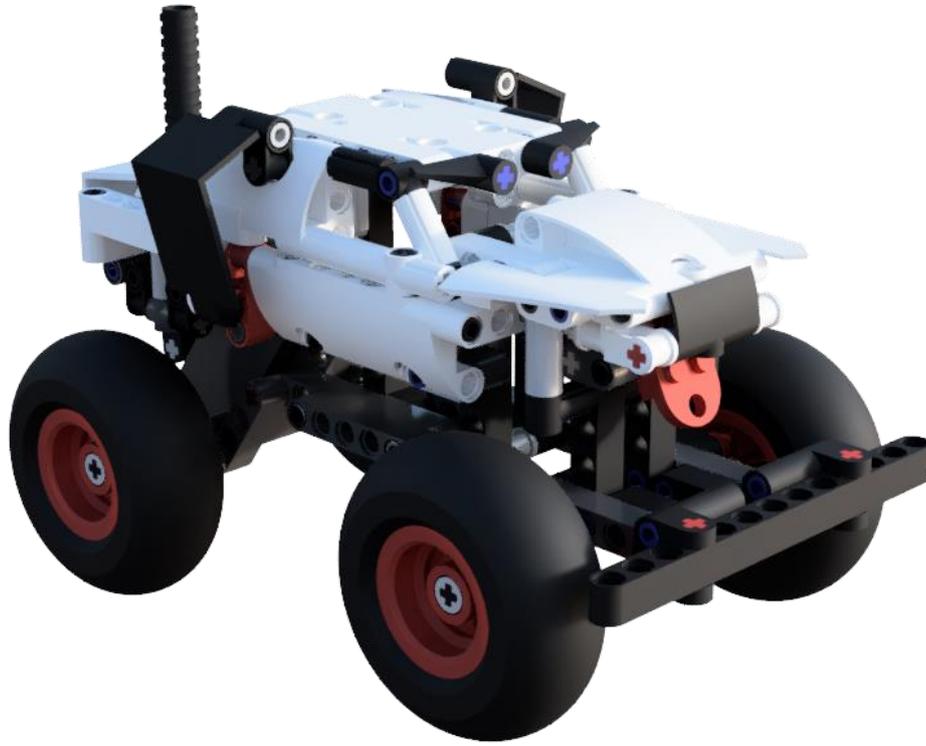# LEGO Technic Monster Jam Monster Mutt Dalmatian

Student number: 36840498

Table of Contents

Statement of Intent

For this project I intend to skilfully recreate a realistic 3D model of a mechanical device using Fusion360 as with material properties and colours as accurate as possible to the real thing. The model I select for the project will most likely be Lego. However as there is a large variety of Lego kits available, I will consider a wide range of possible vehicles and mechanical devices during my research as I could construct these models using Lego. In my portfolio I will include a full set of working drawings for each of the components and an assembly drawing that clearly demonstrates the relationship between the parts and how they fit together. I will also create a set of realistic rendered drawings to showcase the project with materials and colour applied.

I was inspired to choose a LEGO set as the subject of my portfolio due to personal interest. Over the years I have collected many LEGO sets and loved to make my own creations. There were multiple kits readily available, so I was able to find one at my appropriate skill level that looked good. Because I own the set I have decided to model, creating the parts on Fusion360 allows me to easily recreate them using a 3D printer if I lose one. Physically having the kit allows me to evaluate my progress easily and become more familiar with each of the components as I recreate each of them in Fusion360. I will also become more adept at deconstructing and reconstructing the LEGO set making it easier for me to assemble if I lose the instructions. Choosing a LEGO set with various small and unusual geometry allows me to develop my skills on Fusion360 and challenge me to use the program to do things I never thought of previously. As well as improving my skills on Fusion360 this project will allow me to develop my skills using a range of industry level software such as Microsoft Excel and Microsoft Word and develop skills in time and finance management. LEGO Technic sets have lots of moving parts which creates opportunities to develop my skills in component animation and animating exploded views.

All parts need to be able to snap together with the correct fit and move like they would in real life. The 3D model must look as close as possible to the physical LEGO set in relation to colour, type of material and dimension.

The Criteria for Success will be used to regularly evaluate my progress with the project.

Criteria for Success
- The finished version looks like the real thing in relation to colour, type of materials and dimensions.

- Needs to be able to assemble with no clashes and no parts that overlap.

- Includes a full set of accurate dimensioned working drawings.

- Includes an accurate assembly drawing that shows how to build the model if the instructions were ever lost.

- Includes a set of high-quality renders of the complete 3D model.

- Must be able to be finished by the due date.

- Must not exceed my budget of $80.

3

Ongoing Evaluation for Statement of Intent

At this stage of the project, I have decided that I will be CAD modelling an existing mechanical device. My plan is to select the mechanical device and take physical measurements of each component to produce an accurate CAD model of it. I have decided that the mechanical model I choose will need to have some moving parts so it will provide me with the opportunity to learn about CAD model animation. This information will be now used to guide my research.

Research – Similar Projects

This section shows similar designs and ideas to what I intend to create. It also provides an evaluation of the positive, negative and most interesting aspects of each design. The purpose of this section is to guide the decisions for this project.

LEGO Technic 8045 Mini Telehandler
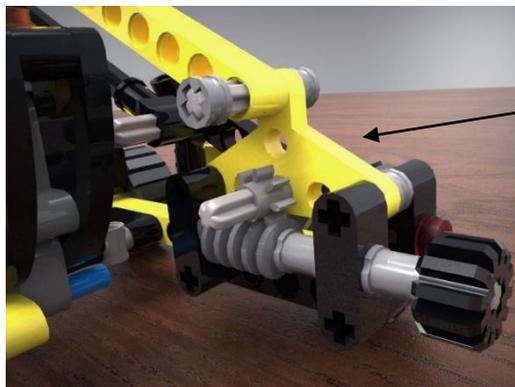
A variety of interesting and unique geometry.

Some of the geometry is very repetitive. The repetitive geometry gives me the opportunity to use functions like the array command.

Not very many different colours and textures used, making the overall design boring.

Some of the components can move which creates an opportunity to animate some motion.

The rendered drawings include a realistic background that make you believe they are photographs.

The rendered drawings have very realistic lighting, including shadows and reflections.

Positive	Negative	Interesting
- some of the components can move which creates an opportunity to animate some motion. - The repetitive geometry gives me the opportunity to use functions like the array command. - The rendered drawings have very realistic lighting, including shadows and reflections. - The rendered drawings include a realistic background that makes you believe they are photographs.	- Some of the geometry is very repetitive. - Not very many different colours and textures used, making the overall design boring.	- A variety of interesting and unique geometry. - Being LEGO it is designed to snap together and could be built by anyone, even a kid.

Go Kart

Some opportunities to add a life size humanoid model to improve the ergonomics and learn about anthropometry.
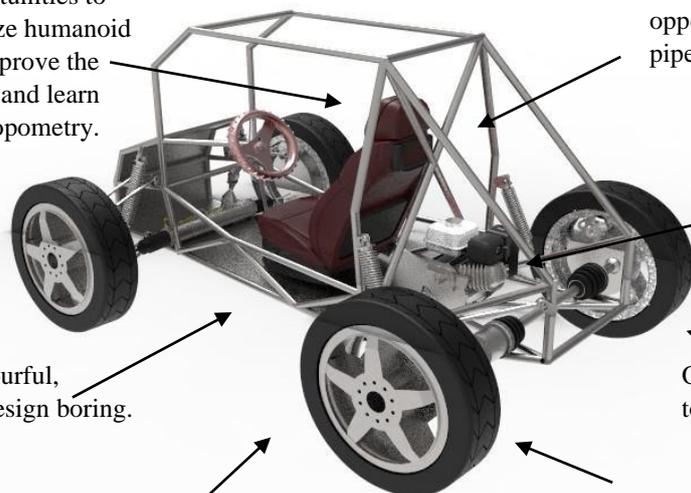
The frame is made out of pipe and CAD modelling the frame will give me the opportunity to learn about pipe modelling.

The engine is exposed and 3D modelling that would take a lot of time as I would have understand how it works in order to model it.



Not very colourful, making the design boring.

Open design allowing you to see all the components.

It would be difficult to get exact dimensions to create it, especially as I do not have access to a real Go Kart to reference from.

