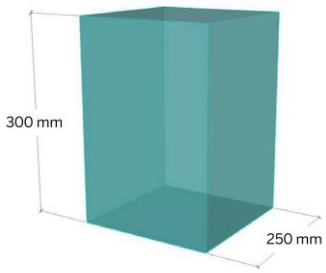
DE2 GIZMO (PHYSICAL COMPUTING) 2020-21
Project Brief (Spring Term)

1 Your task

This is an individual assignment. You are challenged to **weave design and technology** to design, build and demonstrate an electro-mechanical machine that celebrates mechanisms and demonstrate an engaging physical interaction. The objective is to produce a **cardboard machine** that effectively integrates machine elements, sensors, actuators, and embedded processors to perform **an engaging iterative physical interaction.** Since cardboard is the main material to be used in the development of your machine, the unifying theme for the projects of the cohort is **'Gizmo Ode to Cardboard'.**

Your Gizmo Ode to Cardboard should be finished to a high level, and you should aim at creating an interaction in which the user experiences the machine's initial response, and takes more action, in a continued loop. **The machine must work, but it does not need to fulfil a real-world need. It can be playful, joyful, whimsical, devious, absurd.**



The dimensions of your Gizmo should be **maximum depth and width of 250 mm and maximum height of 300 mm.**

It is recommended that you keep a record of your work throughout. Document your production projects, and design and technical research thoroughly. Use these assets to communicate your process and learning in your Portfolio and at the Final Review (Demo Day). Video your Gizmo as soon as it is working!

You can claim up to £25 for the creation of your Gizmo Ode to Cardboard and are encouraged to use material/components taken from waste. This is in addition to the kit you have received for the tutorials and this project (£55).

Seek to challenge yourself throughout this module and learn new skills! You may be highly competent in one or more of the disciplines associated with Physical Computing, namely: Cyber-Physical Systems, mechanisms and machine elements (physical embodiment), and interaction design. Few of you will be expert in all areas so **pick a project focus that enables new learning for you.**

2 Workflow

You should adopt a deterministic approach, in which uncertainties are dealt with by using conservative values, safety factors and best practices ("rules of thumb") and through iterative development through synthesis, simulation, analysis, and **physical prototyping.**

Synthesis is the process of combining ideas, referring to analogous systems, and making estimations to arrive at potential solutions. Analysis involves the application of engineering science to determine quantitative information, geometry, and detail design. Analysis and synthesis invariably go together, but you will have to synthesise your Gizmo device before you analyse it.

In Gizmo, **fixing a concept early** and allowing plenty of time for iteration will give scope for greater level of creativity and invention. **The joy and learning in this module is in the development of your machine through iteration.** Your research should be about getting inspired (generate mood-boards, Pinterest pages, whatever works for you) and looking at prior art.

The world is full of clever mechanisms and machines and you can start with a mechanical system that intrigues you as an alternative to starting with a specific method for generating sound for instance.

v1.0 – N Rojas, based on content previously developed by Andrew Brand (2016-19) and Shayan Sharifi (2019-20)

Tips for the development of your Gizmo

- Define the mechanics first and then the electrical, electronic parts.
- Once you have a concept, decompose the system into basic, independent functions and keep them separate throughout development, whilst keeping an eye on how the solutions will integrate successfully.
- Create Gizmo components that are explicitly simple. Start with the simplest principle and add complexity as needed.
- Build prototypes—virtual and physical.
- Bench level testing is an important process that gives an early indication of the performance that components and subsystems will have when installed in a system that is required to operate in a given environment.
- Good mechanical design is often more about using good practices (based on fundamental engineering principles) and inventiveness than detailed analysis.
- Move quickly but resist the tendency to become too detailed too quickly.
- Design for manufacture and assembly, which means designing for the constraints you face (time, resource, access to materials, and equipment).
- Write code in small chunks and test each of them.
- Provide meaningful names for variables and functions. Write comments to explain coding choices for future reference.
- Organise your code in order to minimise the chance for bugs. Use functions and comment everything.

