NSN#:

# Bed Table Project

## Scholarship Technology 2013

## College

## Introduction

Nowadays, technology has made study and work both easy and complicated. We wish to keep up to be productive. The advent of broadband, enhanced by fibre optics, has made connectivity available anytime and anywhere. My mother, a single mother of six, very hard-working businesswoman, loves to work wherever she can, whether she is in the office, in a restaurant, or at home – practically anywhere there is Wi-Fi. She owns an office in Manila, Philippines which requires constant attention from her. The problem is that there is currently a five hour gap in time difference between the countries. At her age of 55, seeing her working until 11pm on her bed is a sad sight. Since we are a brood of five boys, her most favoured place would be her bedroom, far away from all the noise and distractions. She would lean her back against the headboard, and sometimes place piles of pillows and lean on them. It has been going on for years, and she always requires an ergonomic workspace for working efficiently.

A bed is not a place for work but a place for relaxation, rest and sleep to comfort us in our own time, but she has to work there to rest her back. We all know what it feels like to work in bed without the proper equipment. It struck me and felt the need to solve this problem for my own mother. I felt that this would be an opportunity for me to design and produce a proper table that would solve most of the issues and make a better set up for her, as well as for other people in similar circumstances. I thought that we can upgrade what is readily available in the market. Seeing her like this all the time, gave me the opportunity to come up with a solution to fabricate/make a table which would really fit her lifestyle and the way she works.

This technical report aims to demonstrate sophisticated synthesis and integrate technological experiences to gather skills, ideas and methods to allow their technological targeted outcome to be realised. This particular report describes the fabrication of a very ergonomic, portable, user friendly, durable and at the same time looking neat and elegant piece of furniture, and it aims to justify how and why such methods were chosen to tackle the issues and critically reflect and extrapolate technological methods and experiences, in terms of the accurate presentation of the steps and methods in planning, with the key complexities addressed, development and some of the unique techniques used.

## Planning

The planning stage involves understanding the key complexities in development and naming the methods, tools and preparations that can be used for this project:

- The key complexities must be understood so that the planning of the whole project can be made efficient and most are listed below:
    - The frame has to be attached onto the bed's side rail without any support from legs that rest on the bed or on the ground.
    - The frame has to be small in size in order to take out any form of bulkiness in the design.
    - The table has to be adjustable through some sort of mechanism I had to develop.
    - The table top attachment has to be very strong and durable for long-term use.
    - The clamp has to be adjustable for the ability to be attached onto different sized beds.
    - Precision In the design was a complexity because in order for everything to work together very well, they all have to fit in properly with all of the alignment issue sorted out.
    - As a competing factor, the table has to be adjustable and simple at the same time.
    - Basically every component has to be made durable but also light through the right selection of materials, commonly available in the current market.
    - The design has to be simple yet elegant in order to attract most people in the market.

- The Gantt chart was used to ensure efficient planning all throughout the whole process of the project *(refer to page 3)*. This solved accurate planning for the key stages in the project along with the efficiency in working, because it reduced the risks of any delays in process. This was a key planning tool because I

was able to anticipate possible task overlapping in terms of scheduling to prevent overloading of tasks per week.

- Exploring the identified issues in ergonomics, durability, portability and aesthetics was done to give a clearer understanding of the true goal of the project *(refer to pages 4 -5)*. This solved to prioritise the key specifications that are related to the client's needs regarding the issues. This also enabled me to expand my key ideas on the concept designs.

- The analysis of the existing designs in the market was done to become more familiar with ways to innovate better by eliminating common flaws and picking up some of their strengths and advantages in their designs *(refer to pages 6-7)*. This allowed me to create my concepts efficiently because I was able to get to the key specifications of each unique design. With this, I was able to efficiently communicate and consult my key stakeholders, especially my client, because I was able to ask about some options regarding which design for a particular part or specification to use instead of asking their thoughts on general queries.

- The analysis of the location was done to gain specific knowledge of what can be applied and improved onto the specifications of components which needed development *(refer to page 8)*. It was a key decision for me that it can only be attached on the side rail of the bed because there was no other way of attaching the table without it getting in the way of the user. For example, if it was attached on the headboard, there is a good chance that the user's head will bump it and is therefore, not suitable for safe using. I was able to base my concept designs from the limited space of the bed's side rail provided. The specific requirements from the location enabled me to narrow-down the dimensions in terms of 3D space.

- Analysing external practices from other three previous scholarship students was done to identify which areas of their methods were done well and which weren't, so that the good methods are absorbed and the bad ones avoided *(refer to pages 9, 46)*. Some of the methods that were done well are the use of the Gantt chart for scheduling, the use of efficient modelling using software and the addition of model mock-ups while developing were applied over the whole project. The methods which weren't done well include poor time management and lack of major planning, where the development stage is stretched out significantly and the production time is greatly shortened, and the avoidance of these helped me a lot. Furnware, on the other hand, did a lot of modelling *(refer to page 9)*. I was able to absorb the fact that modelling helps quite well in the development stage of any project. I applied their knowledge to my project and made really good use of modelling techniques.

- Setting out a list of prioritised key attributes was done to become more familiar of which ones are the most to least important of them all, not disregarding the least important *(refer to pages 11-12)*. Being able to categorise strength, durability, ergonomics, and aesthetics with very high priority, I gained better understanding of the key specifications that must be met, allowing for a good lead in the concept designs, which was one of the key milestones in my project because it was a good sign of progression.

## Concepts and Modelling

Concept Designs and Modelling include methods that bridge the gap between planning and development.

- Concept Designs and analysis were done to gain key ideas of what can be taken out from a design worth developing. They open up different possibilities; given a range from complex to simple designs *(refer to pages 13-16)*. Analysing the concept designs allowed me to gain a clearer view of what the client really requires through the process of the consultation, enabling a whole new perspective into the project and justifying the key specifications needed for development. I discussed them with my client and received a new key specification that is required - The bed table has to be transferrable and modular.

It was a key decision for me to decide that I use adjustability in the clamp so that it can be attached onto different sized beds, because I was introduced to a new challenge or problem that I knew had to be solved in order to have complete success in the end.

- Gathering data, for example getting the measurements of the three different sized beds, provided very useful information for my project, becoming more familiar with the wide range of dimensions *(refer to pages 18-19)*. This solved for the valued range for adjustability when I was designing the adjustable clamp. I wasn't satisfied with only three different measurements so I decided to contact other bed companies, which provided me different views on the project also allowing for second opinions and extra useful information. It was a key decision for me to make because I knew that my own research wasn't valid enough, and that external evidence would really cement the justification and validity of the finalised information.

- Using model mock ups give the opportunity to analyse the function of a particular component, and see it physically in action *(refer to page 22 onwards)*. With this key technique, small adjustments can easily be carried out during the process of development. It gave me the opportunity to test it in the client's location and therefore, justifying the proportion, function, and dimensions of the specific components.

- Using computer models give a virtual 3-D view, allowing for better efficiency in making small adjustments on the spot *(refer to page 27, video on page 39)*. This finalised the measurements for the prototype, allowing for less potential risks when producing the design. It was a key stage for my project because I was able to use it to virtually test the properties and aspects of the components with the use of the animation feature, and this really affected the way I looked at the current design at the time, by giving me clearer understanding of what's actually happening, and the opportunity to make adjustments where needed, also to analyse the flaws in the design. Computer models are a step up from model mock ups because it extends the limitations for adjustments in the design.

- Developing a design through prototype modelling allows physical adjustments to be made on the spot, exposing the true feel of the design when making the adjustments *(refer to page 32 onwards)*. This involved testing and justification. This process solved for easy adjustments in the specifications of the design where needed, ensuring the final design is at its best. Prototype modelling was a key stage in my project because it is the only way for testing the final prototype, being able to clearly identify which specifications were met and which weren't.

## Development

The techniques and methods for the development stage involve skill sets that are advanced, and are adapted to the tools and materials available in the workshop which allow for innovation and application of my own techniques I developed over two years of studying the technology course and a very interactive environment and teacher.

- Bending material to shape is better than cutting and joining many pieces to form a shape *(refer to page 33)* because it is much more durable due to the wholeness in the distribution of the strength. Having one single material contributes to the durability of a component, ensuring long-term lasting of the product. Bending the aluminium surely made the whole frame strong and durable, also giving the smooth surface of the metal, significantly contributing to solving the issue of aesthetics and durability.

- Testing different materials and components for their strength gives better knowledge to the designer on what is more compatible to their design *(refer to page 34)*. This helped in better decisions in choosing the right materials because I was given better understanding that the chosen materials would reduce the risk of component failure, with valid evidence supported by the strength testing.

- Increasing the width of the bars give extra support on the sides and therefore, adds more durability to the strength of the prototype *(refer to pages 35, 37)*. Increasing the width of the bars reduced the wobble on

the table top and was most definitely the best improvement of all the other minor tweaks in the design because it basically solved the problem.

- Using layers of plywood allow for the wood grain to point in different directions, even more so when adding more layers *(refer to page 36).* Grains pointing at different directions reduce the weak points for failure in the material through cracking. The use of many layers of plywood definitely solved the issue of durability and strength. It prevented any random cracks in the grain which occurred during the tests when using a whole block of wood.

- Traditional methods of joining metals like the use of bolt and nuts and rivets are proven to be more reliable than using new technology like cold welding because these have been developed for so many years that there is a very minimal chance in component failure *(refer to page 37*). Through the strength tests carried out, bolt-and-nuts and rivets gave the best results in terms of durability, stability, hardness ease of use and maintenance, so I decided to base my designs on these.

- Adjustable components solve most issues in ergonomics because it allows preference, range, ease of use to the user *(refer to page 38).* The adjustability of the tilt of the table top enabled my client to use the table freely at her own preferred setting. I chose to make the table top adjustable and not the height of the frame because I learned that making the bars height adjustable would weaken the pivot point by giving it space for movement and therefore, lessen the durability.

- The use of the laser cutter helps to produce particular components at the exact measurements that were designed through computer models *(refer to pages 40-41).* This made gluing of different layers easier without having to worry about the alignment issues. I included a circle cut out as a cup holder for the top layer, which allowed the use of placing a cup safely and securely on top of the table. It was a key equipment in my project because I was given the opportunity to produce components at the exact measurements, which contribute to the precision of the design.

- Multiple washers distribute the pressure on the material being pressed against for tightening, and prevents damage on the precious material *(refer to page 21*). I was inspired by the idea of laptop hinges, not losing their tightness and had this statement confirmed through the discussion with my physics teacher. The rotational movement and friction are distributed all throughout, and this practice is well-suited for my project because it reduces the chance of component failure for long-term use. Using felt between materials that rub against each other prevent any scratching on the surface that could develop into serious damage and later into component failure *(refer to page 42).* This kept the nicely coated materials protected from any scratches, provided better aesthetics and durability, and allowed smooth movement with reduced friction for better ergonomics in terms of feel to the user. I kept the distribution of friction through the use of washers, but also reduced it so that the metals don't damage the finish - I solved for the most efficient way in between the two.

- Buying a handle instead of making one helps to reduce the time needed in term of better efficiency, and also ensures a developed component, not having to worry about the high chances of component failure when designing and making your own *(refer to page 42).* This was a key decision because it helped a lot with the aesthetics of the design due to the manufactured look and colours, also providing smooth edges for less risks and better developed ergonomics of the grip/handle. It also most definitely saved me some time from having to design and make my own.

- Using coats and finishes not only makes the surface of a material look good but also protect it from any type of damage *(refer to page 42).* Using polyurethane helped to protect the wood from UV/sun damage that could cause discoloration in the future. It also gave a good shine to the surface, as well as the clear coat on the metals, providing the best quality in the issue of aesthetics.

## Conclusion (Critical Reflection)

Sophisticated synthesis and integrated technological experiences to gather skills, ideas and methods to allow their technological targeted outcome to be realised were critically explained in this technical report. The fabrication of a very ergonomic, portable, user friendly, durable piece of furniture was described and demonstrated. How and why specific methods were selected to deal with the issues were justified, and technological methods and experiences were critically analysed, with reference to the accurate presentation of the steps and methods in planning and the complexities involved, development, and some of the unique techniques used.

Ergonomically, the table has met the specifications through the tilting angle adjustability of the table top, which allows for better use of preferences, reducing the slouch on my client's back and allowing for a much more efficient workspace. It is lightweight due to the suitable materials chosen, specifically aluminium and plywood, making it easier to carry around or simply store away for increased portability. Using unique methods and techniques for different materials allow for increased durability through the different forms of structure in the components. It is attached onto the bed's side rail instead of freely placed over the user's legs, allowing for a more rigid and stable feel of the table making it strong and very comfortable to use for writing, reading, organizing, or simply eating. The fact that it can be taken down into two major components for storage makes it very easy to store underneath the bed, which directly meets the requirement under portability. The whole idea of the design along with the development of the clamp and attachments greatly contributes to the durability for long-term use. The use of proper/appropriate and suitable finishes, like polyurethane for the plywood and high-grade clear coat for the aluminium, enhances the quality of the materials through the use of natural, light, and neutral colours, bringing out the true simplicity and elegance in the design.

Without the bed table, everything was scattered around the bed leaving my client restricted from movement. She was always situated in bad ergonomics with a slouched back and always looking down at her laptop and notebooks. The tilting angle of her laptop caused the built in camera to capture only her forehead, which wasn't so good for her online interviews with her clients. She always had a glass of drink that wasn't secure and spilled most of the time. She always found it hard to find her glasses as it usually got lost under the papers or bed sheets. With the bed table, everything was organised. The frame is very stable, giving her a comfortable and rigid feel with very minimal wobbling.

Height adjustability could be an improvement because it makes the design more suitable for a wider range for user's preferences, inviting a wider range of age groups. I could add more storage components to the design like a net-based cup holder for a more secure fit for the cup, and the addition of drawers for more storage capabilities and function. The biggest improvement would be to make it easier to attach the table top, which would attract a wider range of age group (including older people and possibly disabled) due to the ease of use and user-friendliness.

I've planned well ahead of myself to have made sure I used the time wisely. I've designed it so that it can last for a very long time, and can be serviced. Parts are replaceable and would still affect a stable rigid outcome. I am very satisfied with how everything worked out as the small stages in the development helped me visualise and gain a really good understanding on how to come up with solving this tech project. It was a very successful project over the year and solving my mother's problem with working in bed is a great accomplishment and achievement that I will always remember. Seeing her use the table I made makes me feel much rewarded.

# Bed Table Project

Technology 2013

My client (also my mother) is currently experiencing serious back pains on her lumbar due to having to work on the bed for her home-based office. She owns a home-office/business called "ITEAM Limited" which is in conjunction with an office in Manila, Philippines called "IMEETS Philippines". The problem is there is a 5-hour (NZ DST) time difference between Manila, Philippines and New Zealand. Therefore, she starts working really early in the morning and stops until her office is closed in Manila, which is usually at around 10pm at night, New Zealand time. Her exact words were *"I start working in my home office and end up finishing in bed".* We both agreed that I design and produce a suitable bed table which is to meet the following key factors and specifications.

The **key factors/issues** are:

- Storage
- Ergonomics
- Risk Management
- Durability
- Efficiency
- Aesthetics

These **key specifications/client's needs** are shown in my client's own words:

- A bed table which also acts as an **organizer** where I can **secure** my coffee cup and pencil case.
- It should have a container which also has a cover where I can keep notes.
- On top, I should be able to place comfortably my laptop or Ipad without sacrificing my back.
- Cooling pad for Laptop.
- Groove or slot so a laptop up to 13" size will fit.
- I can tuck it in or stow with everything intact.
- Eyeglass space.
- It has to be mounted on the table for stability.
- Usual tables are not so good because everything moves and are not tailor fit to my height and eye level.

**WHAT:** Initial Brief

**WHY:** I gain a sense and a basic understanding on what to make as well as the explored issue. I know the key factors and specifications.

All of these key factors and key specifications/client's needs are to be kept in mind at all times throughout the whole year's project to be able to design and build a prototype that should meet ALL of my client's needs. I will need to carry out investigations and research in order to have a deep and clear understanding of the key factors as well as my client's needs and specifications. It's relieving to think that I wouldn't be making such a big project, in terms of production because it allows me plan well ahead and make sure I make the right design. This is very good for the time management.

Client:

Loreen Carlos (My mother) – Single mother of six children at the age of 55. Owns a business in sending skilled migrants from the Philippines to New Zealand. Runs two offices – Manila, Philippines and Auckland, New Zealand. Finished Masters in Chemistry.

Stakeholders:

Theodore Carlos – Engineering student at Auckland University and my brother.
Tristan Carlos – Bachelor of Technology in Engineering, working at Visionstream and my brother.
Timothy Carlos – Bachelor of Science in Geology and my brother.
Mr. Alxander Breig – my Technology teacher at Rosmini College.
Mr. Phil Jones – Technology teacher at Rosmini College, HOD in Metal Workshop.
Mr. John Smith – Physics Teacher at Rosmini College
Mr. Broome – Technology teacher at Rosmini College
Robert Tang – Visitor of our school; Masters Degree of Mechanical Engineering (undergraduate degree of mechatronics) from The University of Canterbury.

| Key stages | Resources | Week dates (use week ending Friday) | | | | | | | | | | | | | | | | | | | | Outcome and Implications |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1-2 | 8-2 | 15-2 | 22-2 | 1-3 | 8-3 | 15-3 | 22-3 | 29-3 | 5-4 | 12-4 | 19-4 | 26-4 | 3-5 | 10-5 | 17-5 | 24-5 | 31-5 | 7-6 | 14-6 | |
| Project Proposal | Internet, Computer, Clients and Stakeholders | | | | | | | | | | | | | | | | | | | | | I have an understanding of the introduction on the project |
| Issue: Storage Research | Internet, Stakeholders, Clients, Location, Computer | | | | | | | | | | | | | | | | | | | | | I have a clear understanding on storage components so I know which type of storage to apply onto my design. |
| Aesthetics Research | Internet, Computer | | | | | | | | | | | | | | | | | | | | | I have a clear understanding on Aesthetics and Efficiency |
| Initial Brief | Client, Stakeholder, Computer | | | | | | | | | | | | | | | | | | | | | I have a sense and a basic understanding on what to make as well as the explored issue. I know the key factors and specifications. |
| Products Review | Existing Products, Computer, Internet, Clients | | | | | | | | | | | | | | | | | | | | | I have a clear understanding of what things are going to be in my design (objects) |
| Existing Designs Research | Internet, Computer, Clients, Existing Designs | | | | | | | | | | | | | | | | | | | | | I have ideas and basis for designing my own design which will meet the clients' needs. |
| Evaluating/Analysis on Existing Designs | Internet, home, client, Computer, Stakeholder | | | | | | | | | | | | | | | | | | | | | I have made clear with my Clients/Stakeholder what ideas I have in my mind before starting on my own design. |
| Issue: Ergonomics Research | Internet, client, location, computer, stakeholder | | | | | | | | | | | | | | | | | | | | | I have a very good understanding on ergonomics and its aspects as well as how to apply it onto my client's needs AND what to apply. |
| Exploring the location | Location, client, computer | | | | | | | | | | | | | | | | | | | | | I have a clear understanding of the surroundings of where the prototype will be placed so I can base my design on that particular location |
| Client/stakeholder consultation (ongoing) | Client | | | | | | | | | | | | | | | | | | | | | I know specific needs that MUST be included in this year's project. |
| Case Study: Furnware | Internet, Computer, Stakeholder | | | | | | | | | | | | | | | | | | | | | I have a clear understanding on how other companies/manufacturers use planning tools, and justify what to apply onto my project. |
| Updated Brief | Client, Computer, Stakeholder, Location | | | | | | | | | | | | | | | | | | | | | I have gathered and justified all of the information, specifications I need to start on the design process. |
| Materials research (aluminium) + mock ups | | | | | | | | | | | | | | | | | | | | | | I know much more about aluminium and its effects in the design and environment. |
| Concept Sketches | Drawing materials, Client, Stakeholders | | | | | | | | | | | | | | | | | | | | | I have fist-idea drawings and I have consulted my client about what type of designs and which I must develop into finals designs. |
| Concept Development | Drawing materials, Client, Stakeholders, Component modelling. | | | | | | | | | | | | | | | | | | | | | I have developed my designs well to be able to finalise it when doing the final design. |
| Bracket and Hinge Research and Development (+ mock ups) | Computer, Client, Stakeholder, Workshop, Internet | | | | | | | | | | | | | | | | | | | | | I know much more about hinges and therefore, know which types are possibilities for my project |
| Bracket Mechanism Development (+ mock ups) | Computer, Workshop, Client, Stakeholder, Internet | | | | | | | | | | | | | | | | | | | | | I have developed the mechanism of my design and done tests on the way to ensure a developed final design |
| Case Study: Dung Beetle (Exam Week) | Computer, Stakeholder, NZ Herald | | | | | | | | | | | | | | | | | | | | | I know how modelling is used for risk management |
| Mock ups and Welding Practices | Stakeholders, Metal Workshop, Client | | | | | | | | | | | | | | | | | | | | | I have practices some welding and done more modelling for risk management |

| Key Stages | Resources | Week dates (use week ending Friday) | | | | | | | | | | | | | | | | | | | | Outcome and Implications |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 24-5 | 31-5 | 7-6 | 14-6 | 21-5 | 28-6 | 5-7 | 12-7 | 19-7 | 26-7 | 2-8 | 9-8 | 16-8 | 23-8 | 30-8 | 6-9 | 13-9 | 20-9 | 27-9 | | |
| Production with Metal (Cut and Weld) | Metal and wood workshop, Client, stakeholders, teacher | | | | | | | | | | | | | | | | | | | | | Progress in production |
| Production: main block | Metal and wood workshop, Client, stakeholders, teacher | | | | | | | | | | | | | | | | | | | | | Progress in production |
| Production: slider and bars | Metal and wood workshop, Client, stakeholders, teacher | | | | | | | | | | | | | | | | | | | | | Progress in production |
| Production: details | Metal and wood workshop, Client, stakeholders, teacher | | | | | | | | | | | | | | | | | | | | | Progress in production |
| Production: Table top | Metal and wood workshop, Client, stakeholders, teacher | | | | | | | | | | | | | | | | | | | | | Progress in production |
| Production: finishing, and prototype testing | Metal and wood workshop, Client, stakeholders, teacher | | | | | | | | | | | | | | | | | | | | | Progress in production, better aesthetics, and finally the prototype has been tested with my client |
| Finishing Paperwork | Client, Stakeholder, teacher, Computer | | | | | | | | | | | | | | | | | | | | | I have finished everything for my project and therefore, project is finished. |



# Gantt Chart

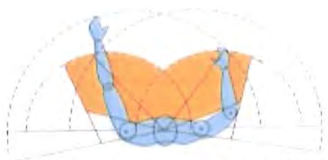
I have quite a number of issues on this project but  out of all the important key factors, 'ergonomics' is the main issue. Ergonomics is the science of making things comfortable in order to make them efficient for use. It focuses on the compatibility of objects in its environment, surroundings, and its users. It is applied onto a design to reduce the risk of any serious injuries and errors by ensuring that us humans work well with the technology. Ergonomics is important for the human health. Proper ergonomics is very well necessary to prevent simultaneous strain injuries, which can develop over time and lead to long-term disability.  The two main aspects of ergonomics are Efficiency and Comfort.

Efficiency is a great nature of work which involves something done with going through only a minimum amount of waste and energy. It's about making something easier to do or use. One of the main aspects of efficiency is 'to reduce in order to become simpler'. Reducing the number of steps in a task/method, amount of time to complete something, and multitasking will result to better efficiency. Efficiency is a high priority in my project and it is very important that I become efficient with my work in order to complete a fully functional working design. There have been many products that are called "all-in-one". These products are made for efficiency and less energy or time used not only for the user but also for the actual product. One example for this is the All-in-One computers. This is a great example of efficiency because the computer user wouldn't have a problem setting up the computer and the computer reduces the risk of anyone tripping on the wires due to it not requiring anymore wires from the CPU to the screen. Risk management have certainly been analysed and applied onto the design of these computers. I must do the same with my project and look at any potential risks that could later on be encountered.