The wheels and steering wheel move giving the opportunity to animate it.

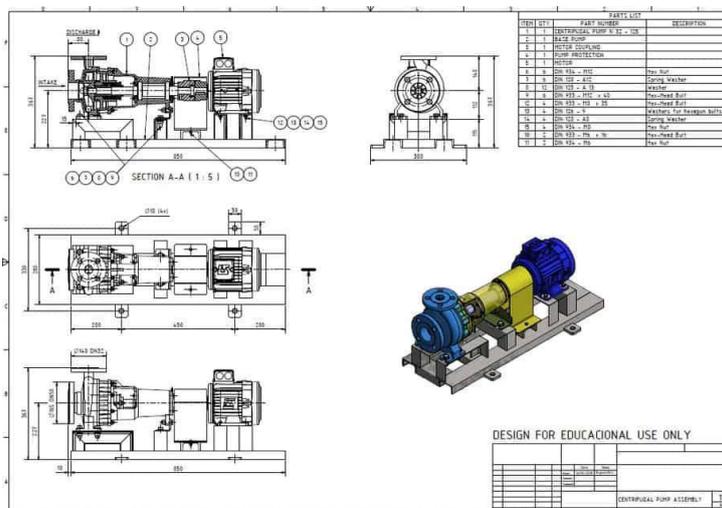| Positive	Negative	Interesting
- The wheels and steering wheel move giving the opportunity to animate it. - Some opportunities to add a life size humanoid model to improve the ergonomics and learn about anthropometry.	- Not very colourful, making the design boring. - The engine is exposed and 3D modelling that would take a lot of time as I would have to understand how it works in order to model it. - It would be difficult to get exact dimensions to create it, especially as I do not have access to a real Go Kart to reference from.	- Open design allowing you to see all the components. - The frame is made out of pipe and CAD modelling the frame will give me the opportunity to learn about pipe modelling.

Centrifugal Pump
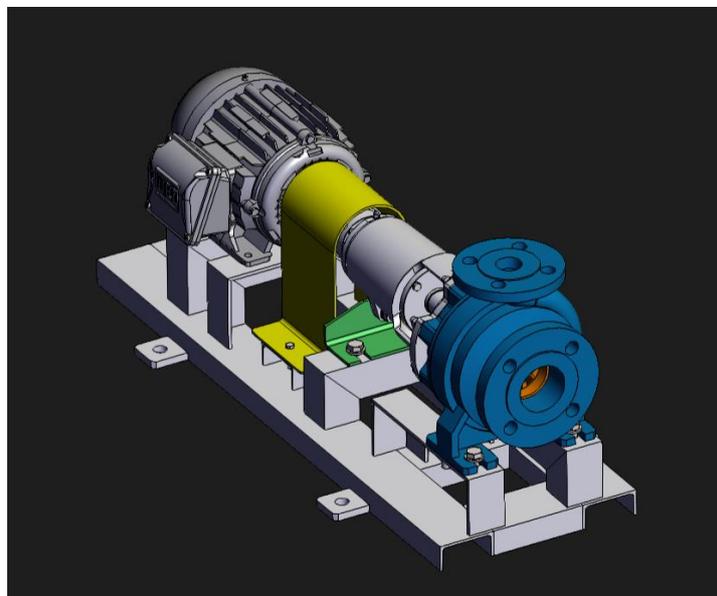
The geometry for some of the pump components such as diffusers and impellers can be quite complex.

I live in an agricultural area and the knowledge of how irrigation pump works could be beneficial when improving my skill set to find employment.

Manufacturers do not usually release all the dimensions of their projects which might make it difficult for me to model it.

There are a variety of different pumps available that I could select from to find a project at my appropriate difficulty level.

There are opportunities to incorporate this pump into a larger system that includes other components like hoses and nozzles.

There are opportunities to add alternative power sources to the pump, such as solar panel components or a wind powered generator.

Positive	Negative	Interesting
- I live in an agricultural area and the knowledge of how an irrigation pump works could be beneficial when improving my skill set to find employment. - There are a variety of different pumps available that I could select from to find a project at my appropriate difficulty level.	- Manufacturers do not usually release all the dimensions of their projects which might make it difficult for me to model it. - The geometry for some of the pump components such as diffusers and impellers can be quite complex.	- There are opportunities to add alternative power sources to the pump, such as solar panel components or a wind powered generator. - There are opportunities to incorporate this pump into a larger system that includes other components like hoses and nozzles.

Honda Engine

Stationary engines like this are common in the farming area where I'm from. Developing an understanding of these components and how to model them would be beneficial if I got a position working in the farming area.

Theres a good variety of different geometry and materials in the components that would allow me to develop skills in material selection and the creation complex geometry.

It will give me an opportunity to learn about different surface finishes, as some surfaces are machined while other surfaces are left rough (as cast).

The relationship between components can vary significantly, for example some components may fit together loosely, while other components need tight tolerances because they need to press together.

To complete this project, I may require an understanding of how an engine works to effectively model it.

Because it has a horizontal shaft it has a large range of uses, for example a golf buggy, ride on lawn mower, a pump, which would allow me to add on components and increase the size of the project.

Positive	Negative	Interesting
- Stationary engines like this are common in the farming area where I'm from. Developing an understanding of these components and how to model them would be	- To complete this project, I may require an understanding of how an engine works to effectively model it. - The relationship between components can vary significantly, for example	- It will give me an opportunity to learn about different surface finishes, as some surfaces are machined while other surfaces are left rough (as cast). - Because it has a horizontal shaft it has a large range of

beneficial if I got a position working in the farming area.
- There is a good variety of different geometry and materials in the components that would allow me to develop skills in material selection and the creation of complex geometry.

some components may fit together loosely, while other components need tight tolerances because they need to press together.

uses, for example a golf buggy, ride on lawn mower, a pump, which would allow me to add on components and increase the size of the project.

Farm Drone

There are a variety of attachment such as cameras, spray nozzles and parcel delivery attachments that can also be included in the design.

I do not have access to a physical drone so if I needed any dimensions, they may be very difficult to obtain.

It has a good variety of geometry, some components are quite complex, such as the propellers and electric motors, whilst the frame is relatively straight forward.

It is an emerging technology and developing an understanding of part for drones can be a very useful skill.

Drones can also be tri-rotor with three rotors, or they can be UAV style for military applications.

Allows opportunities to animate.

Inside the drone can be quite complicated with printed circuit boards and electronic components which would be complex to model.

Positive	Negative	Interesting
- It is an emerging technology and developing an understanding of parts for drones can be a very useful skill. - It has a good variety of geometry, some components are quite complex, such as the propellers and electric motors, whilst the frame is relatively straight forward.	- I do not have access to a physical drone so if I needed any dimensions, they may be very difficult to obtain. - Inside the drone can be quite complicated with printed circuit boards and electronic components which would be complex to model.	- There are a variety of attachments such as cameras, spray nozzles and parcel delivery attachments that can also be included in the design. - Drones can also be tri-rotor with three rotors, or they can be UAV style for military applications.

The thin cover for the drone will allow me to develop my skills in shell modelling.
- Allows opportunities to animate.

Wind turbine

There is a lot of repetition of geometry which means that quite a few parts could be easily created using circular array and pattern tools meaning it might limit my ability to show the extent of my skills.

There is a global movement towards net zero emissions by 2050 and it is predicted that there will be a lot of work CAD modelling renewable energy components.

It is an emerging technology, and it would be beneficial to develop a better understanding of how wind turbines work and develop CAD modelling skills in this area.

May be difficult to find the dimensions of all the components so I can CAD model them as companies such as Siemens Gamesa and Nordex Group, who manufacture them do not release this information.

Although the operation of the wind turbine requires a lot of components many of them are hidden. There would be a lot of work in making the components as many are quite complicated and to view them would require exploded views, section views and removing the covers to present the drawings.

Theres a variety of skills required such as complex curves and there is the ability to animate movement.