3 Deliverables

Assessed Deliverables	Weight[1]	Date/Deadline	Submission/Venue
Project: *Portfolio and video* (individual)	24%	Thursday 18 March 2021 16:00 UK time	Share folder to module leader (n.rojas@imperial.ac.uk) via Box Storage
Project: *Final presentation, demonstration, and inspection* (Demo Day, individual)	20%	Friday 19 March 2021 09:00-18:00 UK time	Gizmo Wonder Room (Pass: 2021Gizmo)

4 Portfolio and Video (24%)

You are required to submit a poster-like, 1 A1 page PDF portfolio and a 60 second promo video of your prototype.

4.1 Portfolio

You may orientate the portfolio page (poster, A1) in portrait or landscape. The content is up to you, but consider the assessment criteria (detailed later herein) and that an effective portfolio works at several levels: *source of information, conversation starter, advertisement of your work, summary of your work*.

Tips for preparing your portfolio (poster-like, 1 A1 page PDF)

- Planning—start planning on paper with a written list and then through sketching.
- Identify the focus for your portfolio page; what information is important, what are the 'messages' that you wish to convey?
- Know your audience and their level of knowledge (in this case, your colleagues, Gizmo teaching team, Design Engineering teaching staff, and potential employers)

[1] Please recall that DE2 Gizmo (Physical Computing) is a two-term module (Spring Term and Summer Term). Assessments of the Spring Term are 50% of the whole module: tutorial exercises (6%), project: portfolio and video (24%), and project: final presentation, demonstration, and inspection (20%).

and tailor your message accordingly.
- Make it visual. Your portfolio page should express points in graphical terms, as much as suitable, in order to make it easy to understand. Use photographs and illustrations of your designs and builds. Use graphs to show results and relationships.
- Ensure images have resolution with min. 300 dpi so they can be printed.
- Order the information. Use a grid layout, use scale and position to indicate the importance of elements on the portfolio page and guide the reader through the information (eye-gaze path top to bottom, left to right or clockwise).
- Present text information through a well-defined hierarchy of headings, short paragraphs, numbered lists, and bulleted lists.
- Aim to use no more than 2 font types and 3 different font sizes.
- Text and visuals should be complementary to avoid redundancy (excessive use of images and text to describe the same thing) and confusion (insufficient information).
- Keep the style consistent.
- Use colour to highlight and draw the reader's attention.
- Recommend white or light colour background and dark colour for text. Use spacing to reinforce the structure of your portfolio page.

4.2 Video

Your video should last no more than 60 seconds. Ensure that you are gathering appropriate, good-quality moving and still images throughout the project. Video everything: *studio sessions, idea generation, experiments, tests, visual representations, CAD images, workshop activities, animations, end-user interaction, interviews, demonstrations*.

Your video may also include animations, panning and tweening photos, digital images, hand drawings, or your own voice-over / narration. The video should have a clear narrative that can be understood without further explanation.

The video should introduce the project name, your name, and date (could be done with a single page). Ensure that any speech in the video is audible. If it is not clearly audible, include subtitles.

Important information about the video

Your video may be distributed publicly at an exhibition and on College websites so:
- You must have the consent of the people you have recorded, for use of their image and audio in your video.
- Third-party images, sounds, or moving image (i.e., assets that you have not created), must be used as per UK copyright law. Please refer to: https://www.imperial.ac.uk/admin-services/library/learning-support/copyright-guidance/copyright-for-students/
- Duration: 60 seconds
- Aspect ratio: 16:9 (widescreen)
- Resolution: Minimum 720p. Ideally 1080p.
- Audio: Include sound, as the video may be uploaded to a Youtube channel.