Comfort is one of the main aspects of a design's effectiveness. Without comfort, ergonomics is completely utterly useless. The comfort is the first thing a user notices when they use a product. The ease of use, the feel, the looks, and the durability all contribute to the ergonomics, design, and functionality of a product. The quality of a product is determined by the comfort to the user and how the user reacts to it. Increased physical comfort in a product will raise its functions and will also most definitely reduce the risk of strains that could later on develop into permanent disability caused by discomfort. It is important that a product is capable of being used for long hours with the ability to give comfort and pleasure to the user while using the product. Better comfort means better ergonomics, and better ergonomics means quality, which means better value when it comes to the selling point of a product.

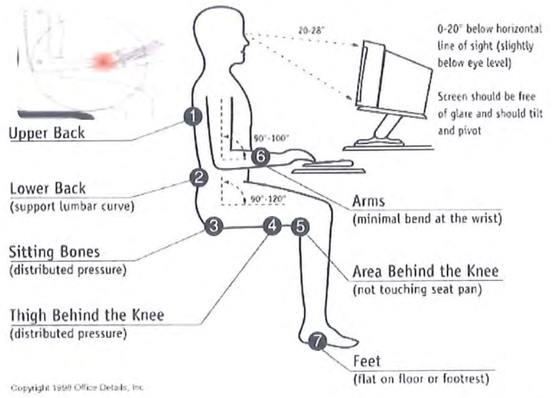
In conclusion, it is important that a product is easy and comfortable to use. I am mainly concerned about the lumbar area of the body where in a normal seating, isn't so affected if the ergonomics of the seat is right whereas in a bed type of seating you are more slouched than having a straight back due to the feet not flat on the ground. I must use proper planning tools for me to be able to plan ahead and result to efficient working standards. Some good planning tools are: the Gantt Chart, a Materials list with all the dimensions and quantities, Method of construction etc. One of my aims for this project is to make my project as efficient as possible *while* designing and making it efficiently as well as the safety of it which is to be analysed from the risk management.  I must expect delays along the way such as failure of tools, another student waiting in line for the use of that particular tool, falling behind schedule, maybe a damaged component that needs re-doing and such things. All of these delays are lessened if I were to plan ahead using planning tools. I must look at my client's views and what she would think about the design as well as ANY risks that I wouldn't be able to spot. I must also look at several existing designs and analyse their designs as well as the risks that are involved in that particular existing design and apply their development features onto my work.

Moving onto the research of ergonomics in the current situation, I must look at some specific ergonomics on normal seating, bed seating, and workspace efficiency. As mentioned before, the current situation is the seating type on the bed. The problem with this is that the ergonomics of sitting on the bed is VERY different from the ergonomics of sitting on a proper chair.



On the right, a diagram of an ergonomic workspace is shown. It is ergonomic due to the circular type of workspace. This allows accessibility, which is shown on the diagram above. Since the human body can rotate from the left to the right side or vice-versa, it's efficient to use all the areas where possible and apply onto a design, particularly a table.

On the right, the diagram shows the basic ergonomics of sitting on a chair of an office-based situation. Some key points that I must analyse are: On a normal seating, the feet must be flat on the floor with the legs at a 90-degree angle. You must have a straight upper and lower (lumbar) back. The sitting bones must have distributed weight for maximum comfort. The arms must be a t a 90-degree angle when typing on a computer/laptop and the wrist must not bend. The thighs must be rested on a 90"-130" length seat. When using a computer/laptop, the screen must be visible at least below 20 degrees of the eye level at a distance of 20"-28" from the eyes.



Here, on the left, a person sitting on the bed is shown to have a slouched back. Some common ideas here are the bed table, laptop, and an almost 90-degree back support. The diagram below the picture resembles the picture due to the fact that the person is sitting with the same manner, with a slouched back. The diagram shows the strain than can be caused by sitting with a slouched back. The whole spine is bent. This could potentially damage the mid-section of the spine as well as severe damage to the lumbar section. When sitting on a bed, there is a very high chance of having the top section of the spine rested on the wall, causing the collateral damage on the lower section. Since the feet aren't flat on the floor when sitting on top of a bed, the angles tend to become more obtuse than right-angled, causing the slouch on the back (As shown in the picture on the left).

Here, the right ergonomics of seating is shown. The highlight of this picture is the expected form of the spine when sitting normally. As shown, a suitable form of the spine is supposed to have the lumbar section INWARDS rather than outwards, which is shown below when a person is sitting with a slouched back, without any type of support from the chair onto the person's back.

Storage or storing something is way of "hiding" something from the "outside" and placing it neatly/organised in the inside of a particular container. A key factor that I must consider when designing this project is the ability to store away the unit. To be able to store something from the outside does not only reduce the potential risk of serious injuries outside, but also reduce any visual pollution that can cause stress. Storing is also a great way of organizing. Since my client wants the table to also act as an organizer, then storage is a suitable issue for this project. This involves quite a bit of research and thinking as to what type of storage I will be using. It is important that I decide on the right type of storage in order to maximise the features of this project . Identifying the client's needs as well as identifying *what* to store will help to narrow down what types of storage I should include in the design.

To be able to test my project's storage, it is highly recommended that I make models on paper like templates for when I am into the production, a Google Sketch Up model to see the proportion and such on computer, but most importantly, a 1:5 scale physical model of the pre-final design in order to see the design as a whole before actually making it in full size. This way, I will be able to see any major flaws that I must consider to alter while doing the final design or perhaps, while I am into the production. I will also be able to see any potential risks that my client and the wider community users could encounter.

I must look at many different views of the wider community and stakeholders for me to be able to design an almost perfect fully functional bed table that is to be done as a prototype. I must also most definitely explore the location, like where the table will be mounted, on which side of the bed etc in order to have a clear understanding of its environment and its surroundings. Not meeting my client's needs will make my project completely useless. Therefore, the outcome of this project MUST include having to meet my client's needs.

Aesthetics is another issue on designing and building this project. For one design to be physically appealing and attractive to one person, it must have good aesthetics. My project must always fit in well with the other furniture and look very similar to them to create this "harmony" or theme in the room. Modern aesthetics is not that easy to just apply onto a design. It' easy do design a complex design but hard to make a simple, yet elegant one. I will have to do some more research and analysing on the room and the existing furniture in it as well as what my client and the wider community users would have to say about this. Not only does aesthetics perform well by itself. A good structure and framework always blend in with aesthetics. For example, if I were to make a frame for an object, it will most likely consist of a few metal materials. Not only does metal and wood together look appealing to the human eye aesthetically, metal is also very strong and durable.

Analysing Existing designs will help me gain ideas of what my design(s) would look like as a prototype. It will also enable me to analyse any potential risks that could affect the wider community as well as look at the ergonomics, storage types, aesthetics, efficiency of work and design, and the durability that could be shown on the designs. This stage of the design process will also allow me to look at how other bed table designs solved problems that I must solve to match my client's needs and specifications. If this wasn't done, then I might not solve the problems that I might encounter during the production process properly.

Existing Design 1

Existing design 1 can be adjusted in two ways: through height and through the tilt/level of the table top. This would be exclusive to this design because it rests on the ground and is supported by a single vertical beam. The other designs can only be adjusted through leg height. Some of them can be adjusted through a one-way tilt of the top. This is the most common type of bed table that is placed on the ground and not actually on the bed. Its frame is made from metal, and the top (where you place things over) is made out of wood. Metal and wood blends very well together when it comes to designs like these. The metal frame is very durable for long-term uses AND also stable, causing no wobble on the table. Knobs are used so that the table itself can rotate or level at different angles for the user's preferences. The wheels will help the user move the table out of the way if ever he/she needed to get out of bed OR help the user to pull the table towards the bed for use in reading etc. What's common between this design and the specifications that my client has provided me with is: it has an area for a cup (possibly a cup holder). It's got a "lip" so that the book won't fall off, similar to the groove that will fit a laptop up to 13" size. A bit of a concern here is the potential risks that the users may encounter. Since it has a base frame that is fairly sticking out, people could trip over it causing severe damage not only to the feet, but also possibly the head from falling over. Clothing or wires could get caught on the knobs causing trips, damage to the product which then leads to failure in design. If I were to design my own, I would reduce the number of knobs or other components sticking out of the main area of the product. In other words, I would keep as much components to be made internally rather than on the outside if possible. The material is more likely made out of MDF covered with a thin layer of natural wood grains to add style and aesthetics onto the design. This is a cheap way of using durable materials. Another options is plywood.

On the right, I am focused more on the storage component of the product. It is seen that a drawer type of storage is used as well as a partial 'stopper' on one side. This is a good feature because one of my clients specifications/needs include her to be able to store notes, papers, files etc. It's possible that I include the drawer as a part of my design as a storage type. Moving on to its use, I don't think it's much help due to the fact that the user's legs might not even fit in between the table's legs (depending on the scale on the picture). It's got some curves over the edges which is good for reducing the risk that could cause injuries from sharp edges. This is definitely a key factor that I must include in my own design in order to maximise the reduction of risk for the user and for the wider community as well. Since my design must be clamped or mounted to the bed, this design isn't much help for me but its storage component may be put into consideration for use in my design. The material used is some solid timber which is definitely durable for long-term uses.

Existing Design 2

Existing Design 3

On the left is another one of the most common types of bed tables. It can be collapsed for easy Storage and when in use, it goes straight over your legs without contact – there is a fair amount Clearance between the user's legs/thighs and the underneath of the table. It's made out of wood So there wouldn't be much hassle or difficulty when carrying it. Some of the common features between this product and my client's given specifications are: the cooling pad so the laptop/ipad doesn't overheat. It has stopper so that the laptop/ipad is in place by downward movement (no guarantee of stability in sideway movement). It has a cup holder, which is taken place by the apple. It has a small storage space, which could be used for eyeglasses, pencils, pens, maybe A5 size paper (not A4). Finally, the laptop holder can be rotated/elevated to a certain angle to fit the user's preferences. This is really good for the ergonomics. In the field of risk management, this is good because it does have some rounded edges, rounded legs so if in case the user is pinned by the table's legs, there is less pressure due to the non-sharp legs. If I were to make a similar design, I would maybe change the material of the legs from wood to metal to increase its stability when in use and to also reduce its weight for portability.



# Existing Designs Research

It is important to look at some other modern/complex design to be able to have a wide range of variety when designing my own bed table.

Existing Design 4

On the left is another common type of bed table but made mainly out of metal – this increases durability. It has a slot for the laptop (which can be elevated/levelled to the user's preferences), a mouse pad, a glass/ cup holder, and a pencil/pen holder. Most of which is included in my client's specifications/requirements. The layout of my design would basically be very similar to this one. The main point of difference would be that mine has to have storage for papers, notes and such as well as having to be mounted onto one side of the bed for easy storage underneath and also frame stability for when the table is in use. There aren't much risks on this design. The adjustable legs have to be pointed out, though. The fact that it is adjustable for height, it requires some slots and knobs. The main problem is, the user's fingers could get stuck into the adjustable slots seen on the side of the legs, which could result to the user's finger being partly cut off, permanently. To summarise, having something adjustable will increase the risk of injuries, whereas having something fixed will add stability to the product and lessen the risk of injuries to the user(s). The top seems to be made out plastic mouldings. It's very light, which allows the user to carry it around with ease. This is a cheap way to mass produce a product in terms of today's market. When it comes to making it in a school's technology workshop, it would be very hard especially with the plastic mouldings. Therefore, if I were to make something similar the frame would probably be made out of metal (aluminium in particular) and the top would be made out of wood for easy shaping and carving etc.

On the right is a slightly different type but of the same concept. This is, in a way very similar to existing design 1. The difference is that it is not situated on the floor, consisting of a long vertical frame for use on the bed. It has four adjustable legs instead. It also has a 'side' cup holder, which seems very innovative as opposed to the cup holders grooved onto the wood itself. Instead, it can be taken out like a drawer, with a similar concept to the ones in a car. Again, the 'laptop holder' can be levelled at different angles by rotating the whole half-section of the table. It also has a stopper, which is very common to bed tables. The legs, on the other hand, are much like camera tripods' legs. They're adjustable individually for much wider preferences for the users. For example if the bed isn't totally flat, then the individual legs can be adjusted. One concern is the stability of the legs. In my experience, those camera tripods aren't as stable as a table but stable enough to hold a camera. They are usually very wobbly. Again, the safety risk of adjustable legs comes in. The user's fingers could get stuck in between if for example the adjustable knob is loose, causing a free fall of the legs, which could then cause permanent injuries on the fingers at its worst. The materials used are chosen well enough. The standard metal frame and legs is always good. The wooden top is also very good. Therefore, there are no issues on the chosen materials, except that the legs could have been made with a thicker diameter tube. Some of the aspects of this design that may be applicable onto mine is the idea of the whole half-section of the top being able to rotate for angle and level adjustment as well as the 'draw-out' cup holder. If I were to make this design, I would change the whole mechanism of the legs and consider stability as being one of the main key factors.

Existing Design 5

Existing Design 6

On the left is a unique bed table design, which differs from the other existing designs in a way that it has a very wide variety of uses. As seen on the left side of the picture, it can be adjusted in a way that the laptop is facing right down on the ground, or in this case the user's face. This allows the user to still be able to use the laptop whilst lying flat down on the bed, with a straight back. This, in a way, reduces back pains but is somewhat not ergonomic due to the fact that you're lying down while using the laptop. What I am interested about is the way that the laptop is kept in place using the fastener/holder. This may be a good way to apply onto my design. Some of the risks, are again, the adjustable mechanism. This time, it acts as scissors. If in any way the joints lose its tightness and overtime, they could cut the user's fingers, and possibly even get their hands stuck in between, causing serious pains and damage to the living tissue. The materials are made from aluminium alloy, which is good due to its light weight, for easy carrying. If I were to make this design, I would do some research on how to keep the joints' tightness in the long-term so there won't be any issues on the safety.

In conclusion, My bed table must be adjustable somewhere and must have a cup holder and a flat area for other things. It must be able to be attached onto the bed so that stability is increased when using it. I must make sure I design something that is safe and easy to use, taking in the risk factors of the design.

Exploring the Location is very important because it is where my finished prototype will be placed/used. It allows me to base my designs on this location for perfect capability, without any features or key specifications wasted.

On the left are pictures of the desired mounting location of the bed table's main frame, which is also the side panel of my client's queen-sized bed. It should be able to be clamped without any instability or durability issues, especially when swivelling or swinging for storage or for use. This is a critical part of the project because I am not only designing this for the bed that my client is using. I'm designing this whole project in a way that it will be used by my client, but not necessarily on the same bed – you never know when she would want to change her whole bed. In other words, the bed table should be able to be used on any type of bed but specifically, by my client. For wider variety of uses, I must always consider the wider community as users as well.

Some other things I must explore are the designs, materials, colours of the existing furniture around the room. The pictures on the left (an on the bottom right, the dresser) show most of the existing products around the room. The room consists of: the bed bench I made last year for tech, curtains with the colour shown on the picture, two wooden cane chairs, and a modern white half-shelf. The room is carpeted with a soft green carpet.

The bed bench is made out of macrocarpa and has some aluminium metal rods on the side for aesthetics. It is located at the end of the bed. Hence called the foot-of-bed bench.

The curtains have flowers printed on them and are mostly lavender in colour, overall. They are almost see through, which is shown on the picture. My client usually doesn't change these curtains, just cleaning as the colour is designed/picked for the room as a theme.

The two wooden cane chairs are, well, made out of cane and include white cushioning with mostly purple throw pillows. These two chairs a re usually moved around different places in the room. The white half-shelf consists of many colourful organisers that include the colours; pink, green, blue, white, peach etc. It's made out of MDF covered with a white matte sheet.

Since my design will require some kind of swivelling or swinging for both storage and for use, the picture above shows the allowed space for the swivelling of the main frame and such. Even though the room is quite big and has a lot of space around the bed, which allows a lot of space for the swivelling, I must limit my design to the most outer part of the side of the bed. In other words, the swivelling or swinging or even the base must not exceed the size of up to the red line, which is shown on the picture.

The dresser, I believe is made out of Rimu and is very wood-coloured, which is shown on the left. It has a large mirror attached to it and has a few metal knobs for pulling.

In conclusion, due to the limited space available, having decided that I will only use the small space around the bed, I must make sure that I design a very compact bed table, yet very rigid and stable. Using light coloured wood is also a favourable and safe option due to the room not having any dark coloured materials.

To be able to develop my designs well, I must look at how different companies go through development using different types of planning tools. By doing this, it will help me gain a very clear understanding on planning tools and apply it onto my project. This is also called a case study. My case study is about the custom classroom furniture by Furnware. The very first thing they did was identified their issue. Without having identified the issue, then the project would lead to nowhere. They gathered actual data to prove the point of their project. Their main issue is on ergonomics. They did a lot of research in and out of the country. This means that they also had quite a few different clients and stakeholders. I think that by doing this, they can get a wide range of perspectives for their project in order to fully lead on with the right decisions throughout. Some of the key factors of making furniture for students involved price in the market, durability, and stackability/portability. They identified key specifications that had to be included in their designs. Collecting data is always good and very reliable as a part of research. After the research and gathering of data, Furnware went straight through to the concept development. They came up with different types of questions to start off with:

**Market opportunity**
- Will it meet a need?
- Will it improve things significantly?
- Will it serve its purpose?

**Ergonomics**
- Is it user friendly?
- Is it physically safe for the user?
- Is it friendly in the wider context, e.g. classroom?

**Client engagement**
- Focus groups, open discussions, directed discussions
- Listen, listen, listen, and listen again
- Prototype and test

**Fitness for purpose**
- Does it solve a problem?
- Does it meet their needs?

**Efficiency and effectiveness**
- Does it make life simpler?

**Optimisation**
- There will be trade-offs, so need to prioritise

All of these questions, I must consider asking myself and my client to be able to critically analyse the needs and outcome of this project. Furnware had come up with the idea of adding storage space to the desk for the students to use. The company tested out different types of storage ideas and developed them. On the right, shown is their first prototype. At this point, they've got an actual base idea of what to design and make. This obviously is a very basic design to start off with. This type of modelling (prototype) can also be called a "mock-up" where it's sort of a template but in the actual size. The good thing about using mock-ups is you are able to see the whole proportion of your design, as well as being within its surroundings. After their concepts models, tests and trials, Furnware went through to Design and raised a couple of questions:

**Functionality**
- Does it meet the findings of the concept development process?
- Durability?

**Testing**
- In market trial and feedback
- Making improvements

**Brand Fit**
- Does it fit fully with brand expectations?
- Does it enhance the brand?
- Are there design links with other products in the brand?

**Materials Selection**
- For efficiency, cost, durability
- For brand consistency
- Availability of materials on an ongoing basis

**Aesthetics**
- Is it pleasing to the eye
- What colours are appropriate?
- Does it fit the brand?

Student (as the 'experts') feedback is very essential during this process. In other words, you have to keep coming back to you client for consultation to make sure that you're on track. The selection of materials is very important when it comes to the clients' preferences. At this point, the clients are very much involved in the project and client consultations are recommended frequently. Furnware went back to their design group to make an actual prototype model of the different types of storage components. The next part of the process is working out how to make the product efficiently. This is where the planning of the production process comes in. Generally, Furnware products are made in their own factory, but some small parts like plastics, wheels, hinges are made by other companies and just bulk bought by Furnware for less hassle in making each and every component. This relates to my project by buying some other materials that would be too hard to make by hand in our school workshop, like metal handles, wheels and such. A brief outline of the planning on production is shown below:

**Tooling**
- Major tools to be built
- Templates
- Special tools, e.g. for assembly

**Other Resources**
- Processing capabilities, e.g. painting or powder coating
- Factory space

**Costs**
- Can we keep the total cost within the target/budget
- How long will it take to recover the costs in the market?

**People/Labour**
- Availability of skills required
- Production time per unit
- Assembly time per unit
- Packaging and dispatch time

In the case of my project, I must apply these key processes into my project and use them for consideration. I must look at the tools that I will be using in the production process, Keep in mind the space I will be working in and how limited it is, The budget costs (will I exceed the budget/target cost?), and most definitely the time and skills that I will be using in order to make an almost perfect and fully functional design for my client. I've learnt from this case study that planning ahead is very useful. Furnware has put some hard work into the development of their product unit and it involved quite a lot of cost, time, and effort to be able to meet their clients' (classrooms) needs as well as adding extra features that improves the efficiency and ergonomics of their product. Furnware has suggested some important key stages that us, students must focus on. We are to develop a brief to include the identified issue and need, with a conceptual statement, and desirable attributes for our projects. Sketch our own conceptual model of the ideas we have for our designs with annotations to describe materials, components and functions to show its intended fitness for the purpose. Develop our concept design into a final design ready for production planning. Identify the main steps in production in order to use the time allotted efficiently. Keep in mind of the risks and features we might be changing – be ready for plan B.

From all the researching I've done, I now have a much clearer understanding on the background of my project. I have looked at the aspects of ergonomics and how to apply it onto my project/designs for my client. I have looked at what aesthetics really is and how to apply it on to my designs. But the 2nd most important research of all, the storage components. I now have a clear understanding on what types of storage components to use for my designs and I should be able to work through what types are the most suitable for my client's needs. I've started on my client consultation which is good to keep track of things. After this, I've done research on six existing designs of different types of bed tables. This was done so I have a base idea of what I will be designing. I then went onto exploring the location, which is a very important stage of the project which is done before designing. This gave me the exact space, location of where the finished prototype will be situated when finished as well as the other existing furniture around the room. A case study on Furnware was done afterwards.

Since the start of the project, there has been quite a minor arrangement in my client's bedroom. The bed is moved to the opposite side of the room. This doesn't affect the current situation at all due to the space I have allocated for the finished prototype to be placed in. As mentioned before, the limit of the finished prototype will only go up to the red line (shown on the left). This means that it should not go out of the whole square bed area.

The finished prototype itself, I know wouldn't be too big, using my knowledge based from my client's needs. This is good for time management as I will be spending most of my time allocated for the project, developing some designs to produce a final design that should be perfect for use of my client. In terms of production time, I will probably need at most a whole term for it due to the fact that I may be doing most of it using the laser cutter. Overall, I don't have any issues on time management and planning but it's always good to be ahead of schedule so I can be ready to tackle some difficulties I may encounter during the process.

After all of the research, I must move on to the concept designs and development in order to start on my designs. This will then give me a basis of the end prototype design which is to be done after the development. Some new specifications are added by my client:

The **key factors/issues** are:

- Ergonomics (new priority)
- Storage
- Risk Management
- Durability
- Efficiency
- Aesthetics

These **key specifications/client's needs** are shown in my client's own words: *(details on consultation with client is on slide #9)*

- A bed table which acts also as an **organizer** where I can **secure** my coffee cup and pencil case.
- It should have a container which also has a cover where I can keep notes.
- On top, I should be able to place comfortably my laptop or Ipad without sacrificing my back.
- Cooling pad for Laptop.
- Groove or slot so a laptop up to 13" size will fit.
- I can tuck it in or stow with everything intact.
- Eyeglass space.
- It has to be mounted on the bed for stability.
- Usual tables are not so good because everything moves and are not tailor fit to my height and eye level.
- There must not be anything hard underneath the bed. Therefore, whatever is underneath must only hover over the bedroom floor

After completing my two briefs I have come up with an addition to the prioritized list of Key Factors: Ergonomics (ease of use), Design, Risk management, and Storage. The bed table must be really comfortable and easy for my client to use in terms of ergonomics. This applies to the same needs that my client provided me with. It must me pleasing to my client's (and the wider community's) eye (Aesthetics). I must ALWAYS keep in mind the risks that could potentially occur when in use and develop my design so that all the risks are prevented from occurring. There must be enough storage for my client's requested space for her personal belongings.



