winner.

Her class, 'MECHENG 4B03 – Topics in Product Development' is a final year course situated in an accredited Canadian engineering school with excellent fabrication resources. All of her suggestions and guidance should be interpreted in that context. Like good design, she thinks good teaching is always 'context appropriate'. She is hopeful this document will be useful as inspiration for your specific teaching context, even if it's different from hers.

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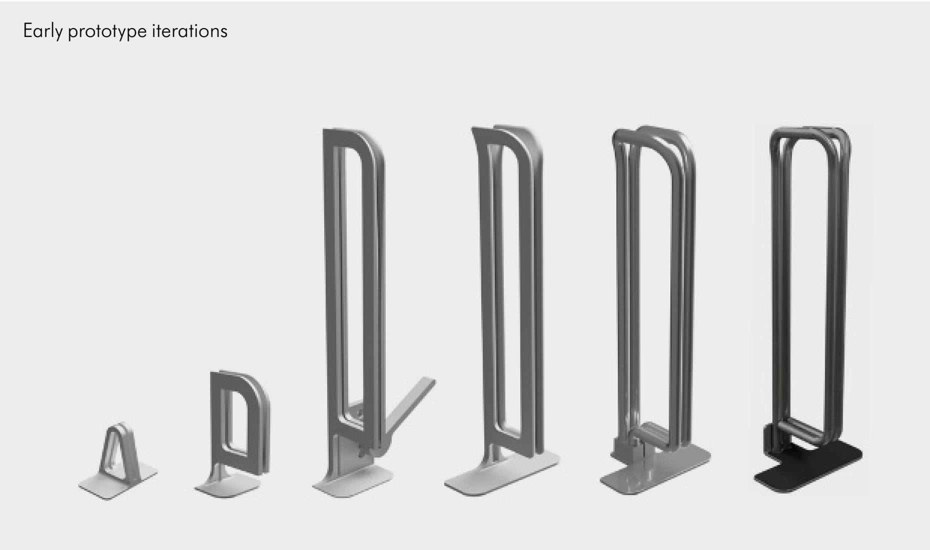
1.2 Student success story

In 2022, a team of McMaster engineering students won the National Winner prize for Canada in the James Dyson Award. Invented by Afeef Khan, Caitlin Kuzler, Clayton MacNeil, and Eden Lazar, Taco is an assistive tool which makes cooking preparation more accessible. It allows inexperienced home cooks and those with limited hand mobility to slice food thinner, straighter, and safer.

In Dr. Hassan's opinion, this project was excellent because of the extent of iteration. Early prototypes had weaknesses, but their persistence was what made the difference. Their submission contained a very compelling side by side comparison video which was strong evidence of usability and improved function for their target user.

Final product submitted into the James Dyson Award



Early prototype iterations

2.0 Rationale and Motivation

Every year Dr. Hassan starts her class the same way, with two slides that read:

Slide 1: "My big dream for this course"

Slide 2: **"I'd like you to win the James Dyson Award"**

She first did this in 2019 as an aspirational goal, and was genuinely shocked that it only took until 2022 for the dream to come true.

Why is the James Dyson Award a great tool for teaching design?

The criteria for the award is the kind of work she wants her students to be doing: impactful, well-iterated, and socially conscious.

This generation of students have a strong impulse to do work that has a positive social or environmental impact; the award criteria resonates with them for this reason.

Students like the brief five paragraph format of the award because it's a break from the usual engineering design report formula. The format forces them to edit and draft their work carefully; this is practice for learning to pitch ideas in a succinct and clear way.

Aligning the coursework with the award format makes entering the James Dyson Award easy, since they just need to submit with minimal edits.

It communicates that their teacher has faith in the quality of their work and communicates high expectations. High expectations are one of the most important aspects of university teaching.

In the context of broader social science literature about human motivation in general, we are most motivated when our needs for competence, relatedness, and autonomy are met. The award promotes human-centred design work that aligns with those needs.

3.0 Dr. Hassan's course

As mentioned in Section 2.0, Dr. Hassan's course was designed to guide students towards a James Dyson Award submission. The group deliverables are structured to match the priorities of iteration and user-focus. The award criteria focuses on process, which is a common feature of good design teaching.

Frequent, formative feedback is the most important aspect of Dr. Hassan's course design. She has two formative design reviews and one summative, with details in the table below. To create constructive alignment in the deliverables, each deliverable corresponds to a particular phase of the design process. The rubrics have been structured so that failed ideas or test results aren't overly penalized, this ensures students are assessed in a way that is congruent with the aspects of their work that are most significant, which are iteration and depth of thought. These rubrics are part of the assignments, which are available in the instructor's resources section. This can be found on pages 20–34.

3.1 Course details

Please note, the below course details are specific to Dr. Hassan's class and can be adapted to other course structures and institution resources.

Enrollment	70-90 upper-level students
Contact hours	1 x 3 hour lecture and 1 x 1.5 hour tutorial per week. 12.5 week term.
Teaching assistant support	Two graduate student teaching assistants, 65 hours each. Primarily for running tutorials and grading individual assignments
Key deliverables	Individual project structured as three connected assignments, Group project structured as three design reviews and report, no exam
Technology	Learning management system (lecture, notes, assignments), Virtual communication tool (informal communication, scheduling design reviews, minimal file sharing)
Relationship to James Dyson Award	Completely optional – students only submit their work if they choose to, no mark incentive is given for submission

3.2 Lectures

Dr. Hassan's weekly lecture schedule is summarized in the table below, with minor adjustments for sessional dates and holidays. The award is only mentioned in the first week's lecture as a framing for the project but not the exclusive focus.

The goal of the lecture materials is to give students process support for developing their products, the business background to understand viability and a broader understanding of the work of product designers with respect to society.

Week	Topic	Overall theme
0	Introduction, concept generation	Process Support
1	Customer insights and design ethnography	Process Support
2	Part design and aesthetics	Process Support
3	DR1 – Design Review 1 in lecture and tutorial	
4	Ergonomics and usability	Process Support
Reading week		
5	Testing, business model	Process Support/ Business
6	DR2 – Design review 2 in lecture and tutorial	
7	Financial Models with Net Present Value	Business
8	Manufacturing techniques (injection molding etc.)	Business
9	Venture capital, Liability	Business/ Designers and society
10	Design for Environment, Branding	Designers and society
11	DR3 – Pitches in lecture and tutorial	
12	DR3 – Pitches in lecture and tutorial	

3.3 Related course materials

Additional course details and rubrics are in the Individual and Group project specification in the Instructor resources section (pg. 21–35).

