TEAM 25: REPORT

NANA STATION

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DESIGN BRIEF

Rube-Goldberg machines are machines that are complex and overcomplicated but perform a very simple task. For Design Cycle Challenge Week, Team 25 ('Nana Station') will collaboratively design a Rube-Goldberg machine that will seamlessly work with other teams's machines. It will contain three actions, two potential energy sources and will reflect our assigned stimulus, an image of two cans being attached by a string.

DESIGN SPECIFICATIONS AND TESTS

Design Specifications	Specification Tests
The target audience will be the KIS Secondary School community.	It will be showcased on Friday at the end of Design Cycle Challenge Week with other MYP Rube-Goldberg machines.
Our team's Rube-Goldberg machine will connect with Team 24 and Team 26's machines through dominoes.	The machine will be powered through connecting dominoes from Team 24. The end of our machine will lead as dominoes to Team 26's.
The Rube-Goldberg machine will take above fifteen seconds to complete from start to finish, to show its complexity.	A stopwatch can be used to time the running of the Rube-Goldberg machine from the start to the finish.
It must function from start to finish without any outside interference by people. The machine will be able to run itself through the energy of the dominoes from Team 24's machine.	During the final test, the Rube-Goldberg machine will not require any person to push or fix it while it is running.
It will fit into the space provided by the school on the auditorium.	There will be no pieces that come out of the area during the final testing.

Design Specifications	Specification Tests
It will contain at least three 'actions'.	During the final test, there will be at least three distinct actions involved in the process of the machine.
It will contain at least two potential energy sources.	During the final test, there will be at least two areas in the machine that hold potential energy, such as a marble.
It will reflect our assigned visual stimulus.	There will be a clear explanation of the visual stimulus and how a justification of how it is reflected in our machine in our final report.
It will work seamlessly with other machines.	Through the connection with Team 24's machine and Team 26's machine, our machine will be able to work seamlessly with the other KIS machines in the final testing- there will be no need of anyone to intervene and start the machine because it will already be connected and powered by other machines.

RESEARCH

What is a Rube-Goldberg machine?

A Rube Goldberg machine is a invention, device deliberately over-engineered or overdone machine that performs a very simple task in a very complicated fashion and will usually includes a chain reaction.

What is potential and kinetic energy?

Potential energy is the same as "stored" energy. It is when you lift something up, you give energy to it. After you drop it, it turns to kinetic energy. Potential energy is when something is staying still and will move later. For example when a wrecking ball is swinging. When it is at the highest point it is potential energy and when it is swinging it would be kinetic energy.

Kinetic energy is when something is moving. The word "kinetic" in Greek means to move. Kinetic energy is the energy of motion. The faster the body is working the more kinetic energy is produced.

What are different types of simple machines?

Wedge: A type of inclined plane that has a double slanted surface.

Gear: A modification of the wheel and the lever where there is also teeth around. Gears work in teams and they help to move each other. The first gear is called a driver gear and the final gear is the driven gear.

Pulley: A pulley is a device, usually a wheel, on an axle that is used to lift a load. Two or more pulleys will allow the load to be lifted with less energy.

Lever: A lever is a tool that pries something loose. It pivots (turn) against a fulcrum (point). The claw end of a hammer which pries a nail loose is an example of a lever. Another example is a balance where the input force causes something to be released (eg. a rock) as the output force.

Inclined plane: A flat surface that is slanted and can help you move objects when they are rolled up or down the side. An example is a ramp.

Wheel/axle: A wheel is a lever that uses rotation to make things move. It is usually a circular object with a horizontal bar in the center. When force is applied, it rotates, which can be used to increase other forces.

Screw: A screw is a simple machine that requires the use of other simple machines for it to work. It is used to crush objects or to press them together.

What are Isaac Newton's Laws of Motion?
Isaac Newton developed the three Laws of Motion during the late 1770s to explain how forces change in relation with an object's motion.

1. *Every object in motion tends to remain in motion unless an external force is applied to it:* every object will remain at rest or continue to move at a constant speed unless an outside force interferes with it.

2. *The relationship between an object's mass (m). Its acceleration (a), and the applied force (F) is F=MA*: if a force acts on an object, the object will accelerate in the direction of the force. The greater the force, the greater the acceleration; the greater the mass, the lesser the acceleration.

