Automaton

2019 Group 11-15

Lu Zihan (2A319)
Lok Peng Yee (2A318)
Jovi Lai (2A313)
Isaac Ho (2A308)

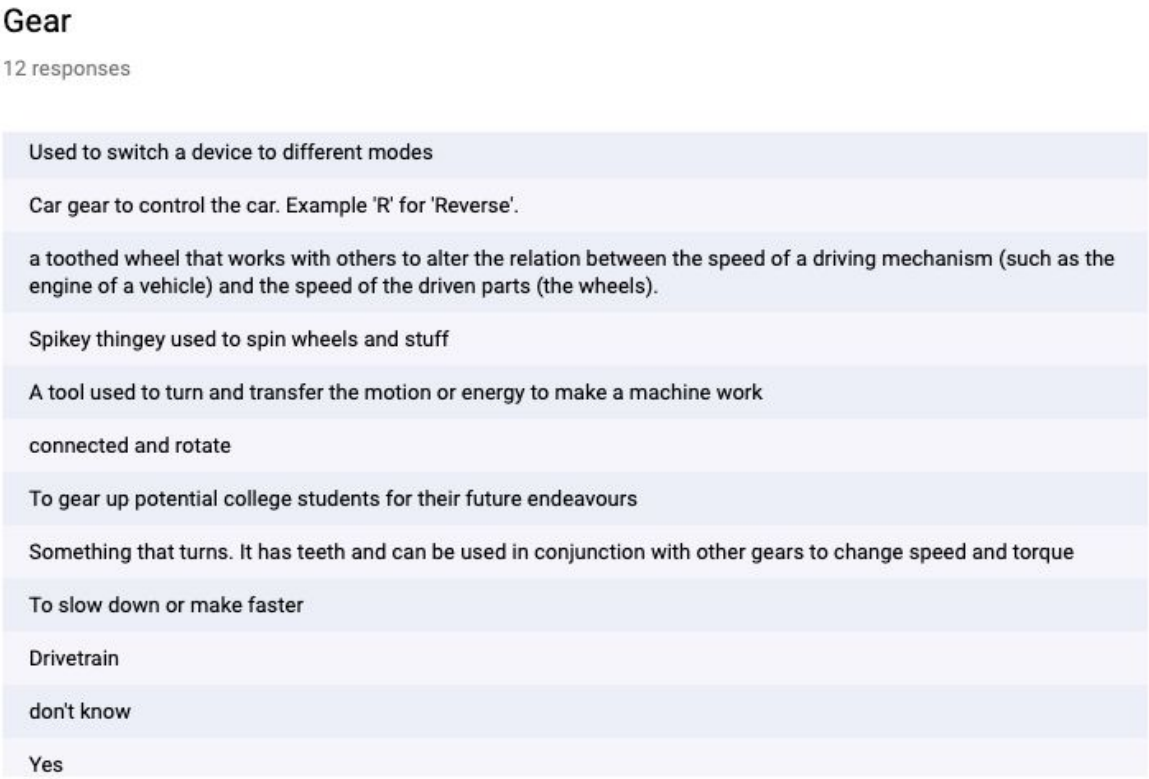
Hwa Chong Institution (High School)

ABSTRACT

A variety of daily objects around us are made of mechanisms like gears, chains, cams, and shafts, with some examples like the chain in the bicycle and the gears in a wristwatch. These mechanisms may spoil sometimes and need to be fixed. The owner needs to know what these mechanisms are used for, to identify the problem and correct it. However, most of the secondary school students we surveyed do not know about their purposes. This project serves to teach these students about the uses of the different mechanisms used in engineering through building a toy automaton and displaying its mechanisms that power its movements, as well as designing a poster that further elaborates the mechanisms' purposes in detail.