Positive	Negative	Interesting
- It is an emerging technology, and it would be beneficial to develop a better understanding of how wind turbines work and develop CAD modelling skills in this area. - There is a variety of skills required such as complex curves and there is the	- There is a lot of repetition of geometry which means that quite a few parts could be easily created using circular array and pattern tools meaning it might limit my ability to show the extent of my skills. - May be difficult to find the dimensions of all the components so I can CAD	- There is a global movement towards net zero emissions by 2050 and it is predicted that there will be a lot of work CAD modelling renewable energy components. - Although the operation of the wind turbine requires a lot of components, many of them are hidden. There

ability to animate movement.	model them as companies such as Siemens Gamesa and Nordex Group, who manufacture them, do not release this information. - It would require an understanding of how they work.	would be a lot of work in making the components as many are quite complicated and to view them would require exploded views, section views and removing the covers to present the drawings.

Mario Kart

The render includes a background and character from the game Mario Kart, making it seem like the real thing.

The soft curves leave room to be more creative with the project and make your own dimensions.

Includes lots of curves which can be hard to model to the correct dimension.

I do not have access to a physical kart as it exists in a game, therefore getting dimensions to recreate it will be very difficult.

There are a variety of different karts aside from the basic one which can be modelled. Wheels and gliders can also be customised to create a unique kart to model.

When using a different character, the kart will change colour to match their appearance. Multiple characters can be created, and the colour of the kart can be tweaked for each one adding more to the project without having to model another whole kart.

Positive	Negative	Interesting
- The render includes a background and character from the game Mario Kart, making it seem like the real thing. - The soft curves leave room to be more creative with the project and make your own dimensions.	- I do not have access to a physical kart as it exists in a game, therefore getting dimensions to recreate it will be very difficult. - Includes lots of curves which can be hard to model to the correct dimension.	- When using a different character, the kart will change colour to match their appearance. Multiple characters can be created, and the colour of the kart can be tweaked for each one adding more to the project without having to model another whole kart. - There are a variety of different karts aside from the

| | basic one which can be modelled. Wheels and gliders can also be customised to create a unique kart to model. |

Ongoing evaluation for Research of Similar Projects

At this stage I have decided not to take a mechanical device and convert it to Lego. I have decided that I will purchase a suitable Lego kit at an appropriate difficulty level which I will select in my Development of Ideas section. My plan now is to conduct research on suitable Lego kit designs.

The lego was chosen because it allowed me to demonstrate a wide variety of skills such as using, circular pattern, revolve, mirror, arcs.

Research – Materials, Process, Resources and Technologies

In this section I have researched possible materials, processes, resources and technologies I may use in my project and several alternatives for each. Of these possibilities I have selected a few and included a justification of why.

Materials

This section discusses the software, hardware, measuring tools and stationery that will be used throughout this project. A range of software and hardware has been researched because this project will require a comprehensive project folio that includes numerical plots, text-based descriptions, 3D modelling and animation. A range of measuring tools and stationery will be required to take measurements of individual Lego pieces and create engineering drawings.

Software	Description – Uses/Price	Image
Fusion360	Fusion 360 is a CAD program developed by Autodesk, used for 3D modelling, electrical circuits, failure mode simulation, manufacturing, and motion animation. I have experience using Fusion360 and believe it will be the best choice for my project because of my familiarity. **System Requirements** Processor (CPU) – 64-bit Intel Core i5 Operation System – Windows 8.1 (until March 2023), 10, or 11; MacOS 10.15.7 Catalina (until March 2023), 12 Monterey, 11 Big Sur Memory (RAM) – 8 GB Graphics Card – 1 GB dedicated GPU with DirectX 10.1 (or greater) 6 GB if using integrated graphics. Storage – 8.5 GB	

	Price – Students can access the full program for free by logging into Autodesk and providing proof of enrolment.	
Autodesk Inventor	Autodesk Inventor is a CAD application for 3D mechanical design, visualization, simulation, and documentation also developed by Autodesk. I have never used this program before and would have to learn the basics which will take up a lot of my time which could be spent modelling my project. **System Requirements** Processor (CPU) – 2.5 GHz or greater Operation System – 64-bit Microsoft® Windows® 11 and Windows 10. Memory (RAM) – 16 GB RAM for less than 500-part assemblies Graphics Card – 1 GB GPU with 29 GB/S Bandwidth and DirectX 11 compliant Storage – Installer plus full installation: 40 GB **Price** – Students and educators can get free one-year educational access to Autodesk products and services, renewable as long as you still are eligible.	
Adobe Acrobat	Adobe Acrobat, developed by Adobe Inc. is used to view, create, manipulate, print and manage Portable Document Format files. It will be useful when I have to edit images before inserting to my folio such as the computer-generated working drawings, I will create of my completed 3D model. I have experience using this program so I will not have to spent time learning to use it. **System Requirements** Processor (CPU) – Intel® or AMD processor, 1.5GHz or faster processor Operation System – Windows Server 2012 (64 bit), 2012 R2 (64 bit)†, 2016 (64 bit), or 2019 (64 bit); Windows 8, 8.1 (32 bit and 64 bit)†, Windows 10 version 1903 or later (32 bit and 64 bit), or Windows 11 (64 bit) Memory (RAM) – 2GB RAM Graphics Card – NVIDIA GeForce® GTX 970 / AMD Radeon™ R9 290 equivalent or greater Storage – 4.5GB of available hard-disk space **Price** – Students can get Acrobat for free by signing up to a free trial.	
Google SketchUp	Google SketchUp is an easy 3D modelling program. You can build anything from skyscrapers to 3D-printable product mock-ups. SketchUp is by far the easiest to learn, though it comes with less tools and features than most other software. I will not use this program because my project is quite complex, and I may not have the right tools to quickly and easily complete it using this program.	

	System Requirements Processor (CPU) – 1 GHz processor Operation System – Windows 11, Windows 10, Mac OS 13+ (Ventura), 12+ (Monterey) and 11+ (Big Sur) Memory (RAM) – 4GB RAM Graphics Card – Current generation AMD or **NVIDIA** Storage – 1GB of free hard-disk space **Price** – Free with a G Suite or Microsoft education account
Microsoft Word	Microsoft Word, also referred to as Word, is a program used to create professional documents with advanced features to format and edit quickly and easily. It is very popular, and I have plenty of experience using Word, so it is the best choice for the making of my portfolio. The system requirements for Microsoft Office are presented below: **System Requirements** Processor (CPU) – 1.6 GHz or faster 2-core processor Operation System – The most recent versions of Windows (like Windows 10 and Windows 11) and some recent versions of macOS. Memory (RAM) – 4 GB RAM for 64-bit or 2 GB RAM for 32-bit systems Graphics Card – A DirectX 10 graphics card Storage – 4 GB on Windows and around 10 GB on macOS **Price –** The program is free for students with a valid email address.
Microsoft Excel	Microsoft Excel, also referred to as Excel, is a program used to organise and format data in spreadsheets. It was developed by Microsoft, the same company that develops Word and I am also very familiar with this program as it is very popular. This program can do simple calculations for you so if data is removed or changed it will update the spreadsheet on its own. See the requirements for Microsoft Office above. **Price –** The program is free for students with a valid email address.
Adobe Illustrator	Adobe Illustrator is used to create a variety of digital images, including charts, diagrams, graphs, and illustrations. With Illustrator you can import a photograph and use it as a guide to trace the image. This could be useful when I have completed the sketches in the Development of Ideas. I have very little experience with the program but could easily use it for the purpose mentioned above.