3.4 How to support 'good' ideas

In Dr. Hassan's class there are always a few students who struggle to come up with a suitable idea, or struggle to converge on a single idea. She tries to support ideation broadly through in-class work but will also work with those students one-on-one, or the teaching assistants will counsel them during the lab time.

Strategy 1: Clarify what is a good idea
Clearing up any confusion about expectations is an important step for students. Dr. Hassan shares the table below as part of her slides and in the Individual project specification. Although this framing is quite specific to mechanical engineering and her class' prototyping resources, it could be easily adapted to other contexts.

For her product development class, 'good' problems are ones with a physical product as the solution, and that physical product is one that is feasible to prototype with current resources.

Good problems:
Physical problems (e.g. not enough leverage)
A student's hobbies (because they know something about them and it's fun)
'Small' problems – if it's larger than a pop can, it might be over the 3D print time limit
Offer a benefit beyond 'cheaper'

Bad problems:
Information problems (e.g. not enough data)
Things students have only heard about (hard to understand, hard to test, might be boring)
'Large' problems – the maximum size of the 3D print volume is roughly 25x25x25cm
Only advantage is cost "it's just a race to the bottom"

Strategy 2: Simplicity

One strategy Dr. Hassan often uses is to encourage students to be simple but specific in identifying their user and the problem the product needs to solve.

The rationale for this advice is that often multifunctional products (especially those designed by amateurs) fulfill their multiple functions sub-optimally. She prefers a well-executed single function product over a contrived multi-function product. Additionally, it's often cognitively easier for students to start with a very specific problem and later expand. To implement this strategy, be clear to students that simplicity is desirable. Sometimes students prematurely discard good, simple ideas in the mistaken belief that a more complicated project will yield a higher grade.

Strategy 3: Volume

Another useful student strategy is to generate a huge volume of ideas. This is a common theme if students read work by other industrial designers or follow them on social media. In a lot of cases, generating a large volume of ideas judgement-free is the solution to the 'inspiration problem' because it's always easier to edit rather than stare at a blank page. The challenge to this technique is that most engineering students hate having bad ideas or wasting time on extra ideas.

In her class, Dr. Hassan tries to overcome this block by having small in-class assignments, usually sketching a solution to an easy, low stakes problem. These tiny assignments can be used as a seed for their individual or group projects, or can serve as a mental activity for practice. Dr. Hassan prioritizes making these more generative in the early weeks of the course when idea generating is happening, later in the course the in-class assignments become more focused, students become more focused on planning an aspect of their project work. Dr. Hassan will also often ask her students to analyze other designs, sometimes engineers get inspiration from the process of 'fixing' a problem with existing products.

Students get a tiny mark incentive (see course outline in Appendix) for completing them in the last 10 minutes of class. Dr. Hassan presents them on her last lecture slide and then walks around the class to consult. Students hand in their sketches through their online learning management system, which are graded for completion, not quality.

In class assignment examples:

Scenario: The juice pack part of the Juicero business survived but they scrap the expensive and over-designed machine. Imagine you're the junior engineer tasked with developing Juicero 2.0, sketch me a better juice pack squeezing machine.

Identify at least 10 different problems you think a product could solve. Don't worry about your prototyping ability, feasibility, just think and write. Write these down on a single sheet of paper and hand in on course management site.

Phone accessories are popular online purchases. Draw a 'new' phone accessory. Can you fit your proposed phone accessory into a cue-routine-reward cycle? Make a cue-routine-reward diagram for this activity.

Iterate. Iterate. Iterate. Last week we talked about designing a phone accessory. Sketch 10 totally different phone holding devices for use during video calls.

Based on your contextual interview, sketch a product for a problem that was identified during the interview. What would the needs and metrics be for a product like this? Identify 2 or 3 needs and their corresponding metrics (for assignment purposes, you don't need to fill the matrix).

If you've ever parked on campus you've experienced 'unclear affordances'. On the board, in groups, draw a realistic sized parking payment machine that is more aesthetic and usable than the ones on campus.

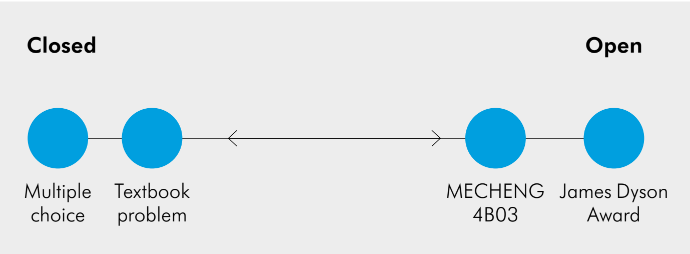
Sketch your individual project. Identify how you could make it faster/better to 3D print.

3.5 Posing the 'problem'

The Group project 'problem' is extremely open:

Design and prototype a commercially-viable product

If we place student work on a continuum from closed-ended to open-ended problems, with the James Dyson Award itself representing maximum openness (100%) and a conventional multiple-choice test representing minimum openness (0%), Dr. Hassan's course would fall at around 90% open. Dr. Hassan's chose to 'close the problem' by restricting her students to commercial products to ensure they address the course learning objectives regarding product business models and user-centred design.



There are advantages and disadvantages to open and closed problems. There are places for both in teaching engineering design, although there is a current trend towards openness in the engineering pedagogy literature.

The pros and cons of open and closed problems from Dr. Hassan's perspective are summarized below:

Pros	Cons
Open problems	
Tend to lead to better engagement, since students can leverage their interests and experience.	Tend to need more formative feedback and consultation from teaching assistant or instructor.
Cultivate the perception that the instructor has trust in students' abilities.	
Closed problems	
Easier to direct to a particular learning objective or technical topic. For example, the instructor could require their students design with plastic so they 'have to' learn about molding techniques.	More congruent with student expectations in some cases, especially students who are fresh from high school. Junior students might need the instructor to explain how more open work can be graded fairly and what expectations for the work are.
Easier to scaffold in class, for example doing sample calculations.	
Easier to forecast demand for resources like prototyping.	

Choose the degree of openness intentionally, considering the following factors:

Specific learning objectives: If the class is teaching something other than product design and the instructor wants to achieve a specific learning objective, think about a more closed problem. Ideas for these types of classes are found later in this document.