INTRODUCTION

To evaluate the necessity of our project, we surveyed 29 secondary two students to test their knowledge in the different mechanisms used in these engineering products. They could choose to leave the question blank if they did not know the answer. The results of the survey showed that most of them did not know about the purposes of the mechanisms:



Gear

12 responses

Used to switch a device to different modes
Car gear to control the car. Example 'R' for 'Reverse'.
a toothed wheel that works with others to alter the relation between the speed of a driving mechanism (such as the engine of a vehicle) and the speed of the driven parts (the wheels).
Spikey thingey used to spin wheels and stuff
A tool used to turn and transfer the motion or energy to make a machine work
connected and rotate
To gear up potential college students for their future endeavours
Something that turns. It has teeth and can be used in conjunction with other gears to change speed and torque
To slow down or make faster
Drivetrain
don't know
Yes

Crank

9 responses

No
a part of an axle or shaft bent out at right angles, for converting reciprocal to circular motion and vice versa.
A device you use to turn to trigger another mechanism to fulfill a purpose
Some spinning thing
To make someone cranky
Something that turns
don't know
Yes

As the answers are mostly incorrect and inaccurate, it shows that the students do not have much knowledge of the uses of these mechanisms. Therefore, as it is important for them to be aware of it, we have made a toy in the form of an automaton that displays its mechanisms. As they play with it, they can simultaneously study the mechanisms that are powering it and have an idea of what they do. We have also made a poster that gives an in-depth explanation of the different mechanisms, so users will understand them more thoroughly.

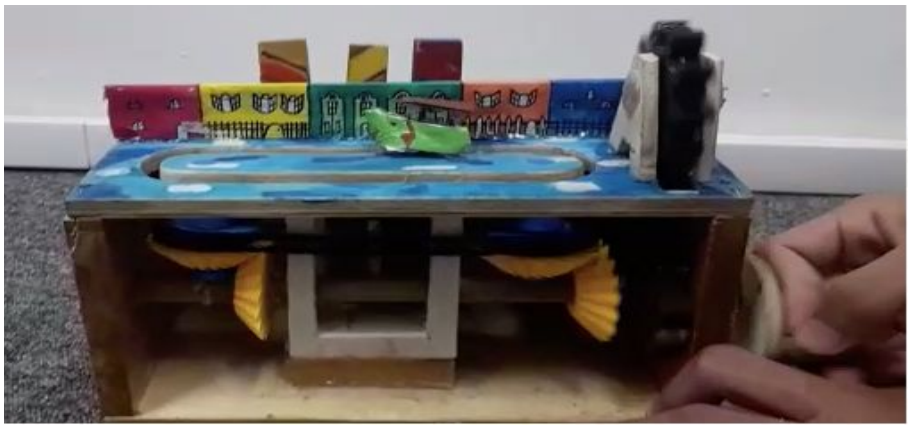
An automaton is a moving toy that by spinning a crank, certain instructions are performed. It is made of different mechanisms such as a crank, shafts, gears, and cams. It displays the mechanisms to the user so they can see what is powering the movements. This picture is an example of an automaton:

When the crank is turned, the crankshaft spins, causing the cam to spin, moving the monster up and down.

We decided to use the idea of an automaton to teach the users. Due to it being a physical toy, it would entertain them as they are occupied with spinning the crankshaft and watching its movements below. Therefore, we feel using an automaton to convey our ideas is the best way to keep the audience engaged, allowing them to stay productive in their learning.