# Updated Brief

I have come up with some factors that will be involved in my project:

- **Ergonomics** – This is the main issue of my project and the product must meet this issue in order to have a successful project. The product's comfort, efficiency, safety and ease of use will all affect its ergonomics and its effectiveness to it.
- **Strength and Durability** – The product MUST last for a long time as well as no damage in any of the components during use in order to have a durable product for everyday use.
- **Risk and Safety** – The product must me non-toxic and non –chemically dangerous and must not have any sharp edges or objects that could lead to a certain injuries to the client/ user as well as the wider community stakeholders and users. Anything that can hurt or damage my client/stakeholder in any way lead to an unsuccessful product.
- **Practicality** – The product's quality should be in the state of being useful and not to simply go to waste.
- **Portability** – for a portable product, the factors of size and weight must be considered at all times. The weight must be as low as possible yet durable enough. This will be met using the right materials. The size must be as small as possible yet practical enough for the human hands and can sustain everyday usage considering the weight added to it.
- **Available Equipment** – adapt and use the available equipment found in workshop as much as possible to save precious time, cost and effort.
- **Materials** –The materials going to be used for construction are important as it affects the strength, durability and overall efficiency of the design as well as portability. Research is needed for this as each part has a different role so I would need to find out what material is best for each one.
- **Type of use** – product would be designed for indoor climates. It will be attached to the bed. It should have the ability to be folded down temporarily for easier access in and out of the bed.
- **Innovation** – The design needs to be innovative and to possibly have multiple uses, while adapting to existing materials and surroundings in the location (client's bedroom).
- **Time of production** – How long it takes and how much time I have to finish my product affects the overall project and its outcome. This project is considerably a small project and would take up quite a little time onto production. Therefore, I have a lot of time to spend designing it and ensuring that the design is at its maximum capabilities.
- **Cost of production** – I would have to take into consideration the total cost of the design. I will have to be careful to keep the cost low and not reach or go above a certain price so that the finished product would remain cost effective and well below the similar products on the market.
- **Social** – influence, likes and dislikes of people and others. I would have ongoing consultations with my clients and stakeholders, other students in my class would also share opinions during the process and I will need to bear in mind these things.
- **Design/Looks** – It must be appealing to the human eye (aesthetics) so that it will be an item that a particular user would want to use as much as possible without being turned off by the looks.
- **Stakeholder** – The stake holder's experience and skills, opinions, tips and advice are needed. Ongoing consultations with my stakeholders are essential and very important for a successful outcome. I will need to keep in record what they say, tech, and suggest towards the design.
- **Client** – what the clients would value is an important key factor for a successful product. My clients are the ones who created a certain task or goal that I would need to reach. They will be involved throughout the entire process, from the designing and development until the product is finished. I will need to keep in record what they say.
- **Environment** – It must somewhat be sustainable to the environment.



# Key attributes selection

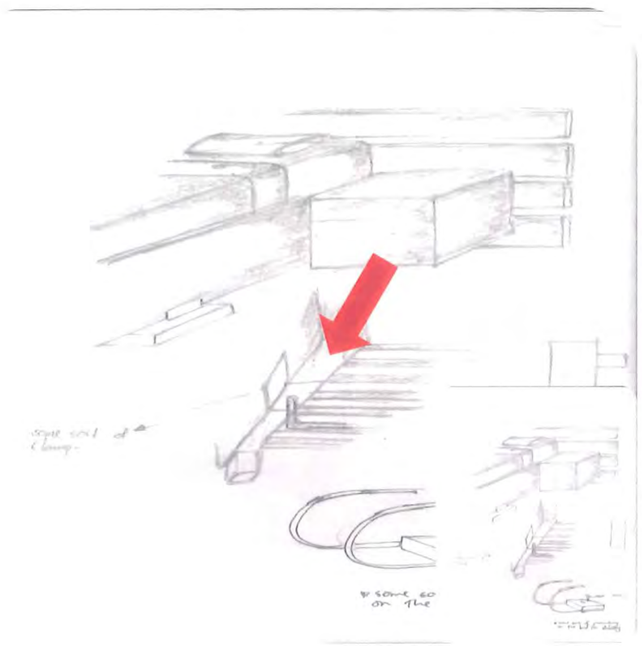
I have prioritsed key factors through high-medium-low priorities.

- **Ergonomics** – The ergonomics of the product is a **very high** priority as it is the main issue. It must be very comfortable to use, have efficient working space, safe, and easy to use. Not having an overall ergonomic design would result to a completely useless project along with the waste of time, energy, and money.
- **Strength and Durability** – The strength of the final product is a **very high** priority as it should last a long time without having to break any components along the way. It will not only be used by my client, it will also be used by others. Therefore, its strength for different types of uses is very important. Failure to meet this key factor can result to a broken project and therefore, a complete waste of time and money.
- **Risk and Safety** – This risk ands safety is a **high** priority. I don't want anybody, not just the client but also the wider community to get hurt from my design. A risk of injury may result to a serious injury and therefore, a result to the product not being used because of this. If this happens, the project is completely useless.
- **Practicality** – The product's practicality is a **high** priority as it must be used the way it should be. In other words, it must do its job and purpose – to help organise files and improve ergonomics while working in bed. The product's quality should be in the state of being useful and not to simply go to waste.
- **Portability –** is a **medium** priority because it will mostly be situated at my client's bed/bedroom. Although, it must have a low enough weight and compact enough size for the ability to be carried around, especially as my client flies a lot overseas (she wouldn't be bringing it though). It must also be transferable and modular to any type of bed and size.
- **Available Equipment** – Available equipment found at school is a **low** priority as I can of course fin other materials in shops like mitre 10 mega if ever the school cannot provide a certain type of material for student's to use.
- **Materials** –The materials used in this project will be a **high** priority because it greatly affects the product's looks, strength, portability through weight, and ability to fit with its surroundings. Selecting the wrong materials can lead to a wrong outcome and disability to its function. If the selected materials don't suite the design, then money and time is wasted towards the project.
- **Type of use** – Type of use is a **low** priority because the design can be easily manipulated to suite the desired type of use.
- **Innovation** – The innovation cannot be properly prioritised as it is an entirely different key factor that has to be in my head at all times throughout the entire process. In this key factor I would have to consider these things: What innovations may be able to help me, what other trends may affect my design or ideas, how I will be able to adapt existing materials and techniques to better suit me and my project, what new innovations might have influence on the way I think, word or design and what is novel about my ideas.
- **Time of production** – The time of production is a **medium** priority because my project is a fairly small project compared to an actual furniture. I will have plenty of time designing and therefore, medium prioritise the time of production available.
- **Cost of production** – The cost of production is a **medium** priority because having a small project reduce the amount of materials used. Therefore, I will have no problem with the cost but must always consider getting the "bang for the buck" materials.
- **Social** – Besides my clients, other users may also be present. What other people would value for my project is a **medium** priority. I am open to any suggestion or opinions to those who regularly have views during the process and those who are to use my product. Suggestions are slightly limited, mainly only during the designing and production processes.
- **Design/Looks** – The design/looks is a **very high** priority as my client and other users must have the right first impression towards the design in order to have the drive to use it often through long term periods. Failure to design an attractive product may result to the product not having much use at all and therefore, a completely useless project.
- **Stakeholder** – The stake holder's experience and skills, opinions, tips and advice are needed and is therefore, a **high** priority. Ongoing consultations with my stakeholders are essential and very important for a successful outcome. I will need to keep in record what they say, tech, and suggest towards the design.
- **Client** – The client and what she says is very valuable and will have great impact onto the design of this project. Therefore, it is a **very high** priority. Failure to meet the client's needs will result to a completely useless project. I must ensure that I update with my client at all times during this project to ensure that I meet all the specifications required.
- **Environment** – The environment the product would be in is a **low** priority as it is already set. I just need to keep in mind what environment I made the product for during the planning stages and this factor would not be much of a problem. Thorough research on materials, dimensions and shape is the key to this factor.



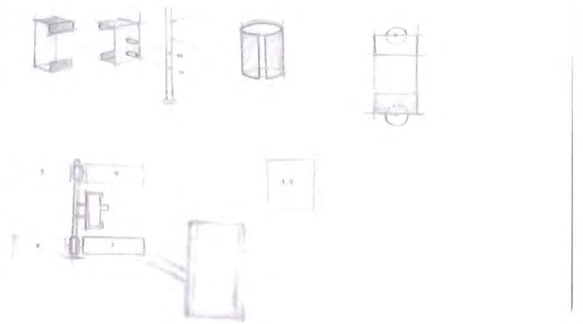
# Key attributes Prioritisation

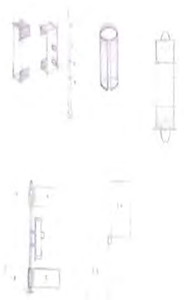
I have decided to do some concept sketches on the mechanism first, before the actual table top itself. This is done so that I can base the table top on the most suitable mechanism for my client to use. I have divided the types of mechanisms into two; Automatic and Manual. The automatic mechanism is described so that the user doesn't have to put much force on getting it on the bed as it is attached almost permanently onto the supporting mechanism. The manual mechanism is described so that the unit is separated into two major components; the frame and the table top.



On the left is my drawing of my client's bed location. It shows where I can attach whatever type of clamp I will be using for my design. The bottom drawing shows the underneath of one side of the bed where the clamp is to be attached. The bottom right of the picture shows a side-view of the whole side-section of the bed, shown using the red arrow. The red arrow shows where you are looking from and into. The small box attached to it is the long piece that holds the slats intact. If the whole bed was shown, you'd see this on the other side (shown very lightly opposite t the actual drawing/photo). As my client has stated, the frame of the bed table must be attached somewhere onto the bed. I have clearly decided that it will be attached to the side panel of the bed so there will be minimal wobbling. Not only does the location of the clamp affect the wobbling of the unit but also the design on how to prevent any wobbling.

The concept drawing on the left shows a universal mount idea that is to be used possibly on every design of mine. It's basically a rectangular piece of metal bent at different points to create a "C-shape" mount. The reason why it is c-shaped is so that it mounts firmly onto the side panel of the bed. This is shown at the very bottom of the drawing which is much similar to the previous drawing's understanding. It shows the c-clamp firmly mounted onto the side panel, allowing no allowance between the metal and the wood. In other words, the c-shaped bracket is flushed onto the wood. It would be necessary to say that this c-shaped mount is still free to move along the side panel.



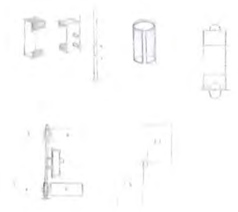


On the left is my drawing of the front view of the c-shaped bracket. Since I have decided that this clamp would be tightly mounted onto side panel of the bed, there will certainly be quite a lot of friction occurring. To lessen the friction occurring, I have come up with the idea to put rollers on both top and bottom parts of the bracket like in a sliding door. It has come to my mind that the bed table is better off with the ability of being moved along the side panel by my client through sliding it. This Is so that my client could easily get the table out of the way temporarily and place it back for use. When I say temporarily, I mean the bed table not having to be disassembled or collapsed for storage underneath the bed. This idea would be very efficient for my client that it would really be easy to use. It is much preferred in terms of the ergonomics. My only problem is, how will I fit the rollers/wheels into the bracket's very thin sheet of metal? I may have to revisit the development of the bracket just before the final design in order to perfect the design that is to be used with ease as efficiently and as useful for my client. When looking at the risks relating to this design, a potential risk that I could see is the clamp getting in the way of the mattress. Hence the revisiting of the development of the bracket later on.

After the bracket component, I will move onto the concept designs of the mechanism and look at various ideas relating to my client's needs. I will explain how each concept design works and put each design into consideration for the design development of the mechanism. Then after the development of the mechanism, I will move onto the concept designs of the table top itself. This will be done so I can base all of my designs on the justified design of the mechanism.



# Concepts: Bracket development

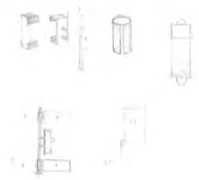


My first concept design consists of the same bracket from the previous slide attached to the side bed panel but includes a rather complex mechanism. It is categorised as an automatic mechanism. What it basically does is swivel around a fixed metal pole that is well attached to the mounting bracket through two thick-enough rods. It has a flat bottom at the lower end of the pole to stop the table from making contact with the actual ground. The table will be mounted onto a thick plastic cylinder (possibly made with the 3D printer) or metal cylinder which is to slide up and down the metal pole. As shown, there are four steps on using and storing this mechanism. This is shown in the numbered phases. Step 1: the table is stored underneath the bed. Step 2: the table is rotated 180 degrees about the metal pole. Step 3: the table is lifted up through the metal pole - no swivelling occurring. Step 4: The table is again rotated 180 degrees about the metal pole and is now hovering above the user's legs as a proper table. The plan view is shown in the diagram below the one on the left.

## Concept Design 1



A close-up of the plastic cylinder is shown on the right. It is shown that it has a vertical gap on one side of the cylinder. This is so that the cylinder passes through the double rod support from the bracket and no stoppage between the vertical sliding through the metal pole will be caused. It may also act as a lock by swivelling it and stopping the force downwards so that the table doesn't free-fall along the metal pole, causing any type of injuries to the user. The cylinder will also be relative to the metal pole to prevent any wobbling.



There are certainly some other types of risks involved. I must ensure that the cylinder (metal or plastic) is well built and robust for everyday long-term use. I must ensure no free-falling of the table which could cause injuries to the user due to the fact that the table is situated on a smooth, vertical pole. Therefore, locks will be involved in this design. It must be an ergonomic design which shouldn't require to much energy to set up so back injuries and such are prevented when setting it up. One example for this is the user having to reach down underneath the bed just to lift the table onto the desired position. This requires bending down and therefore, back pains leading to severe injuries where possible. As said before, the bracket must not get in the way of anything like fingers and such, especially when rolling along the side panel of the bed.

## Concept Design 2

My drawing on the right shows the side view of an automatic mechanism. This view is the same as the view of the 1st drawing on concept design 1 where the bed is located in between phases 1 and 2. Basically this mechanism is like any other table except that the table top can be moved so that it can be stored underneath the bed as well. It surrounds the side of the bed as having phase 1 underneath the bed and phase 3 on top of the bed, which in this case will be hovering above the users legs. The C-shape is a bent metal rod. It's necessary to say that there will be two bent rods next to each other, with the table top in between. It's not seen in this drawing as it is the side view of the mechanism. The bed table will basically have rotating cylinders (like the one from the previous concept design) on the each side and will follow through the curve of the c-shaped frame as it goes up and around the bed with the same side facing up. It's shown that the bed table is facing the same side up when underneath the bed for storage and when in use on top of the bed by showing 'pencils' as a reference to the same side up. This may not be an easy design but it is possible with a bit of development. The main risk that is involved in this design is the fact that it cannot be collapsed nor disassembled. It's always sticking out. It's just like a normal table and this might not suit the client's needs and its purpose. Although, there are possibilities of storing this mechanism properly.

## Concept Design 3

The 3rd concept design is very similar to the 2nd concept design in a way that the table follows the curve of the bent frame, but his time using non-rotating cylinders. It is categorised as an automatic mechanism. The problem I found with this concept is it involves the table upside down when in its storage position. Therefore, whatever type of storage inside must involve the design of tight and firmly attached storage components in order to prevent the stored items from falling down through the force of gravity. Again, the L-shaped rod is meant to be very smooth for easy lifting. It consists of the same c-shaped bracket mounted on the side panel of the bed. It should just hover above the user's legs when in use – for ergonomics. I have not clearly shown the overall mechanism and how it works because the main point of difference from others is the fact that it will be stored upside down, underneath the bed.

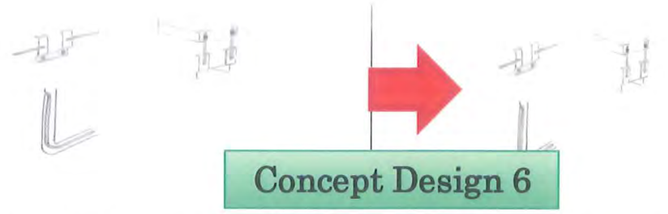
## Concept Design 4



The drawing on the right is my 4th concept design and it may not look like much of a concept design but it is much different from the other concept designs. It is an automatic mechanism which involves one single groove that is cut out of the metal rod/pipe. The mounted bed table will simply follow the groove and its swivel or rotation naturally. So underneath it will be rotated 90 degrees so it won't stick out. It will smoothly rotate 90 degrees so it is pointing away from the bed and is lifted facing outwards. And then it will rotate 180 degrees, which will then be the position where it will be hovering above the user's legs. For this design to properly work, it must be designed very well. It's considered a complex design due to the fact that the mount from the table has to be strong enough. There are limitations to this because too thick hinges will be too heavy for the vertical pole/pipe. Too thin hinges will simply bend due to the weight of the bed table itself. A major risk in this is the free fall when the user is to push it away for storage. Although this is a risk, it is also an advantage for the user as it only requires a little push and it will follow the groove 'til underneath the bed where stored away.

## Concept Design 5

On the left, concept design 5 is shown. It is another automatic mechanism. I would say it's a very basic and common mechanism for everyday use, which is used in a wide variety of ways on many different products. It still has the same c-shaped bracket around the bed's side panel. The joint between the c-shaped bracket and the rod is supposed to swivel. Therefore it has three swivelling points/joints; One between the table and the rod, one between the two rods, and one between the c-shaped bracket and the rod. This way, it the user is easily supported by the mechanism when he/she is pulling it up to position. A major concern of risk in this design is the swivelling joint between the two rods. It's not only potentially weak but it's also pointing outwards, which can cause trips and such leading to severe injuries on the user. A close-up of the swivelling joint between the two rods are shown below, basically how it will be constructed. As you can see, it probably won't be as strong as the other mechanisms when looking at it now, but it can possibly be developed into a much stronger mechanism just like any other designs.



## Concept Design 6

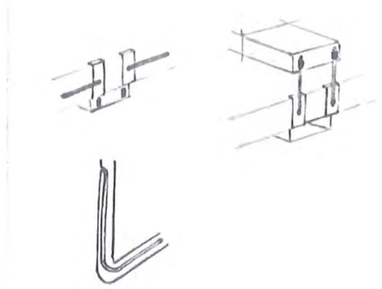
The two major components (table top and frame) can be assembled together. It shows that the previously horizontally rotated rods are now both rotated 90 degrees to form two vertical rods as the main frame. Since the table top is now in use, the container where it was placed when stored is now a vacant space. If I am to develop this design, I would make much more use of that vacant space so there would be much better efficiency in terms of storage and work space. The only two things that hold the frame and the table top together are the plastic or metal cylinders. Therefore, if I am to develop this design I will probably consider making a separate sturdy frame attached to the table top or maybe even just some reinforcements so the table top Is ensured to not fall off on one side by counter-weight. I could even add two support legs on the other end, which is very easy to do. Also, the container must be very well attached to either the c-shaped bracket or maybe even a separate mount on the bed just to make sure that the container is just hovering above the floor as my client added in the specifications – "there must not be anything hard underneath the bed, on the floor".

On the left, shown is the 6th and final concept design. It's a view of the side part of the bed, showing particularly the side paned with the two c-shaped bracket attached to it. It is categorised as a manual mechanism due to the two major components (frame and table top) separated when in its storage function. It shows here that the two main rods are rotated to a horizontal angle, opposite to each other and the table top is stored inside another box underneath the bed. The rectangles attached to the table top represent two plastic or metal cylinder slots as of the ones from concept design 1. It would be better if the two c-shaped brackets are linked together with some sort of thin metal or thin rods so they don't separate and so that they would keep the desired distance perfect for the table top to be attached.

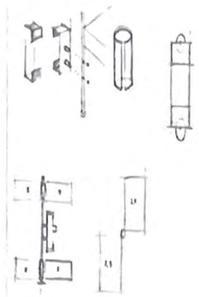
Now that I have finished analysing my concept sketches, I will consult my client regarding my concept designs and ask for her opinions and/or additions to the designs and what she would prefer. After the client consultation, I will move on to the development of the chosen concept design(s) and do some further research and analysis, then consult my client again. The development of the mechanism designs won't necessarily be from one concept design. I may join two or more concept designs' features to improve on any issues. I must always keep in mind the ergonomics of the mechanism to the user, the efficiency, as well as any potential risks to the user and also the wider community that may arise when the mechanism is in use.

The first thing I asked my client was, "do you prefer an automatic or manual mechanism?" along with what the two categories actually mean. So I showed her all of my concept sketches and asked her what she thought about them and if she had any addition to any of the sketches. She liked the way that Concept 6 was put up and designed as two different components. She added "I don't want it to look like a feature of the bed, but an accessory which is useful." "An accessory is an add-on or an enhancement", she added. This means that she doesn't want the whole design to be permanently located at the bed space. It has given me the chance to think about how all this works. An automatic mechanism is more permanent than temporary where you can't disassemble it on a regular basis (for example, every night before you go to sleep to get it out of the way). And her thoughts about having a permanent mechanism around the bed were, "I don't like too much metal around the bed." She has explained clearly that metal still can be used as a material but maybe not too much – minimalized.

My client then went on to talk about the ACTUAL purpose of this bed table in addition to the key specifications she stated earlier this year. Her exact words were, "The purpose of this bed table is to be able to work in case I need to work in bed, it allows me to relax while working and even write in my diary." This enables me to design a very ergonomic design for my client. "To complete urgent tasks and to organise while working in bed. Ready to be used any time. Readily available when needed." It has to be easily set up especially by my client where she wouldn't have any trouble doing it. It also has to be uncomplicated when setting it up as she did say that it has to be made for urgent tasks for organising while working. "It has to be transferrable, where it can be used in other beds. It has to be modular." This means that it must be designed so that it will fit other types of beds. It has to be even a little bit portable around the house, in different rooms and maybe even for travelling, like for use in hotels and such. This is where I explained how the c-shaped bracket really works, even for other types of beds. She even added, it's purpose is to fulfil the phrase "a relaxing way to complete some tasks." This means that she really has to be comfortable when using it, especially in terms of ergonomics. That'd the true purpose of this project.



We then moved onto each concept design very carefully, analysing each and every one. My client particularly liked the 6th concept design due to it being a manual mechanism. I asked her if she'd be fine with having to assemble it normally on an everyday basis. She said that it's actually better to be able to store it more, rather than have it sticking out, as the automatic mechanism does. She even added that she should be able to fully disassemble the unit easily if ever the holidays took over. This gives me an opportunity to think about how to be able to take the c-bracket out easily and even assemble it onto the side panel of the bed without having to disassemble the whole bed. Due to the C-shaped bracket, it would be impossible to assemble and take it out without having to disassemble the whole bed for access from one end of the side panel of the bed. Therefore, I must design a much more convenient bracket based on the c-shaped bracket. Some "mock-ups" I can do as a stage for modelling are; 1:1 scale cardboard, smaller scale acrylic, Computer modelling using Sketch Up. Since she doesn't want "too much metal around", I could probably get away with a strong, durable, and thick enough plastic pipe, although metal is much preferred as a frame for increased durability.



On the left it shows that my client is using her laptop while on her cell phone. The view shows a lot of the needed specifications for this project. Her glass of water is located on the bedside (on the bottom right of the picture). Her notebook is located on her left along with her glasses and pen on top of it. She uses pillows to support her back for ergonomics. It is clearly shown that her body form isn't normal, as to the ergonomics of sitting on a proper seat. She is slouched and looking down. This could lead to severe neck and back injuries.