Class level: Upper-level students tend to independently handle open-ended problems better. The problems posed in Dr. Hassan's second-year class tend to be much more closed than in her fourth-year class.

Grading load: Open problems generally take longer. If the instructor has lots of grading support they have more time to facilitate an open problem. With less teaching support the instructor may want to narrow the focus with a closed problem.

Class size: If the class is very large, a closed problem might be more appropriate so that the need for consultation is limited and prototyping demands can be reduced.

3.6 How to run design reviews

Dr. Hassan's design review process is grounded in the following principle:

Only give feedback that can be acted upon and only **when** it can be acted upon.

That's to say Dr. Hassan prefers formative feedback to summative in her classes. Students get (justifiably) upset when they are told in their final presentation that their idea has predictable fundamental flaws or 'physics problems', therefore it's far better to address these issues when a change of direction is still possible. Usually, the best time for this feedback is before fabrication, or at least before final fabrication.

Dr. Hassan has three design reviews in her course, each one performs a different function:

Design Review	Feedback Type and Timing	Goals or key questions
DR1 – Design Review 1	Formative – 10 min (5 min presentation, 5 min questions) Week 3 of 12 in term	Establish the direction of the project. Is this a good idea? Is this physically possible?
DR2 – Design Review 2	Formative – 10 min (5 min presentation, 5 min questions) Week 6 of 12 in term	Does this form make sense? What features could be added or removed? How can this be fabricated with current resources?
DR3 – Pitch presentations	Summative – 15 min (10 min presentation, 5 min questions), Weeks 11 and 12 of 12 in term	Did this project achieve its objectives? Could this be commercialized? How deep was the thinking?

Full details and rubrics are in the Group Project specification in the instructor resources section (pg. 20–34).

3.6.1 The role of peers

One thing that unexpectedly came out of design reviews during online pandemic teaching was the role of peers in the audience. Because the online meeting platform supported text submissions students voluntarily and spontaneously added comments to the chat about other presentations. These contributions made for exceptionally high-quality feedback; it was often very tactical and targeted, based on shared hobbies or past co-op experience. This is a feature that was intentionally preserved when students returned to in-class instruction because it has the following advantages:

Better student engagement, watching presentations can be boring otherwise.

Specific feedback about topics or market segments that the instructor and teaching assistants might not know about, for example, hobbies that aren't shared.

A mechanism to contextualize the quality of students' own work on a relative basis.

During Dr. Hassan's current in-person Design Reviews, peer audience members submit their comments digitally on posts that she creates for each team. They get in-class assignment points for that day if they hand in a screen grab or text of their comments on the course management site.

3.6.2 Design Review logistics tips

In design review weeks, all lecture and tutorial time slots are used for design reviews. The students are asked to attend their design review time slots, plus one additional one so they can provide feedback (as described above). This gives them a bit of a 'break' in design review weeks, which students usually appreciate.

Design reviews are scheduled through a shared spreadsheet. Students sign up for a time slot, first come first serve, with tutorial time slots being reserved for those in that tutorial.

Prior to their time slot, students upload their presentation for that session to a shared folder, this allows them all to be run from a common device, reducing the transition time between groups.

Feedback is dominantly verbal. All the grading is done during the design reviews using a template for the rubric.

At the end of the design review week Dr. Hassan sends the rubric .pdf files to the teaching assistants to upload and record the scores in the learning management system.

4.0 The James Dyson Award: A head start for budding investors

4.1 The brief: Design something that solves a problem

Similar to students that enter the James Dyson Award, Dyson Engineers follow an iterative design process to solve problems. The award judges – and Sir James Dyson – are drawn to designs that employ clever yet simple engineering principles.

4.1.1 Judging criteria

Below lists the key judging criteria. The application includes a total of six questions: what does your invention do, what was your inspiration, how does it work, what was the design process, how is it different to what already exists, and what are your future plans? There's also space to note down any other awards the inventor has won.

Meet the brief

- Entries should solve a clear problem related to a social, global or sustainability issues.
- Present a compelling solution.
- Have the potential to improve people's lives.

How it works

- How it works has been explained thoroughly.
- Sustainability has been considered in the design – this could be materials used or the way the design is manufactured etc.

Design process

- Provide evidence of iterative development (ex: designs, sketches, prototyping, testing). To do so, there are 5 images and a video that can be uploaded.
- Prototypes can help explain the student's design in more depth, giving the judges a better idea of how (and if) it works. If it doesn't work, share plans for the next development stages.
- Frustration and failures fueled Dyson's success. Our judges want to learn about the student's failures in their design process, both real and potential and how they've been addressed.

How is it different?

- The students should share how their invention offers something different from what already exists in the market.

Real world application

- Judges are not expecting finished or working inventions, but they do want to see its potential. Students can show this through engineering applications/equations which prove that their concepts can work, even if they haven't been showcased through testing.
- Share how the invention could advance the field it's in and its potential to be produced or commercialized.

Clear, concise, and well-evidenced

- How the invention is communicated is key. Provide a clear and concise explanation of how the invention meets the brief. Clarity on how it works is important to allow the judges to better understand the invention.

Additional tips for a successful application include:

Review past winning entries to understand the format of the application. There is a word limit on each question, so students need to ensure they can make their answers concise and impactful.

Using statistics can express the scope and gravity of the issue that the student's invention solves.

If relevant, make sure the students showcase how their invention interacts with people.

If the student does not have a working prototype of their invention at the time of application, it is suggested that they share sketches, mathematics/formulas, or any other proof that their proposed invention will work. This evidence is key for the judging panels.

4.2 Intellectual property (IP) and Copyright

All successful entries will be published to the James Dyson Award website. This also means their story, project details, images and footage may be used for publicity purposes. It is imperative that the students completely own the IP of their invention. Therefore, if necessary, they must seek any necessary advice and protection from their local patent or IP office before submitting their entry. They can read more about this in the Terms and Conditions.

You may use examples of Dyson technology or past James Dyson Award winners to inspire your students above open-ended problem solving.

Case study: Dyson Supersonic™ Hair Dryer

The Dyson Supersonic™ hair dryer challenges the conventional hair dryer design. It is an example of the pioneering approach used by Dyson engineers to better develop technology and challenge the norm.

Every aspect of a Dyson machine is developed through an iterative engineering process which includes cycles of prototyping, testing, evaluating, and refining. It is an exhaustive process that positively seeks failure to learn from what can be hundreds of prototypes. It took over five years to develop the Dyson Supersonic™. In total, Dyson engineers built over 600 prototypes.