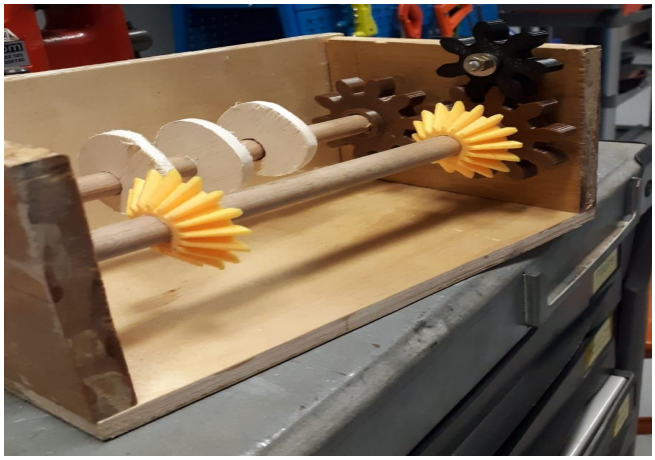
SOLUTION DESIGN

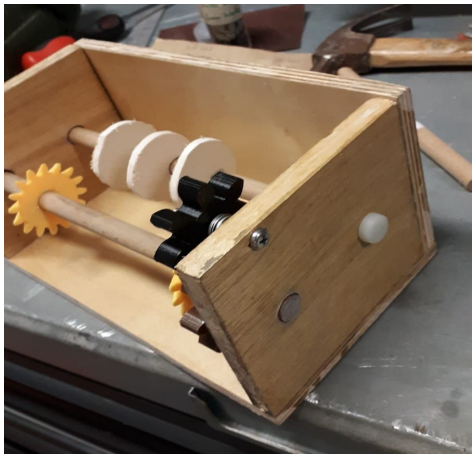
We decided to design and fabricate our toy automaton to teach the users the functions of the different mechanisms in engineering. Our Automaton is mostly made of wood, while we also used the school's 3D printers to 3D print the gears used as seen in the picture below:



When the crank is turned, the three buildings at the back that resembles skyscrapers will rise and fall; the boat will move in the path, and the ferris wheel on the right will spin. We have decided to choose a scene along the Singapore River so that our users can relate to it better and thus enjoy it more.

We have decided to use a twin crankshaft mechanism to power two layers . These photos below shows the twin crankshaft mechanisms:





When the crank is turned, the two brown gears at the back will turn, therefore spinning both shafts. The cams on the second layer power the skyscrapers rising and falling; the two gears in the first layer allow the ferris wheel to be set up and spin; the two bevel gears will power the boat using another mechanism.

While building the automaton, we encountered a few problems along the way. The first problem was that the gears would move about their positions due to the lack of friction between the gears and the shaft. When they move around, they will not be connected to the other gear, therefore the whole mechanism will be affected and will not work. Therefore, we decided to 3D print the gears differently, including a thicker layer in the middle, as shown in the picture below. This increases friction between the gear and the shaft, so the gears are less likely to move out of their desired positions.

Next, we used the mechanism below to power the boat:

4 bevel gears interlock with each other to transmit rotary motion from the horizontal crankshaft to the blue vertical shafts. The vertical shafts have a stopper on them to prevent the bevel gears from slipping down and away from their positions. This is seen in an enlarged picture below:

This is one of the two identical mechanisms used in the boat. The blue gear is glued to the bevel gear, which is interlocking with another bevel gear, so the blue gear will spin when the bevel gears spin. Its position is confirmed by the stopper above it, which is glued to the blue shaft, therefore the gear's position will be fixed.

A black chain is interlocked with both blue gears, and will continuously rotate horizontally when the two gears are rotating. A boat is fixed on the chain through the use of two sticks glued onto the chain, so it appears that the boat is moving in its path when the crank is turned.

Another problem faced at this stage was to fix this mechanism in its place, as it is difficult to fix a platform that is 'floating in mid air'. Therefore, we decided to put a stand in its place to fix its position. Lots of trial and error was carried out to find the perfect position where it both interlocks with the bevel gear and does not touch and get in the way of other mechanisms.

Finally, we made the cover of the automaton, as seen in this picture:

We had to cut the wood in openings where the skyscrapers rise and fall, the path of the boat, and below the ferris wheel. By working closely with the SRC laboratory assistants, Mdm Chua and Mdm Foo, we were able to cut it open at the desired locations. After doing that, we painted the cover and added artificial grass along the roads, before nailing it on top of the automaton.

