Animated Beautiful Machine

IAT 106 Spatial Thinking and Communicating

Project Overview

In the course final project, you will iteratively design an Animated Beautiful Machine (ABM). An ABM is a machine that combines mechanical components to amplify the effects of human effort—yes! but also, and more importantly, presents a pleasant and surprising output motion. An ABM looks beautiful on its own even when it's not operated and surprises its viewers/operators when they interact with it.

What is considered beautiful can be a personal, cultural or socially agreed-upon construct. In the lecture today by Dr. Robert Woodbury, we will discuss 'what is beautiful' by examples.

ABMs and similar systems have been built for centuries for different reasons: sometimes to imitate nature, sometimes to impress a king, or sometimes to entertain children [1]. Today, they are built by curious puzzle solvers, artists, educators, engineers and scientists [1-7]. It has even become a business for many companies that design ready-to-build kits to market and sell online. Yes, it would be easy to purchase and assemble one, but you would miss the fun of making your own and you would lose the opportunity of testing your knowledge and skills in spatial thinking and communicating. Still, you can learn a lot from these examples.

ABMs are fun to watch and play with, but, more importantly, designing and making such machines require knowledge and skills similar to those you are studying and developing in this course. ABMs can be found in different sizes with and of diverse complexity. For this project, we want you to make a simple but functional ABM. For this purpose, we prefer that you use and select mechanisms that we discuss in lectures and labs to complete your ABMs in the given time.

The best ABM would be the one that integrates the mechanical components with the housing (support-system/figure/walls/box holding the mechanical components) such that together they make a beautiful machine. There are three ways to achieve a successful ABM;

1. The housing is made beautiful (e.g. inspired by the art of origami – faceted figure), all mechanical parts are embedded inside it. The mechanical components connect different parts of the flexible housing to generate a beautiful motion. See Category 01 examples.

   NOTE: In this scenario, the mechanical parts should NOT be entirely hidden. The mechanism should be visible at least from one side for instructors to see.

2. The mechanical parts are visible and are integrated with the housing such that they enhance the overall visual beauty of the machine and its motion. See Category 02 examples.

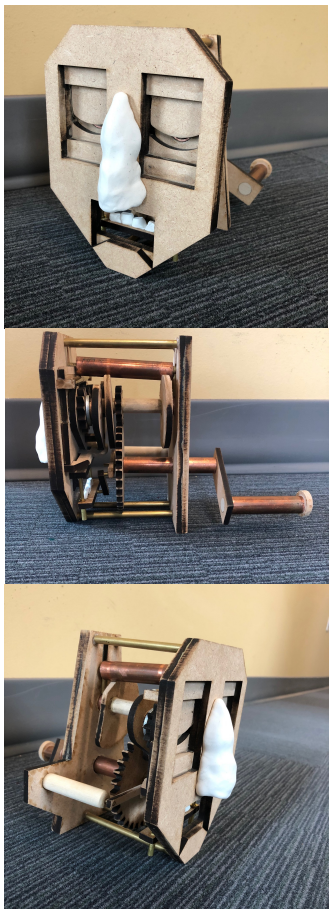
3. The mechanical parts ARE the beautiful machine. See Category 03 examples.

Please note that none of the above ways include a separate mechanical box to hold the mechanical components inside.