On the right, is the other side of the view. This time it shows that she has more paper and an extra pen. She is, again, seen to be slouching and looking down. Her things and stationery are all scattered on the bed. My client clearly lacks storage for her things and therefore, is one of the main issues/key factors of this project. The storage issue along with the other issues have to be met in order to produce a completely useful bed table for my client. If I didn't meet the storage issue in the end, then my client won't be able to store anything or organise her thing. Being done so will result to a completely useless project.

On the left, a picture of a view from the side is shown. This picture mainly focuses on the current ergonomics. It clearly shows that my client is slouched and looking down, the same with all the other pictures. Her lumbar is definitely affected by the ergonomics of her current situation. The pillow doesn't really help in the lumbar area, it's only used to soften the area where she rests her back. From the ergonomics research I've done, her eyes are not 20-28 degrees to the screen and is therefore, non-ergonomic. Her arms are not 90 degrees to the elbows. Her legs aren't bent (this sis more of her preference).



# Concepts: Client Consultation

After going through some deeper information about my client and her needs, I realised that the ergonomics in her posture somewhat needs more attention than that of the ergonomics on using the table and its workspace. My key stakeholder, Mr. Breig has also realised this. He sent me some pictures through email, which struck me and made me think about a whole different idea.

The design on the left shows a half-seat that can be placed on top of the bed to act as an ergonomic back support with enough space for storage while the user is on the bed.

The **advantages**:

- Very ergonomic
- Enough space for storage
- Can attach quite a lot of things from modifications
- Stable
- Durable
- Efficient in working space

The **disadvantages**:

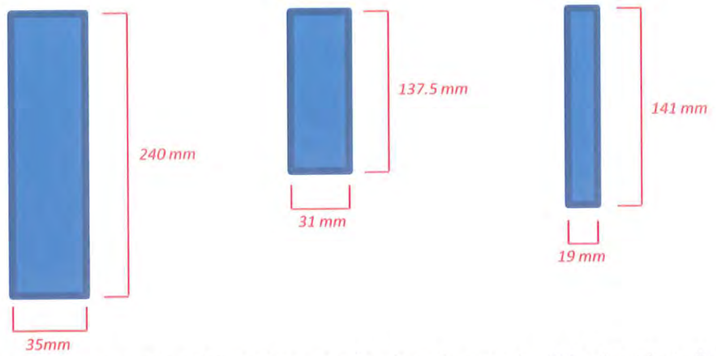
- Not easy to store away
- Not really portable based on my client's needs
- Very Bulky
- Inefficient (requires a lot of energy to move)

If I were to design something similar to this one, I would make major modifications so that it will perfectly suit my client's needs. Firstly, the main disadvantage of this is the fact that it will almost totally set aside one of the main issues – storage as well as portability. It can be modified so that it can store more things but it initially can't be something you just store away, underneath the bed unless mechanisms are made to give the ability to make it collapsible.

I have consulted my client about possibly making something like this and just modifying it to have a table attached to it. Overall, she didn't like the idea. I suggested, since I have enough research to support my suggestion, that correcting her posture is just a bit more important than having an organiser. She completely disagreed with me. My client said that it would be better to stick to the initial idea. That is, to have a bed table which also acts as an **organizer** where she can secure her things even while stored away. This is because the first idea of a bed table saves a lot of space compared to the seating idea. She then added, "whatever lumbar support needed to correct my posture, can always be bought from somewhere". Then as we brainstormed, I suggested that we do buy a lumbar support pillow/cushion/back rest, then I just modify it so that it can be firmly attached to the bed (e.g. the headboard as Mr. Breig suggested).

In conlusion, we decided not to do the transition from a bed table into a bed seat + table. This is because these key factors and priorities are highly affected; Storage, Portability, Ergonomics (in a good way), and Efficiency. It may have enough storage space to store things in or may even have more than required – this is a good thing but the seating idea disables the ability to be able to store the seat away and underneath the bed. This then doesn't serve one of my client's main purpose (Storage) and will therefore result to a useless project in terms of being able to store it away and out of sight to reduce visual pollution. Secondly, the Portability of the second idea is definitely disabled as well – it wouldn't be light enough for my client to carry into and out of the bed unless special materials like fibre glass, thin ply, carbon fibre are used. My client not being able to carry it properly as it may be too heavy for her and as it may not be transferrable and modular as my client wants it to be, may result to more severe back injuries and is therefore, completely useless as it may just cause more problems to her. The ergonomics is of course affected in a good way as the seating idea will definitely provide more comfort to my client, as the user. This then leads to better ergonomics and prevention of back pains and injuries during her hours of use in the bed seat, which of course leads to a successful project in terms of meeting the client's main issue – ergonomics. But then again, none of this could be done without resulting to a too heavy and bulky item for my client to carry unless special, expensive materials are used. Therefore, this is also somewhat useless. Lastly, due to the fact that my client does have to always carry it out and into the bed, a lot of energy provided by my client, as the user is required to be able to do this so. An item which requires a lot of energy from the user to make it function properly results to an inefficient product and is therefore useless in terms of the ease of use for the user. Looking at its aesthetics, it may not be too pleasing enough to an average person's eye. Aesthetics for some people do affect their first impression on the product. As the picture above doesn't look too pleasing to the eye, in my opinion, it may also not be pleasing to other people's eyes and therefore, to be able to design a similar product, modifications must be made to suit every persons first impression to the product for better marketing as well (e.g. carbon fibre, curves, none couch-looking design).

It has come to thought that the c-shaped bracket isn't suitable for this project , particularly in the wide range of different sizes of beds. First of all, The c-shaped bracket does not have the ability to be mounted onto the side panel of the bed without having to disassemble the bed completely. At home we have three different types of beds. I have used these to measure the side panels of each different types of bed to be able to have a wide enough comparison and variety as to what suitable measurements for the clamp are.




These are views of the side panel of the three different beds looking from the end, showing the difference in dimensions and scale. My client's bed is by far the biggest bed in size out of all the three other beds I've measured, in terms of the overall size but also particularly the side panel of the bed. Therefore, the maximum bracket size that is to be clamped onto the bed must be at least equal to my client's bed's side panel dimensions. It shows a clear variety of the different types of beds and hence the development of the bracket after my client has added to the specifications that the unit should be transferrable and modular. Thickness is also a problem. As shown, bed 3 is very much thinner than beds 1 and 2. This suggests that the clamp must also be adjustable wide-wise. Therefore, the clamp must be adjustable wide-wise and length-wise. During this development, I must always keep in mind the durability of this clamp, along with the risks that may arise when my client is to use the final prototype.

After spending quite a lot of time on the development of the bracket alone, I have consulted two of my stakeholders on what is best to do, in general. My key stakeholder, Mr. Breig has suggested that I just buy a clamp and modify it from existing designs just so it will suit my designs. My other key stakeholder, Theodore Carlos has supported this suggestion by giving me some reasons for it. First of all, it is very time-consuming. This is because clamps have already been developed and engineered well to this day. There is no point on starting from scratch just to make my own clamp that will suit my client's needs. Theodore suggested to me, a well-known phrase that is suitable for this issue; "Don't reinvent the wheel". The wheel has already been well-developed over the thousands of years. There is no need to start another development and end up in the same final design - It's not practical. Mr Breig added "Mechanical engineering students take half a year just to make a clamp". Our students from this school do actually take half a year and therefore, is impractical for my project. In other words, I must focus on designing and developing particular components that should suit my client's needs, specifically from the base idea (what the actual purpose was since the start – a bed table) and not on an already developed component like the clamp, which I can just buy as hardware. Theodore added that if I make my own clamp from scratch, there is a good chance that it will fail when being used due to the fact that it will be my own development and design. Failure of any component will result to a non-useable mechanism and therefore, my client will have problems with the ergonomics and then won't be able to use the design. Not being able to meet my client's main issue will result to my client not being able to use the design of the bed table. Not being able to use the bed table will result to a completely useless project. I have consulted Theodore about the manual mechanism as well. I suggested that I make 3 major components instead of 2 due to the idea of the table being transferrable and modular, in relation to the bracket. This time, the bracket itself, then the rods, then the table. This of course increases the time and effort for my client to assemble the table first before being able to use it. Theodore said that this may be unnecessary because the client will have to use more energy for more work, which I then added that it wouldn't be efficient, as efficiency being one of my main issues. He said, "What's the more priority? Transferability (portability) or Efficiency? This then made me think that my client won't always be transferring the bed table to another bed as she has her own and therefore, making efficiency the more priority for ease of use. Making wrong decisions in this project will lead to an utterly useless prototype and therefore, I must prioritise my key factors properly. If I can't find a suitable enough clamp to buy, then I'd have to really design and make my own to suit my clients needs.

The **prioritised key factors** are:

- Ergonomics (1st - most priority)
- Efficiency (2nd)
- Portability ( 3rd - new priority)
- Durability
- Storage
- Risk Management
- Aesthetics

Here, it shows that I have a new priority based on all of the research and consulting I've done – Portability. It's priority is less compared to Ergonomics and efficiency but it is definitely one of the main key factors since my client has added the terms "transferable" and "modular".



# Bracket development

After looking more about possible ideas, it has given me the idea of giving the bed table the ability to be carried in with the luggage during flight to overseas. My client specifically travels a lot, as mentioned in the initial brief. It is important that I consider the idea of her taking the bed table with her to overseas for use in hotel beds, generally beds with other different bed side panel sizes. Some things to consider are: its size; its weight; passing through the metal detector; its ability to be used with other bed side panel sizes. I will have to consult some people such as bed companies (for a more valid data on bed side panel measurements), the airport companies regarding limits, sizes, restrictions etc. What my client had to say about this is that she prefers its use to be only within the house, as it will probably be attached onto her bed most of the time anyway. She wouldn't want to take it overseas but it would be good if this was possible - she would rather have a duplicated design for use overseas. I have consulted bed companies such as Bed Post, Natural Beds and Furniture, Furniture City, Freedom Furniture, and Target Furniture North Shore. So Far, only Bed Post and Furniture City have replied. I asked for some side rail/panel dimensions for a more valid data for my project, politely. My email was:

*Hi there,*

*I am a Year 12 student at Rosmini College currently doing Technology Scholarship. I am designing an organizer/bed table that should be able to clamp onto a BED'S SIDE PANEL. I need some valid data and I would like to know different side panel dimensions (you can exclude the length). I am more interested in the width and the thickness/depth of the panel. My client has indicated that I make a modular and transferrable unit, where it can pretty much be attached onto any type of wooden bed with different side panel sizes for increased the head to the feet) portability. To sum it all up, I would please like to know the bed's side panel dimensions from different types of beds (more on width and thickness/width - not much on its whole horizontal length across*

*I hope to hear from you soon.*

*Thank you very much for your time,*
*Theophilus Carlos*
*Y12 Rosmini College*

They both gave me dimensions from their existing bed furniture.

Julia Doak (Marketing Manager), from Bed Post replied saying *"The depth of the side rails does vary from bed to bed , we have measured 3 beds to give you an indication."* The first bed's side rail measured 20mm x 140mm. The second measured 20mm x 150mm. The third measured 30mm x 170mm.

Jan Baker (Marketing Manager), from Furniture City replied saying *"The width/depth of the side rail wood on this particular model is 2cm* (talking about a particular model pointed out In the email). *It can vary – sometimes up to 3cm. 2cm would be reasonably common – no narrower than that. The height of the side rail panel can also vary. Most would be around 11- 14cm, but can range up to 20cm. Every manufacturer and every design can be slightly different. I have attached 4 different styles of popular bedrooms to show you that they are all reasonably similar."*





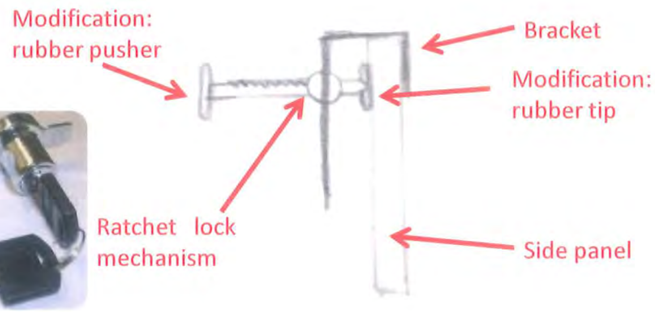
I have looked at two types of bracket mounts – Interchangeable and Adjustable. The interchangeable bracket involves 3 different sizes of hanging brackets which will be based on the 3 different side panel measurements shown on slide 21. The Adjustable bracket involves one single hanging bracket that can be adjusted through width and height based upon the different side panel measurements.

On the right is what I refer to as a hanging bracket. The one in the picture shows a ladder with a hanging bracket that hangs on the side panel of the top bed (double-deck). It's got a shorter fold on the one side and a longer fold on the side shown. The advantages of having this type of bracket are; it's efficient in a way that the user can just lift the object with the attached bracket easily. It's Sturdy depending on the thickness of the metal used. It's light, which is definitely good for the portability issue. It isn't so bulky. The disadvantages; It could be a risk factor to the user as it could squeeze for example the user's fingers in between the bracket and the side panel. It's not guaranteed that it will fit on every type of bed with different side panel measurements unless (as mentioned) they are interchangeable. Overall, this type of bracket design may turn out well as it is very simple.

It was lightly explained what the interchangeable type bracket is. It's basically the idea of having three types of brackets with each three having different dimensions based on the measurements of three different common side panels. I will most likely use the dimension from my previous research on different side panel measurements shown on slide 21. Having interchangeable hanging brackets will allow compatibility to most beds with different side panel measurements. And therefore, will meet my client's specifications – that the bed table should be transferable and modular, where you can attach it onto different beds with different side panel sizes.

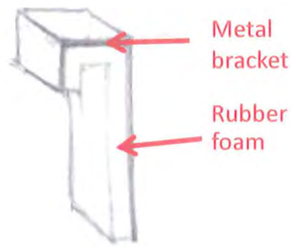
The idea of the adjustable bracket is to have one universal hanging bracket with and adjustable clamp attached to the metal to tighten the fit between the wood width-wise to enable a snug fit of the bracket. At the time when I visited Mitre 10 Mega (Glenfield), I found an idea based on the quick-release clamp. This is shown on the right. The mount will involve two of these clamps with a wooden vertical plank to be attached to these clamps going through the holes in the wooden plank. This will allow adjustment in between the side panel of the bed and the tightness of the fit of the bracket for increase in stability for the user of the bed table. The **screw holes** shown in the picture could be taken out so that one singular metal rod could go through both quick release clamps to provide alignment between the two quick release clamps. Notice the 1st stopper is also moved inwards to provide space for the metal rod – this does not have to be done as the metal rod could go through the 1st stopper anyway. A disadvantage for this is the complexity of having to tighten the bracket using the clamps. The user has to go through double alignment process. This is a problem in terms of efficiency. It's not efficient because the user has to use both hands to be able to align the bracket well and flushed to the side panel. This, of course requires more energy to operate and set up. Requiring more energy will not help meet the issue on efficiency and may therefore, be a completely useless project.

The ratchet lock has given me an idea on the locking system of the bracket to tighten when placed around the side panel. It is commonly used in glass windows as a lock. This is shown in the picture and diagrams below.




In the diagram/drawing above, it shows that the ratchet lock is attached to the bracket through welding, which passes through a hole in the bracket. It basically acts as an adjustable push lock that can be used on any thickness of the side panel. This way, the design will meet my client's need/issue that it'd be transferable and modular. As shown, rubber tip modifications are used to protect the user's thumb used to push the ratchet lock to tighten as well as to protect the wood of the side panel so that marks wouldn't show which are caused by the tight sharp tip of the initial ratchet lock. The only major problem for this is, that this type of lock is now obsolete. I have spent some time looking around for these, especially in Mitre 10 Mega, Bunnings Warehouse, Placemakers, Locksmiths but all of them have said that these are now getting old and are usually required to be specially ordered to get them. One of the security specialists have quoted me a price of $26 for one but this may be too uneconomical considering they were only $15 before. One thing that suggests that these are now obsolete is that it's design isn't really strong, considering that it was used to lock glass windows/doors.

Looking at the development of the interchangeable bracket, it has given me the idea of adding a foam inner layer so that the bracket will fit tightly around the side panel. This way the whole table itself won't wobble due to the tight bracket. Not only is it a simple idea, it also affects the table's portability on the whole due to not having so much space taken by the mechanism itself. Below, it shows that the bracket is equipped with an inner rubber foam.




The addition of the rubber foam increases the stability and grip of the bracket as it hangs over the side panel of the bed. Almost all of the stress coming from the bed table is located at the bracket that hangs on the side panel. Therefore, whatever mechanism or whatever bracket is used to mount the bed table onto the bed must be very strong, durable, stable, and rigid. The addition of the rubber foam not only adds stability, it also adds protection to the wood. Having a bare metal bracket hanging on the side panel may potentially damage the wood if the design is wrong or if the user misuses the item. And damage to the wood can lead to an unstable bed table, which then causes the user to not use the bed table. Therefore, it can be a completely useless design/project. An therefore, thorough design processes and testing must be carried out to maximise this bracket's purpose.

I have looked at three different types of foam that can be used as the inner layer of the bracket – Memory foam, Rubber foam, and Sponge foam.

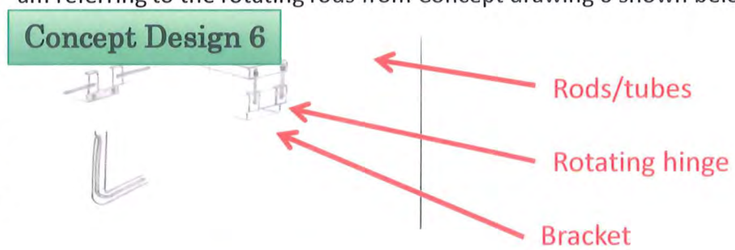

Memory foam technology keeps the "memory" of the shape of an object that rests on top of the foam. In this picture, the memory foam takes shape of the hand for a certain period of time. It is commonly used in bed mattresses to prevent aches from pressure pains when lying on one side. It may not be good as the inner layer of the bracket as it will take the shape of the side panel and eventually cause less rigidity due to the lack of hardness in the foam. It is very soft.

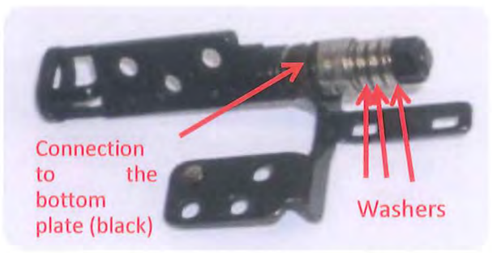

This rubber foam is a hard sponge-like material in the inside but very hard rubber on the outside. It's sort of like a bike tyre. It's soft enough to possibly take the shape of the side panel when used as an inner layer of the bracket. It's very easy to bend. Compared to the prices of the lock mechanisms in the previous slide, this is only $16 for a metre from ParaRubber. Realistically, I don't need that much of rubber. Therefore, I could always get a short cut amount for less the price. This may be used as the inner layer.


The sponge foam is probably the ideal type of inner layer to use as it is very light compared to the rubber foam and hard enough for a rigid grip around the side panel of the bed. If it is too soft though, there is always a much harder and thicker type of sponge foam that I can use. It is very cheap (roughly $10) for a square metre of material and is therefore economical. It can easily be shaped and cut using scissors or the laser cutter provided at the school workshop. As mentioned, this may be the ideal type of foam for the inner layer of the bracket.

As I was looking for alternative tightening mechanisms for the bracket, I came across a Satin Chrome Window Restrictor. It's sort of a hydraulic mechanism that is commonly used on windows. It has given me a very vague idea on how to use it as a tightening lock mechanism on the bracket that is not worth mentioning. It is very uneconomical due to it's price. It costs roughly $50 just for one window restrictor. Of course, if I were to use this on my design of the bracket, it would require two sets for increased stability and alignment. That would then result to roughly $100 just for the bracket locking mechanism. After this, I did start looking at the price more.

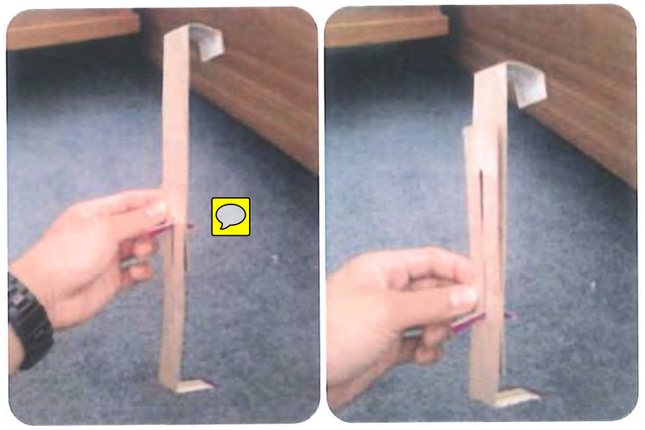

I then at how the rotating rods/tubes will be attached onto the bracket. I am referring to the rotating rods from Concept drawing 6 shown below.




The picture above shows a laptop hinge from the HP DV2000 laptop. It is the hinge that is used to attach the LCD screen to the Keyboard base. The connection to the bottom plate doesn't rotate. This may represent the rube in my project. Notice the excessive amount of washers? That's what's causing it to not rotate. It allows to hinge to not loosen up over a long term period as opposed to many other laptop hinges. The extensive amount of washers reduce a lot of stress as the hinge functions because the rotational stress is distributed along the other washers. These are used on every side. There is always no harm done when adding a lot of washers on the same side.

I've decided to do a 1:1 scale cardboard  model of a rough idea of the bracket. This will help me look at potential risks, how it functions and whether or not it functions properly, and the rough dimensions.



Above, are pictures of a rough idea of a mechanism for the bracket. The first picture basically highlights the top end of the bracket. It is bend at two points so that it hangs over the side panel of my client's bed. The purple component represents a fixed bolt to the top component. The second (bottom) component can move freely about the fixed bolt and has a one point bend (for grip underneath). It has a line cut in the middle for this ability. The second picture shows the mechanism on a functioning position. In other words, it's in a position where it will hold tight onto the side panel. To be able to tighten this mechanism, a knob will be used on the threaded bolt (turning clockwise). Note that the thread of the bolt must be widely spaced so that it acts as a quick release. Having a quick release mechanism helps to increase a product's efficiency and is therefore ergonomic to the user.

On the left, it shows the mechanism functioning on my client's bed's side panel. The top end was a perfect fit. It doesn't really bother the mattress, as my client wished. On the first picture, the second component is seen the be hanging freely onto the fixed bolt and is not touching the ground. This is good because no free parts will be lying on the ground and therefore won't cause any potential injuries to the user and the wider community. The second picture simulates how the bracket will fit tightly onto he side panel. The top component's bends help to keep the table secure onto the bed when clamped and the second component's bend at the bottom helps to keep the table rigid and stable from the sidewards movement. This then helps with the efficiency as there is less allowance between the bracket and the side panel due to the tight fit and less energy and action being released from movement.

As seen on the picture above, the bottom component of the clamp hangs freely and may move around from side to side and could cause serious injuries in the environment. A solution that may be used for this is to have a side support, like an L-shaped metal rod to guide sideways movement.

The top component isn't a tight fit on the smaller side panel as expected, hence the idea of the inner rubber foam layer. Also, the top component must be short enough to clamp onto the smaller side panel but long enough to be able to accommodate my client's abnormally large side panel. Therefore, the dimensions must be exact to be able to accommodate as much types of bed side panels rat different sizes.

Due to the low clearance between the side panel and the ground, the area is restricted for a component underneath the clamp. For example, a knob for tightening from underneath. Therefore the locking mechanism has be from the sides. The top is also restricted due to the mattress covering the whole mechanism. As seen in the pictures on the left, there is very limited space (only about 95mm) between the side panel and the ground (clearance). Imagine if there was a fixed mechanism that allowed access from underneath. The hand of my client, specifically wouldn't even fit and besides, it may cause stress to bend over just to reach underneath the bed.