The Dyson Supersonic™ draws in air through the Dyson digital motor, accelerating over an annular aperture. This creates a jet of air which passes over an aerofoil-shaped ramp that channels its direction. Surrounding air is drawn into the airflow (this is called inducement and entrainment). The result is that the volume of air coming out of the hair dryer is three times that going into the motor. This system is called Air Multiplier™ technology.

The Dyson digital motor was designed to fit into the handle of the Supersonic™. By using an axial flow impeller, Dyson engineers simplified the pathway of the air, reducing turbulence and swirling. The motor impeller also has 13 blades instead of the usual 11. This reduced the tone in the motor to a sound frequency beyond the audible range for humans.

4.3 Success stories

4.3.1 SoaPen, 2016 US National Finalist

Invented by Amanat Anand and Shubham Issar from the US, SoaPen is a pen filled with colorful soap that kids can draw with before washing their hands. The gentle, stain-free formula of SoaPen is designed to ensure handwashing for 20 to 40 seconds. Since entering the award, Amanat and Shubham have turned SoaPen into a brand that creates educational products for little creatives. They have sold SoaPens to over 5,000 customers and recently expanded their product line to include colorful seamless socks, new SoaPen colors, and a children's book.

4.3.2 MarinaTex, 2019 International Winner

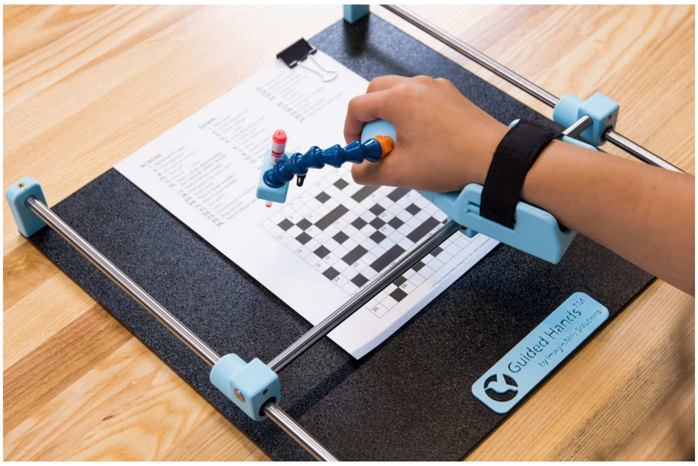
Invented by Lucy Hughes from the UK, MarinaTex is a material made from waste fish that can be used as an alternative to plastic film. It is translucent, strong, and flexible, making it an ideal alternative for single-use packaging, while being home compostable. In 2022, MarinaTex secured private investment and in 2023 won an Innovate UK Grant to pursue technical developments. The team has grown to four people, with an additional set of advisors. MarinaTex has gone on to win more awards including Disruptor of the Year award in the 2023 Maritime SME Awards. Lucy continues to speak at events and conferences including Sustainable Plastics Live/ GRIPS 2023.

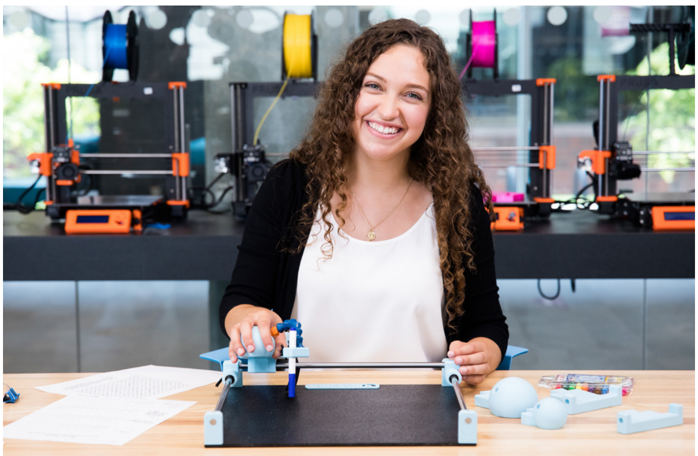
4.3.3 Guided Hands, 2021 Canadian National Winner

Invented by Lianna Genovese from Canada, Guided Hands is a mechanical assistive device that enables anyone living with limited hand mobility to write, paint, draw, and use a touch-screen device. At age 18, Lianna created her first prototype for Guided Hands for her friend with Cerebral Palsy. Since then, Lianna and her team at ImaginAble Solutions have sold Guided Hands to leading hospitals, schools and directly to families across Canada, the US and other countries overseas. Lianna has also won over 30 international design awards and was recently named Forbes 30 under 30 in Toronto for her impact in the disability and accessibility industry.

4.3.4 REACT, 2021 Medical Winner

Invented by Joseph Bentley, from the UK, REACT is a medical device that stems the bleeding of stab wounds by using an inflatable tamponade which applies pressure to the wound. Since winning the award, Joseph has established his own company, ACT Medical, expanding to a team of three full time employees. They have recently closed a pre-seed investment which will support the continued development, pre-clinical verification, and initial commercialisation of their invention. Next, they will be working with US partners to conduct initial safety and efficacy testing of their system, while doubling their team to support this work.