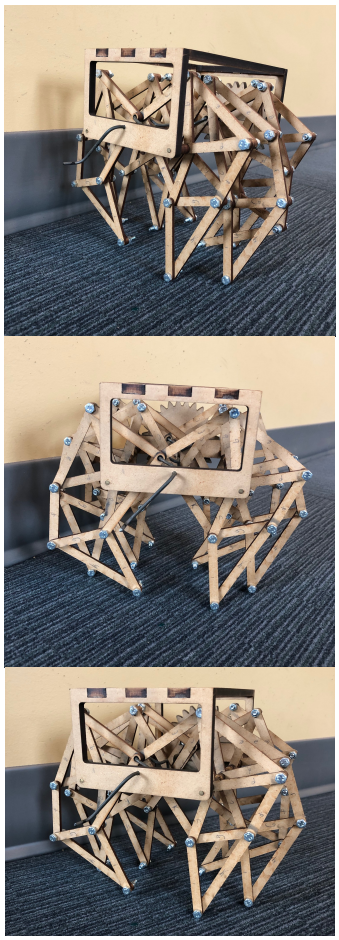
Constraints

1. The machine must be under 40 cm length, 40 cm depth, 40 cm height. Smaller is better.
2. The resultant motion or output should be inspired by Nature (human, animals, wind, water, plants, etc.).
3. The ABM should be designed with an intention to be actuated by hand usually through a manual crank.
4. The ABM must have at least one kind of linkage mechanism (preferably 3+ linkage mechanisms).
5. The ABM must have at least two mechanically distinct motions (in other words, it cannot have same mechanical motion repeated multiple times to generate its overall effect, e.g., see dragon(ish) example in Lecture 07 slide-12).

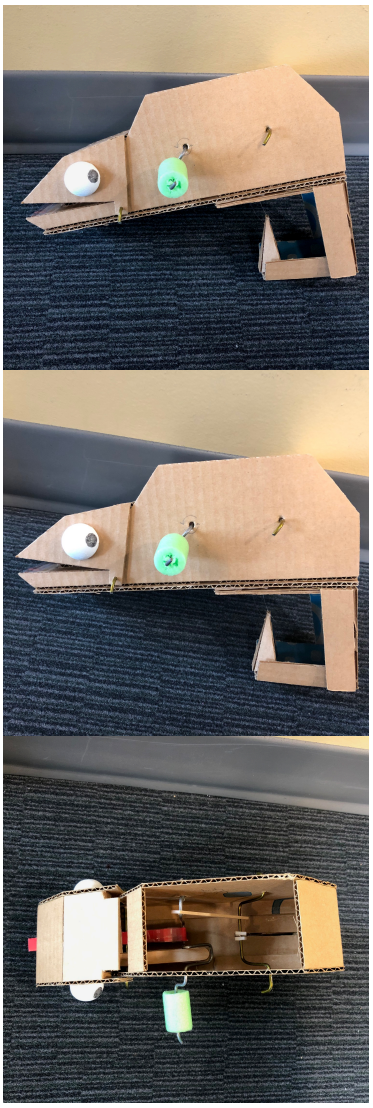
Category 01 ABM – housing holds the mechanical parts (Housing is made out of paper, folded and glued to achieve origami effects)



Category 02 ABM – the mechanical parts integrate with the housing to create the overall effect. In this case the skull and the complexity of ideas in one's head are depicted using complex chains of gears, cams and linkages.

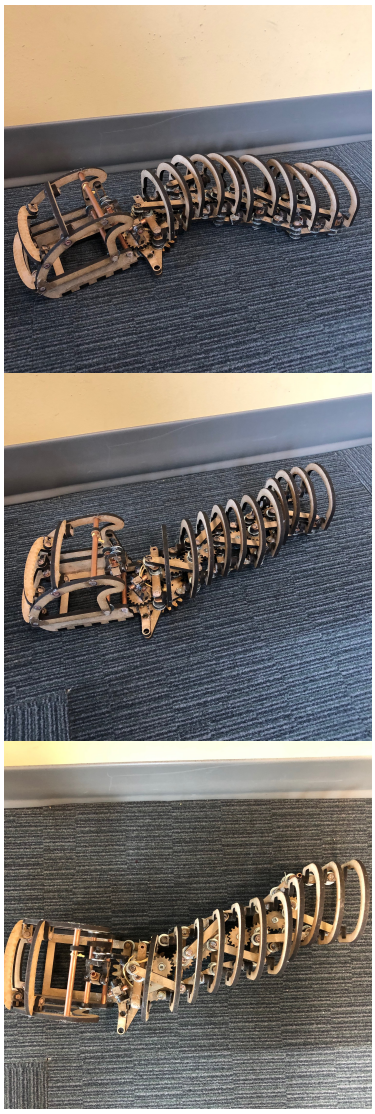


Category 03 ABM – the mechanical parts are the machine. No extra part is added without a mechanical function/output. The mechanical parts move in a motion inspired by a crawling insect, when the crank shaft is operated.