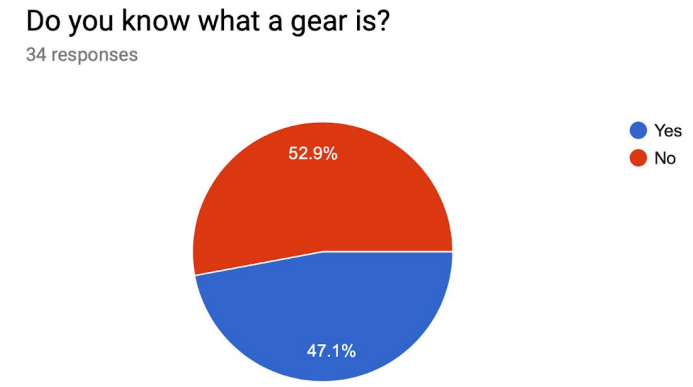
The last problem we faced was the path of the boat was cut too small, so the boat would constantly rub against the corners while moving. Therefore, we carefully filed off layers of the path until it was wide enough for the boat to move without any hindrance.

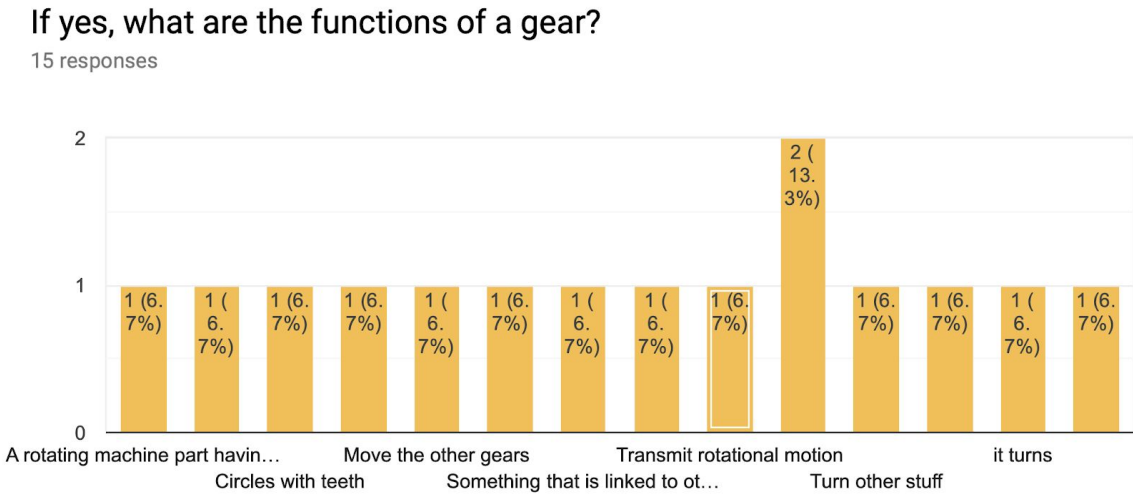
We created a poster to help users playing with our automaton to further understand the different parts of the automaton. Our poster included the functions of the different parts used in our automaton, some parts include, crankshaft, cams, gears and chain. This poster will be useful if the user is unsure of a specific part of our automaton. One problem we faced when making the poster is that there are some parts with a technical term and the users with not be able to identify the part in out automaton. This might confuse them or even cause a misconception. Therefore, we decided to colour code the different parts and mechanisms so that our users can easily identify the parts.

CONCLUSION

We conducted another test among 34 other students to test the effectiveness of our automaton and poster in teaching them the purpose of the different mechanisms used in engineering. We asked them about the purposes of these mechanisms before viewing our products, before showing them a video of the automaton at work, as well as

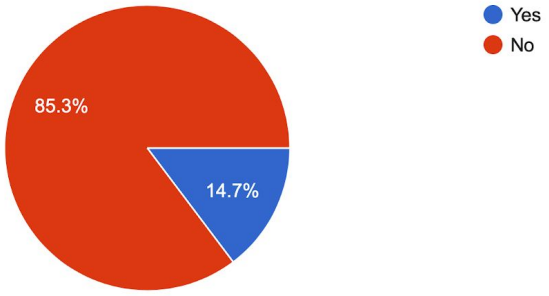
a picture of the poster teaching them the various purposes. We then tested their understanding after viewing our products. These are the results of their knowledge before viewing our products:





Do you know what a cam is?

34 responses



If yes, what are the functions of a cam?

