SCHOOL OF ENGINEERING

TAYLOR'S UNIVERSITY

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PRJ60203 - Engineering Design and Ergonomics

Project Portfolio

Ergonomic Food Trolley

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Bachelor in Engineering (Honours)

Mechanical Engineering

Group Details: *Team 5 Cups*

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About Me

Name: Yap Jin Teck
DOB: 18 SEP 1998
Semester 2 of Mechanical Engineering at Taylor's University
Finished my Foundation in Science in Taylor's University.
I have chosen to study Mechanical Engineering is because of the interest and appreciation I have gain on cars and airplanes such as the very complicated engines they have and also various engineering designs that have been implemented in them.

Mission Statement

After graduation from this course, I hope that I can become a automobile engineer that may help out in designing a better and more efficient automobile for future users. I hope that I would be able to utilize what my degree course have taught me in terms of experiences when working as an engineer as it is very useful when working together with a team.

Personal S.W.O.T

	Useful	Harmful
Internal	Strengths ● Cooperative ● Hardworking ● Adaptable	Weaknesses ● Hot headed ● Easily frustrated ● Lack of planning
External	Opportunities ● Advices taken from seniors and other more experienced people may help out in future projects ● Better understanding of members to ensure smoother discussion and planning.	Threats ● Manufacturing stage may be prone to manufacturing accidents. ● Financial issues ● A competitive job markets results in high employment rate

Achievement of LOs

LO1: Produce useful ideas and concepts using Cognitive Ergonomics.

We have carried out couple of brainstorming sessions to figure out what are the criterias needed for an ergonomic project. With some lengthy brainstorming, we decided to improve food trolleys or multipurpose trolleys to allow for more ergonomic.

Table 1: Ergonomic Checklist

Ease of Use
We have used the anthropometry data to reference for the best height for the best posture for the users.
Comfort
We want to ensure that the user feels comfortable using the trolley to ensure proper ergonomics.
Productivity
With the better and simple design, it will be faster and easier to place items on the trolley without hassling about bending over.
Aesthetics
Optional beautification is considered to make the trolley more attractive.
Safety
The trolley design has been thought out so that the design allows for safe operation without causing injuries to users.

The trolley was selected in this project as we realise it is sometimes difficult for users to use a food trolley for multiple people in a confined space as you need to bend over to place food trays in multiple layers.

By preparing the ergonomic checklist, I learn that when planning a project, it is important to have criterias to achieve to have a proper planning of the project. Our project emphasises the importance of the ease of use and also the comfort of the user. Other factors that are considered includes productivity, safety and aesthetics. A conceive checklist is also produce to reinforce our decisions to go ahead with the idea.

Table 2: Conceive Checklist

Desirability - Current food trolleys often times requires users to bend over to to put trays at lower layers when top layers are occupied.
Technologically Feasible - The trolley requires no coding. But chains and sprockets are used and tension on the chain and sprockets is needed to ensure trolley is secure when in use
Economically Viable - The product is built within a budget of RM400 which is economical for the consumers.
Environmentally Friendly - Most components used are recyclable which can be reused or remanufactured.
Legal and Ethical - The product does not have any legal and ethical issues as it is just a trolley.

Table 3: Ergonomic Principle

Physical Principle	Cognitive Principle
Reduce Excessive Force - The team hopes that the trolley can help reduce excessive force applied on the user's back.	Provide Instantaneous Feedback - Due to the chain and sprocket system is fully mechanical, there are no electronic parts involved, which reduces the probability of input lag.
Minimise Fatigue - We are trying to minimize the fatigue of the user when using the trolley by implementing moving platforms.	Use Pattern - The simple mechanism of cranking the sprockets when needing to lower to raise the tray when needed.
Easy Reach - We have made a chain and sprocket mechanism to allow users to place items on the trolley without reaching down when needed.	Use Stereotype - A crank is used as it is known to raise and lower platforms.

We have also decided on the trolley project based on the physical and cognitive ergonomic principles that we have learned during our lectures. While manufacturing the project, I have learned that a project should be manufactured based on the physical and cognitive ergonomic principles as it is important for the user to have good ergonomics when operating the prototype to allow for better productivity and better overall safety.