3. *For every action there is an equal and opposite reaction*: when an object is pushed or pulled, the force meets with an equal opposite force (the reaction force).

PROCESS JOURNAL: DESIGNS AND CHANGES

Day 1: First Design *(written at end of day)*

Today we began by inquiring into Rube-Goldberg machines and related concepts, such as potential energy and simple machines. Our design today was based mostly from our observation that many Rube-Goldberg machines make extensive use of dominoes, so we used that as the main source of energy that would push things forward.

The design used dominoes going up a step of books that would then hit a cup. The cup triggered another domino chain that then went up another step of books which then rolled down a marble that trigged one last domino chain. The design turned out to be very simple and did not fulfill our specifications- intervention was still required and the whole process took a very short amount of time. Upon completion, we found it to be repetitive and unimaginative. A literal reflection of the visual stimulus was first added through two cups being attached by a string, but this did not work so we had to take it out.

Two members were absent, so we found it hard to divide up tasks. Tomorrow we intend to work on this design and increase its complexity so that they match our specifications, and to find a way for it to reflect our visual stimulus.

Day 2: Changes to Original Design *(written at end of day)*

Today, our collaboration improved because all group members were present, whereas the previous day we only had three people. Therefore, we were able to effectively delegate tasks among the group. We brainstormed creatively together.

Our plan for today was to increase the complexity and creativeness of the machine and we intended to do that by adding more simple machines. We retained the majority of the framework of the original design, but made changes to it. We spent time creating and adding a pulley to the Rube-Goldberg machine. The pulley required a marble to drop into a cup which will then, through being tied to the wheel, would pull up the marble and this would trigger a domino chain reaction through a string. We also added in a labyrinth style wedge. This would delay the marble's speed and add in an extra layer of complexity to the machine- we hope this would allow the machine to come closer to fulfilling our design specifications. These were adjustments made to the beginning of the machine. However, we did not have time to make any changes to the last parts of the machine- we intend to make that a priority for the next day.

We added in another literal interpretation of our visual stimulus in our pulley. It involved two cups with a string. The fact that we connected the two parts with a 'string' of dominoes could also be a metaphorical interpretation of the visual stimulus.

We will find out how well the machine does in terms of consistency tomorrow during the consistency test.

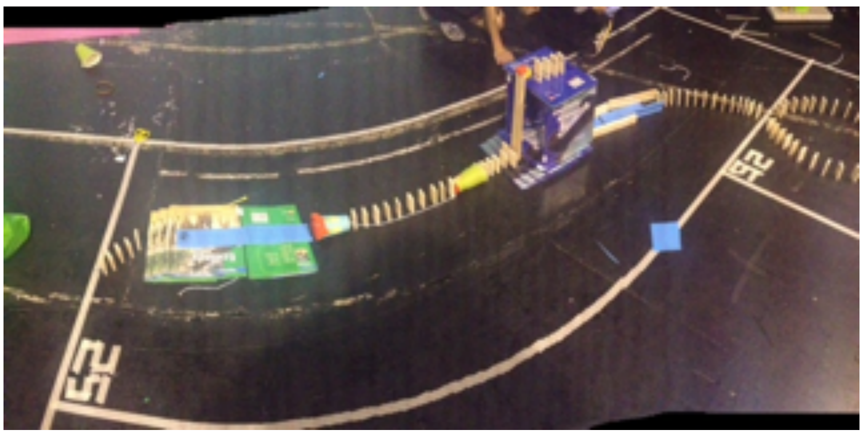
Day 3: Reflection of Second Design and Changes *(written at start of day after consistency test)*

We started the day off by testing our machine from the previous day for consistency. During these tests, the machine failed two of our specifications. It certainly did not reach our fifteen second goal, failed to work from start to finish without intervention; these are all specifications that we consider important. The challenge for today, therefore, will be to make our machine fit with these specifications. On the bright side, the machine, despite using intervention, did manage to work seamlessly with other groups when we tried for fun, and it contained three actions and two potential energy sources. It also contained both a literal and metaphorical interpretation of our visual stimulus and fitted into the space provided.