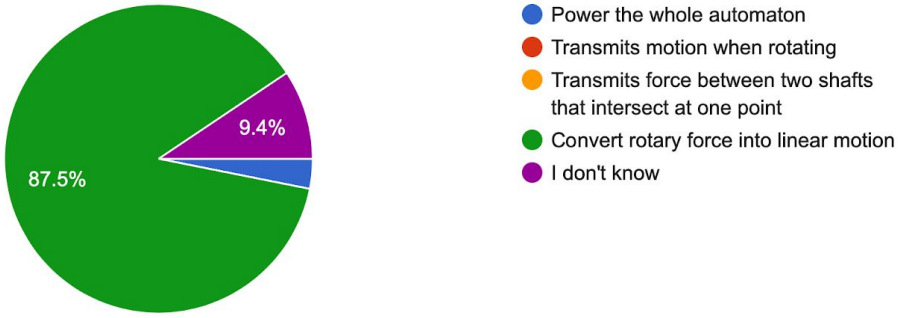
5 responses

-
Somewhat like a gear, also rotating happily around a shaft, but gets its mood swings and shoves against something else
Convert rotational motion into a reciprocating horizontal motion
Turn rotating force into up and down force.
to convert crankshaft to linear rotation

The answers show a majority of these students do not know about these mechanisms prior to viewing our poster. Those who knew also did not give accurate answers. They were given the poster and the video of our automaton to view after that, and a multiple-choice test was given to assess how much they learnt from our products. These are the following results:

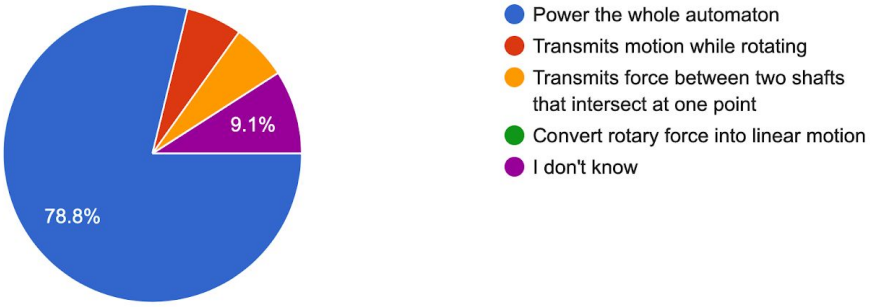
What is the purpose of a cam?

32 responses



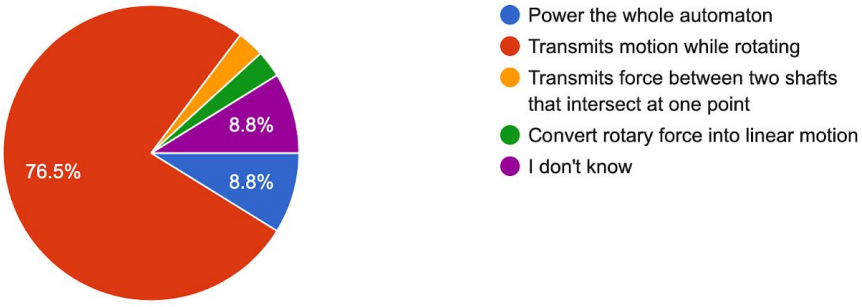
What is the purpose of a crank / crankshaft?