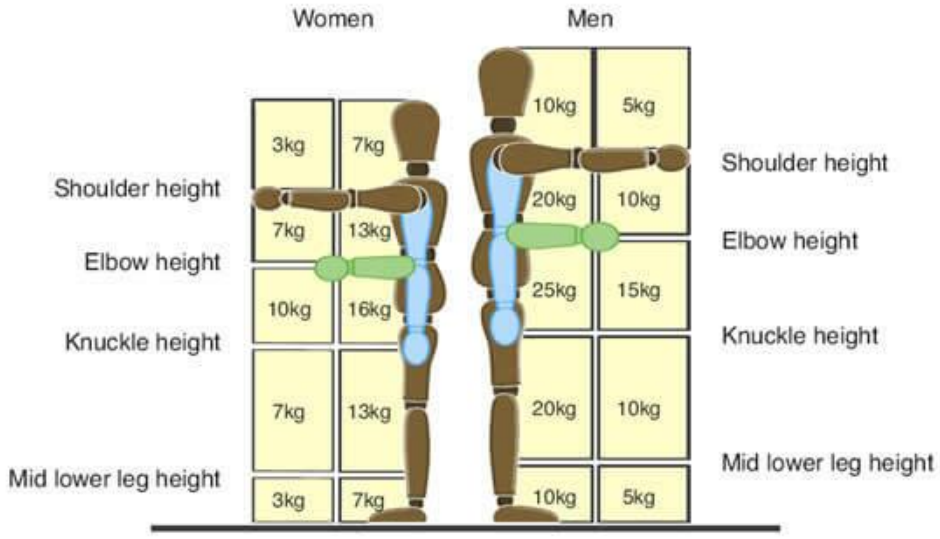
LO2: Design a system that solves a complex engineering challenge with an emphasis on Human Factors.

Our trolley has been designed and manufactured based on a physical system. Electronic systems are not used as it is just a simple trolley system.

Table 4: Physical system and its subsystem

Physical System
Chains and Sprockets mechanism - To reduce the force on the user when operating the trolley, chains and sprockets are used to allow tray to move to different elevation when needed.
Foldable Tray system - In an effort to reduce the footprint of the trolley, a folding mechanism is designed around the chain and sprocket system to allow the trays to be folded nicely when not in used and extended when used.
Brake system - To prevent tray from slipping and falling in an undesirable speed, a brake system has been used to lock the sprocket in place when needed.

In this trolley prototype, our team has taken the anthropometry data of the height of the average malaysian in male and female. We also taken the correct posture of normal trolley operation into consideration when designing the trolley prototype.



Average weight a human can carry without hurting them

Country	Average male height	Average female height
Lithuania	176.3 cm (5' 9.4")	
Malaysia	164.7 cm (5' 4.8")	153.3 cm (5' 0.4")
Malta	169 cm (5' 6.5")	159 cm (5' 2.6")
Malawi	166 cm (5' 5.3")	155 cm (5' 1.1")

The average height of male and female in Malaysia in relation to other countries

During ongoing research for this project, I have learned that it is important to have a design based on the anthropometry data found for the specific need in the project. With the data acquired, we are able to find the best height and posture for users to carry their items in and out of the trolley when needed.

LO3: Evaluate the occupational health and safety of an engineering system as well as its success in being sustainable.

The team has identified several possible failures and or unsafe factors that may occur and have list them in a product failure and unsafe table.

Table: Product failure and unsafe

Failures	Unsafe
Termite Infestation - The prototype we are manufacturing is made out of wood. This may attract termites if not stored properly.	Trays hitting users when folding - Due to the nature of the design of the product, when the tray extend and or retract, the trays will swing towards the user, this may hit the user when user is unaware.
The breaking of bearings - As the project ages, the bearings may fail due to the high tension force from the chains and sprocket.	Fingers caught on sprockets and chains - Sprockets are relatively sharp. With the tension required for the chain, it will have a lot of clamping force if a finger is caught between the sprocket and the chain.

Table: End of life factors of each materials and components

Old items	Disposing method	New items
Bolts and nuts	Reuse	Bolts and Nuts
Castor wheels	Reuse	Castor wheels
Wood beams	Recycle	Smaller wood
Sprocket	Reuse	Sprocket
Chains	Reuse	chains
Tray holder	Recycle	Smaller wood
Cable	Recycle	Smaller cable
L brackets	Reuse	L brackets
Aluminium plates	Recycle	Aluminium ore
Screws	Reuse	Screws

Reflection

Artifact Assessment 1

During construction of the first prototype, which was entire made out of cardboard and pvc pipe in small scale, we have managed to point out future problems that we will be facing during the construction of the actual prototype. Even though we have used toilet roll and cardboard as the sprockets and chains, it is apparent that the system needs to be precise in order for the system to operate with precision. It also showed us that the detailed design of the project should be thought out well before manufacturing the product.

Artifact Assessment 2

We had issues meeting deadlines for the second artifact assessment. This is mostly due to the poor detail given during designing phase, causing members to delay the construction as the amount of material needed for the project was not given in time. This caused the manufacturing time to be shorter than expected. Added to the fact that the lack of dedication from members caused a short manufacturing time to be even more constrained as no other helping hands and brains are present to tackle the problems surfacing due to the lack of a detailed design. This has shown to be the biggest challenge we had faced the entire project as it has led to a not so ideal outcome for this project. A lot has been promised but nothing has been achieved due to miscommunications, lack of experience, and also the general lack of responsibilities of separate parties. I have learned from this project that communication is key in any project no matter how simple or hard the project may seem and all parties are to be responsible for their given roles and also as a member of a given project.