Category 01 ABM – housing holds the mechanical parts Housing is made out of cardboard. Once again it is made beautiful by using geometric shapes to represent a curvilinear chameleon.

Category 02 ABM – the mechanical parts integrate with the housing to create the overall effect. In this case the linkage mechanism is used outside the elephant's body to represent its legs creating a beautiful walking motion.



Category 03 ABM – the mechanical parts are the machine. No extra part is added without a mechanical function/output; except the arches repeated to represent insect's body perhaps. The mechanical parts move in a motion inspired by a slithering snake-like insect.

Purpose

This is a more advanced project than your first and second creations (referring to the golf ball case project and the Lego digital gimbal project). In this project, you will create and combine several different parts into a working assembly. It is designed to advance your awareness of spatial thinking while improving your skills in creating and using different kinds of representations (sketches, OnShape models, physical models- this year we are not building physical models, keeping in with the online learning constraints). This project integrates and makes use of the individual lab exercises you have been doing. You will carry out this project individually (see Format section).

At the end of this project, each of you will give a presentation with a demo of your ABM during the last lab of the course. Throughout the project, the most relevant spatial thinking issues you explore are;

- Defining individual objects as part of an assembly,
- Determining objects' properties--dimensions and shape,
- Spatially relating their relationships and interaction with each other in the assembly, and
- Describing the functions of each part and the complete assembly when taken as a whole.

As you practice and learn about spatial thinking, you will begin to see that it both requires and helps with communicating ideas about spatial objects, in both 2D and 3D. You will use the representation techniques and tools you learned and practiced earlier in the course to explore your ideas individually, to share these ideas with others, and to demonstrate what you have learned. These techniques include sketching, digital modeling, partial physical modeling (as needed, not required), and composing different representations to market your designs! The TA and instructor will help as you make progress.

Objectives

The project's overall objectives are:

1. Analyze existing ABMs with respect to their structure, parts, and assemblies, in order to infer their functionality and category they fall under (refer to ABM categories in the table of examples).
2. Communicate your ideas about ABM with your class fellows in order to create concepts for a new ABM together.
3. Refine your ABM design using sketching techniques, such as multi-view and isometric drawings.
4. Using your sketches, convince your TA, instructor, and classmates that your idea will work.
5. Using your sketches, model the parts in OnShape and then create a working assembly that demonstrates your ABM's functionality.
6. ~~Create a physical model of your ABM using your sketches and SolidWorks model as a blueprint.~~
7. Present and demonstrate your ABM to the class using sketches, your OnShape model, physical models (if any), screenshots, animations, etc.
8. Prepare an individual sketchbook recording your thoughts and work about the project.
9. Prepare a short video demonstrating your physical ABM.

Process

You will complete the project through incremental and iterative phases. The main weekly instructions describing the objectives, deliverables, and assessment are given below:

Week	Objectives and Activities
Week 8 – Mar 15th	Study and analyze existing ABMs, sketch your ABM individually in several ways, present your design to the TA and later to the class. Make individual sketchbook entries.
Week 9 –	Refine your ABM design based on the discussion from Week 08. Come with multi-view drawings and

Mar 22nd	isometric drawings of your final chosen design.
Week 10 Mar 29th	Work on individual part-by-part sketches and start making each part using OnShape, based on the sketches.
Week 11 Apr 5th	NO LABS – Easter Monday. Start working on OnShape assembly. Make individual sketchbook entries.
Week 12 Apr12th	Complete OnShape assembly, complete your individual sketchbook and prepare final presentation (including a short video). Present and demo your ABM in the lab or announced date and location.