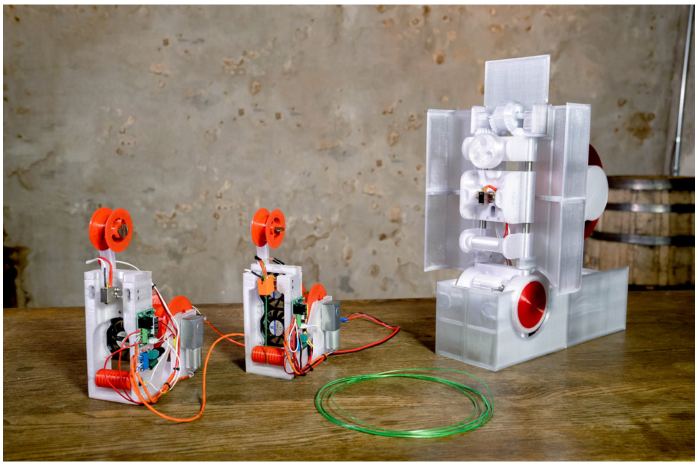


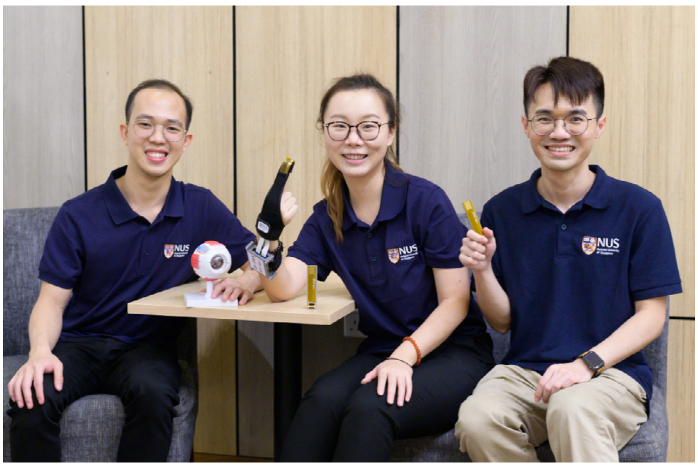
4.3.5 HOPES, 2021 International Winner

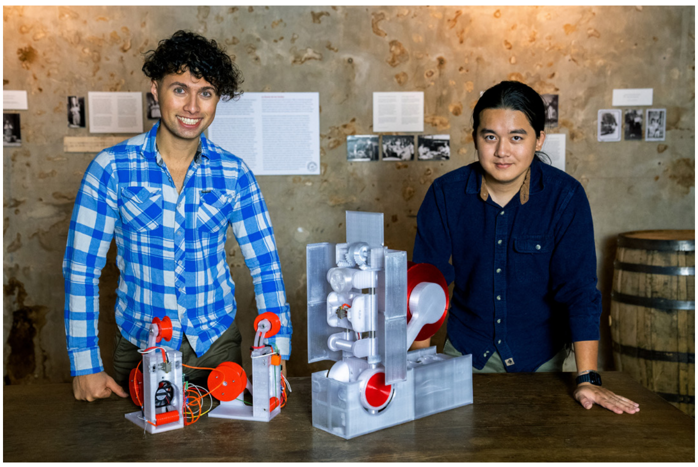
Invented by David Lee, Kelu Yu and Si Li from Singapore, HOPES is a wearable biomedical device for pain-free, low cost and at-home intraocular pressure testing, which uses sensors, signals, and algorithms to determine whether a user has glaucoma. Since winning the award, the HOPES team have successfully secured intellectual property rights as of February 2023. They continue to iterate their prototype, being mindful of human interaction and safety. Their latest prototype has received approval from National University Health System and is now entering the official clinical trials phase.

4.3.6 Polyformer, 2022 Sustainability Winner

Invented by Swaleh Owais and Reiten Cheng from Canada, Polyformer is a machine that recycles plastic bottles into 3D printer filament to reduce plastic consumption while also producing 3D printer filament at low costs. Since winning the award, the Polyformer team has dispatched over 500 kits globally. Currently, the project is largely operating on autopilot, as the inventors shift their focus toward their next endeavor in the realm of 3D printing and recycling. Their efforts are directed at sustaining the momentum surrounding Polyformer while envisioning a more comprehensive ecosystem that revolves around plastic recycling and 3D printing.







5.0 Using the James Dyson Award in other courses

Pages 6–12 outline specifically how Dr. Hassan has introduced the James Dyson Award into her Mechanical Engineering course. She is aware that not every course can be built around the James Dyson Award, and that all engineering and design courses globally will differ. Please see the following for some further ideas around using the award in a less intensive way:

Options	Effort	Resources
Promote the award	Low	Share information about the James Dyson Award with students by pulling details from www.jamesdysonaward.org.
Invite or encourage students with a strong project to apply	Low	Share information from www.jamesdysonaward.org or digital poster. To receive a digital poster email, jda-support@jamesdysonfoundation.com.
Assignment	Medium	See table to the right.
Build the course around the James Dyson Award.	High	Review materials outlined in this teaching guide

5.1 Low resource suggestions

Dr. Hassan's course has a relatively rich prototype budget and technician resources, and many of her students have extensive fabrication expertise and home resources.

If this course were taught in a less resource-rich environment (e.g. a much larger class, a class with less experience, a class with fewer departmental resources, an online course), these are some strategies that could work either alone or in combination:

Use sketching and drawing

Students have gotten quite comfortable at sketching on tablets. "A good sketch is always preferable to bad CAD" is a common sentiment amongst design professors. You should encourage students to sketch because it's easy to offer rapid formative feedback and iterate at this stage, which is the most important part of the design process.

Use quality CAD and rendering

If students' computer aided design skills are sufficient there are some great online tools for making very marketable and visually appealing renders of potential products.

Use analysis, such as hand calculations or FEA to justify design choices

Dr. Hassan loves to see when students bring their analysis skills from another course. For example, for simple products, students could assess load and torque to size components with hand calculations, they could use CAD assembly models to test motion and fit.

Use low fidelity prototypes

Working with sheets of cardboard, plastic or found objects can be an effective prototyping strategy, one that Dr. Hassan has used in her first-year design course for years. It is especially useful for testing ergonomics or fit, similarly, using Lego or other building tools such as a '3D sketch' can help students communicate with each other, or test fit and part interaction.

5.2 Assignment ideas for other courses

The following are examples of ideas and assignments that Dr. Hassan proposes for use in existing technical courses. Please note, the James Dyson Foundation encourages all problem-solving ideas. The brief to enter the James Dyson Award is 'design something that solves a problem'. Those who fulfil this brief and align with the other eligibility requirements are welcome to enter the competition.

Type of course	Potential James Dyson Award applications
First Year Design	Ask students to design something that meets the award criteria. Dr. Hassan's students designed something for a community member with a disability.
Materials	Design something and select a suitable material for that design.
Statics or Dynamics	Pose a physics problem that is also a human design problem e.g. Design and analyze a solution for seating, show that your device will support an average person.
Finite Element Analysis or Computational Fluid Analysis	Analyze a physics problem that is also a human design problem e.g. Design and analyze a solution for seating. Prove that your design will support a designated load using FEA. or Design a nozzle or bottle attachment that keeps a soft drink more carbonated while it is being poured. Computationally show why your device would work.
Biomechanics or Ergonomics	Ask students to design something for sports or occupations that meets common ergonomic standards (ergonomics), while also meeting the award criteria, or to design and analyze something to reduce effort. An example could be: Design something that reduces the effort of lifting a box.
Universal Design/Accessible Design	Ask students to design something for people with disabilities or explore how to make a process more accessible. An example could be: Design something that makes using an elevator easier for wheelchair or walker users.
Capstone/Final Year/Thesis Project	Propose a project that lends itself to the project criteria.