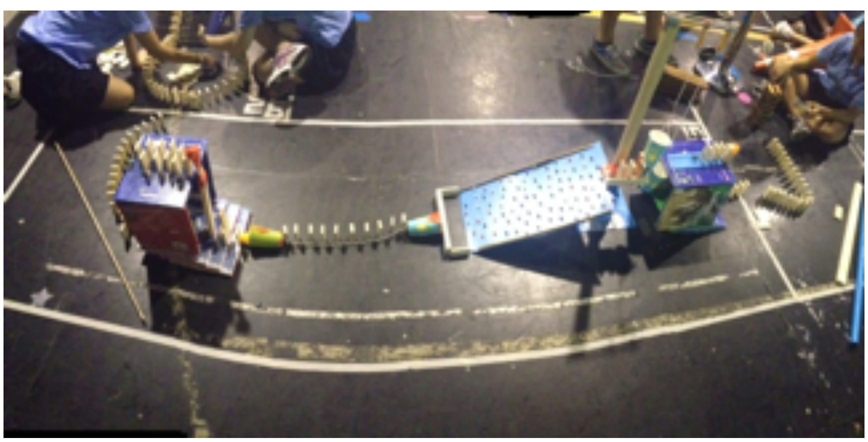
As today is the final day we have to work on the machine before the showcase, the design we make today will be final.
Changes we intend to make are:

- Fixing the pulley's mechanics
- Adjusting pin-board
- Redesigning the center and end o the machine
    - Using the tube to send a marble for more consistency
    - Creating a new design for the end

RANGE OF DESIGNS



Design 1: refer to Day 1 in Process Journal for description. The design was repetitive, required intervention, simple and uncreative. We attempted to use a cup connected by a string in this design to fit with our visual stimulus but failed to do so.



Design 2: refer to Day 2 in Process Journal for description. It had both a literal and metaphorical interpretation of our visual stimulus. We added in more simple machines like pulleys and wedges. Overall, however, the machine still required intervention to help it run from start to finish; it was also extremely inconsistent.

FINAL DESIGN: EXPLANATION & JUSTIFICATION

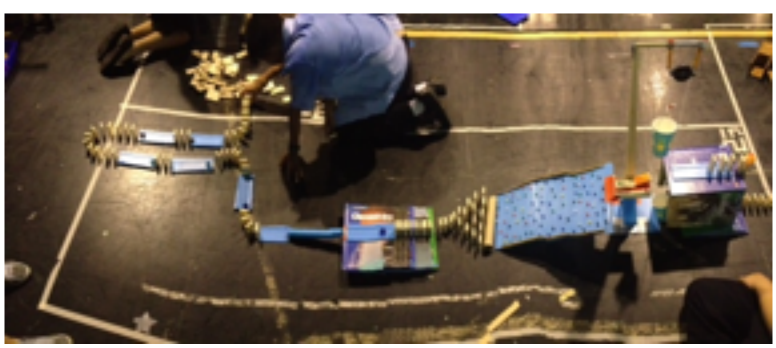
The final design starts with dominoes that lead from Team 24's machine which go up a stair of books. This hits dominoes that then rolls a marble into a cup pulley that had a wheel to pull.. The pulley causes another domino to push another marble down a labyrinth-style pin wedge, which hits a toilet roll that rolls over more dominoes. These dominoes trigger a marble that rolls into a pipe and falls into more dominoes. This leads to a chain reaction in a path consisting of dominoes and marbles.

This was the result of our reflection of the weaknesses of our previous designs. The biggest weakness of our second design had been its inability to work by itself from start to finish; it failed to do so in any of our consistency tests. Therefore, our final design focused on the ability for the machine to be able to run without any intervention by the team members during its process. We chose not to focus on achieving our specification of having the machine run for at least fifteen seconds, because now that the speed test was no longer going to be held, it was no longer needed for the machine to have speed; we felt that if adding complexity for speed would mean an inconsistent machine, we would rather have a less complex but more consistent machine. This machine reflects this intention; the start and middle of the machine consistently worked, while only the ending of the machine that involved a track of marbles were sometimes inconsistency due to the marbles sometimes going off-track.

Another reason why we chose this design was because of the fact that we feel it is aesthetically pleasing and sets off many chain reactions, through dominoes and marbles, which is one of the defining features of a Rube-Goldberg machine based on our research. The track also looked similar to the train track, which would fit in with our team name, 'Nana Station', a BTS train station.