	System Requirements Processor (CPU) – Multicore Intel processor (with 64-bit support) with SSE 4.2 or later or AMD Athlon 64 processor with SSE 4.2 or later. Operation System – Windows 11 v22H2 and v21H2, Windows 10 v22H2. Windows Server 2022, 2019 Memory (RAM) – 8 GB of RAM Graphics Card – A minimum of 1 GB of VRAM. Support OpenGL version 4.0 or greater. Storage – 4GB **Price –** Students get Adobe Illustrator as part of Adobe Creative Cloud at over 70% off. A$21.99/mo incl. GST
Twinmotion	Twinmotion is a real-time 3D immersion program powered by Unreal Engine that creates high-quality images, panoramas and standard or 360° VR videos quickly and easily that allow architects, urban planners and designers working on commercial products to showcase their work digitally. I have not used any rendering program other than Fusion360 and so I don't have any experience using Twinmotion, however I believe the inclusion of this program will take the renders of my project to the next level and help me create clear images of the finished 3D model. **System Requirements** Processor (CPU) – Quad-core Intel or AMD, 2.5 GHz or faster Operation System – Windows 7, 8, 10 64-bit Memory (RAM) – 8GB RAM Graphics Card – DirectX11 or DirectX12 compatible graphics card (AMD, Intel, or NVidia), 8GB of VRAM Storage – 30 GB of free disk space. **Price –** The Twinmotion Education Edition, which includes the full version, is freely available for students and teachers to learn and use Twinmotion for any academic reasons.
Lumion	Lumion is a program used for architectural design, interior design, and landscape architecture. It takes your 3D models and makes high quality rendered videos, pictures and 360 panoramas. Like Twinmotion I have also not used this program but may still be useful in my project. However, between the two programs, Twinmotion is described as more beginner friendly, which would allow me to spend less time focusing on learning how to use the software and more time making renders. **System Requirements** Processor (CPU) – Intel/AMD processor scoring a single thread CPUMark of 2,200 or higher. Operation System – Up-to-date Windows 10 64-bit (version 2004) or newer Memory (RAM) – 16 GB

	Graphics Card – GPU scoring a G3DMark of 8,000 or higher with up-to-date drivers. Storage – Minimum 75 GB	
15		
	Price – Free for students	

Hardware	Description – Uses/Price	Image
USB Stick	Sandisk CZ410 USB Drive 128GB Black **Price –** $23.00	
Printer	HP DeskJet 3720 All-in-One Printer **Price –** $59.00	
Mouse	Logitech Corded Mouse M100R Black from Officeworks. **Price –** $11.00	
Computer	HP 15s-eq2232AU 15.6" Full HD Laptop (512GB)[Ryzen 5] **Price –** $899.00	

Measuring Tools	Description – Uses/Price	Image
Ruler	Studymate Recycled Plastic Ruler 30cm Clear from Officeworks **Price –** $0.49	

Vernier Calipers	Kincrome 150mm Vernier Calipers from Bunnings **Price** – $79.00	
Digital Calipers	Kincrome 150mm Digital Vernier from Bunnings **Price** – $130.00	
Protractor	Studymate 15cm 180 Degree Protractor from Officeworks **Price** – $2.68	

Stationary	**Description – Uses/Price**	**Image**
Eraser	Studymate People & Planet Positive Eraser Small **Price** – $0.25	
Pencil	Keji Graphite Pencil HB **Price** – $0.25	
Pen	Artline Smoove Ballpoint Pen Black **Price** – $0.39	
Paper	J.Burrows 80gsm Premium A4 Copy Paper 500 Sheet Ream **Price** – $7.75	
Plastic sleeve	J.Burrows A4 60 Micron Sheet Protectors 100 Pack **Price** – $10.66	

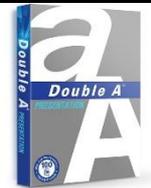|		
Pencil Sharpener	Studymate Barrel 2 Hole Sharpener Blue **Price –** $1.92	
Compass Set	Kent 8004 Compass Set **Price –** $26.97	
Drawing Board	Rotring A3 Drafting board DBL Lock **Price –** $237.95	
Drafting Paper	Double A Copy Paper A4 100gsm White Ream of 200 **Price –** $6.35 This paper does not come with the Title block printed on it and will need to be printed on using my printer.	
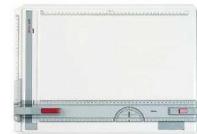
Drafting Paper

The drafting paper that will be used will 100 – 130 grams per square metre (GSM). The sizes that will be used will be A3 and A4 because that is the capacity of the printers available to be used. The sizes are shown below in the image.
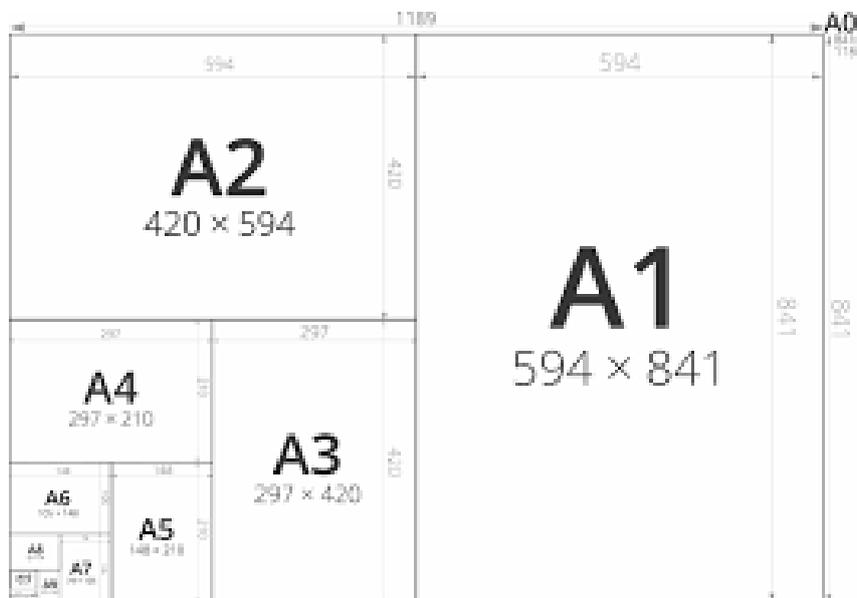
Title block

A title block, similar to what is shown below, will be used to provide the technical information for manually drafted and CAD generated drawings. The title block will communicate that the drawing is completed to the AS1100 drawing standard. It will also have

the title of the drawing, the number of drawings in the set, the date the drawing was completed and the drawing scale.
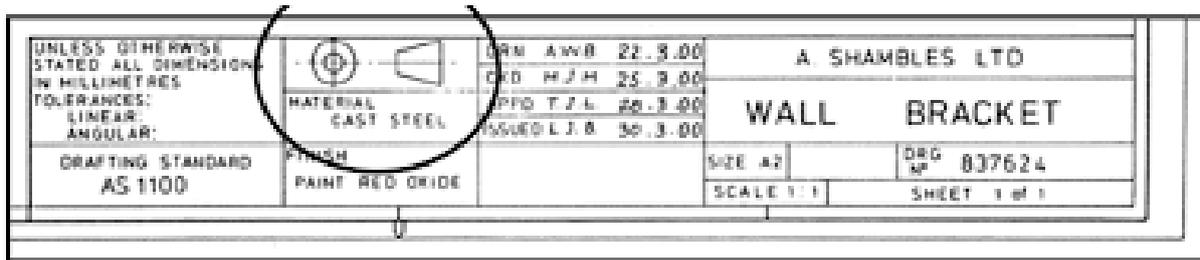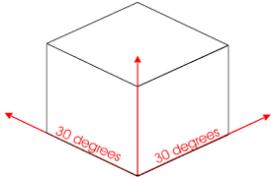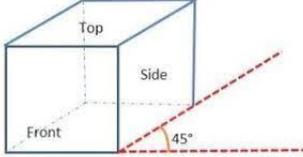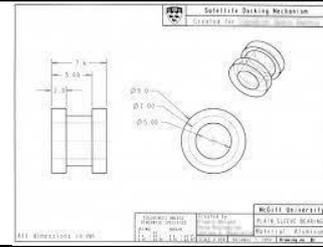

Processes

This project will require a broad range of manual drafting techniques and 3D modelling processes to the AS1100 drawing standard. Manual drafting will be used to generate engineering drawings and sketches to present the initial design. CAD modelling will be used to create detail drawings, assembly drawings, presentation drawings and animations.
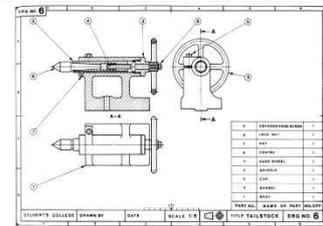
AS1100

All drawings will be presented to AS1100 drawing standard. AS1100 sets the standard for technical drawings in Australia. The standard covers aspects such as conventions for Australian engineers, architects, designers and a number of trades people such as builders and plumbers to follow. The standard covers areas such as dimensioning, types of lines, scales, symbols, surface textures and tolerances.