6.0 Instructor resources

The following pages outline the assignments and corresponding rubrics for Dr. Hassan's fourth year course, "Topics in Product Development" which focuses on design of commercial products. The course is structured around two parallel projects, one individual and one group. Dr. Hassan's intention is that students leave the course with two unique design projects for their portfolio, which may be useful for eventual co-op or job seeking. Both projects would be suitable for submission to the James Dyson Award.

6.1 Course grade breakdown

Breakdown	Due date	Value
Individual deliverables		
In-class assignments	In-class and 24-hour grace period	5%
Individual project	Submit .pdf on course management site	
A1 – Problem identification and concept drawings	Week 6	10%
A2 – Testing report	Week 7	15%
A3 – Financial and manufacturing analysis	Week 12	15%
Group deliverables		
Weekly design reviews with TA	Weekly in tutorial	5%
Design reviews		
DR1 – Problem and customer	In-class and tutorial week 2	5%
DR2 – Form and function	In-class and tutorial week 6	10%
DR3 – Final Pitch, business model	In-class and tutorial week 12/13	10%
Final project report and prototype	Submit .pdf on course management site, due on week 13	25%
Total		**100%**

6.2 Individual project specification and rubrics

The individual design project is composed of three assignments (A1, A2, A3) to encourage timely completion. Students can hand in their work anytime in advance of the following deadlines. See table below.

6.2.1 Individual project scope:

Design a simple, commercial product made of plastic suitable for sale on an online marketplace.

The product does NOT need to be entirely novel, but if it is replicating something that exists, the new version should offer additional functionality over the existing product.

Assignments A1, A2 and A3 are the process for developing this product and assessing feasibility.

Assignment	Value	Due date	Format
A1 – Problem Identification and Concept Drawings	10%	Week 4	.pdf
Part Fabrication		Week 4 (No grace period)	.stl
A2 – Testing Report	15%	Week 7	.pdf and video
A3 – Financial and Manufacturing Analysis	15%	Week 12/13	.pdf

6.3 A1: Problem identification and concept drawings

Constraints:

Must have a function (not purely decorative)

The function must be able to be tested by the student (e.g. not for use in outer space, not for use in a hospital operating room, unless the function can be reasonably simulated at home)

Must be a commercial product (something multiple users would buy, not bespoke for one person/client)

Must not be a single use/disposable product (e.g. not a plastic fork for takeout)

Must be a geometry that can be 3D printed in 3 hours (student's material budget)

What is a good and a bad problem to solve will be covered in class, but generally:

Good problems	Bad problems
Physical problems (e.g. not enough leverage)	Informationproblems (e.g. not enough data)
A student's hobbies (because they know something about them and it's fun)	Things students have only heard about (hard to understand, hard to test, might be boring)
'Small' problems – if it's larger than a pop can, it might be over the 3D-print time limit	'Large' problems – the max size of the print volume is roughly 25x25x25cm
Offer a benefit beyond 'cheaper'	Only advantage is cost (it's just a race to the bottom)

6.3.1 Frequently asked assignment questions

Can it be a part of a larger assembly? (E.g. a modular system)
Yes, in that case feel free to only print as many as necessary to demonstrate function. For example, if the product was a LEGO-like toy building system, at least two blocks would need to be printed, even if a typical user would use hundreds of blocks.

Can it be a scale model?
No, the function must be able to be tested, that's generally difficult with a scale model.

Can the form change from A1 to part submission?
Absolutely. If you discover something about your part that would make it print better or function better, you should implement it when submitting the part, and keep track of ideas for use in your discussion in A2.

The A1 report should contain:

A description of what problem the product solves for the customer.
– Who would buy this?
– What advantages does their product offer over their existing solution?

Sketches of multiple forms considered for the product (iterations) and an explanation of why the finalized form was chosen.

A high-quality visualization of the form that will be prototyped (the part submitted). This can be a hand drawing, CAD, or a render, whatever shows the form most clearly. Label this visualization with key features to make the function clear. For help with rendering, see these simple videos.

6.3.2 Rubric

	Below expectations	Marginal	Meets expectations	Exceeds expectations
Idea quality	Major problems, this would not work [1]	Multiple small problems or one major problem [2]	One or two small issues, needs small redesign [3]	Could be produced today, someone would want this product [4]
Customer identification	Product is not right for the target market, worse than existing solution [1]	Form offers no advantage over current solution [2]	Form minimal advantage over current solution [3]	Clear match between customer needs and proposed form, substantial advantage over current solution [4]
Sketches/ evidence of iteration	Only one solution proposed [1]	Multiple solutions proposed but substantially similar to each other, AND alternate solutions not viable [2]	Multiple solutions proposed but substantially similar to each other, OR alternate solutions not viable [3]	Range of diverse solutions considered; multiple viable solutions proposed [4]
Decision making	Ideas all the same, choice irrelevant [1]	Idea choice seems arbitrary [2]	Best solution chosen but reasoning ambiguous [3]	Best solution chosen, reasoning clear [4]
Final visualization	Annotations minimal OR very poor visual appeal [1]	More annotations needed to make function clear [2]	Visual appeal suboptimal, but function clear [3]	Function perfectly clear, high quality, visually appealing [4]
Deductions	Not in pdf format [-5] Illegible images [-15]			**Maximum score: 20**

6.4 A2: Testing Report

Hand in a .pdf of your report and video of your functional test. After you have your physical prototype, conduct documented (video) tests of the intended function. Then prepare a report describing:

How well your part achieved your goals.

The design changes you would make to improve your design's function and manufacturability.

Updated visualization of your improved revised part highlighting updated features.