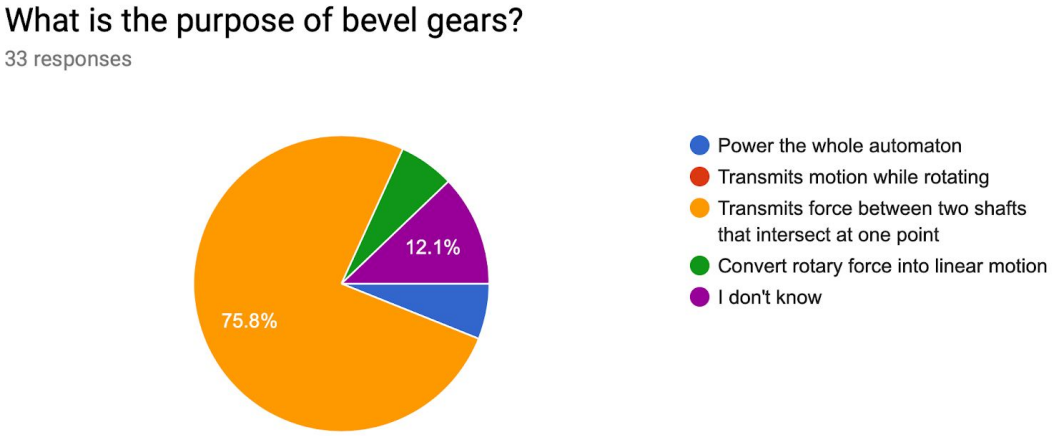
33 responses



What is the purpose of gears?

34 responses





A large majority of students were able to get the correct answers, showing that they mostly understood the mechanisms' purposes. Therefore, our project was helpful in teaching them about the various uses of mechanisms used in engineering.

ACKNOWLEDGEMENTS

Firstly, we would like to thank our mentor, Dr Kelvin Tan, for guiding us along this journey. He has given us unwavering support for any questions and doubts we have and has always been there to help us when in need. He even sacrificed part of his holiday to improve our project with us.

Secondly, we would like to thank the laboratory assistants in the Student Research Centre (SRC), Mdm Chua and Mdm Foo, for assisting us in using the various machines, like the scroll saw, when we are using it to cut pieces of wood needed in the construction of the automaton.

Thirdly, we would like to thank the users who participated in our needs analysis survey. They have given us constructive information and statistics to help us in identifying our target audience, as well as whether our project was necessary.

Lastly, we would like to thank the teachers in our Proposal and Mid-Term Evaluations, for giving us relevant feedback so that we have a path to follow and know what else we lack to improve upon.

REFERENCES

Alo, B. (2019, January 10). What Are the Functions of a Camshaft? Retrieved from https://itstillruns.com/functions-camshaft-6130062.html

Automaton. (2019, July 18). Retrieved from https://en.wikipedia.org/wiki/Automaton

Engineering, W. (2015, December 03). 10 Mechanisms That Are Oddly Satisfying To Watch. Retrieved from https://www.youtube.com/watch?v=lXO69eRWkkY

Futuristic city: How the Singapore skyline changed over the past decade. (2018, October 11). Retrieved from https://www.lifestyleasia.com/sg/living/property-interiors/futuristic-city-singapores-skyline-changed-past-decade/

Gear. (2019, July 18). Retrieved from https://en.wikipedia.org/wiki/Gear

Lets Take a Ride. (n.d.). Retrieved from https://rivercruise.com.sg/

To get a picture of the boat on our automaton

Limer, E. (2017, November 14). 7 Everyday Objects With Brilliant and Simple Designs. Retrieved from https://www.popularmechanics.com/technology/gadgets/g2180/everyday-objects-genius-design/

Mechanical, K. (2018, March 04). MECHANISCAL MECHANISM - chain drive. Retrieved from https://www.youtube.com/watch?v=oS4VuXM0SGc

Moshe Safdie, the architect changing the face of Singapore's skyline. (2019, June 03). Retrieved from https://www.lifestyleasia.com/sg/culture/architecture/moshe-safdie-the-architect-changing-the-face-of-singapores-skyline/

Staff, C. M. (n.d.). 6 Different Mechanisms We Use Everyday. Retrieved from https://www.creativemechanisms.com/blog/6-different-mechanisms-we-use-everyday

What is a crankshaft? (n.d.). Retrieved from https://www.quora.com/What-is-a-crankshaft

What is an automaton. (n.d.). Retrieved from http://www.mechanical-toys.com/mechanisums.htm

Wonderfully Whimsical Kinetic Wooden Automata That Come Alive With the Simple Turn of a Handle. (2018, March 09). Retrieved from https://laughingsquid.com/kinetic-wooden-automata/