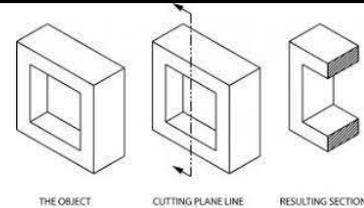| Drawing Types	Description	Image
Isometric	An isometric drawing is a representation of an object where all 3 dimensions are drawn at full scale. The proportions are maintained in the 3D drawing giving the illusion of depth. The angles between the axes are always 120 degrees.	
Oblique	Oblique projection is a simple type of technical drawing used for producing 2D images of 3D objects. All sides other than the front of the object are drawn at 45 degrees and are half their true proportion.	
Orthogonal Projection	An orthogonal projection is a way of describing a 3D object using multiple 2D views. Most commonly used for this are the top, front and a side view.	
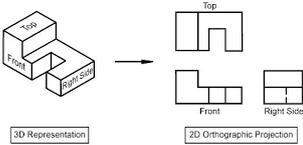
Detail Drawing	A detail drawing is a drawing of a single component in an assembly of multiple parts. A detail drawing includes all the necessary dimensions of the component in order to manufacture it.	
Assembly Drawing	Shows how multiple components will fit together when completed. Assembly drawings do not include dimensions but label each component with a number so detail drawings of the individual components can be easily identified to understand them further.	
Section Drawing	Section drawings are used to view parts of a component that may be difficult to see normally by drawing from a vertical plane slicing through the object. This is very useful when an object has important details on the interior that cannot be easily understood by looking at hidden detail lines.	
Rendered Drawing	Rendered drawings are images or videos of 3D objects that have been made to look realistic using lighting, shadows, materials, and backgrounds using the calculations of computer software. They are very useful when displaying your final product as people without knowledge of working drawings or CAD can easily understand the image.	

resources

The completion of the successful project will require skills and knowledge in a range of areas. To acquire this knowledge and learn these skills a range of resources will be used. These resources include books, online courses with practice exercises, videos and the Autodesk online training centre.

Resource	Description
Parametric Modelling with Autodesk Fusion 360 Spring 2023 Edition	A textbook written by Randy H. Shih designed specifically for beginners with no prior CAD experience. Teaches 3D modelling using Fusion 360 and includes a chapter dedicated to 3D printing.
Fusion 360 Beginners Course	A course from Udemy by Jaiprakash Pandey for $26.99. the course teaches 3D modelling in Fusion 360, making assemblies, making detail drawings and photo realistic rendering.

Fusion 360 Essential Training	A beginner level LinkedIn learning course by Nick Kloski for $59.99.
Learn Autodesk Fusion 360 in 30 Days for Complete Beginners!	A free YouTube series by Product Design Online that teaches the basics and gradually gets more in depth.
Fusion 360 fundamentals	Free courses form Fusion 360's website. There are many videos that cover the basics, 3D modelling, assemblies, configurations, electronics and many other things.
Fusion 360 cloud	Fusion 360 cloud storage will be used to store the CAD models and working drawings safely and for version control.
Microsoft One Drive	One Drive will be used to safely store the Microsoft Word folio, my Microsoft Excel files and any images that are taken of the project. It will also be used for version control.

Technologies

There are a number of opportunities to apply recent technologies to this project to improve its quality. 3D printing additive technologies and laser cutting equipment can be used to modify components of the physical model, add to the model or prototype new ideas. The following recent technologies will be considered for use during this project.

Technology	Description
Ultimaker Up FDM printer	The Ultimaker 2 is a desktop 3D printer that uses Fused Deposition Modelling (FDM) technology. It is precise and reliable when printing complex models. The printer heats the thermoplastic filament and layer by layer expels it through the nozzle to create objects. The Ultimaker 2 features a user-friendly interface, a heated build platform for stronger adhesion and supports a variety of filaments.
Formlab SLA printer	The Formlab SLA printer is a Steriolithography (SLA) printer well known for its high-quality printing capabilities. SLA printers use a laser to cure liquid resin into solid forms, unlike FDM printers. This allows for extremely fine details and a smooth finish, ideal for product design. Like the Ultimaker 2 it is also a compact desktop printer.
Universal Systems Laser Cutter	The Universal Systems laser cutter use a high-powered laser to engrave or cut materials such as wood, plastic, glass and some metals. This allows for heavily detailed designs or clean cuts to be created with ease and make it easy to reproduce the designs. This laser cutter has a user-friendly interface, safety features and the ability to handle different materials by using different settings.

Ongoing evaluation for Research on Materials, Processes, Technologies and Resources

After conducting comprehensive research, I have decided I will use Fusion 360 because I already have some experience with it and after reading the specifications it will do everything, I need it to do. Fusion 360 provided a lot of functionality, such as advanced 3D modelling techniques, the ability to produce realistic rendered images, accurate working drawings and animations.

I will use Microsoft Word and Microsoft Excel for the folio because it is installed on the computers in school and on my home computer. Measurements will be taken using Vernier Calipers a protractor and a ruler because this equipment can accurately measure internal dimensions, external dimensions and angles. A range of drawing types will be used including isometric, detail, orthogonal, assembly, section and rendered drawings to effectively communicate all the details of the model. If there are skills that I need to acquire for this project I will use a range of resources including textbooks, Udemy, LinkedIn learning and YouTube. At this stage I have decided that if there is time remaining, I will design and create some additional features for the Lego model using 3D printing technologies.

Development of Ideas

I have selected Lego because I am interested in it personally owning many Lego kits and I understand how it works and there are many different kits available. As I have 3D printing technologies available to me, I can create my own modifications to the set I choose. Below is a table that shows the Lego projects I considered for my major work.

Product	Positive	Negative	Interesting
LEGO® Technic Monster Jam Dragon 42149	- Very interesting and colourful design. - Low price of $29.	- Due to the design including many curved shapes it would be very hard to model accurately. - The degree of difficulty is too low and will not show the full extent of my skills. - No steering.	- The product is a replica of the Monster Jam Truck Dragon. Fans of Monster Jam may be interested in this because of that reason.
LEGO® Technic John Deere 948L-II Skidder 42157	- Incredibly high degree of motion throughout	- Price is $279 which is out of my budget.	- Movement of the claw gives the

|	Pros	Cons	Features
	the entire vehicle especially the wheels and claw. - Appealing green, yellow and black colour scheme. - The doors open and the driver seat position is switchable.	- The degree of difficulty is too high, and I would not be able to complete it in time.	opportunity to animate. - The product is a LEGO replica of a John Deere Skidder. - Uses pressurised air to move the claw.
LEGO® Technic PEUGEOT 9X8 24H Le Mans Hybrid Hypercar 42156	- The wheels have steering. - Many moving parts including the steering wheel and opening doors.	- Costs $245 which is far out of my budget. - Degree of difficulty is too high to create in the designated time frame.	- Authentic 1-10 scale model replica of PEUGEOT 9X8 24H Le Mans Hybrid Hypercar.
LEGO® Technic Snow Groomer 42148	- Interesting geometry that could enhance my skills. - Colourful.	- Low degree of difficulty. - This product does not interest me personally and I wouldn't want to spend so much time and energy on it.	- The shovel at the front moves. - It has tracks which means it skid steers.
LEGO® Technic Monster Jam Monster Mutt Dalmatian 42150	- Low price of $29. - Interesting design with lots of stickers.	- Mostly black and white colour scheme means it's not very eye-	- Has pull-back action. - Can be disassembled and reassembled

- Something I'm personally interested in (monster trucks).
- Multiple moving parts.

catching from a distance.
- The wheels don't have steering.

as a truck using the same parts.

The components will have to be modelled as accurately as I can get them due to the amount and the tight fit LEGO bricks have.