4.3. Assessment Criteria: Portfolio and Video

Criteria	4 – Exceeds expectations	3 – Secure (Meets expectations)	2 – Developing (Approaches expectations)	1 - Beginning
Engineering Design & Refinement	Evidence that final machine is elaborate and	Evidence that final machine developed	Some evidence of evaluation and analysis but with	Little evidence of iteration, synthesis,

	developed through full and appropriate evaluation and analysis. Specified requirements are fulfilled. Design accommodates manufacturing and time constraints.	though partial and appropriate evaluation and analysis. Specified requirements fulfilled. Design accommodates manufacturing and time constraints.	several mistakes. Some specified requirements fulfilled. Design does not fully take manufacturing and time constraints into account.	analysis, or evaluation. Specified requirements unfulfilled.
Narrative & Reportage	Balanced description of process and final machine, incl. excellent level of evidence that multiple solutions have been explored & an iterative process of synthesis, analysis, prototyping and judgement has been adopted.	Balanced description of process and final machine, incl. very good level of evidence that multiple solutions have been explored & an iterative process of synthesis, analysis, prototyping and judgement has been adopted.	Unbalanced description of process and final machine with good level of evidence.	Unbalanced description of process and final machine with limited evidence.
Quality of Visual Assets - Boards	Visually engaging and easy to understand structure created through composition and colour, a clear hierarchy of content, professional style and character.	Visually engaging and easy to understand structure created through composition and colour, a clear hierarchy of content.	Easy to understand structure with clear composition and hierarchy of content.	Difficult to understand structure, no clear composition or hierarchy of content.
Quality of Visual Assets - Video	Highly watchable video which is excellently edited and shot (i.e. at a level that might be expected of a professional design engineer). Audio and other enhancements used to engage viewer with content.	Engaging video which is well edited and shot. Audio and other enhancements used to engage viewer with content.	Video is well edited. Audio and other enhancements used to engage viewer with content.	Video is poorly edited. Limited enhancements to engage viewer with content.

5 Demo Day: Final Presentation, Demonstration, and Inspection (20%)

The Demo Day is a formal review of your completed working machine and takes the form of a 5-minute demonstration and presentation, followed by questions from a review panel (up to 5 minutes). It will occur in the Gizmo Wonder Room.

You should perform a live demonstration of your engaging physical interaction. If a live demonstration is not possible (e.g., a fundamental part broke few minutes before the demo), then you may show a video. In fact, everyone should have a video of their Gizmo working as a back-up, ready to show at the Demo Day in case the machine does not work.

In addition to the demonstration, you should show sketch books, prototypes, analyses, and video content. There is no specific ground plan for your presentation, but a plan should exist. This presentation will be given to three members of the teaching team (review panel) and to a mixed audience which may include faculty members, visiting tutors, and other fellow students. The review panel will seek clarification of your intentions by inspection of your final machine and asking questions to give advice and feedback verbally.

The schedule of presentations will be released closer to the Demo Day. The time zones of the students will be considered for the allocation of slots.

During the Demo Day

- Arrive on time to your presentation slot, this is at least 10 minutes before the scheduled time. The presentation will be held in the Gizmo Wonder Room. Look for the 'circle' of your review panel.
- Be prepared—this means to give a structured, practised presentation. Time is limited: you will have up to 5 minutes to present plus up to 5 minutes for feedback, questions.
- Explain your work, visually and verbally; better still, demonstrate your work.
- Illustrate your process and direction.
- Listen to responses. Learn from responses.
- Defend, but don't be overly defensive.

You are invited to attend any presentation of the Demo Day, provided that there is space as one Wonder circle is currently limited to 15 persons. Please be considerate when joining.