Although the process is listed linearly, we do expect that some aspects of your ABM will change throughout the process. For example, while creating your assembly, you may discover that certain parts need to be modified. Slight modifications throughout the process are accepted while major changes, such as a complete redesign, are not. In general, significant changes after **obtaining TA approval** of your design are discouraged. If you run into problems and feel change is required, you must obtain permission from both the TA and instructor.

Format

You will do this project individually; however, you will be asked to give your lab mates feedback on their designs.

Sketchbook

Each student is responsible for his or her own sketchbook. Sketchbooks record ideas; thoughts; notes; sketches; and problems and their solutions (and lots of other things). A good sketchbook, rich in its record, is an absolute hallmark of an effective designer. Show your sketchbook each week to your Lab TA and bring it to the final review. Improvement from week to week will count!

Assessment & Deliverables

The ABM project is worth 15% of your final IAT106 grade. Each week's handout will clearly list the assessment marks. On the day of your final presentation, each group is required to submit all digital deliverables to Canvas. The overall distribution of marks is as follows:

Deliverables	Points
Sketches of ABM, oral in-lab presentation	75
Sketches of ABM parts, OnShape parts	75
OnShape assembly	100
Onshape final model, Video & Presentation	250
TOTAL	500

Assessment of the Final Digital model

We will assess your digital model according to the following criteria. Each will be equally weighted.

1. **Mechanical Simplicity.** We encourage teams to use simple mechanisms. If the same output or resultant motion can be achieved using a simpler mechanism, then the students will be given fewer points. Unnecessarily adding complexity to a simple motion will have negative impacts.
2. **Technical Appeal.** Are all parts of the ABM carefully designed? Does your ABM have the technical appeal in terms of creatively using the simplest available mechanisms? Does the detailing of the parts and assemblies make sense as a whole?
3. **Visual Appeal.** The final ABM must be one of the three categories explained earlier. Visually it should

appeal to the audience and be fun and surprising to the intended operator. We do understand that "visual beauty" is relatable but can be defined within a context, hence can be argued on. This assessment criteria may be graded in comparison with the other ABM submissions from your classmates.

4. **Your descriptor.** You provide to us an adjective or adjectival phrase that captures an important quality of your ABM. Here are some of the thousands of possible descriptors: cool, crisp, sharp, funny, ironic, spooky, silly, playful, modernist, baroque, medieval, ethereal, urban… This adjective or adjectival phrase MUST occur prominently in your presentation. We will evaluate your ABM based on how well it matches your descriptor.

The work submitted throughout the project must be your own. In case of plagiarism, the procedure defined in SFU policies as noted in the syllabus will be followed.

Badges (Bonus points):

There are some extra bonus points that each one of you is eligible for. In order to receive these bonus points, you will have to earn one of the following *badges*.

1. **The Prime Spatial Thinker** → will the best ABM voted by the majority of the class → 5 bonus points max.
2. **The Ultimate Designer** → one who cautiously designs the best solution, judged by the teaching team → 5 bonus points max.
3. **The Truth Charmer** → one who gives honest and constructive feedback on other student's reflections/ideas. The person will be chosen by the instructor → 5 bonus points max.
6. **The Best 3D Modeler** → This category is for a person who spent good time on modelling the details of the ABM digital representation → 5 bonus points max.

References and Useful Links

1. http://automata.co.uk/mainpage.html :Commercial and educational mechanical toys products
2. http://flying-pig.co.uk/index.php
3. http://www.cabaret.co.uk/
4. http://www.youtube.com/watch?v=XzQp-9GDpu8 <News clip on Cabaret>
5. http://www.youtube.com/watch?v=Azg1tsTpVo4 :Dog figure playing with ball>
6. http://www.mechanicalmonkey.co.uk/
7. http://www.zuko.to/kobo/english/e-works/e-ctop.html : Japanese Kit website
8. http://www.walterruffler.de/index1.html :Paper machines: exhibition and art of Walter Ruffle