I found an image of the sticker sheet online so I can cut out the stickers and apply them to my 3D model as decals.
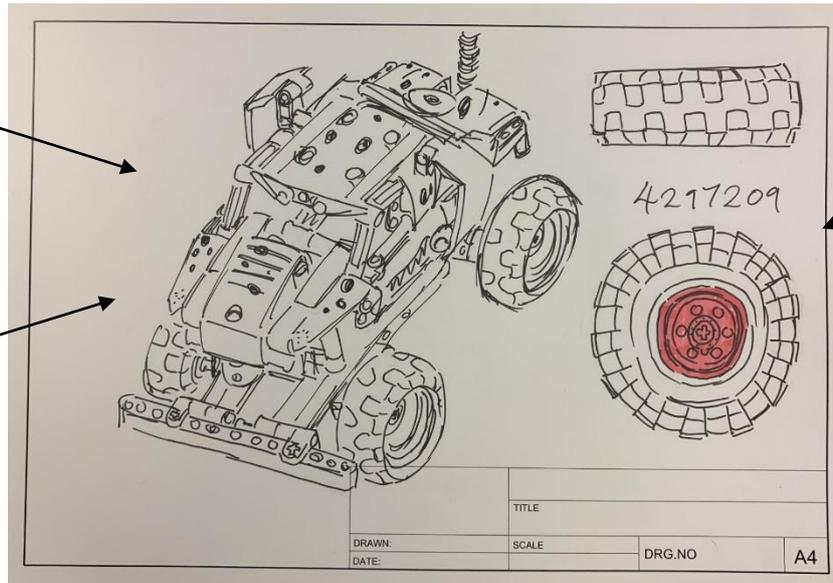
I have practiced assembling it, so I understand the relationship between the parts and how they all fit together.

4217209

The rims and wheels are made of circular geometry and can be created using the revolve tool.

The axel will need to be a neat fit inside the rim because it will need to drive the wheel.
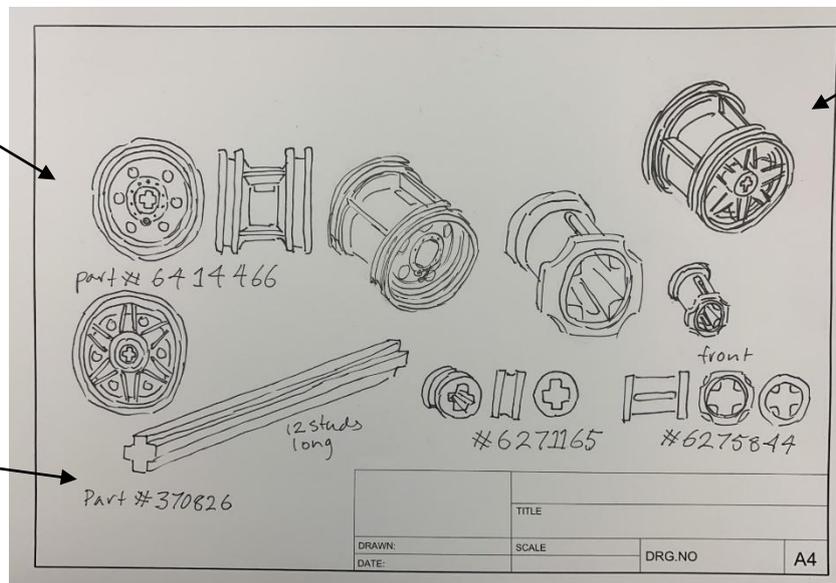
When creating the rim and tyre care will have to be used to make sure the tyre fits on the rim properly.

part # 6414466

12 studs long

#6271165

front

#6275844

Part #370826

There are a lot of components that are very similar so they can be copy and pasted.
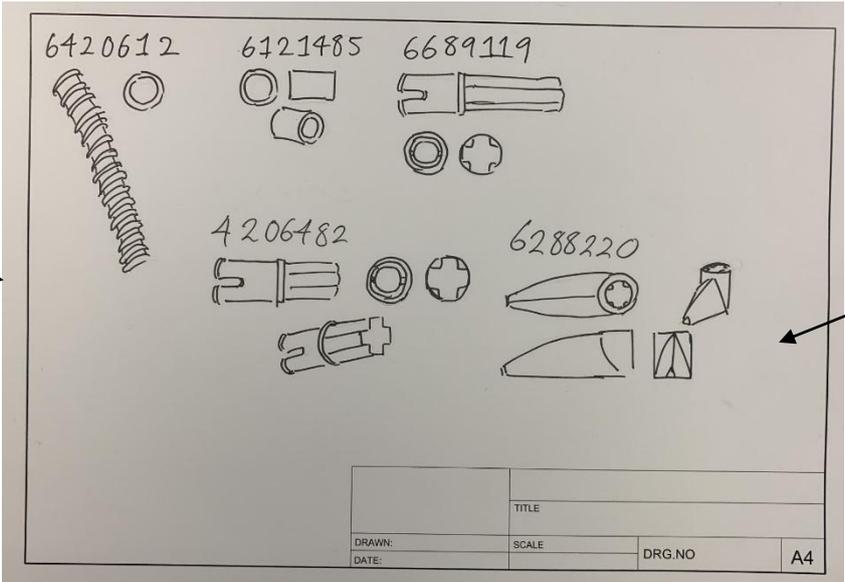
There are lots of patterns so they can easily be created using circular arrays.
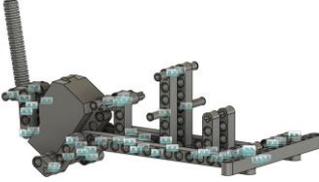

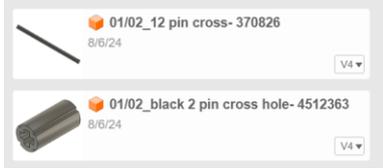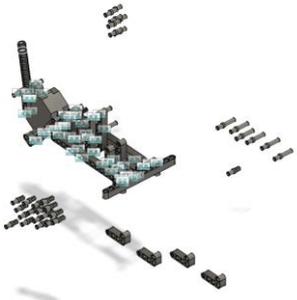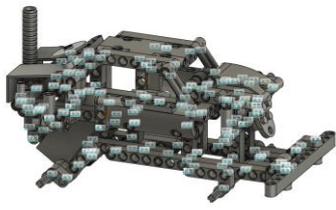6420612   6121485   6689119

4206482   6288220

There are a lot of components that are very similar so they can be copy and pasted and slightly modified.
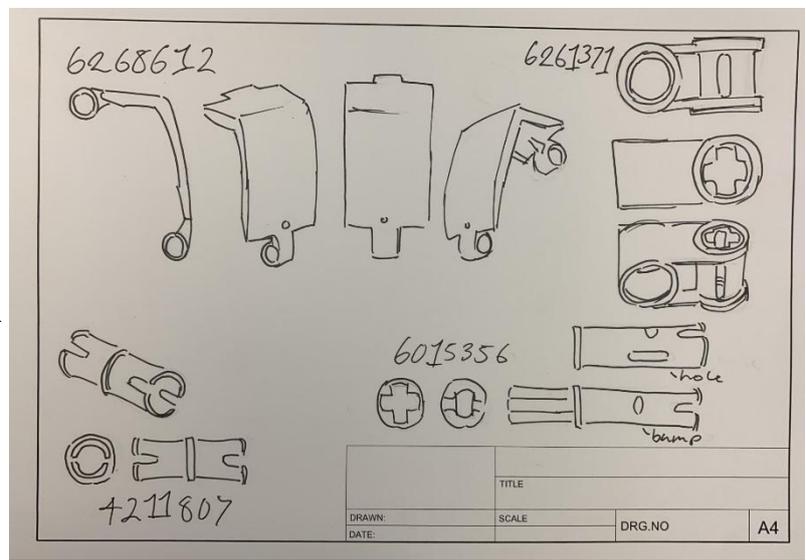
Theres quite a few part that are almost identical but are mirrored so we can use the mirror tool to create them.