# Bracket Development

After having a rough idea of how the bracket works on the side panel, I have looked at many different types of metal tubes and flat sheets. It's always good to have a wide selection of materials for the ability to look at different possibilities. I have looked at 38mm x 1.5mm galvanised steel. I found that Galvanised steel is very flexible compared to a thicker material aluminium; 50mm x 2.5mm aluminium (with a perpendicular sheet on one side 25mm wide); 69mm x 1mm aluminium (very limited resources); c shaped aluminium as shown in the photo on the right; 32mm diameter aluminium tube with 25mm diameter hollow; 25mm diameter aluminium tube with 18mm diameter hollow; Approximately 12mm, 11mm threaded rod. Aluminium's properties include a very soft material compared to many other different types of metal and is overall hard to weld as it may melt fairly quickly. This was suggested to me by my stakeholder/teacher. Therefore, I may have to either practice through welding courses or get a professional welder to weld aluminium together. I have experimented on this wide selection of materials. For example, I placed different types and shapes of tubes and strips on each other to simulate a "roller" as in a drawer. On the very left of the picture on the right, the two different sized cylindrical tubes are attached to each other. The reason I thought of this was because of the availability of the aluminium tube with the outer diameter of 25mm and another one with the inner diameter of 25mm. Therefore, one would fit inside the other. The L-shaped strips also show this.

***Properties of Aluminium***

*Aluminium has a unique and unbeatable combination of properties that make it into a versatile, highly usable and attractive construction material.*

***Weight***

*Aluminium is light with a density one third that of steel, 2.700 kg/m3.*

***Strength***

*Aluminium is strong with a tensile strength of 70 to 700 MPa depending on the alloy and manufacturing process. It is very soft compared to other metals like steel.*

***Elasticity***

*The Young's modulus for aluminium is a third that of steel (E = 70,000 MPa).*

***Machining***

*Aluminium is very easy to machine. Ordinary machining equipment can be used such as saws and drills.*

***Joining***

*Aluminium can be joined using all the normal methods available such as welding, soldering, adhesive bonding and riveting.*

***Corrosion resistance***

*A thin layer of oxide is formed in contact with air, which provides very good protection against corrosion even in corrosive environments.*

***Non-toxic***

*Aluminium is not poisonous and is therefore highly suitable for the preparation and storage of food.*

*http://www.aadl.co.uk/properties-of-aluminium.html*

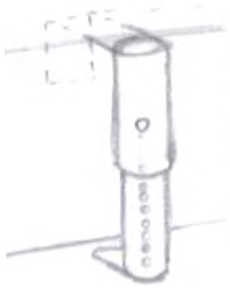
Combining the aspects of Portability and Durability, Mr. Breig has suggested that I do case studies on light yet durable things. One example is the development of the Airplane wing. Airplanes are made out of many different types of metals. A lot of metals are chosen as a material for airplanes because they hold the most desirable properties for aircraft structures. The use of metal combines strength, low weight, none-corrosive material, and high temperature tolerance. During the flight of an airplane, the wings provide lift and the rest of the airplane basically hangs over the wings, which causes the most stress in the wings. For the wings to be able to handle high amounts of stress from the wind creating lift, the materials and the structure of the wings must be chosen and designed thoroughly by many different experts. Titanium and aluminium have been well known for their strength and durability for use in airplane wings along with the almost weightless material property. Weight is a big factor when it comes to flight. For something to be strong and durable, heavier materials are usually used as they are more solid and dense. Titanium has a very good strength-to-weight ratio because it's as strong as steel, but only half the weight. Hence its use as a material for the airplane wing. It is much heavier than aluminium, but significantly stronger. In conclusion, to maximize the ability of portability, I must select the most suitable materials. I am referring this not only to the table itself, but also the possible back lumbar support. I must select a material that can withstand my client's weight for long-term use along with the ability of portability. Of course, not only the materials help to meet these key factors but also the design of the frame and bracing.

Based on the properties of aluminium shown on the left, aluminium can be machined using basic equipment such as saws and drills. My stakeholder suggested that I could use the scroll saw to cut up to 3mm of aluminium sheets. So I then tried it and failed on the first attempt. My stakeholder showed me how it was done properly and as a result, he cut a very clean, straight line through the metal. This is shown on the picture on the left. As a result of this, I may not have much problems when cutting a slot, for example, into the aluminium sheet. Aluminium can also have the tendency to become very shiny when sanded with fine grit due to the high lustre of it. If aluminium was machined or sanded to become shiny, it would be very appealing to the human eye and is therefore good for aesthetics.



# Research: Materials and Aluminium

I have decided to develop the round cylindrical aluminium tube mechanism for a number of reasons. Below, is a comparison between the flat mechanism and the round mechanism. I will be analysing the risk management from the different modelling types as well.



On the left, shown is a picture of my drawing of the cylindrical tube mechanism simulating the mechanism in its intended location, this side panel of my client's bed. It shows that the bracket that hangs on the side panel is welded onto the aluminium. As mentioned before, aluminium is hard, more difficult to weld compared to welding other types of metal such as steel. It is soft and may melt at an instant if an inexperienced welder (like myself) did the welding and therefore I may have to either spend some time of my own to weld or get a professional welder to do a simple job for me. The bottom component of the cylindrical tube mechanism theoretically has less or possibly even no wobble when attached properly compared to that of a flat mechanism. This is due to the all-round support on all sides, whereas in the flat mechanism shown below, only has a support on one side. Another term for this is having the two tubes flushed. In other words, there is almost no space in between the larger tube's inner layer and the smaller tube's outer layer. Hence the correctly measured diameter of having a common 25mm. This is shown in the bottom picture on the left. Note that the shadow may affect the overall appearance of the "flushness" between the two as one was lower than the other when the picture was taken.

Pistons are a great example of flushed materials. The more flushed something is to another object, usually the more efficient it is. Car companies design their engines so that there will almost be no space between the pistons and the engine heads – no friction. Oil is added as lubrication to minimise friction. It has been developed well to meet today's standards of fuel efficiency. Hence the more efficient newer cars compared to the older, more inefficient models. It is important that I design my mechanism to be efficient so that it meets one of the main key factors of this project, efficiency. This then leads to better ergonomics for my client. If my mechanism isn't designed with the aspect of efficiency, then the whole project won't totally meet the main issue, ergonomics. An therefore, the project may be completely useless without meeting the main issue, ergonomics.

On the top right, is my sample of the cylindrical tube mechanism (without any actual mechanism, just the metal). I used the band saw to cut this. Please note that these aren't the actual dimensions and may be much bigger than the actual designed mechanism. This picture shows a simulation of what the mechanism will look like in its desired location, beside my client's queen-sized bed. It is safe from injures due to the rounded edges but may have sharp edges from clean cuts and therefore, will definitely need smoothening later on. My stakeholder suggested that this may be too bulky compared to the flat mechanism. My client agreed on this statement and found that it looked like it was for hospital use, which is not a good impression. Therefore, I will be using flat surfaced material later on in the design development.

On the left, again is a picture showing the 1:1 cardboard model simulating the mechanism in its desired location, my client's bed's side panel. It is definitely less bulky compared to the cylindrical tube mechanism. It can be easily painted to fit its surroundings due to the flat surface, whereas in the cylindrical tube mechanism, the sliding function may interfere with the paint as it scrapes of unless a special oil is used for lubrication. For example, I may paint it brown to fit in with the colour of my client's bed as my stakeholder suggested. The very main problem, though (as mentioned before) is the fact that the bottom component will for sure sway around freely due to the single pivot point (the fixed bolt) where the bottom component may swing about the bolt. This can be a huge risk factor as it can injure people around it from the freely swaying component.

Overall, the cylindrical tube mechanism has a lot of advantages compared to the flat mechanism. It is very efficient due to the flushed mechanism whereas the flat mechanism's bottom component sways around and therefore less efficient due to more energy being exerted and is also a risk factor. It is appealing to the eye due to the smooth round edges and shape (but may be too bulky at some point). It is well structured due having no pressure points caused by sharp edges. Both are light, yet durable (compared to steel) due to the aluminium material.



# Bracket Mechanism Development

On the left, is an alternative locking system. It's a basic strap with a tight locking mechanism on one end and can be used as is with a little guide from a flat component. As the other end of the strap goes through this mechanism, there is a push release mechanism which would allow the "push" to release strap free to move about the mechanism. Once let go, the "push" is activated. This is done by a spring. Anyway, the idea of this type of locking mechanism is to have a metal guide that would run the strap along it. This flat piece of metal will be held tight against the side panel of the bed. There would, of course be side supports on the flat piece of metal so that the strap stays "in track". The advantage of this is the less risk involved due to practically having no straight edges (with the exemption of the metal mentioned). It would probably also be easier for my people to use depending on the type of design used on it.

On the left, is another mock up of the cylindrical tube mechanism. It has been cut to the exact measurements of 135mm length each component. I have decided to cut it out to 135mm because the smallest bed side panel size from my research was 137mm. Therefore, 2mm shorter would certainly lock onto the side panel. Not only did I cut it to 135mm because of the smallest side panel size, I also cut each to 135mm so that when extended, it would extend to 135mm x 2 = 270mm, which is definitely well over the biggest side panel size (my client's bed). Here is also plenty of allowance for the smallest and the largest bed side panel sizes, good for a more efficient use when setting it up onto the bed side panel.

What's planned to be used as a locking mechanism is basically a slot on the top component, a fixed bolt on the bottom component that goes through the top component's slot, then a tightening knob to push the two components against each other. This type of locking mechanism is much like the locking mechanism of the flat cardboard mock-up shown previously.

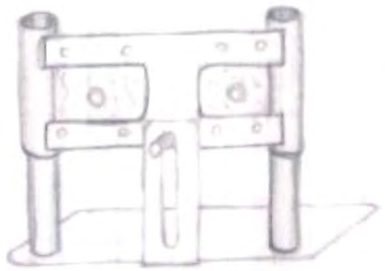
My key stakeholder, Mr. Breig, and I have discussed a model mock up of a type of mechanism. We have discussed: portability; durability; wider use; materials. On the right, a picture of the model mock up is shown. The wooden planks it is attached to represents a bed side panel. The whole mock up is scaled up. Basically, all the wooden components are attached to each other. The intersection where the two vertical wooden planks meets with the horizontal panel is where they will both be attached/fixed. The horizontal metal will hang over the tope of the bed side panel and just under the mattress. The middle vertical metal strip will have the ability to move up and down with the side support located by the horizontal metal strip. As the middle vertical metal strip moves up, it adjusts to the size of the bed's side panel so it adds support to the underneath of the side panel and prevent it tipping over to one side. There will be a tightening knob at the centre of the horizontal wooden plank so that it could lock onto the desired height of the middle vertical metal strip as it adjusts to the bed's side panel size. The actual table can be attached in many different ways

Risks that are involved are: as the middle vertical metal strip adjusts its height to a smaller bed side panel, the excess of the metal strip will go up higher. The metal strip will extend to a non-desirable height in the air. This could cause severe injuries due to sharp edges, pointy tips all due to the fact that it is made out of metal. Even though it was made out of wood, it would still be a very big risk hazard; The two vertical wooden planks may also cause the same risk hazard as they both extend upwards to the air towards the user's side. Therefore, it may be wise to cut them down to at most the bed side panel's height; It may be large in its overall size due to having quite a lot of components and this could cause severe injuries from carrying such a big and heavy load. This can be solved by using the right selection of materials; The metal hanging brackets may not fit other bed side panels and therefore, a solution may be an inner foam layer for added grip on the side panel; It is most definitely sturdy due to having quite a lot of "triangles" in the design for added rigidity at different angles as well as having TWO vertical supports for increase in stability as opposed to only one.



# Bracket Research and Development

As I decided to use two pipes instead of one and after looking at the "model mock-up" my teacher/stakeholder and I discussed, I came up with a combined "model mock up" of the very first/initial locking mechanism and the idea of having two pipes. This is shown on the picture on the right. Basically, the first locking mechanism is welded at the very bottom onto the ruler, which represents the sheet that is supposed to hold tight onto the bottom part of the bed's side panel providing it is extended for added length and easier hold. Both the bottom components of the pipes are to be welded on the same ruler/sheet. Of course, a 'hanger' will be welded on the top part of the top component of the pipes to hang onto the top part of the bed's side panel. The purpose of this model mock up is to visualise the idea of the combination between the locking mechanism and the pipe mechanism. There will most definitely be more development into this such as; thinking about the middle component's sway, the structure, the durability, ease of use etc.



On the left, is an upgraded design mock up. As shown, the same cylindrical pipes are used. They are both still attached onto the sheet at the bottom through welding. The bottom component of the locking mechanism is also welded onto the sheet metal at the bottom. The only major difference is the "H-shaped" component. The reason why it is H-shaped is so that there won't be any weak points especially when it is made as a whole and not made by 3 different components welded together to form an H-shaped component. The same fixed threaded bolt is attached, with the same locking mechanism idea (+ locking knob). There will be thick ply attached at the back (as a whole) so that the rotating rods will securely pivot about the thick plywood with the provided support from the thickness itself. On the right, is a paper cut out of the H-shaped component as well as the second component of the locking mechanism. It has been cut to the desired measurements so that I can use it for tracing around the next wooden model mock-up just before the actual metal part.

On the left, is the wooden model mock-up without the wooden component behind the H-shaped bracket. The purpose of this wooden model mock up is to actually visualise the design while actually attached onto the actual metal pipe mechanism. I used a basic bench scroll saw to cut through the thin ply wood. The only part that is not exactly cut to size is the bottom sheet. On the right, is a taped mock up so that the components will be held in the desired place. These taped parts will most likely be the welding points between the metals. The big wooden plank underneath the whole mock up represents a section of a bed's side panel. The picture shows what the mechanism looks like when attached onto a smaller size bed side panel. The H-shaped component definitely stabilises the horizontal movement of the two pipes. Please note that this picture shows the mechanism flat on the ground – the actual thing should be facing vertically, of course.

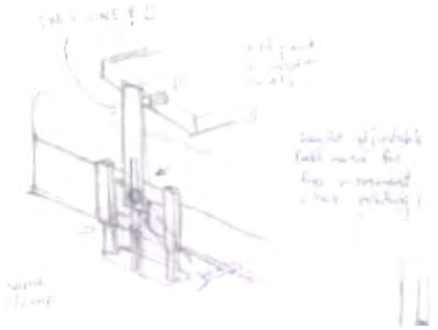
The ruler on the pictures on the left represent the rotating rods that will hold the table when positioned vertically. It will of coursed pivot about the hole which represents the pivot point on the wooden plank that should be attached at the back of the H-shaped bracket. The frames basically show the steps 1,2, and 3. When not in use, the rods will be positioned horizontally for easier access for the user to go in and out of the bed. The second frame shows a middle point of the process, which shows the transition between the part where it's not in use and where it is used. The final frame shows that rods pointing up (vertically) to represent it supporting the weight of the attached table top.

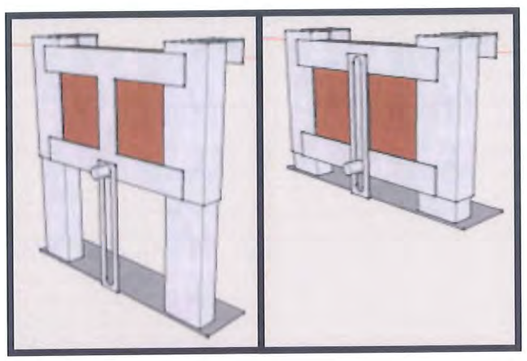


# Bracket Research and Development

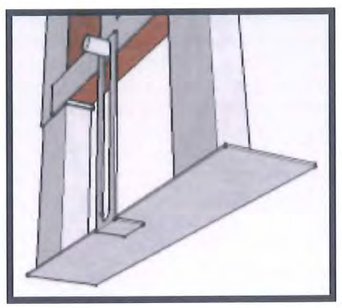
Since my client and I have decided to use any flat surfaced metal as an alternative to the cylindrical pipes, I will have to look at different materials, particularly aluminium if possible due to its lightness. The flat surfaced components are definitely applicable to the design now due to some changes in the design such as having one knob, then leading to one adjustable locking mechanism with two supports on both sides as opposed to having the locking mechanisms on the supports themselves, leading to two knobs for tightening. My stakeholder has suggested that the cylindrical pipes may be too bulky and less attractive/aesthetic to the human eye. My client has approved of this and described the cylindrical pipes as being used in hospitals, which she didn't like. My stakeholder has also suggested that there may also be other materials that are thinner and lighter, such as rectangular/square/flat pieces of metal but of the same material, which is aluminium.

My teacher then suggested, that the design with two rotating poles is too complex. Therefore, he suggested that I look at a single-pole design. I drew a picture of a simple idea on how this works and we discussed the idea. It basically has a groove/slot at the bottom end of the pole (the pole could be flat or square, but not cylindrical) for easy adjustment to the height at which the user prefers. It has a knob to tighten the position of the pole through this groove/slot. Not only is it good for adjusting the height, it is also good for free movement when rotating about the pivot point through the slot and therefore, it can be rotated and placed underneath the bed as shown in blue lines in the drawing on the right. The single-p[ole idea also raises the idea of the table top being able to rotate about the top end of the pole. This is, again, good for user preferences. And is therefore, good for the ergonomics. As I have pretty much decided to use this locking mechanism as a final, I will be working around it to now focus on the folding mechanism of the poles - how it will be positioned when it's not in use and how it will be positioned when it is in use along with the risks, ergonomics, durability, and complexity involved.

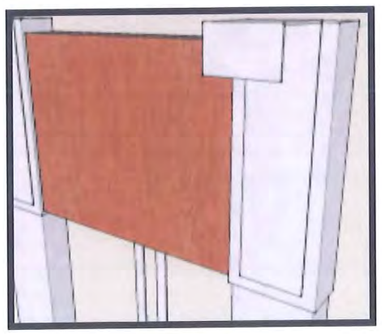




On the left, is a computer model of the pre-finalised locking mechanism (without the rod(s) to hold the table top). It is done in 1:1 scale. It shows very basic components, meaning the edges are not yet rounded for safety and reduced risk to the environment. This computer model was done so that I can base my measurements for production on it and can make adjustments easily. For example, if I found a particular component too small regarding its proportion, I can easily adjust its size on the computer model to its desired proportion. After the adjustment, I can use the actual measurements from the computer model and use it for the actual production. I am also able to analyse different risks and changes that I would make in the real thing. The "computer model" step is basically a step up from the "mock up model". I can actually visualise it looking like the real prototype I would end up making. The pictures on the left basically shows the sliding mechanism working as it should – from its full extension to almost the least extension.



The picture above shows how I will prevent the bottom components of the locking mechanism from falling apart from the main components. Basically, the slide-lock is welded onto the aluminium plate, which is also attached/welded onto the sliders. As the middle slide-lock stops as it hangs on the threaded bolt through the slot, the sliders attached will also stop as a whole.



On the left, it shows the back of the whole locking mechanism. Attached to the back of each top slider are hooks that are bent at two points so that it hags onto the bed's side panel/rail. It will be attached either through special glue or welding. Notice that there is some allowance on either sides of the hook from the edges so that there will be enough space for tig welding. The wooden part of the locking mechanism will be attached through bolts, as mentioned before. As shown, this block of wood is cut as a whole for extra strength. My stakeholder, Theodore Carlos, has suggested that him knowing Mr. Breig, knows that he'd prefer all components made as a whole as possible. This, he says, was known from experience and suggests that sometimes experience is better than designing a completely new design built from scratch.

As I thought that my project required some welding, I went on to the welding workshop to do some practice for the first time. I consulted a stakeholder, Mr. Phil Jones, on which type of welding is best for aluminium. The only type would be tig welding. I researched about tig welding and found some key safety features on how to use it properly. Firstly, I made sure that I wear the correct safety gear; proper welding helmet, welding apron, thick welding gloves, boots. I have done this accordingly. There are two simple parts to it – the electrode and the filler. The main rule is that the electrode must NOT touch any part of the metal around it, whether it's the filler or the metal to be welded together. The electrode must have a gap between the filler of at least 10mm. The electrode and the filler must both be held at an angle (filler: 15 degrees, electrode: 60 – 70 degrees). The only gas used for tig welding is argon. The amps should be set between 80-110 Amps, depending on the thickness of the metal to be welded together. There must always be grounding to prevent concentrate charging in the metals and welder itself. Below are a series of pictures on my experience on tig welding:

As I went on with welding aluminium through tig welding, I later found out that it is HARD, as my stakeholders have told me compared to welding other types of metal like steel together. I noticed that welding sheet metal with rectangular hollows was very hard as the sheet metal melted within a second of the metal exposed to the heat (shown on the right). Therefore, I consulted Mr. Phil Jones again about what other types of bonding are there to join two aluminium pieces together. He said that some adhesives are fairly strong. An example he gave was the Lotus Elise sports car. From experience, he has told me that Lotus Elise car chassis are bonded through adhesives. This struck me as I thought that bonding through adhesives would require less skill (e.g. a welder) and would be much easier as I have had experience with using adhesives to glue things together, as we all do. He suggested companies such as 3M (who specialises for adhesives as we all know about). A classmate of mine (also a stakeholder) also suggested Selleys for adhesive supplies.

I have contacted both, 3M and Selleys for a suitable adhesive as an alternative to welding (about the same strength). Simon Hoskins from 3M said "*No adhesives are going to be as strong as a weld. However for what you are doing, you may not need it to be that strong. If you are using an adhesive of any description, you will need to prepare the aluminium properly. Clean it with White spirits or acetone or MEK or General purpose Adhesive Cleaner. Lightly scuff the surface with a Scotch-Brite hand pad and the clean a gain with the same solvent and a clean rag. Keep wiping the aluminium until no more grey, finely divide metal is removed. You could then use a two part epoxy, for example, Araldite, that you can buy from Mitre 10 or Bunnings. Alternatively, depending on how much weight you want to hold, how well the two surfaces fit together and the surface area you have to make the bond, a VHB Tape (Very High Bond Tape) might do. I can probably give you enough tape to try*." Richard, from Selleys said, "*In certain situations Epoxy may be suitable as a substitute for welding, however this would depend on many contributing factors to do with the application of the item. Epoxy type adhesives such as Araldite Super Strength will develop very good bond strengths however you would need to carry out your own testing to see if it is suitable to your particular application*". I would have to look at using Epoxy as a bond between two metals. In conclusion, strong epoxy suggested by the two stakeholders is suitable enough for my project.

As I consulted Mr Phil Jones about my design, he asked "how are you going to make the h-shaped component?". I said I would get a sheet of aluminium and cut through it to make a whole h-shape. I suggested that making it whole (as I learned from my stakeholders) would make it much more stronger. Mr Jones said "why not cut three strips and join them together? It would be much cheaper than buying a whole sheet just for a small component." He was right, Aluminium sheets could only be ordered at the sizes of roughly 1.2m x 1.2m. I would only use about 200mm x 200mm. Technically speaking, buying a whole sheet would be much uneconomical compared to buying a whole strip and joining them together. This would be good for efficiency as I would not waste any material from cutting from the sheet compared to using almost every bit of the ordered aluminium strip. I asked "wouldn't joining the three strips together be much weaker?" It would be but the design doesn't require all of the strength needed from a whole piece. Mr Jones suggested some ways of joining them together at the intersections: Riveting, bolting, adhesives. I will be looking at these three types.

## Bolt and Nut

Bolting is when a bolt and nut is used to join two or more things together. It involves a bolt going through the pieces that require joining together and a nut on the other end of the bolt which tightens between the materials as the nut rotates along the threaded bolt clockwise. The advantages of using bolt and nut is having allowance for movement in between the materials where needed. This "allowance" increases strength. Bolt and nuts come in different sizes for different purposes. Washers can be used in between to reduce stress not only on the materials being joined together but also the bolt and nut themselves. The nuts can also work as knobs when the right type is used for the right thread on the bolt.