Future Goals

In the future, I hope that I would learn from my mistakes and are able to perform better in these kinds of situations based on the experienced gained here. I hope that I would also get better teammates when planning out projects together as the teammates in this project are not as responsible and dedicated as needed to complete the project in time.

Return on Failure

Making mistakes and failing is an integral part of learning. Failures and mistakes can be the result of accidents, miscommunication, ignoring instructions or regulations or ignoring basic laws of nature. Failures can also be a result of trial and error when the correct answer or the right solution does nor exist or has not been discovered yet.

Failures are often a source of very valuable learning. In order for us to reap the full benefit of the failures we encounter and mistakes we make, it is necessary for us to see failure as an investment that we can seek return over. This form is named **Return on Failure** and is designed to help you analyse your failure and grow. Let us start!

Complete the sections below. You may expand the space and use diagrams and pictures as necessary

Describe the failure that you are analysing

The failure in the project is the use of chains and sprockets in the project. This is a technical failure as it is not

The failure in the project is the lack of communication between the leader and the reset of the team members. This is a relational failure as miscommunications and other problems have occurred under the leadership of our leader. This is by no means the sole problem of the project as the lack of manufacturing experience also has caused same of the failures throughout the project.

The execution on the sprocket and chains system is also considered a failure in this project. As the manufacturing of the product is near completion, we realise that the chain and sprockets are quite tedious and requires a lot of precision to make it work flawlessly.

The trays in the project were also not as aligned and straight as intended as the tools that we are using are not compatible with now we want to make the ends of the cables to attach to the chains.

Examine what was the Root Cause of the failure

(Ask 5 Why questions starting with "Why this failure happened?" if the answer is the failure occurred because of "X", as "Why X happened?" and repeat this 5 times. This will yield the Root Cause of the failure)

Why is there a lack of communication in the project?

In the project, a detailed design has not been created as most of the members think that a rough design sufficient. It has not been the case as it has shown its limitation when deciding the materials needed for the project. The detailed design has been asked and argued about but nothing has been made until the very last minute. This has caused a lot of manufacturing delays and also design flaws during manufacturing.

Why did the Chains and Sprockets fail?

The chains and sprockets that are used are not as tensioned as desired. This is due to the lack of a tensioner in this design. The purpose of a tensioner is to allow for the chains to be in tension as it is required for a smooth operation and also needed in this project to make sure the trays are stable and not move around. The lack of tensioner in our design means that when designing the length of the system, it needs to be extended a little from its intended length to allow for the chains to be in tension. This leaves the problem of

misaligned sprockets to essentially fail when trying to tension the system as a misaligned sprocket means the tension will be different at different parts of the sprockets, causing difficulty in cracking, and essentially, causing the entire system to fail.

Why did the trays not aligned?
Due to the materials of the cable, we are not able to weld it onto the chain. This means that are need to tie a knot on both the chain and also the tray. As the material of the cable is stiff, the knot tied with the cable is not ideally tight. This is not a problem when there is no load. When load is added onto the tray, the cables will extend due to the loosely tied cables. This sometimes cause the tray to be not straight and centered as desired. This may cause potential risk for items on the tray to tilt over and possibly spill.

Are there any other ways that you could have failed to achieve your objectives?
(Here try to predict other ways that failure could have also happened)
Due to the prototype made out of wood, it is possible that the wood used for this experiment is not sturdy enough to withstand the tension of the chain and sprockets. This may cause the frame of the trolley to fail. This is not desirable as it may injure the user.

Another failure that may have occur is the bearings may break from the tension of the chains and sprockets. The improper construction of the trolley and also using the wrong size of pipe when connecting the bearing to the sprockets may cause the bearing to operate under non ideal conditions. This may cause the bearing to fail when under load.

Another problem that may surface due to the materials used in this project is the possibility of a termite infestation if the project is not kept properly. A termite infestation will be detrimental as the structural integrity of the trolley will be compromised.

Describe how you will use the insight above so that you eliminate or minimise the possibility of failure in the future.
Based on the above insight, one of the ways to eliminate or minimise the possibility of failure in the future is to use a different material than wood. Metal bars would have been a better idea even though it may cost more and way heavier. But the structural integrity from a metal trolley will be far better than one made by wood.

Another way to minimize or eliminate possibility of failure is to have a more detailed and in depth discussion on the design and function of a project before manufacturing. Due to the lack of detailed and in depth discussion and design, we are not able to finish the manufacturing stage in time to allow for tests and improvements. This is crucial in a project as it means that no errors and other possibilities of failure has surfaced since manufacturing besides the theorised failures. This is dangerous as it has not went through real life testing to ensure the product is safe.

What are the other key learnings from this failure?
I have also learned from the failures is that time management is important as it allows for more time to diagnose problems surface during a project. Resource management is also important as throughout the project I have realised that we sometimes waste human resources on simple tasks instead of heading for the next step of the project.