6268612   6261371

6015356

`hole

`bump

4211807

Record of Production

Created 9-hole rail	Created 125°-degree 9-hole rail, blue 3 pin	Created black 3 pin and cross, blue 2 pin and cross, black 2 pin, yellow 5 pin
Created 90 ° black 5-hole rail, grey 2-hole rail, grey 3 pin, black 1 pin hole, 2 sided 2-hole rail, 15-hole rail, 7 hole rail	Created engine	Created white pivot, white cross with hole, 3-hole rail with cross
Created roof, quarter panel left and right, snout, left side piece and right side piece, tail	Created rear panel, wheel rim, left and right bonnet sides	Created the 3 components that make up the tongue
Created 11-hole rail, circular plate, red 2 pin cross, red 3-hole rail, white 2 pin cross hole	Created red 7-hole rail, red 2 cross rail, sandy half pin, grey ring, grey cross hole, grey half cross hole, black	Created 15 pin cross, grey 7 pin cross, black 4 pin cross, black U with 4 holes, white 7-hole rail, eyebrow
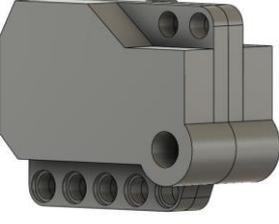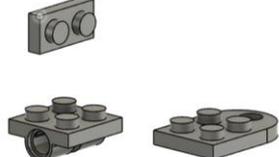
	pin with cross hole, black cross pin, grey pin with hole, grey 3 pin with cross, light grey 2 pin	
Created white rear panel, black 2 pin cross hole, grey 2 pin with cross hole, grey 3 pin, black 13-hole rail, dark grey joiner	Created nose	Created tyre
Completed all unique components	Began assembly	Due to the lag of duplicating each component I deleted all the duplicated and copied each component into its own design to drag into the assembly
Restarted assembly using components dragged in from other designs	Continued assembly	Continued assembly

|		
Finished assembly	Added colour to each component via Appearance	Created detail drawings of each unique component
Created section drawing of the wheel rim	Created assembly drawing	Created rendered drawings
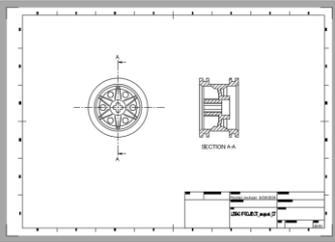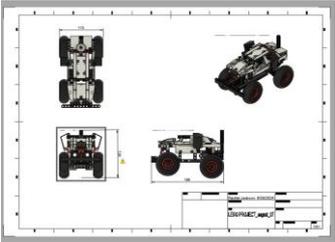
Timeline Plan

This Timeline Plan presents the time used to create each section of the project in Term 4 of 2023 and Terms 1 to 3 or 2024. The Timeline Plan is a visual representation of where my time was spent each term, divided into weeks, providing visibility to the flow of the project. This allows the progress to be easily monitored and helps manage time efficiently.

Term 4 2023												
Activity	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Est. Weeks	Act. Weeks
Statement of Intent Est.											1	
Statement of Intent Act.												1
Reasearch of Similar Projects Est.											1	
Reasearch of Similar Projects Act.												1
Research of Materials Est.											2	
Research of Materials Act.												3
Research of Processes Est.											1	
Research of Processes Act.												0.5
Research of Resources Est.											1	
Research of Resources Act.												0.5
Research of Technologies Est.											1	
Research of Technologies Act.												1
Development of Ideas Est.											0.5	
Development of ideas Act.												0.5
Timeline Plan Est.											0.5	
Timeline Plan Act.												0.5
Finance Plan Est.											1	
Finance Plan Act.												1
Ongoing Evaluation Est.											1	
Ongoing Evaluation Act.												1
										Total	10	10

Evaluation of term 4

Overall, the differences between the two are very few. As you can see the actual time needed to complete the Research of Materials took slightly longer than anticipated. This is because there were many more different types of software to research than I expected. This caused me

to fall behind schedule when completing the Research of Processes though fortunately that and the Research of Resources did not take as long as I expected, and I was able to get back on schedule. This is because I had not looked at examples of these sections and following the Research of Materials which I initially expected to spend 2 weeks on, the most time I would spend on one section, I expected them to be quite long.
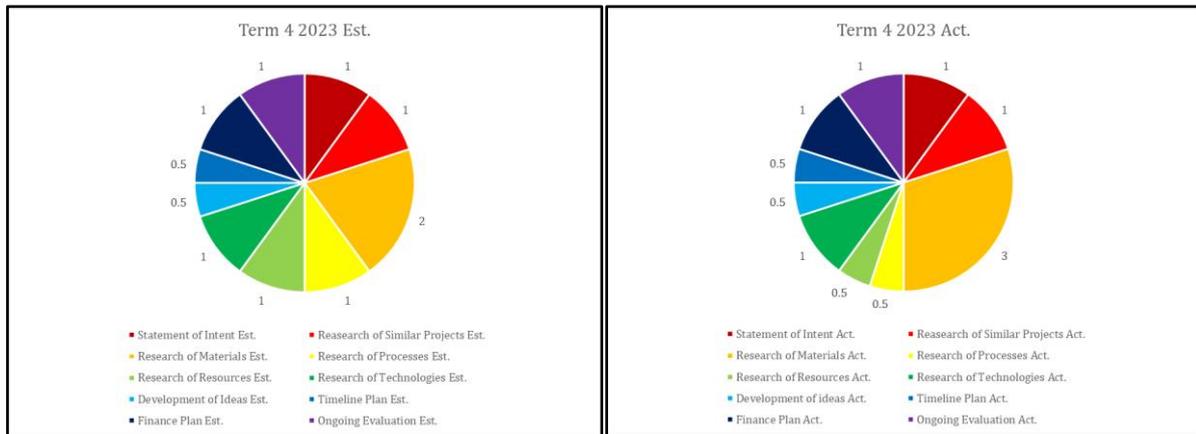
Term 1 2023											
Activity	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Est. Weeks	Act. Weeks
Learning Fusion 360 Est.										0.5	
Learning Fusion 360 Act.											0.5
Practicing Fusion 360 skills Est.										0.5	
Practicing Fusion 360 skills Act.											0.5
Modelling car frame Est.										3	
Modelling car frame Act.											2.5
Modelling wheels and drive assembly Est.										2	
Modelling wheels and drive assembly Act.											1.5
Updating Ongoing Evaluation Est.										1	
Updating Ongoing Evaluation Act.											2
Updating Timeline Plan Est.										1	
Updating Timeline Plan Act.											1
									Total	8	8

Evaluation of Term 1

The actual timeline remained quite close to the estimation however modelling the wheels and drive assembly took slightly longer that anticipated due to the many complicated parts which needed to be touched up during the assembly process when I found mistakes that led them to not being a perfect fit. This process took time away from me updating the ongoing evaluation but it was still completed in the reduced timeframe.

Term 1 2024 Est.

Term 1 2024 Act.
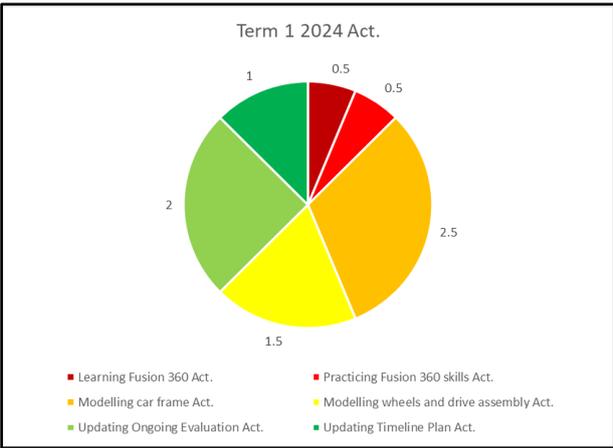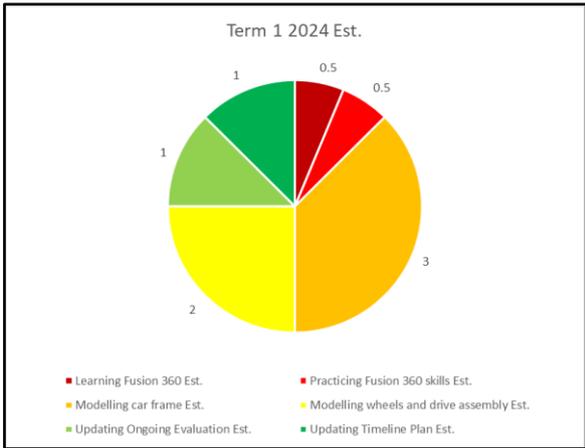
	Term 2 2023											
Activity	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Est. Weeks	Act. Weeks
Learning how to add Materials Est.											1	
Learning how to add Materials Act.												0.5
Learning about project assembly Est.											1	
Learning about project assembly Act.												0.5
Assembling project Est.											1	
Assembling project Act.												5.5
Learning about project animation Est.											1	
Learning about project animation Act.												
Generating project animations in Fusion 360 Est.											1	
Generating project animations in Fusion 360 Act.												
Animating wheels Est.											1	
Animating wheels Act.												
Updating Ongoing evaluation Est.											1	
Updating Ongoing evaluation Act.												0.5
Updating folio Record of Production Est.											1	
Updating folio Record of Production Act.												2
Updating Timeline Plan Est.											1	
Updating Timeline Plan Act.												1
										Total	10	10

Evaluation of Term 2

The Assembly took the longest period of time because each component was modelled individually and there were many that needed to be duplicated, some up to 45 times. The number of components in the drawing caused lag and made it impossible to continue working. To remedy this, I copied each component that needed to be duplicated into another drawing and dragged that component into the assembly when needed which greatly reduced the lag. Because of the excess time taken to assemble the project I was not able to animate the wheels.