## Riveting

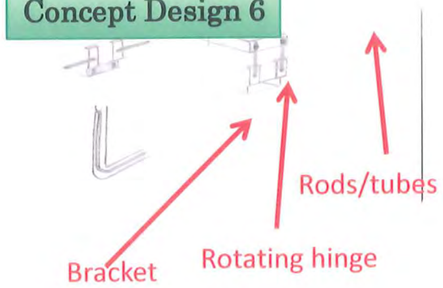
Riveting is when two or more materials are forced held together. It involves rivets as shown above, and a riveting tool (either handheld or bench top). Some advantages of using rivets is that it's very quick and easy to use and requires little energy from the person using the riveter. Some disadvantages are: it is weaker than bolting, and adhesives at some points. It is used in structural components as well as aircrafts on a larger scale. It is weaker because of the tight joinery and almost no allowance for movement. Therefore, tension around the materials built up. The area of rivets usually just creates a weak point.

## Adhesives

Adhesives are a liquid bond that would harden as the bond cures. This bond is placed between two materials only unless it can be a point of intersection for different materials which is highly unlikely. Some types of adhesives are known to be great alternatives to welding and riveting. These types are called structural adhesives, which would most likely be the type that is most suitable for my project. Advantages for using adhesives is: some are colourless which is good for a clean look, they are lighter than metal welding, they don't rust. These advantages are in fact very good. A disadvantage would be a weak bonding if the application isn't done right. Therefore, this requires a clean surface and clamping for increased curing when bonding together.


In conclusion, the main ones that I will be using are bolt and nut, and adhesives. As I researched more about adhesives, I looked back at Selleys Araldite Super Strength Epoxy and found that they cost no more than $15 from The Warehouse. As I looked at more different brands, I came across Scotch-weld from 3M along with JB-Weld (Sold in Jaycar Electronics) from the net. I looked at videos about demonstrations on how to use these types of adhesives as well break tests. I found that, compared to rivets and spot welds, structural adhesives are MUCH more stronger and didn't break, as the rivets and welds did first. That basically means that adhesives are stronger overall, compared to the weaker types at smaller scales of course. Mr Jones and Mr Breig even said that adhesives are used on car manufacturing (especially Lotus Elise) to bond different types of components on chassis, panels etc nowadays. Which suggests that adhesives really are strong, based on existing outcomes like the cars.

## Concept Design 6



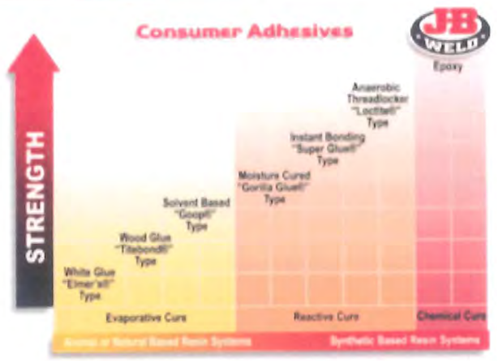

On the left, shown is an idea on how to make a right angled cylindrical tube so that it can be attached onto the bracket, and allows rotating movement (referring to the concept design 6). Basically, I cut the tube at a 45 degree angle and turn the top cut so that it lies horizontally. This way, the points of intersection between the two pieces will exactly meet assuming that the cut is very clean and straight. A risk hazard for this would be the corner pointing out. This could be refined by smoothening out the edges.

On the left, is my drawing of an alternative type of hinge for the rotating attachment between the rods/tubes and the bracket shown in concept design 6. The shaded circle represents the bird's eye view of the tube. It is attached to another shorter external tube (with a screw attachment) through a metal rod, which is shown in the drawing as a vertical rectangle going across the slide. There are holes, of course, cut through each side of the tubes in order for the common rod to pass through securely. Basically the component that holds the tube is taking all the stress at the point of the thread where it will be rotating.



# Research: Joining and rotation

*"J-B Weld, known as "The Original Cold Weld," was developed as an alternative to traditional torch welding. It's designed to be extremely effective in even the harshest environments. Because it's a two-component (or 2k) epoxy system, it uses reactive chemistry to create the strongest bond possible. Think of it as having a cross-woven pattern that provides extra strength, much like rebar does to reinforce cement structures. And once it sets, it's tougher than steel. All of our epoxy products are based on this same chemistry, making them the best choice for any project you need to tackle. Plus they're extremely easy to use, whether you choose the original twin tubes, the putty sticks, or the syringes."* - http://www.jbweld.com/know-your-bond/ The chart on the right was taken from the same website. I credit their work for use in this project. It shows the difference in strength of the JB-weld product compared to other existing and previous products. It clearly shows that JB-weld is above them all. Due to the "chemical reaction curing", JB-weld seems to be really strong especially in the outcome after the curing. It can be sanded to suit the shape required after the excess product has cured. I went through some videos on the internet and found some demonstrations on how to use JB-weld, also showing its strength as a structural adhesive through tests.





On the left, are screenshots of the video from YouTube (http://www.youtube.com/watch?v=3NWzODqhSbw) on how to use JB-weld properly and its outcome. This person used JB-weld to join two long metal bars together at an intersection and did strength tests on it afterwards. On the pictures, it shows that he used quick release clamps also known as welding clamps (as Theodore Carlos told me). This person used a blow dryer to increase the speed of curing. In fact, increase in temperature also increases the rate of curing from 24 hours to less than 12 hours, which is very useful if ever I run out of time allocated. As he did the strength tests, he managed to put a 65kg weight 30cm from the bonding point, which is really heavy! Therefore, it suggests that the compound really is strong!

*"JB-weld can be used as adhesive, laminate, plug filler, sealant, or electrical insulator. It can be formed, drilled, ground, tapped, machined, filled, sanded, and painted. It has an open time of about 30 minutes and sets in 4-6 hours, and cures fully in 15-24 hours. It's waterproof, petroleum, chemical, and acid-resistant; resists shock, vibration and temperature variations. Super strong, non-toxic and cleans up with soap and water before setting. Bonds almost any combination of iron, steel, copper, aluminium, brass, bronze, pewter, porcelain, ceramic, marble, glass, PVC & ABS, concrete, fibreglass, wood, fabric, paper - just about any porous and non-porous material."* - http://www.jaycar.co.nz/ It has a tensile strength of 273,00. It has 0% shrinkage, and a heat resistance of 260% Celsius.



I also did tests myself, comparing JB-weld with a normal 2-part clear epoxy. Firstly, I used acetone to clean the surface of the metals being joined together to ensure clean bonding. I then sanded the surfaces with 120-grit sandpaper to add grip to the metal as the compound cures as opposed to a smooth slippery surface. As I used the F clamps I found that as I tightened the clamps, the metal bars rotated due to the clockwise tightening. This then caused me to take up time and require concentration to get the bars straight at a 90-degree angle from the base metal. My teacher, Mr Breig suggested that when I do the "gluing" for the real thing, I may need to oil the tips of the clamps that rotate clockwise to tighten, so that as it tightens the whole component doesn't go with it. I suggested maybe I use a welding clamp like the one from the video above.

I then tested the two compound's strengths by clamping the base metal and bending the rods as far as I can. If it separates from the bond then the bond isn't strong enough. If the metal bends as far as possible, then the bond is strong enough. The outcome was that the epoxy broke easily. The JB-weld then broke at an attempt to bend upwards. I focused on a second attempt on the JB-weld, without having to test the epoxy again. This time, I filled the sides with the compound covering any gaps. After the cure, the horizontal bend attempt was successful and showed no breaking sins. The vertical bend was again a failure. I noticed that using a clamp forces the compound out from in between the two metals causing no compound in the middle. Therefore, I went on to a third attempt but this time without using any clamps. I tapped the two metals together lightly with a little force just to push them together a little. This is so that there is still compound in between the two metals. My teacher said that the compound sticks onto the metal quite well and does not come off. That's why using no clamps may help as no compound is pushed away from in between the two pieces of metal. The outcome was that the metal bent quite a bit before snapping off, which is of course a good sign because it had to bend before breaking. This isn't good enough for me as it could easily break with instant force acting on it.



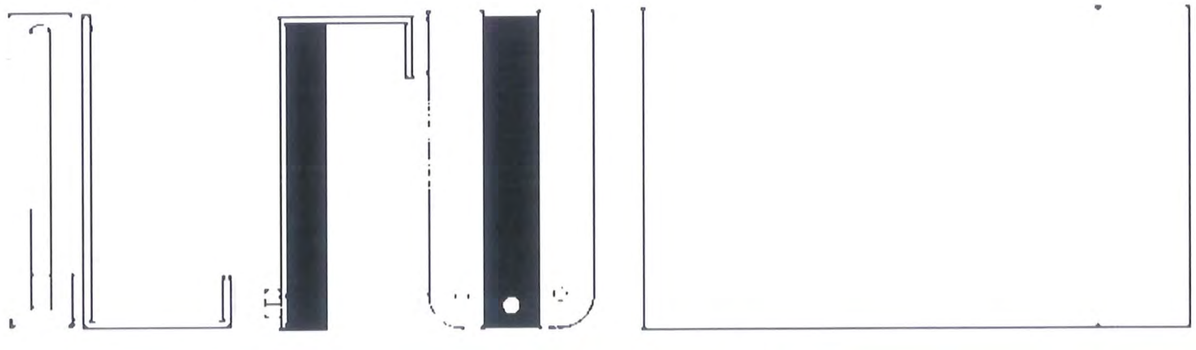
# Product research: JB Weld

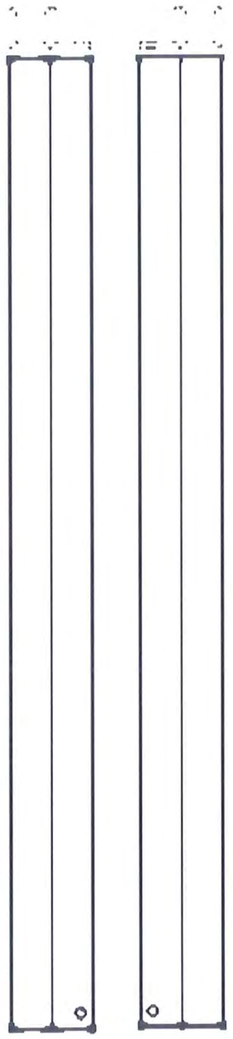
From all of the research I've done, I now have a finalised background of my project. I prioritised my selection of key attributes to have made sure I knew which were the most important to the least. I've used the PMBOK that Robert Tang has provided me the knowledge of, for planning a project. I developed every component through the stages of concept designing, developed, and finalising and made sure I updated my client and stakeholders along the way for some feedback as well. I did some computer modelling to visualise my components well and also analysed other projects like the dung beetle case study. As I did the development per component, I also did a lot of research along the way to have made sure I got the right knowledge to where I was heading and not having any false information for development. I practiced other skills like welding and turned out I didn't need it, but still it is good for future use and have definitely learnt a lot from it. I am now heading into starting my first prototype.

I noticed the importance of having a symmetrical design for the capability of using the bed table on both sides of the bed and have decided to make the design as symmetrical as possible. I have consulted my client and stakeholders along the way and came to a point where I've gathered all of the information needed to start the production of my project. I have finalised my key specifications, making sure that I would not miss any of it in the end.

The **key factors/issues** are:

- Ergonomics
- Storage
- Risk Management
- Durability
- Efficiency
- Aesthetics





The finalised **key specifications/client's needs** are:

- A bed table which acts also as an **organizer** where I can **secure** my coffee cup and pencil case.
- It should have a cup holder to accommodate space for a large mug and a flat surface to place her glasses on.
- On top, my client should be able to place comfortably her laptop or Ipad without suffering her back.
- A table top to accommodate the size of a 13" screen sized laptop with allowance for other things.
- My client can tuck it in or stow underneath the bed or on the side of the bed along the rail.
- It has to be mounted on the bed for stability.
- It must be tailor fit to her height and eye level, suggesting adjustability yet to be developed.
- It must be very easy to set up so that only a small amount of effort is required, which prevents any pain on the user.
- It must look good, simple but elegant.
- There must be a minimal amount of wobbling or even almost none for client satisfactory. Wobbling cannot be eliminated as far as I know but can be greatly reduced.
- I must have rounded edges where possible so that risks of getting cuts is very minimal.

| | |
|---|---|
| Hooks | 3X 25mm aluminium (one slotted) 55mm gap |
| Main block | 75mm x 140mm 18mm plywood |
| Table top large portion | 460mm x 335mm 9mm plywood |
| Table top small portion | 140mm x 335mm 9mm plywood |
| M8 bolts | 1x |
| M6 bolts | 2x |
| Right-angled Bars | 600mm x 25 mm wide 3mm thick wall |
| Square tubes | 600mm x 25mm wide 3mm thick wall |



# Final Brief and Specifications

Although the test joint successfully bent a little before breaking apart, I am not comfortable that it will be able to handle weight of an instant force acting on it – for example, if the user accidentally pushes the table down and adds pressure onto the joints or intersection, it may cause the component stuck together to just fall off and may cause injury to the user. A failure to meet the durability will lead to a completely useless project. On the right, is a photo of the hardened compound completely wrecked as I hammered it down. I call this a "strength test". The bond from the JB-weld compound was separated by the extreme force from hammering. Because this strength test resulted to a failure with the JB-weld compound, I have decided that I use bolt and nut for the joints because I am more confident with using them from past experience and logic. Mr Breig and I discussed other alternatives like rivet nuts but concluded that they may not work the only difference compared to bolt and nut is that it won't extend to the back end. The thing is, I may need it to extend so that it bolts the tube and the bar as well as the hook that hooks onto the side panel at the back end of the mechanism.

I need to get some idea on how strong your clamp has to be in order to support the weight I intend to put on it. I would work out the weight requirement and then double the strength. This is called "built in redundancy" or "over engineering". However, this can be done where weight does not matter. Where it does matter, I need to be pretty clear about how much material I want to commit. In racing boats or airplanes they use high tech materials for that reason. Since I will be designing a cantilever arrangement (all weight is supported from one side only) I will need to be pretty clear about the forces involved. On top of that, it has to be user friendly and reasonably nice to look at, or it will not be used. I will be making mock ups that shows exactly how it will work.

On the left, is a prototype of the frame of the clamp. No bonding was used, only placed on top of each other so I could visualise its size and proportion to other components. What I found that this may be too bulky as a result. Mr Breig and I discussed some ways to reduce its cumbersomeness so that it will be more attractive to any user, and therefore be used. I ordered the materials from Mico metals. The problem was, they didn't have any of the smaller sized materials (which I preferred) so Mr Jones came back to me saying that he ordered slightly bigger ones and was hopeful that the two types would fit inside the other so it could slide. Since the metal tube increased in size from 20mm to 25mm, I decided that I use timber as the inner tube so that the bulkiness is reduced. Having 30mm as the outer tube (which was the other one ordered) would be too big and heavy for any user especially with a 3mm wall thickness. I also selected 25mm x 3mm strip because I found out it is strong enough to hold enough weight and pressure, regarding that I have the right type of joint (e.g. bolt and nut). I tested out crooked aluminium strips and found that they bend quite easily. But with using new materials, they are much stronger.

On the left, is a sample model of having timber as the inner tube. I thought, since the inner tubes aren't structural and wouldn't affect the overall strength and durability of the clamp, I could use timber (also using the laser cutter for an easier process). Selecting the right timber would most definitely max out the potential strength of the structure. It's also easy to work with timber compared to metal due to timber's softness and my experience with working with timber. Therefore, this would lessen my production time and hassle, and therefore would make my project more efficient towards the end. Strength and durability being a very high prioritised key factor makes it important for me to discuss the possibilities of selecting the right materials towards the overall strength.

I was thinking, "Do I really do need the second part of the clamp that slides and locks?". "Is it really necessary?". I'm talking about the whole bottom component. "What if hanging it onto the side rail is good enough?" "Maybe there wouldn't be any sideway movement." "Maybe I could find a way to get the clamp (which wouldn't be called a clamp anymore) to push towards the side rail so it is rigid and doesn't tip over". Here, I asked myself some questions and consulted Mr Breig. The best thing to do would be to start making actual mock ups/prototypes of the particular component or even the whole clamp design – Actual is better than theoretical. This is so that I can actually SEE what's happening.

Since the bolts get in the way of the inner part of the hollow tube, I'd have to figure out how to make the sliding tube inside most likely by using Corel Draw 12 on the laser cutter. Using the laser cutter will be a part of my modelling.

On the right, is one of the two hooks I made using the vice. I practiced and practiced until I got the perfect bend at the right size. I had to calibrate around the measurements a little for the desired bend. In between the two parallel surfaces is a 35mm gap. This is because of the 3mm width of my client's bed's side rail size.

On the left, it shows the hook placed on my client's bed's side rail, where it is supposed to be situated. It is seen that the hook fits perfectly around the side rail leaving only a little gap between the wood and the metal. I discovered that the hook slides across the side rail easily, which is a plus because for example: in case my client wants to easily get the mechanism away towards the end of the bed, She could just push it away. The second picture shows the inside part of the side rail, which allows the hook to fit through the small gap, suggesting that the gap is just more than 3mm. I also tested out the outward bend/ looseness. This was tested so that it simulates what will happen if weight is put onto the clamp forcing the bottom part of this hook to move away from the rail. To prevent this risk, I designed the second component of the clamp which tightens underneath the rail (which has been mentioned way back in the project). This could affect the durability issue.

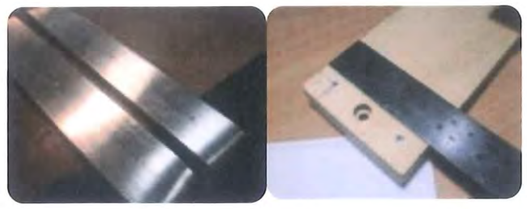
On the right, is a picture showing how much space is taken up by the nuts from the bolt. What I did was use the same bolt and nut to attach the hook onto the mechanism. What I found out was that the nut had taken an extra 5mm on the overall width/depth of the mechanism from the side rail. 5mm might not be much but when it comes to the overall dimension, it is a huge extension. I could of course cut the bolts shorter to the desired size but I will have trouble keeping the surface that will rest against the side rail flat. I could countersink the metal but this would not make the surface flat. Trying to avoid bulkiness, Mr Breig and I discussed other ways to prevent or reduce the overall bulkiness of the clamp. Theodore and I also discussed this and found no other way unless changing the "hook" design in a way that the hook will be attached from the front then extending to the back.

On the left, it shows the pre-finished prototype of the very initial design. My hand as a reference to scale, the prototype seems very bulky and big Imagine having to put that beside a bed. I made laser cutter bits using CorelDraw 12 and placed them on this prototype as the whole bottom component and slider. Knowing that the hook wouldn't fit too well and the design is heavy and bulky, I have decided to stop the prototype and think of a more compact design from this. Having a bulky mechanism would be too risky for the user as it could create stress when carrying even though it isn't as heavy and could also injure or cut though the skin from the sharp edges and bulkiness. The next prototype would have similar features to this but will have to be much more compact. Mr Breig and I had also discussed that this may be too well over-engineered.

On the right are two different components from different routers, both of the same type. Mr Breig and I discussed the nature of these components and has particularly struck me on the idea on how the locking mechanism works and its portability as well. This has helped me to alter my next design which will be shown on the next slide. My next design is very much based on the idea of these router components.

So I came up with a different idea and started making a very quick prototype/mockup of it. Shown on the right is the design. It involves 2 lengths of aluminium strips bent at 2 points to form a hook shape that hangs on the side rail of the bed. Notice that the wood is narrower than the previous prototype to reduce weight and increase portability (for the issue). Screws are used to join the metal and the wood together. Bolts from behind, sticking out are used to act as the pivot points for the rotating rods. The aesthetics issue has also improved by having two curved metal strips. Notice that the 'curve' is very important for aesthetics.

I then decided to go on with the actual mechanism with only two weeks left in the term. I knew it would be very easy to make. Some key things that I did to make the design more useful, which I also found out as I was making it was: the use of pilot holes to prevent the drill bit going off course on the aluminium metal; Measurements for accuracy; Countersinking to make a flat surface when the screws are installed.





# Production: Prototype

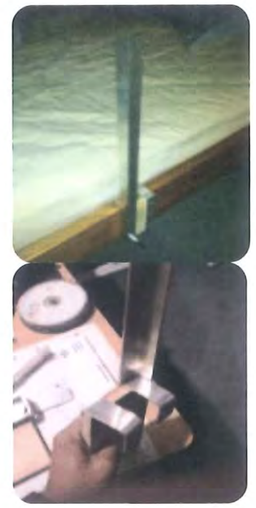
Mr Broome and I discussed particular flaws on the design and found that the load on the pivot point may be too much for the metal rods. Here, the clamp point represents the pivot point and we discussed that there would be too much torque at the very top of the rod, which could cause injuries as a potential risk of a sudden snap. Therefore, bringing the pivot point down from the middle to the bottom of the body will provide extra support on the affected area of the rods. Reducing the wobble would increase the ergonomics.

Above, shown is my way of testing which type of wood I must use to prevent wobble or bending. Above, the first to pictures show sideway movement both ways when the wider surface of the strip is resting on the clamp's pressure. When the wood is rotated 90 degrees so that he narrower surface rests, there is no movement the same way. I have come to conclusion that I will not be using timbre due to the fact that it is rather flexible compared to metal at different shapes. The next one I tested was a piece of scrap metal of an right-angled shaped aluminium bar.

After assembling the main body, I went on to cutting the L-strips to size at 600mm (600mm due to an estimation using a ruler on my client's preferred height). The bolts are used as pivot points for the rotation of these rods. Since the rods have to have the ability to rotate 90 degrees from horizontal to vertical, I had to round the two bottom corners using a circular bench sander. To prevent scratches affecting the design and overall quality, I used some tape to cover parts of the metal that would be likely to touch any surface when sanding. Then, after assembling the rods and main body together, I decided to put washers in between the main body and the metal, as well as a lot of washers between the bolt and the rods. The reason for doing this so was explained in my research about the laptop hinge causing the rotation to stay tight and not become loose over a period of time to prevent any hindrance overtime. Mr Breig added that I should include a spring washer on both side so that when the table is pushed outwards, it will easily go back to the straight position.

Above it shows me testing the use of a right-angled bar of aluminium. This has left me with no chance of wobble on any sides due to the support of the two strips adjacent to each other.

After choosing the use of the tight-angled aluminium, I made the input onto the prototype design on only one side of it. There had been some size issues so I decided that I would just increase the thickness of the wood so that the metal right-angled would not touch the side rail first but the wooden body would first do so. I also tested the prototype on my client's bed to see if I am on the right track. I tested the wobbling, which was successful because it was very minimal and I could reduce it by using spring washers on the bolt (pivot point). The right-angled fit quite nicely with the additional support on the side as it locks into vertical position as well as in the front.



Coming back to making the slot for the slider, I used a mill drill to cut the slot through the 3mm thick aluminium strip. First, I bent it at 2 points as for the other bent strip to form a hook. This time, the hook will be used for the underneath portion of the side rail to reduce movement. My aim is to make a very stable clamp. Mr Breig has made me a wooden template to place the metal in to prevent any wobble when using the mill drill, which could later on cause injuries. I used screws to lock the metal in from the sides because the mill drill uses a lot of force when 'carving' out a whole slot from the metal 3mm thick. I first started out with a pilot hole to keep the mill drill on track at the very initial strike because the initial is the most important, the others are just 'follow throughs'. I used the mill drill to 'drill' the slots per layer, which took about less than a minute per layer until I've cut a whole slot through the 3mm thick metal. Doing them by layers also prevents any forced impact on the metal, i.e. doing it in one go. I used lubrication so that there would be less stress not only on the metal when being cut but also the special brass drill bit, which costs a lot. The wooden template helped a lot by cancelling out the wobble while cutting the slot through by layers.