Clear improvements have been made from the second design in accord with our intentions: instead of relying on the very inconsistent paper cups, we now switch to solely using dominoes and marbles which are much more accurate and consistent.

Our final design reflects our visual stimulus in a variety of ways. First, the pulley uses two cups connected to the string, which is exactly what our visual stimulus is. This would reflect the importance of our visual stimulus in our machine in the way that the pulley involving this is one of the most complex parts of our machine and both cups have to be in sync with each other for their weights to cause the other to react; since this complex piece is in the start of the machine, if it fails, the rest of the machine would also fail, as a sign of our emphasis of this visual stimulus. There are also other areas of the machine that reflects this stimulus. We have many paths created from futureboard- this is an interpretation of the string. In children's games such as the tin-can telephone, the string can convey sounds and voices over; here, in the track, we use the marbles as a symbol for the strong which moves energy over from domino to domino. (The principle is similar, but the medium is different). However, we had to take out our old interpretation of the stimulus as being a connection between two distinct main parts of the machine, because the second pile of books that was connected to the first was too high and we were unable to get the dominoes up.



EVALUATION OF FINAL DESIGN

Reaching the end of the design cycle, the machine had gone through numerous changes. Although retaining the basic framework of starting with a stair of books, all the other parts of the machine changed; more simple machines such as pulleys, wheels and wedges have been added, the second stair of books had been replaced with a marble-domino track, etc. These changes have been thoroughly documented in our Process Journal section of this report.

Our machine worked relatively well when compared with our two previous designs. There were much fewer problems and the working was almost seamless, with only the track of marbles sometimes working incorrectly because the marbles do not hit the dominoes, so intervention was still needed there. However, the rest of the machine performed correctly and was usually seamless. We managed to hook up with Team 24 and Team 26's machines.

The final design matches with the majority of our design specifications. We succeeded with many of our specification tests. It was showcased with other Rube-Goldberg machines for our target audience, the KIS Secondary School students. It was powered through dominoes from Team 24 and connected with Team 26. It fitted into the space provided. There were over three actions and two sources of potential energy. We have also provided a clear justification and explanation of how our machine reflects our visual stimulus in this final report.

However, there are some specifications that we have not yet managed to fulfill. For example, the machine is still unable to function seamlessly consistently without any help from team members from start to finish, which was actually the biggest goal we had for the final design. In the last test, the machine was actually able to run itself, but it did not run itself properly- the marble, instead of going through the tube, went right off the track but still hit the dominoes. While the machine worked, it was not seamless and required luck. Another specification that we were unsure about was the specification regarding the amount of time. We did not get a chance to time the final test, but during one of our trial runs the machine took 18 seconds to run. However, at that trial the marble had been stuck on some spots, so that could have taken up at least three to five seconds. Therefore, it would be reasonable to assume that we had not yet completely fulfilled that specification.

The most major point for improvement would be to ensure that it consistently works seamlessly without requiring any help. To do this, we would need to make sure that the marble tracks were better designed so that the marbles did not go off track and would always hit the dominoes, which would always hit the next marble. This could be improved by changing the design so that the dominoes and tracks curve too much and was straighter, which would allow the marble to hit the next dominoes more easily. Another way to improve it would be adjust the pipe so that the marble would always go through.

The second point for improvement that we would make would be to increase the complexity of the machine. To do this, we could have added more simple machines, such as a lever. In fact, a catapult would be an excellent addition to our design. If we did this again, we would probably use much more elevations which would allow us to make the design more complex; we had not done this for the design because no one had an object that was tall enough to use, and we also did not have time to design something that would lead the dominoes or marbles up a very tall object.

A final point for improvement would be to use tools other than marbles and dominoes in the design. With so many marbles and dominoes, the design could be viewed as repetitive, although we did use the marbles and dominoes in a variety of different ways. However, we could perhaps have incorporated other objects like balloons, toys, and wheels into the design.

In conclusion, while we managed to create a Rube-Goldberg machine that reflects our visual stimulus and fulfilled the majority of our specifications, its working was still not seamless and we could have challenged ourselves to make the machine more complex.

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