6.4.1 Rubric

	Below expectations	Marginal	Meets expectations	Exceeds expectations
Form: Product quality	Major Problems, this would not work. No description or description is lacking depth. [1]	Multiple small problems or one major problem [2]	One or two small issues, needs small redesign [3]	Could be produced today, someone would want this product [4]
Validation: Quality of evidence (video)	Evidence incomplete [2]	Evidence ambiguous [4]	Enough evidence presented that further work is justified [6]	Enough evidence presented that commercial development could occur today [8]
Description of function and future design changes	No description or description is lacking depth. [3]	Multiple solutions proposed but substantially similar to each other, AND alternate solutions not viable [2]	Multiple solutions proposed but substantially similar to each other, OR alternate solutions not viable [3]	Range of diverse solutions considered; multiple viable solutions proposed [4]
Final visualization	Annotations minimal OR very poor visual appeal [1]	More annotations needed to make function clear [2]	Visual appeal suboptimal, but function clear [3]	Function perfectly clear, high quality, visually appealing [4]
Deductions	Not in pdf format [-5] Illegible images [-20]			**Maximum score: 20**

6.5 A3: Financial and manufacturing analysis

Hand in a single .pdf containing your financial analysis and report.

Your pdf should contain:

An image of your part and a brief description of the function.

A paragraph explaining the highlights of your business canvas.

A paragraph explaining the key assumptions and outcomes of your financial analysis.

A paragraph explaining what design changes you would advise based on your business model and financial analysis (e.g. making the part lighter to reduce shipping costs) [future work in the rubric].

Business model canvas
(details next column, see lectures for guidance)

Financial model
(details next column, see lectures for guidance)

6.5.1 Business Model Canvas

Develop a business model canvas for your product.

The more detailed the canvas, the higher your grade, per the rubric.

If you don't have enough room on the template, feel free to make a similar document or spreadsheet, whatever is easiest for the TA to understand, as long as it is part of the same pdf.

6.5.2 Financial Model

Based on your business model canvas, develop a detailed financial model using NPV.

Feel free to adapt the spreadsheets shown in class and linked on our learning management system, but keep in mind that level of details in these models is about a level 3 on the rubric.

The more detailed the model, the higher your grade, per the rubric.

The most important thing is to show your thinking and that you've included all relevant aspects (e.g. don't produce parts and not pay for shipping them to a customer). Exact dollar amounts are less important than your logic, some aspects are hard to quantify, but make reasonable assumptions and cite your sources when you can.

Make a pdf of your spreadsheet, showing your supporting calculations.

The time horizon of your analysis is up to you.

To reach level 4, be sure to include a sensitivity analysis including at least two factors (e.g. sales volume, manufacturing technique), summarize these results in a table or graph.

6.5.3 Future Work

Write a paragraph or two summarizing what the next steps would be if you were to pursue this product as a business. Would you advise design changes? A change to the business model? If you model doesn't show a positive NPV, what would you advise investigating next?

6.5.4 Rubric

	Below expectations	Marginal	Meets expectations	Exceeds expectations
Business model: Level of insight	Derivative, too similar to an in-class ex., not customized to product [1]	In class example adapted to product [2]	Some creative elements [3]	Very creative, identified non-obvious elements [4]
Business model: Feasibility and level of detail	Major Problems, missing multiple major elements, this would not work [1]	Missing a major element. Multiple small issues or one larger one [2]	Some issues, needs small adjustment [3]	Could be a business today with no modification [4]
Language clarity and quality paragraphs	Meaning unclear throughout [1]	Multiple solutions proposed but substantially similar to each other, AND alternate solutions not viable [2]	Multiple solutions proposed but substantially similar to each other, OR alternate solutions not viable [3]	Range of diverse solutions considered; multiple viable solutions proposed [4]
Analysis: Estimate of cost to mass produce	Incomplete or inaccurate [0.5]	Missing one part or process [1]	Uses provided spreadsheet only [1.5]	Seeks out and uses additional resources/citations, linked to past design/validation work (e.g. uses part volume to estimate injection molding costs etc.) [2]
Analysis: NPV analysis (selling price and volume etc.)	Incomplete or inaccurate [2]	Multiple unrealistic assumptions [4]	Minor adjustments needed, or one unrealistic assumption or missing some supporting calculations [6]	Could be a business today with no adjustment, included all relevant supporting calculations, easy to follow [8]
Analysis: Sensitivity analysis	None presented [0]	Cursory sensitivity analysis discussion but results not presented [1]	Thorough examination of one factor (e.g. selling price) [1.5]	Analysis of 2 or more relevant factors summarized with visualization and thoughtful discussion [2]
Discussion: Future work	None presented [0]	Insights generic (e.g. increase prices always makes more money) [4]	Insights a little muddled but relevant and would improve the business for this product [6]	Insightful, clear, linked to financial analysis and validation work [8]
Deductions	Not in pdf format [-5]			**Maximum score: 32**

6.6 Group project specification and rubrics

Group Project Specification

These deliverables are intended to replicate the process you would go through if you were seeking funding to further develop and commercialize your product. Therefore, the language you use should be clear and accessible.

6.6.1 Project deadlines

Description	Value	Timeline	Hand In Format
Design Review DR1 – Identify a problem and customer insights	5%	Week 2	No hand in, in person presentation in lecture or tutorial. Book a time slot and upload your slides to the correct folder in advance to class.
Design Review DR2 – Identify what functions your product will have, potential forms it could take, validation plan	10%	Week 6	
Design Review DR3 – Pitch your finalized product, share your business model, demonstrate prototype	10%	Week 11/12	
Final Report in Dyson Award Format [5 images, short text, optional video] plus Business Model Canvas and Financial Model	25%	Week 12/13	.pdf document
Prototype		At DR3	Submit video demo on the course management site and bring physical prototype to DR3

6.6.2 Project Goals

Design and prototype a commercially viable product.

Validate design by testing.

Prepare a financial justification and business plan.

Present product in "James Dyson Award" format [5 images, short text, optional video].

Welcome to submit your product to the Awards but it's not mandatory.

This product cannot be a duplicate or extension of your capstone, co-op, or any other academic work. Duplication is a form of academic dishonesty.

Mixed physical/software projects are acceptable, but some aspect of the product must be physically prototyped.

6.6.3 Design Reviews

See rubrics below.

Scheduled during class or tutorial using a spreadsheet in Microsoft Team, first come first served.

You need to attend your team's design review session to get marks for it.

For full marks on in class assignments, attend your design review and one other in each block (DR1, DR2, DR3) and give feedback.

You need to screen grab your comments and hand in on Avenue to get credit for feedback as in class assignments.

Plan to talk for 5 minutes and discuss for 5 minutes, upload your slides to the correct folder.

6.6.4 Prototyping

Prototype = something to justify moving forward with your plan + some way to communicate form.

Your prototype budget is for 3D printing and laser cutting, an exact value will be shared via class/Avenue. You are welcome to use any additional resources you have at home.