# Bar and Slider Development

After making all of the components I could during the two week period, I decided to assemble the whole thing. I tested the mechanism with a piece of cut-off wood to simulate my client's bed's side rail measuring it as close as possible to the same dimensions. It turned out pretty good and stable. I saw that adding some extra bits to it could greatly affect its quality and performance. These were very minor and I could do them all in less than a week. A classmate, Sam Levestam, has suggested I use a wing nut for tightening the mechanism lock system. I already had this in mind. Since the project isn't the type where I design the whole thing and just make it, I take notes on the changes I made which will be mentioned in the Final specifications. So far, it has been pretty successful and the only thing left major I have to design is the table top. So far, I have met the issues regarding portability with its light overall weight and small components; stability (ergonomics); durabilty with metal; efficiency; and will be looking at risk management with the small details.

I've been looking at the current minor issues or flaws in the design. I found that when on the horizontal position, the right-angles aren't aligned parallel to the ground (gradient 0, 180 degrees). This is due to some extra space between the metal and the block that is present because of the misalignment of the hole for the rotation. This can be fixed by adding a small layer in the gap, which could be wooden or rubber or foam. This also affects the movement of the sliding component. Another flaw I found is the locking of the right-angles in the vertical position. What I thought about was "would I lock it through the attachment of the table top/tray or trough the main block?". I thought it would be better off in the main block because the user will find it easier to lock first then attach, rather than hold the right-angles vertically and then attach the table top. I found the first option more efficient for the user because you don't have to use two hands at minimum to set it up. Basically, rotate to vertical position and lock automatically; slowly attach table top (which easily aligns). Compared to: Rotate both right-angles and hold together at vertical position; keep holding the right-angles while attaching the table top, which is inefficient.

I did a very quick mock-up component of the attachment for the table top – something that would be able to slide through the right-angles. I decided to attach it onto a flat piece of MDF to represent the idea of an actual table top. The flat piece has been cut to 600m wide because it was my estimation of an ergonomically sized table, but this will need further research for the proper size in terms of ergonomics and efficiency. I've screwed the attachment onto the table top and placed it on the right-angles as if it were in the actual user position. I found that there was a lot of sideways movement, which I didn't expect earlier on due to the sturdiness of the right-angles. The metal twisted a lot and caused a rotational movement from side to side. I suspected that the washer in between the right-angles and the block at the bolt, contributed to this so I took out the washer in between and it has improved on the situation a bit (shown on the picture on the right). It also helped stiffen the rotation for a better, more sturdy feel and less wobble when rotating them.

Mr Breig and I discussed the idea of having these "extra bars" on the outer part of the right-angles as a sort of extension to the existing unit. So then I decided to test this using a scrap piece of metal tube (25mm x 25mm) and using the same method with the use of clamps. Keeping in mind, using the thin pieces of wood to protect the metal. I found out that this had literally solved the problem and took out the 'instant' twisting of the table top as well. After finding this out, I went out looking for different materials that could be used as the 'extension'. What I found was the same size 25mm x 25mm shiny aluminium, but with a wall thickness of 3mm. I thought that this would be too heavy for my client. The decision I had to make was whether to use it or not, due to the fact that it weighs quite a lot. I came to a conclusion that the 3mm wall thickness definitely helps with the overall strength capacity which reduces the twisting and that a thinner wall may result to a more 'twisting' bar. Therefore, my decision was to use it anyway. I have made sure with my client and she said that if it really adds that extra strength, then just use it.

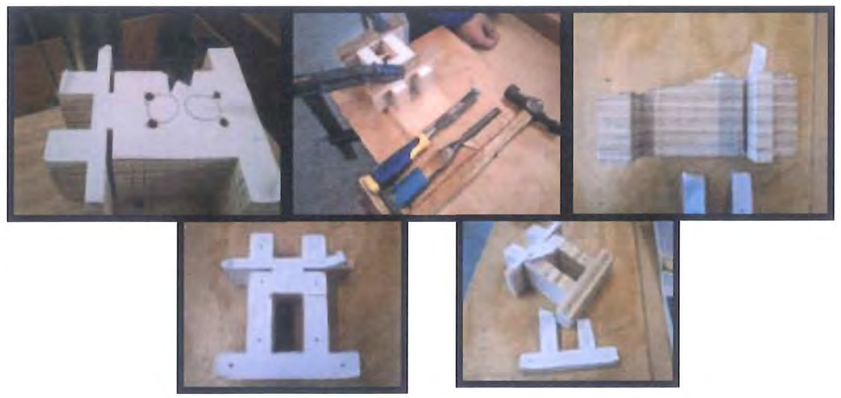
I proceeded with the development of the attachment. I started with the extended width at the front. I then cut various pieces square first for easy gluing then just cut the angled cuts later. I did this because as I was doing my first attachment, I can recall cutting the parts triangle first then I had trouble with gluing because the clamps wouldn't hold well. I learnt from this and decided to glue together the square pieces first and then just cut the angled bits afterwards. This is shown on the picture on the very right. I kept the block that goes in between the right-angles to be of the same size (approximately 60mm x 80mm) because I was already happy with this size and it is the maximum size that can fit in between them anyway.

I did some strength tests for this component and Mr Breig and I discussed about it in ways which the material affects it as well as the structure. I found that the component cracked with the addition of force on the table top. He suggested that the grains would make this weak structurally and that the wrong positioning would result to a worse outcome. I thought of different ways to make this particular component and thought about different possibilities like using the schools new "UP 3D printer" or making layers using the laser cutter, or even making it in layers by hand. After going through different possibilities with this, I came up with using 3mm plywood and cutting 20 pieces of the same shape to make a 60mm thick block. We discussed this and thought that this would be a very complex way of making the component as I would have to be using too much material because the laser cutter can safely cut only up to 5mm depending on the material and time allocated for my own personal deadline. It can cut up too more than 5mm but this would be too time consuming. Another problem I came up with is having to align the pieces to fit perfectly together and form a solid, straight block of the component. We looked at including holes in the computer model so that I can insert a dowel into the common holes for easy alignment with the ability to still clamp them together nicely.

I made a computer model using "CorelDraw 12" for the laser cutter as I planned to use the laser cutter for this component. I decided not to use the laser cutter for the reasons I've said before. I also did a computer model using sketchup for the use of the 3D printer for this component but as I loaded the model onto the 3D printer's software, Mr. Jones and I found that it would take an estimated time between 6 hours and 23 hours depending on the setting of the webbing for the strength internally. The maximum dimensions for the 3D printer was 120mm x 120mm x 120mm. This then immediately assisted me to decide to make the component by hand.

I picked out ready-made 18mm ply wood and thought of gluing 4 pieces together to make a 72mm thickness block. I could always use the table saw to thin it down to 60mm if needed. So I glued the four pieces using the vice attached on the workbench and left it overnight. I made sure that I covered all areas needed for gluing using a flat piece of wood to spread the glue evenly on the surface. I also applied glue onto both surfaces bonding together to ensure a strong bond. I used a damp rag to clean out any exce3ss glue when clamped together. The next day, the results were great and I left no empty spaces for the glue. It all looked as if the pieces were glued together from a factory. I then got an idea of using the previously made CorelDraw 12 model that was meant for laser cutting to be used as a printed template for when I'm cutting the block out by hand. I stuck the template onto the top surface of the block using paper glue stick and started cutting out the block for shaping. A problem arose when I was thinking of how to get the slots where the right-angles slide into to be perfectly identical to each other. I thought about using the guided band saw but ended up having to get it cut using the table saw. This was decided because I tested the band saw blades thickness and it turned out to be exactly 3mm. I tested this using a test piece and compared the slot to the previously made component as well as the metal itself. I found out it was the perfect size (3mm) as planned before.

I decided to chisel the middle of the block for easy access to the system despite having other options like using the mill drill, scroll saw and other methods. On the right, shown is the development of the layered structure towards completion after chiselling out the middle. I used a 25mm drill bit to take out most of the excess wood and smaller drill bits for the corners. This helped with efficiency in getting a block out of the wood easier. I clamped the block on a trusted flat surface to reduce bounce as I chisel out the middle section. I made sure I wouldn't injure myself nor anyone around me for safety purposes. After the middle section was taken out, I decided to cut the thro the block at an angle, because from what I found from testing at home, it may interfere with the user's legs. I did this using a scroll saw. The aesthetics had also improved.





# Attachment Development

The next thing I tested was the addition of a square bar on the inside of the right angles. I did this by using scrap wood, placing it on the inside of the right-angles and clamping them in place for a temporary simulation of the idea. I found that this helped by about 60% of the twisting and reduced it by that much. There was quite a lot of "instant" twisting with 'instant' force and the table top just sort of bounces frequently on either side. However, I didn't really want that remaining 40% of twisting. I used thing scrap pieces of wood to protect the delicate metal areas exposed to the clamp, especially when tightening.

To try and simulate the elimination of this twisting, I used a clamp to push the right-angles together to secure them in the desired position when vertically upright. The clamp is placed at the bottom so that it assists on the load that the right-angles have to take from all the weight at the top. I found little help from this and thought I'd do a different test to find the cause of this twisting. The right-angles still twisted quite significantly.

I proceeded with the 'extension' using rivets and 2-part epoxy to attach the extension onto the existing right-angles. For the epoxy to bond the two metals well, the surface of the metal has to be roughened through sanding to avoid less grip between the two metals due to a smooth surface. After sanding the surface, I made pilot holes for the holes in which the rivets go through. S I went on to sticking them together, I applied the mixed epoxy on both metals then riveted them (having to use only the 4 available rivets with two on each 'extension' and therefore rivets are placed on the ends to ensure a distributed overall strength on the length of the bars). I used wooden scraps that are square to ensure a square finish as the epoxy dries up and this is shown on the second picture on the right. This was also done to align the two metals perfectly , which resulted to a nice smooth flat surface, exposed to the eyes. Since the majority of the strength comes from the epoxy, I used the rivets only as guides for alignment as well as long-term strength for the durability, which will keep the two metals attached to each other for a very long time. I didn't use clamps to clamp the two metals together because the rivets clamp them well enough and from past experience in testing during this project, I found out that clamping the two pieces of metal together with a bonding compound in between will push the compound out and leave none in between.

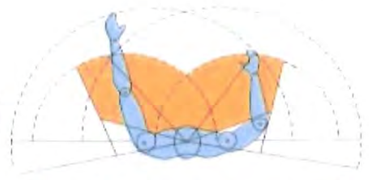
Above, is a picture of how the finished 'extension' looks like from behind. It clearly shows very good alignment for a smooth and consistent surface as a result. I believe that what has helped by making this very well aligned is the rivets as well as the scrap pieces of wood to help as support for the back when the two are pushed together for bonding.

I found that the extension made the table top attachment look very small and therefore, bad for the aesthetics. I also found that the table top was wobbling due to the minimal support from the attachment. So I decided to increase the width of the table top attachment to not only make it look better and more equal in proportion to the bars, but to also reduce the remaining wobble of the table top.

Above, It shows what the 'extension' looks like from the front, which is exposed more tho the human eyes/users. It seems very smooth and consistent throughout. This is very good for the aesthetics as well as the overall structural strength. I clearly shows, just by looking at it, the addition of the extensions to the strength of the bars as well as the reduction of the twisting of the metal.

After the riveting, I proceeded with the minor flaw that I had already seen as I was planning the process – that the rivet would be in the way of the metal bars in the closed /vertical position. What I did to solve this issue was drill a very hollow semi-hole so that the wooden block gives way to the rivet when in the vertical position. This is shown in the picture on the right.

After successfully designing the clamp, mechanism, and the attachment for the table top, I decided to take a step forward and start designing the table top. I have done little research about the workspace but a lot on the positioning of the user. I've decided to leave the workspace for last anyway. I know that from my current design, the user will have approximately 260mm for leg clearance. I have tested this leg clearance with my client and she seems comfortable with it. Since my design is for use while sitting on a bed, the elbow ergonomics doesn't apply. As shown in the picture below, the man's elbows are at 90 degrees to the body but his wrists are rotated. As seen in the same picture, the desk design by another company, can be rotated about the front edges. This allows for easier access for the wrist to the computer he is using. I could use the same idea for my design, but will require some different ideas put into it. Moving onto the workspace, I must do some research on the ideal dimensions of the tray. I found that my approximate measurements for the tray, is considered a student desk's dimensions. A primary school in Taiwan had done some designing and research to suit the children's ergonomic workspace. The "Mingchi Institute of Technology" has helped with designing this. In a table they presented, the ideal dimensions is 650mm (width) x 500mm (depth). I have to keep in mind, the idea that my client doesn't require a large workspace due to her height's (152cm) capability. 500mm x 200mm is also a size I found while researching. I must also consider the weight that will be added or reduced per modification in the design. I must keep in mind that portability is also an issue, and that size and weight sure does affect it. My client and I have also made a scenario of using the table by imagining what the ideal dimensions would be for her. We came up with 600mm x 330mm.

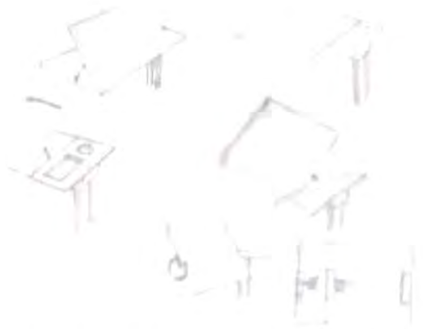




# Testing and Development

Since she has a 13" Laptop, a 'Sony Vaio Duo 13', we have to allow space for her laptop on the tray as well as her wrists that should be able to rest on the tray while typing or using the laptop. This laptop's dimensions are as follows:


If the laptop is sitting right in line the far edge of the try, this will give her 120mm for wrist space, which I would say is enough due to the fact that the average built in wrist space on laptops is 75mm. 120mm plus the extra wrist space on her laptop (which is below average) would give, not only her, but all users more than enough for total wrist space.



The laptop has a web cam that my client uses very frequently for Skype use. The problem is, the tilting angle of the screen is not adjustable. Therefore, when she has video calls such as interviews, the only visible part of her head is her forehead. This makes it very uncomfortable for her. An idea I presented to her was to have a rotational mechanism on the table so she could set the desired angle through the table, due to the fact that her laptop's tilting angle cannot be set.

As I was designing the table top attachment, I was also designing the table top itself to use the time wisely and not waste any of it for an outcome of better efficiency. Looking at the table top that I used as a mock up or "place holder", I thought that for my client to be able to use it, she has to feel comfortable using it. It has to have the ability to be set to her preferences. In other words, it has to be adjustable. So My first thought was to have the table height adjustable from the top through the table attachment with the attachment being able to slide up and down the vertical bars. I thought that this was a good idea but then it came to mind that it would be very hard to make a locking mechanism for it, putting aside basic idea of using pegs to lock it from falling on my client's legs. The peg idea, I thought, was too basic and too ancient/old for an idea. I thought of ways to lock it by tightening mechanisms but I couldn't figure one out due to the limitations of my skills and time available for testing. Due to the time restriction, I decided to think of a different idea of making it adjustable. I drew some sketches and also had some discussions with Mr Breig about the concepts.

On the bottom left, it shows my drawings of the concepts for the adjustable table top. My very first idea was to have another layer that can be adjusted by a hinge from the front of the user as if it were a "drawing table" or and art table. Some ways of locking it would be by the use of hydraulics, as Mr Smith (Physics teacher) had mentioned before. I even thought of using the self-locking mechanism used on drawing tables, seen from the graphics department. I thought that the layer above where the attachment is, would be the most stable part of all. Therefore, I thought of using it as an advantage to avail the ability to put things on top of it like cups or pens. So I did a little groove on the drawing indicting the place where the cups and pens are going to be.

I then thought, "what if the user will be using it on the other side of the bed?". The user would have no access to the adjustability of the table from both sides. So then I thought of having the pivot of rotation to be located at the centre of the table. I kept the idea of the cup holder because it was the area of the table that is not to be adjusted and will be kept flat and rigid while the user is using it. A way that could stop the table from rotating the full 360 degrees was to tighten the two pieces together by using the classic bolt and nut with the help of washers to prevent any long term loosening of the bolts. There would be a rod that goes the full length of the two combined (approx 600mm). I decided to not waste anymore time and start testing the second concept. I did exactly that and tested out the design.

I found that the design resulted to a problem in the levelling. Mr Breig suspected that it was caused by the wooden blocks, which were not properly glued underneath the table top and therefore, were not completely square. He ran the edge on the table saw and fortunately, it helped.

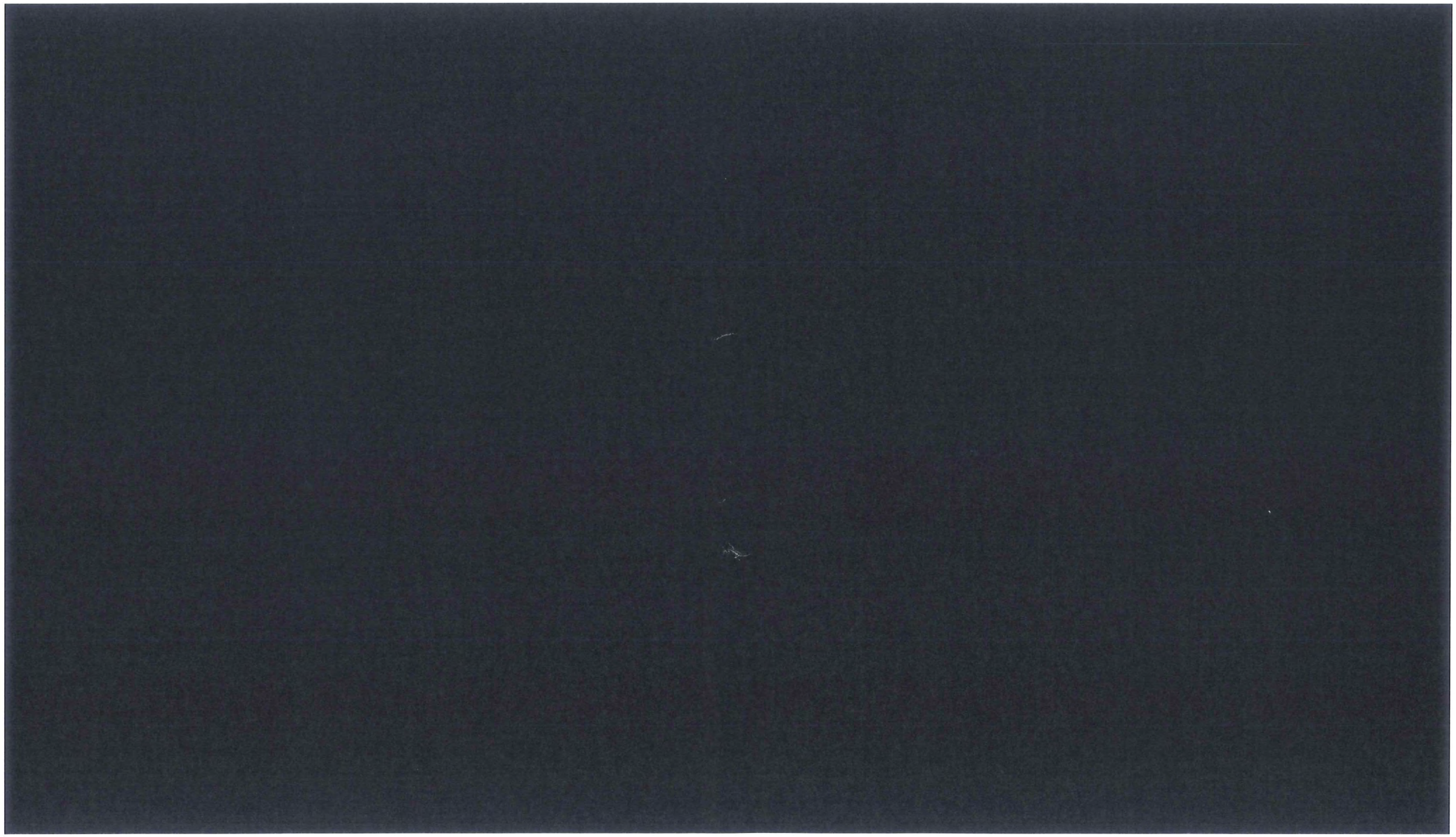
What I did was cut the existing model mock up of the previous table top that I used for testing to create the two parts. I glued 3 pieces of drilled wooden blocks in the desired places to accommodate the rod. I looked and found an M8 threaded rod and decided to cut it to size. At this time, I was using the model attachment because it was already attached. I used some nuts to put them in places where the wood needs tightening to eliminate the free rotation.

As I was analysing the problem with the levelling of the two parts of the table top, I came up with several solutions from just "tweaking" the design a little. The first thing I thought of doing was to extend the threaded rod so that it goes inside the model attachment. I thought "why not just let the threaded rod go all the way through the attachment?". And so I drilled through the attachment and found the threaded rod extended on the outside. At first I thought that this would of course be a hazard to people around and could potentially cause injuries. But then I thought that it could actually be used as a tightening component of the table top. Mr Breig and I discussed the possibilities of using this as part of a tightening component. The very first idea I had was to cut off any excess threaded rod to reduce the weight where not needed. Basically, the rod across to the far end of the table from the rotation point was not needed. So I decided to take it out of the equation.



# Table top Development

Click BOX BELOW during slideshow to watch how the final design works. For better voice quality, please use earphones.





# Final Design function animation

The basic idea was that there would be lock nuts (replaced with double nuts locked onto each other for cheaper material) fixed on the threaded rod. As the rod is rotated (clockwise for tightening, anti-clockwise for loosening), the lock nuts go with the rotation and eventually push toward the wooden blocks. Washers are used so that the wood is undamaged after large amounts of force applied from tightening. There would be a fixed nut on the other side (on the other component of the table top), so that as the rod turns, it "sandwiches" sandwiches the blocks together per clockwise turn. Therefore, the friction between the two components increase. The rod can then be loosened so that the user will be able to set the table at a desired angle, then turned clockwise, to lock it in the desired position for the preferred angle of the table top. Having the rod rotated means that I would need to attach a handle to the rod so that the user can easily rotate it with proper ergonomics of the handle.

Without the handle being available at the moment, I decided to use a wing nut for testing purposes. It would basically be locked in between two nuts so that the wing nut doesn't loosen when being rotated anti-clockwise as well. So I took the whole project home for testing with the location as well as the client. I found several things that needed editing as well as several good things about the design with the response from my client and stakeholders. I found that the table top fit quite well underneath the bed , despite having little clearance. The design still had alignment issues like the two rods not completely horizontal, and this makes the design look bad but can easily be fixed. The tabletop had a slight problem with the levelling as planned and I easily found the solution to this – by using the new attachment, and by making sure the holes are aligned as well as precise engineering when it comes to the final prototype. The rotation worked very well, and with the help of the wing nut, the desired angle was kept well enough that when hands are placed on top it wouldn't rotate. My client tested it out and found the rotational mechanism very convenient for her as she could use it for her skype video calls allowing her clients to see her whole face during interviews. She was also pleased with this as she could write comfortably with enough clearance for her legs the right dimensions of the table top. She liked the fact that there would be space for her cup and space to put her eyeglasses on, with this surface being very flat and stable, giving the impression of not having to worry about any spills or nuisance when using it.

After the completion of the attachment and the table top development, I decided to move onto the final table top. I planned the use of the school's laser cutter for the smaller portion of the table top because it needed a circular groove to act as a cup holder. The larger part of the table top will only be plain and therefore, can be made by hand. I designed the groove and the three layers of plywood (3 x 3mm thick to make 9mm) using CorelDraw 12. I added in a plan view of the table top attachment (engraved option) as a guide to when I'm going to attach the attachment underneath. I laid the parts out really close to each other to ensure no waste of material for the courtesy of the school's budget in materials. This, of course helps with efficiency. Before using the laser cutter, I made sure I had the correct material set for the power of the laser and made sure all the buttons were pressed (as required for proper use). I made sure I did not look at the glow of the laser as it cut through the wood so that I don't damage my eyes. After the process, the computer software showed a run time of 5 mins and 30 seconds as shown in the picture.