5.1. Assessment Criteria: Final Presentation, Demonstration, and Inspection

Criteria	4 – Exceeds expectations	3 – Secure (Meets expectations)	2 – Developing (Approaches expectations)	1 - Beginning
Inventiveness and Creativity	Highly inventive and creative thinking is clearly evident in overcoming a problem or limitation in the mechanics, manufacturing, electronics, or programming of your machine.	Some inventive and creative thinking is evident in overcoming a problem or limitation in the mechanics, manufacturing, electronics, or programming of your machine.	Evidence of overcoming a problem or limitation in the mechanics, manufacturing, electronics, or programming of your machine though determination and perseverance.	Scant evidence of overcoming a problem or limitation in the mechanics, manufacturing, electronics, or programming of your machine.
Gizmo machine works as intended	All functional objectives fulfilled – it works! Successful integration of machine elements,	Functional objectives are addressed but are incomplete or missing some elements – it almost worked!	Functional objectives are inadequately described or poorly translated – it could have worked.	Functional objectives have not been considered.

	actuator(s), sensor(s), & control.			
Physical interaction	A delightful exchange of information between two or more actors. Iterative (continuous loop or repeatable), with hidden layer(s) of value and reward. Clear, prompt, and effective response.	A delightful exchange of information between two or more actors, with hidden layer(s) of value and reward. Not iterative (i.e. one time experience). Clear, prompt, and effective response.	An exchange of information between two or more actors. Not iterative (i.e. one time experience). Response delayed but clear and effective.	Exchange of information between two or more actors is delayed and not clear.
Bench level control system	High fidelity bench level control system that successfully integrates digital input and output, analogue input and output, serial communication as required by your physical interaction. Design intent hardware used.	Bench level control system that successfully integrates digital input and output, analogue input and output, serial communication as required by your physical interaction. Substitute hardware used.	Bench level control system that integrates digital input and output, analogue input and output, serial communication as required by your physical interaction. Substitute hardware used. Not fully working.	Bench level control system integrates inputs and outputs, but not representative of your physical interaction.
Visual presentation of machine	Visually engaging, appropriate use of manufacturing techniques & materials. Well finished.	Visually engaging, mostly appropriate use of manufacturing techniques & materials. Well finished.	Mostly appropriate use of manufacturing techniques, roughly finish.	Inappropriate use of manufacturing techniques, poorly finished.
Presentation and Questions	Content balanced and professional, audible, good use of props (e.g. diagrams) and live demonstration. Questions handled expertly.	Content balanced and professional, audible, good use of props and live demonstration. Student has some difficulty answering questions.	Audible, good use of props. Student has significant difficulty answering questions.	Inaudible, poor use of props. Student has significant difficulty answering questions.

6 Claiming Expenses

You can use either of these forms (expense_claim_pdf, expense_claim_excel) for claiming expenses up to £25 for your Spring Term Gizmo Project. Once completed, please send it via e-mail to Rebecca Allen (r.allen@imperial.ac.uk), our Senior Finance Administrator, along with the corresponding receipts. The cost centre for DE2 Gizmo (Physical Computing) is NDAA and the activity no. is G47510.

Please submit only one form and ensure that all the receipts are attached.

7 Health and Safety

As stated in the UG DE Student Handbook, 'to be a professional engineer your consciousness of risk, and concern for your own and others' safety, must be considered and instinctive'. This is of course the case despite your Gizmo is going to be developed remotely, please recall that 'you are responsible for looking after your own health and safety and that of others affected by your College-related work and leisure activities. You must:

- comply with all local and College policies, procedures and codes of practice and with the arrangements which the College has in place to control health and safety risks;
- ensure that your activities do not present unnecessary or uncontrolled risks to yourself or to others;
- attend appropriate induction and training;
- report any accidents, unsafe circumstances or work-related ill health of which you become aware to the appropriate person;
- not interfere with any equipment provided for Health and Safety;
- inform your supervisor or the person in charge of the activity in cases where you are not confident that you are competent to carry out a work or leisure activity safely, rather than compromise your own safety or the safety of others'.

8 Mechanisms and Cardboard

The following is a list of some resources that you may find inspiring (or may lead you to find inspiring things) for the development of your Gizmo Ode to Cardboard.

- Cardboard Caterpillar Automata
- How to Make a Robot out of Cardboard
- Mechanical Counter from Cardboard
- 2100 Animated Mechanical Mechanisms
- Kinematic Models for Design Digital Library
- Deployable Mechanisms
- An Atlas of Linkage-Type Robotic Grippers