You can prototype a subsystem if necessary or use multiple prototypes. (E.g. one prototype to show form, one to show function)

6.6.5 Final Pitch

You have 10 minutes to sell your product. You may use any number of slides and videos if you wish. Cover the customer insights that drove your development and the benefits your product offers your customers.

6.6.6 Final report

Format your report in the same way as the finalists for the James Dyson Awards. You are welcome to submit your idea to the Award, but it's completely your choice. Regardless of if you submit or not, you will follow that format, which is five images and captions (one image can be a video) plus five paragraphs.

See an example here.

The five paragraph headings are:

What it does

Your inspiration

How it works

Design process

How it's different

Also include:

Prototype validation (test results, simulation, calculations, video, etc.)

Business model canvas (similar to your A3)

Financial analysis (similar to your A3)

Include these elements in a single .pdf document formatted as five images and captions, followed by five paragraphs, followed by your prototype validation, business canvas, and financial analysis. You may add a page of explanation following your business model and financial analysis if you think that it is necessary. If one of your images is a video, upload that separately. Make sure the teaching assistants and lecturer have the correct permissions to view the video.

Suggestions:

Brevity and clear language are the focus.
Each paragraph should be no more than 300 words.

Just because it is a short report does not mean that it is cursory. This report and prototype are worth 25% of your grade, so write with care and precision. Marks will be deducted for spelling, grammar, and unclear language.

Use at least one of your images/videos to show your product validation (test data, a user test, simulation, etc.)

Captions can be very useful in making your images clear, use them thoughtfully. They are especially useful for explaining graphs of user data and things like that.

Your financial analysis should follow the same format and scope as your individual A3. As in A3, your product does not have to be profitable, what matters is a thorough and accurate financial analysis even if it turns out your business model has a flaw. If the NPV of your product is negative, address this by describing under what conditions it could be made profitable, how you might change your product so that it could be profitable.

6.6.7 Rubric

DR1: 5% of final grade

Present the problem you intend to solve, what value you will deliver to your customer, and what insights led to your decision to pursue this idea. Early sketches or visualizations are appropriate at this point, it is acceptable to be deciding between a few different ideas at this stage, particularly if you have an early time slot.

	Below expectations	Marginal	Meets expectations	Exceeds expectations
Idea quality	Doesn't solve a problem [2]	Solves a trivial problem [4]	Has potential, but needs refinement [6]	Good idea, obviously solves a real problem [8]
Customer insights	No insight, product is useless for intended customer [2]	Insight trivial, minimal advantage over existing [4]	A little bit obvious, a twist on an existing product [6]	Shows real empathy and insight [8]
Sketches/ visualization	Images messy, hard to read or unclear [1]	Images marginal [2]	All images clearly show idea [3]	Outstanding, clear, all could be shown to a client [4]
Communication	Clearly unrehearsed, poorly done [1]	Hard to follow at times [2]	Narrative a little muddled at times but overall good [3]	Presentation clear, succinct [4]
Deductions				**Maximum score: 24**

DR2: 10% of final grade

At this point you should have a firm idea of what kind of product you are designing. Present the exact problem you are solving for your customer, what you think your product could look like, how you plan to validate your design (testing or analysis plan).

	Below expectations	Marginal	Meets expectations	Exceeds expectations
Idea quality	Doesn't solve a problem [1]	Solves a trivial problem [2]	Has potential, but needs refinement [3]	Good idea, obviously solves a real problem [4]
Validation plan	Planned approach addresses form OR feasibility only [2]	Form and feasibility both addresses but incompletely [4]	Planned approach addresses both form and feasibility [6]	Outstanding, rigorous [8]
Image quality	Images messy, hard to read or unclear [1]	Images marginal [2]	All images clearly show function [3]	Outstanding, clear, all could be shown to a client [4]
Feasibility	Will not work [2]	Might work [4]	Feasible [6]	Outstanding [8]
Communication	Clearly unrehearsed, poorly done [1]	Hard to follow at times [2]	Narrative a little muddled at times but overall good [3]	Presentation clear, succinct [4]
Deductions				**Maximum score: 28**

DR3 – Pitch – 10% of final grade
See description above.

Group		
Feasibility for production	Major Problems, this would not work = 1 Some issues, needs small redesign = 7 Could be produced today, someone would want this product = 10	/10
Evidence of feasibility/ usability presented	No evidence presented = 1 Some evidence presented but weak in some areas = 7 Enough evidence presented that I am convinced it will work = 10	/10
Business insight/ commercialization	No evidence presented = 1 Some evidence presented but weak in some areas = 7 Strong evidence that business model would work = 10	/10
Communication	Clearly unrehearsed, poorly done = 1 Presentation clear, succinct = 5	/5
Max score		**35**

Final report, prototype, and validation: 25% of final grade

Dyson images and text		
Image clarity and quality	Images are low quality, hard to read or missing captions = 1 Images could be more attractive, but they are clear = 7 Images and captions makes sense and are clear. Beautiful, professional level quality= 10	/10
Language clarity and quality	Meaning unclear throughout = 1 A few instances of jargon or overly technical language but otherwise readable = 7 Thoughtful and compelling, technical details could be understood by lay person = 10	/10
Spelling/grammar	Many spelling/grammar mistakes = 0 A few small errors = 4 Perfect, professional quality = 5	/5
Prototype validation		
Feasibility for production, commercialization	Major problems, this would not work = 1 Some issues, needs small redesign = 7 Could be produced today, someone would want this product = 10	/10
Ease of use	Major problems, someone could be hurt = 1 Small ergonomic or similar problem = 7 Could be used today, functional as is = 10	/10
Testing/user results	No user testing/validation = 1 Validation reasonable = 14 Test results compelling, supports feasibility = 20	/20
Build quality/aesthetics	Major problems, someone could be hurt = 1 Small fit or finish issue but proportions and construction good = 7 Beautiful, functional, professional level quality = 10	/10
Business model canvas		
Business model canvas	Major problems, this would not work = 1 Some issues, needs small adjustment = 4 Could be a business today with no modification = 5	/5
Financial justification		
Financial Plan	Major problems, missing a key element (e.g. material cost) = 1 Some issues, needs small adjustment to assumptions = 14 Could be a business today with no modification = 20	/20
Max score		**100**

THE JAMES DYSON AWARD

You can find more James Dyson Foundation educational resources online at
www.jamesdysonfoundation.com