Term 2 2024 Est.

term 2 2024 Act.
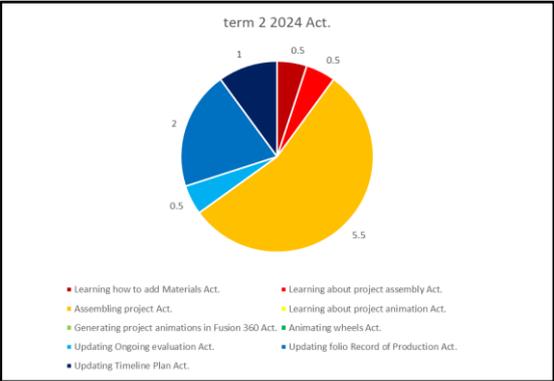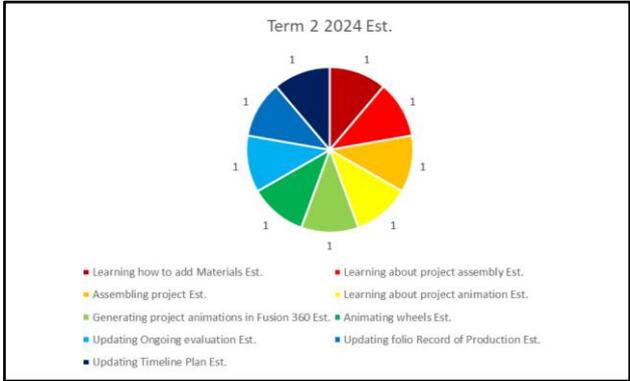
Term 3 2023							
Activity	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Est. Weeks	Act. Weeks
Learning how to create Working and Assembly Drawings Est.						1	
Learning how to create Working and Assembly Drawings Act.							1
Generating Working and Assembly Drawings Est.						2.5	
Generating Working and Assembly Drawings Act.							1.5
Completing project Evaluation in folio Est.						0.5	
Completing project Evaluation in folio Act.							1.5
Printing to submit Est.						1	
Printing to submit Act.							1
					Total	5	5

Evaluation of Term 3

The actual timeline at the beginning of term 3 was the same as the estimated timeline however I took slightly longer than anticipated to create the working and assembly drawings due to underestimating the number of unique components, causing me to have less time when completing the project evaluation.

30
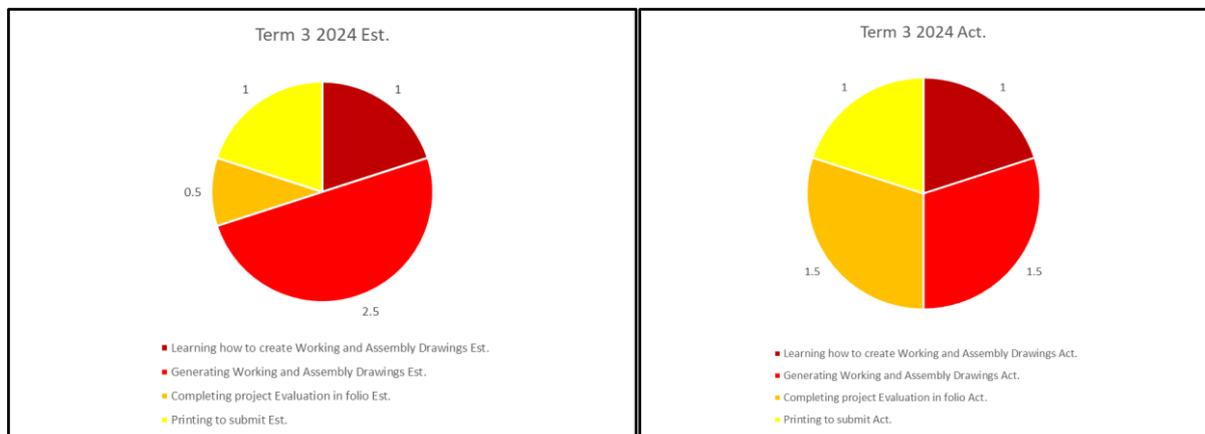
Finance Plan

Item	Estimated cost	Projected cost	Actual cost
Fusion 360	$70	$ 690.00	$ -
Adobe Acrobat	$40	$ 347.88	$ -
Microsoft Word	$20	$ 179.00	$ -
Microsoft Excel	$15	$ 159.99	$ -
Printer	$50	$ 59.00	$ -
Mouse	$5	$ 11.00	$ -
Computer	$500	$ 899.00	$ -
Ruler	$1	$ 0.49	$ -
Vernier Calipers	30	$ 79.00	$ -
Protractor	$1	$ 2.68	$ -
Eraser	$0.50	$ 0.25	$ -
Pencil	$0.50	$ 0.25	$ -
Pen	$1	$ 0.39	$ -
Paper	$15	$ 7.75	$ -
Plastic sleeve	$10	$ 10.66	$ -
Pencil sharpener	$0.50	$ 1.92	$ -
Compass set	$10	$ 26.97	$ -
Drawing board	$40	$ 237.95	$ -
Drafting paper	$20	$ 6.35	$ -
A3 Display book	$15	$ 13.95	$ -
Lego set	$15	$ 29.00	$ 29.00
Total	$860	$ 2,763.48	$ 29.00

Ongoing evaluation of Finance plan

A large variety of equipment and software was used to develop the project and folio including technical drawing equipment, information software, spreadsheets CAD modelling software and presentation software such as drafting paper and display book. The costs of the equipment used to develop the project was calculated and a table with estimated, projected and actual costs was formed. The table highlights how an individual aiming to create a similar project would likely need to be sponsored by their school of workplace to achieve this or must look for cheaper alternatives.

I decided to purchase an appropriate LEGO set to model the parts off which I bought locally, independent of the equipment provided to me by the school. Because my school provided all the equipment and software, I could ask for free of charge this was the only cost to me, making the actual cost of the project $29.

The licenses used for the software used such as Fusion360, are educational licences I am unable to sell any of my designs.

Final evaluation

The project successfully addressed all of the criteria in the Statement of Intent. Throughout the project I was able to learn the skills I identifies in my Statement of Intent such as improving my ability to use industry software such as Fusion360, Microsoft Excel and Microsoft Word. I was able to develop my skills in time and finance management as well as written and graphical communication.

The project also achieved all of the Criteria for Success. The finished project looks like the real thing in relation to colour, type of materials and dimensions, this was achieved by using digital calipers to accurately measure each part that I modelled, then in Fusion360 I added materials similar and changed the appearance to colours that looked similar to the Lego Technic set.

It is assembled with no clashes and no parts that overlap. Although I was careful to design each piece as accurately as possible some clashes were still evident in the assembly process. To fix this problem I found my mistakes and remade the pieces so they would fit snugly.

The project includes a full set of accurate dimensioned working drawings. After assembling the project to determine if there were any mistakes that would cause clashes, and fixing subsequent clashes I made a dimensioned working drawing of each unique component in Fusion360 ensuring they were accurate.

I was able to include a drawing of the assembled Lego Monster Mutt, which included the overall dimensions of the project as specified in my original Criteria of Success. However, as the project had 243 parts it was not possible to include all of the individualised components in the assembly drawing.

Includes a set of high-quality renders of the complete 3D model. After changing the appearance of the assembled project to resemble the Lego Technic set, I used Fusion360's rendering feature to create several renders of the project from many different angles, both with and without backgrounds.

I finished the project by the due date by creating and following a timeline plan for each of the 4 terms I was to work on it. This kept me organised and on track allowing me to understand what would need more time and focus to complete.

My budget did not exceed $80 because I choose a Lego set that wasn't too costly to model and any other equipment and software, I required was provided to me by the school.