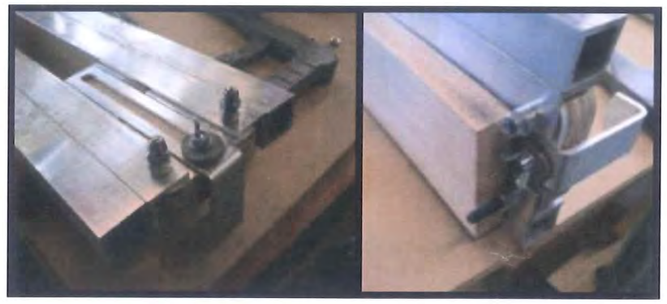



# Production: Prototype

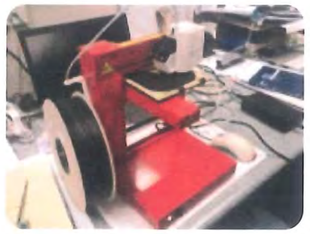
I went on to glue the 3 layers of plywood for both the small and the larger part of the table top. I did this by applying a small amount of glue on all the surfaces that would be inside of the block, ensuring no spaces by using a flat scrap piece of wood for spreading out the glue throughout the surface. I used a bench vice for the smaller part and a press for the larger part. I made sure no glue would stick to the school's materials and tools by using newspaper to also protect my project. I used newspaper because it can be sanded off afterwards if glue stuck to it and the project. While using the press, I used a trusted flat wooden panel (coated MDF) to protect at least the good side from any dirty bits on the press which could damage the wood as I experienced from the first time I used it and caused the whole panel to bend while drying. I made sure this was prevented by applying past knowledge to my project.

I glued the attachment onto the smaller piece with the help from the engraved lines for alignment. Then I used the table saw to run along the side which should be perfectly square. I f it isn't made square, then it would result to a levelling problem as I experienced in my model mock up before. Since the bars have rivets in the way of the attachment, I decided to use the clamp to dent out the wood instead of drilling. This is so that the dent is at the exact position and that I don't have to worry about any measurements - a basic skill used. I cut out the second part of the attachment, which will be attached to the other part of the table top (underneath). I cut it to the exact size then drilled a hole right down the middle, along the hole from the main attachment. I used a pencil through the mutual holes for alignment and then marked out the wood for the shape I intended to make – a basic square piece with back support for extra strength. As noticed, alignment is a very crucial part of this stage of the project where everything has to be precisely made. At the time when I wanted to cut the block at an angle to match the main attachment's "triangle" shape, the bandsaw wasn't working. It left me no choice, but to use the handsaw. In the end, the outcome was successful and all I had to do to "precisely" shape it out was to sand it using the bench rotational sander plus extra help from the hand sanding block.

I cut off the excess bolt to reduce the risk of tangling or getting cut and also added some M6 dome nuts to the end of the bolts so that the tips are rounded, again, for less risk in injuries and better aesthetics. I made sure I didn't damage the metal while doing this by adding tape to prevent scratching on the surface and also added a piece of wooden block to increase stability and support on the sides when cutting.



I used some tape to wrap around the thread on the rod so that the wood doesn't get damaged overtime through the wear from the thread. This was done to increase durability in the long run. After assembling the two parts of the table top together, I got the sides cut altogether to give the perfect alignment, and got rid of any excess material.



I was going to use the school's 3D printer to make the table top attachment but found out that it would Take 23 hours at the highest (strongest) setting and 6 hours on the lowest setting. Therefore, I decided not to proceed as it wouldn't be too efficient for the allotted time. Hence the idea I came up with the layered structure I did earlier.

I tapered the ends of the metal bars where the table top will be attached so that it will be easier to attach the table top in the initial contact. The addition of CRC onto the table top attachment was also of great help

I added magnets inside of the wood and behind the metal bars so that when the bars are in the vertical/upright position, the lock into place, preventing it to fall off by itself which could cause serious injuries to my client and/or the user. I added the magnets inside of the aluminium bars because magnets don't attract with anodised aluminium. I also tightened the bolt and nut at the pivot point to give a nice feel for the ergonomics and also to prevent the falling.

My client and key stakeholders including Robert Tang suggested the addition of stoppers for the table top to prevent the laptop or book or anything else from falling when in the tilted position. I suggested adding it on both sides due to the symmetrical design of the table, allowing it to be used on either side of the bed. I also added to the design, as a part of it, the stoppers on the flat piece as well to improve the aesthetics of the table top.

I suggested painting the metal pieces black but decided not to paint it due to the areas where the components rub against each other, causing removal of the paint. Therefore, I asked my client about what she would want for the finish regarding the colours and told me to base the colours on the table shown: light wood and metallic frame. This was perfect because the plywood I used for the table top is already light in colour and would only require clear polyurethane for protection of the wood, whereas the metal is already a metallic finish by itself due to the anodised finish. The metal would only require high grade clear coat for protection against surface scratches in the future. The high grade clear coat was suggested to me by my brother, Timothy Carlos. Robert Tang suggested the use of polyurethane for protection against water or coffee or other drink which could cause stains on the would as soon as he saw the cup holder. Mr Breig also suggested polyurethane for protection against sun damage.

I decided to redesign and remake the slider and the main block so that all of the measurements were precise. I managed to take out the gaps between components that affected the design and function and got better results, which was well worth it having only taken a week from my schedule.


I proceeded with using clear cabothane polyurethane for my wooden components and high grade clear coat for my metal pieces. I made sure the surfaces were clean and clear from scratches beforehand by sanding and wiping. I did three to four coats of the finish per component. The clear coat only took a small amount of time because the drying time for recoat was 10 mins and this was very helpful. The drying time for recoat on the polyurethane was only 2 hours and I managed to use the time well.

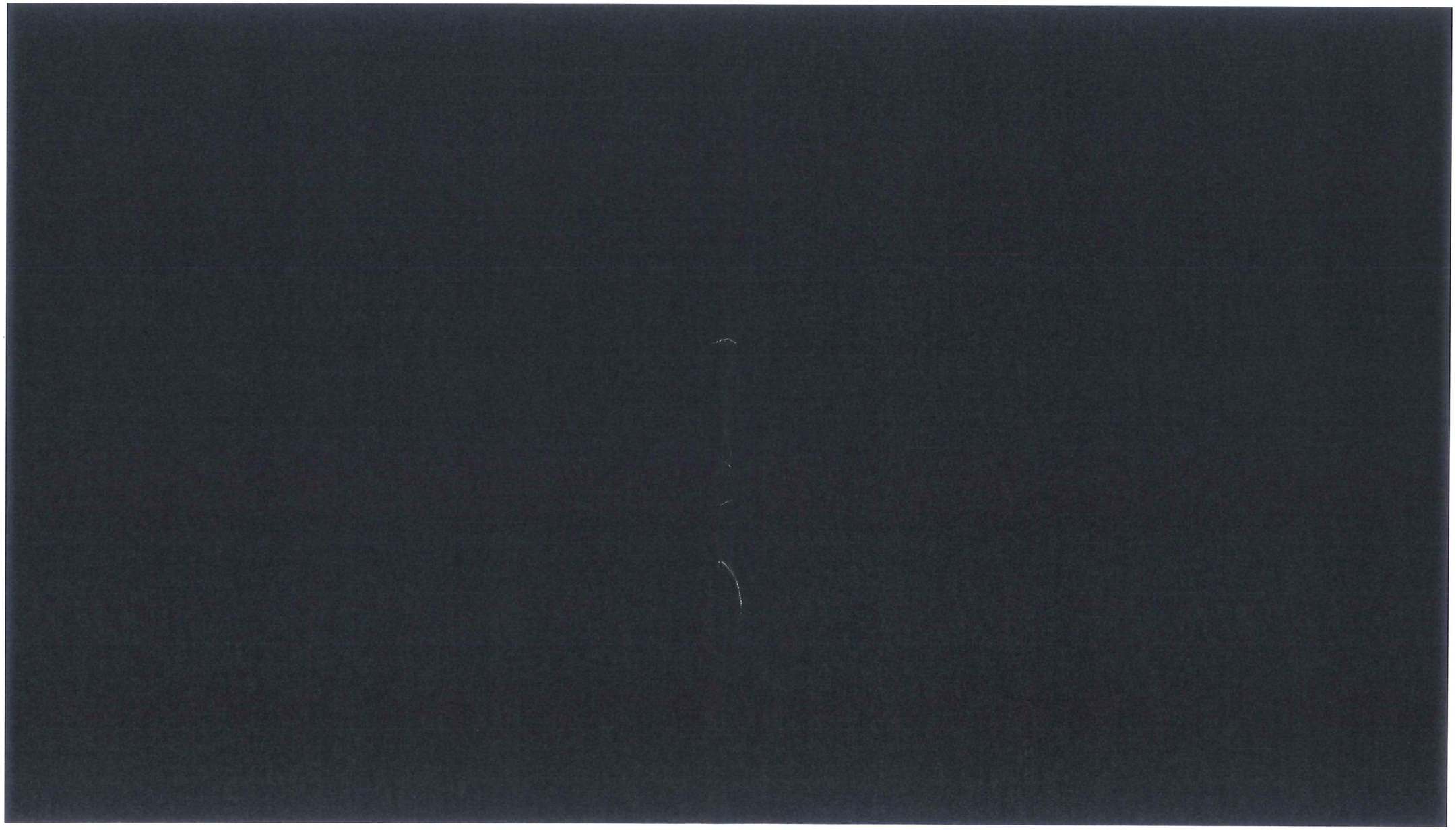
I was going to use CRC in between the parts that rub against each other to eliminate scratching but Mr Breig said it wouldn't help so I decided to use felt adhesives that I found in the workshop. I cut them to size and applied it onto the surfaces where the metals would rub against like behind the metal bars, on the pivot points, and ion the hooks to protect my client's bed from getting any scratches from the metal components of the unit.

I included the lever handle I ordered into the project for both the table top and the slider. The lever was a female type and had thread inserts. I did some research beforehand to have made sure I got the right size and type for my project. These were only about $10 each. I decided to use it for the slider as well but for that, I had to make some adjustments on the slider and the bolt (from M6 to M8). This improves the aesthetics a lot by adding accent from the black and orange colour of the lever handle as opposed to just using a small wing nut. It has also improved the ergonomics for the user through the existing curves for the fingers on the grip and also reduced the risk of injuries by having rounded edges.



# Prototype detailing and finishes

Click **BOX BELOW** during slideshow to watch how the final prototype works





# Final Prototype Demonstration

After producing a bed table, I believe I managed to meet all of my client's needs and specifications through the development of the issues involved in the project.

- Starting off with the ergonomics, the bed table has improved my client's posture through the design of the table top and its adjustability. The tilt adjustability allowed for a comfortable position for my client to set so that it is set in her own preference. I received feedback from her and other stakeholders who tested the prototype , "it's very comfortable but the table top is a bit hard o attach". I came to a conclusion that attaching the table top wasn't an easy job and this could be seen in the video on the previous slide. Aside from the weak magnets included in the design, what I could have done to keep the uprights close to each other was add some sort of elastics that would hold them close together, or maybe even some bungy cords or springs. This way, the uprights would not come away from each other during the process of attaching the table top and while being stored away. Keeping them close together would result to an easier job for the user to attach the table top and also reduce the risk of getting injured from free rotating metal bars.
- Onto the storage issue, the table can be safely stored away underneath the bed, allowing for less visual pollution in the room and also reducing the risk of any excess objects that could cause trips or cuts due to the hard metal surface. Rounding the edges also helped reduce this risk. I received feedback from my client saying, "I like how I can store it away and out of sight so I don't have to see it when I wake up in the morning." This has been a very positive outcome. One thing I should have considered, though was the handle on the slider. The handle disabled the frame to slide underneath my client's bed due to the low clearance from the ground. This resulted to the frame being put aside underneath the drawers attached to my client's bed as shown in the video demonstration on the previous slide.
- I have kept the risks to a minimum by adding felt pads on particular surfaces and rounding edges, as mentioned before. One thing I could improve on more the table top attachment. If I could design it so that it went in through the uprights easier, it may have made the assembly much easier for my client. An easier fitment would result to less risks from muscle strain. A solution to this may be a whole new attachment with slots going in through the square tubes to prevent possible separation of the uprights as well. What I've noticed though is that the separation between the uprights isn't a problem at all due to the tight fit from the current table top attachment holding them together.
- The durability part of this project, my client has no problems with. I am happy with the decision of using metal for the frame, providing a lot of strength for stability as well. Using layered plywood for the table top attachment was also a good decision because I can already see that it carries most of the load from the table top and I do not regret going through the extra mile for it. The design of the bracket is very sturdy and show no signs of damage, while carrying all of the load.
- The assembly of the bed table only takes a few steps and this results to better efficiency. I made sure this was done and have succeeded. My client commented, "It's very easy to set up and only takes less than a minute. I also received similar comments from my other stakeholders.

As far as I know, the aesthetics of the bed table is at its best.

As shown, without the bed table I designed, my client has her mug of coffee and glasses on the bedside drawer. Her laptop is on her lap and causes her head to tilt down to allow for a better view of the screen instead of with the bed table, where the adjustability allows for her head to not tilt for a better view – better ergonomics for the user. Her mug and glasses are placed on the flat space on the bed table and gives her easier access to these objects – better efficiency. She has more free movement on the legs due to the laptop not resting on her lap. This allows for more comfort with free movement and therefore better ergonomics. The frame of the table isn't at all affected by the movement of the user on the bed due to it being attached on the bed's side rail – increased durability. Handles and rounded edges are used to prevent any injuries from cuts – better risk management. The combination of metal and wood gives a very good contrast of materials – better aesthetics.


The **key factors/issues** solved are:

- Ergonomics
- Storage
- Risk Management
- Durability
- Efficiency
- Aesthetics

The feedback from my client was pleasing to hear. She said "ending up with a complex design is easy but ending up with a simple and functional design definitely requires a lot of development". Through her words, I finally know that I met one of my main goals for this project, which is to design a simple yet elegant bed table.

Without having done the research on the issues, location and existing designs, I wouldn't have come up with much of an idea. Looking at existing designs helped me to have a wider range of ideas for the project. Talking to my client about the ideas I've come up with helped to narrow down what her actual needs were, gaining specifications needed to be met for a successful project.

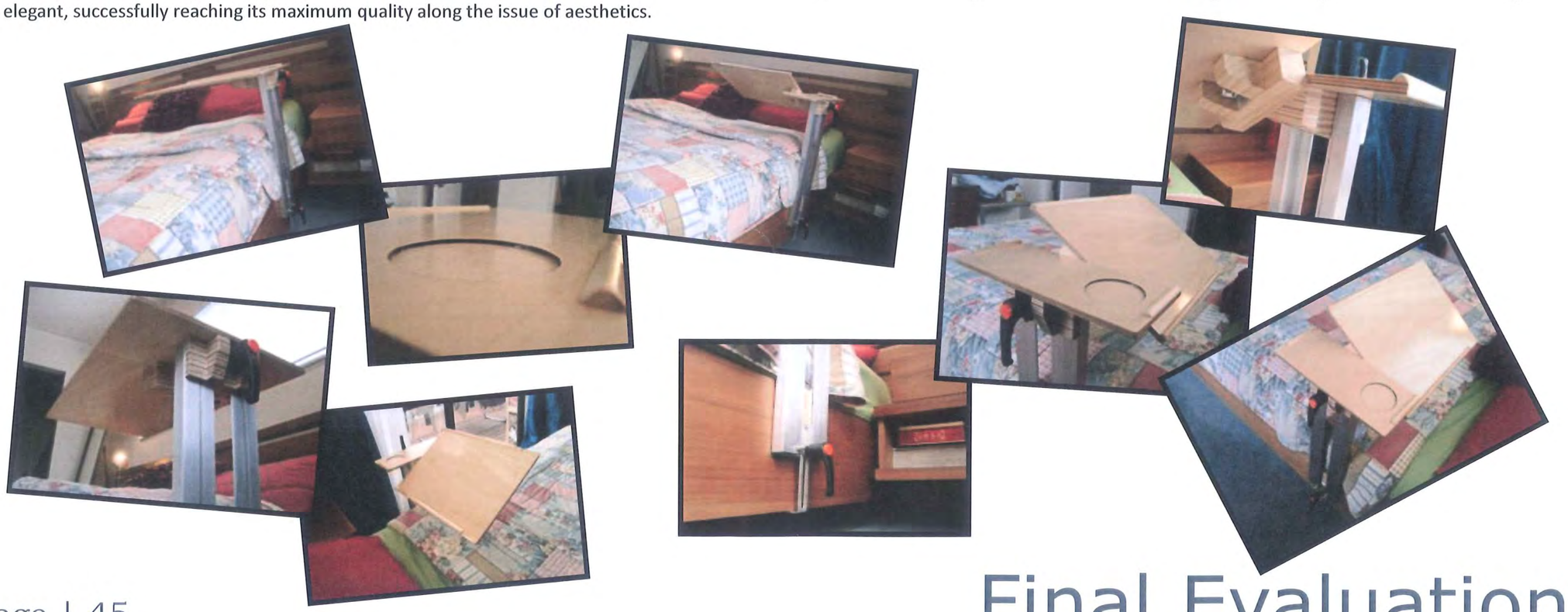
Looking at case studies definitely helped with knowing what to do in the planning stages and therefore, being able to prioritise the key factors and attributes of this project. The Gantt Chart helped a lot with my planning, being able to prepare myself for the upcoming stage of the project. This gave me a kick start for the concept designs. Doing concept designs as a part of modelling definitely helped with being able to explain my ideas to my client and stakeholders visually. Quite a lot more research on specific areas of the project allowed me to choose a concept design that's worth developing with the assistance from my client and stakeholders. Seeing the project in a whole different view was very useful to a designer's point of view.

I did a lot of modelling throughout the year and I think that modelling is a very important part of a project because that's where all the testing is happening. And from all the testing, comes the decisions for the next step. Modelling allowed me to explain easier to my client and stakeholders how a particular function of a design worked, making them understand better. I am very happy having done all the modelling I did and is a very effective stage of the project, seeing it now.

From all the research, modelling, and practical, I know I have learnt from it during the processes. Some things, I've never worked with before like welding, and using metals. I believe that I benefited from this year's project having learnt new sets of skills and techniques that I'm sure will be useful for my future and my career.

The development stages of my project was one of the most stressful stages of the year. It was the stage where I did most of my decision making, where usually one option would lead to a totally different path in the project. I made sure I could control this by using all of my resources around me and applying them onto my project as much as possible. Going around school and seeing different teachers about a particular issue was very helpful – sharing other people's knowledge. Having come up with the rotational hinge on the table top was definitely a big help to the ergonomics of the design, contributing a lot to better posture for my mother.

I developed the design to a point where it can be adjusted easily for an outcome with better ease of use for my client and made computer model components to show how the whole design worked. I've planned well ahead of me to make sure I use the time wisely and designed it so that it can last for a very long time with everyday use and meet the issue on durability, along with the least possible potential risks involved in the design. I've chosen light yet durable materials, especially for succeeding to meet the issue on portability and durability. It has met the issue on ergonomics through the adjustability for the preference of the user and the ease of use when assembling and disassembling the unit and the overall design. It is a design made to become simple yet elegant, successfully reaching its maximum quality along the issue of aesthetics.



During the period of two years (2011 and 2012), six Rosmini College students have been awarded Technology scholarship. I've studied the projects from three of those students: Justin Rosaria, Momo Muira, and Theodore Carlos (awarded Top Scholar and brother). It came to mind that their experience from their own projects would be very useful for me as a shared experience with them so I decided to critically analyse their projects in order for me to gain knowledge of what I am heading into this year.

Justin Rosaria designed and produced a flip-foldable bed for his neighbour. I could already tell that having an external client allows for a wider view of perspectives for the project and therefore, easier to work around. It also tends to be a more professional relationship with the external client. The idea of the project straight away presents the main issue of the project; to allow for more space in the room and lessening the visual pollution. He started off with the development stages through planning. He did some research about his issues as I did in my early stages. Due to his project being so physically large (a whole single-sized bed), there came a point where he notice time was running out for him and just had to start his production process, even though he didn't have a concrete design of the unit. This took place during the fist weeks of term two. This led him to not have enough time to plan for his next steps. In my opinion, Justin spent too much time on the development stages of his project and not enough time on his planning and this mistake was obvious. The outcome of his unit was great and well finished but it looked very basic because he didn't have a final design to develop, which he could have spent time on to improve on the overall aesthetics. This gave me the opportunity to think about what my next steps were, while I was in the early stages of my project. I made sure I planned well ahead of the current situation and did this by using a Gantt chart (seen at the end of the portfolio) and several other small to-do-lists for the following day's use.

Momo Muira designed and produced a filing-system cabinet that is to be placed on top of a piano. One of the main difficulties that he had during the project was that one of his main clients was overseas and so he was only able to communicate with him for a limited time. Having a lot of issues was also a difficulty for him because sometimes designing a solution to one issue can completely worsen the other. As his project required him to come up with something completely new, he had difficulty coming up with designs as he didn't have anything to reference other than existing outcomes that solved similar issues to his. He did his development stages, as usual and spent a lot of time trying to solve his issues through testing and research. In the end, he came up with rotatable individual drawers for easier access when playing the piano as it would be positioned slightly higher than eye level. The number one problem was that he was thinking too much about all the issues that he had to solve and although he was able to prioritize it later in the project, it was too late and he just ended up making something that wasn't tested enough to see if it actually solved all the issues. I think that this is a common problem with a lot of Technology students, seeing it already from two of the students from Rosmini College. Momo had a very similar problem to Justin's. They both spent too much time in the development stages until the middle of the year and therefore, realized that they would have trouble finishing off their projects. This resulted to having not enough time for the planning stages prior to the production process. Momo made minor mistakes in his production process as a result of this. His project consisted of making eight drawers which were supposed to be of equal size but due to mistakes in his dimension calculations, they either didn't fit in the slots or were too loose. Because of this he had to make adjustments by sanding and adding strips of wood to make it perfectly fit. He also had problems using machinery and so he made a lot of mistake cuts that led to wasting material:). I think that what he could have done to solve this issue prior to it happening, was to make a computer model of the unit per component using software. This would have enabled him to look at the visual aspects of his project that may have included mistaken measurements and could therefore adjust the measurements through the computer instead of in the practical. The biggest positive effect would have come from the planning.

Theodore Carlos designed and produced a driving simulator coffee table. His main problem that arose throughout his project was the enormous size of his unit. He planned well ahead of him, using different methods like the Gantt chart, the Problem Prediction Matrix, and the use of modelling through computer software like Corel Draw 12 and Google Sketch Up for his basis in the measurements. I think that he had no major problems during his planning and development stages. The real main problem was that he had to produce a large unit. Time constraint is the key idea here. He started off with the table top in the late weeks of term one. He knew he had to start because he was already aware of the time restriction and limitation he had for the project. Again, this is another problem on the "I just had to start" issue. I think that what he could have done to cope with this even better, was to have focused on reducing the size of the unit. It's not a matter of ignoring his main issue on ergonomics, but to have a little more effort put into the idea of producing a smaller-sized unit. By doing this, it may have saved him a lot of time and may have enabled him to focus on the aesthetics of the coffee table even more. He did produce an outstanding unit, but I know that it could have been better if he reduced the size. Aesthetics, being one of my main issues is a great deal to my project and I have learnt how to manage time for aesthetics through Theodore's project.

# Appendix – Critical Analysis