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Practical Work Portal

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Employment at Metal Concepts Limited

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Report Submitted : 2024-03-25 PASSED

Assigned Marks : 25 / 25 (Grade : A)

Marker : [redacted]

Hours Verified : 930

Student : [redacted]

Specialisation : Mechatronics Engineering

Student Group : [redacted]

Uploaded Report

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Scoring Rubric

Section One	**Passed Section** If you pass Section One you still need to pass Section Two.			**Failed Section** If you fail Section One you will be asked to resubmit the report.			5/5
Section Two	**Passed Section** If you pass Section Two you will still need to pass Section Three			**Failed Section** If you fail Section Two you will be asked to revise and resubmit the report.			5/5
Section Three Part A : Structure of the Report	Excellent	Above Average	Satisfactory	Room for Improvement	Below Average	No Marks	5/5
Section Three Part B : Quality of the Report	Excellent	Above Average	Satisfactory	Room for Improvement	Below Average	No Marks	5/5
Section Three Part C : Presentation of the Report.	Excellent	Above Average	Satisfactory	Room for Improvement	Below Average	No Marks	5/5

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Administrator Details

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Verified Hours | Hours Type

University of Auckland

Department of Mechatronics Engineering

ENGGEN 499

Practical Work Report

Name: [redacted]

Company: Metal Concepts Ltd

Supervisor: [redacted]

Address: [redacted]

Work Period: 28th November 2022 to 24th February 2023 and
13th November 2023 to 23rd February 2024

Date of Reporting: March 25, 2024

Executive Summary

During the summer breaks of both my second and third year studying towards an Engineering Degree, I was employed as a Design Engineer Intern at Metal Concepts Ltd. Metal Concepts specialises in offering design and fabrication services to the wider Construction and Architectural markets with products such as, Facades, Metal Ceiling, Louvres, Balustrades, Handrails, Custom Kitchen Benches and AC Unit Covers.

During my two internship periods, I worked within the design and production team primarily creating designs of products in SolidWorks for fabrication in-house. This positions has taught me many invaluable skills that expand upon my knowledge gained during studying. I learnt many skills related to the development of sheet metal and weldment parts. I worked on various projects which ranged from designing to client specification to creating sets of standard products from scratch for future use at the company.

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1 Introduction

During both the 2023 summer break and the 2024 summer break I worked at Metal Concepts Ltd. Metal Concepts is a manufacturer of Mild Steel, Stainless and Aluminium products mainly for the construction and architectural markets. Majority of products are things like Facades, Louvres, Balustrades and Handrails.

My position at Metal Concepts was as a Design Engineer Intern, where I worked within the design/production team. In our team there was five design engineers and two production engineers. In the design team, we worked to create function designs of metal products based on architectural drawings or customer specification. We used SolidWorks to model the parts and create approval drawings to send to clients or production drawings to send to the factory for manufacture.

During my time at Metal Concepts Ltd, I worked on various projects where I designed many products based on client specifications as well as designing standard products for future use at the company.

2 Workplace

2.1 Workplace Location

The Metal Concepts Ltd office and factory (Figure 1a) is located in the Wiri industrial area, surrounded by many other manufacturing companies (Figure 1b). The building has a two-storey office in the front attached to the factory behind it, with parking available in the front and back. This location is close to a bus stop that goes to the Manukau train station as well as being a 15-minute walk from the Southern Line Homai train station, which was my primary form of transportation to and from work.

[redacted]

(a) Workplace from Street

[redacted]

(b) Workplace on Google Maps

Figure 1: Location of Office/Factory Building

2.2 Office and Factory Layout

The design and production team and the factory manager are in the ground floor office. The office space is split into a shared area, three private offices and a meeting room (Figure 2). In the private offices are the Purchasing and Logistics Coordinator, the ERP & Product Development Manager and the Factory Manager. The five design engineers (including me) and the two production engineers are in the shared space. Everyone in the ground floor office reports directly to the ERP & Product Development Manager. The ground floor also has a break room and bathrooms that are shared with the factory workers.

Upstairs, on the first floor, is the rest of the office, including the Managing Director, the Executive Assistant, the Projects Manager, the three Project Managers, the Business Development Manager and the rest of the Sales team (Figure 3). The Managing Director, Executive Assistant and Projects Manager each have their own office, and the three Project Managers share an office—the rest of the Sales team works in the communal office space. On the first floor, there is another meeting room, a kitchen and the bathrooms.

[redacted]

Figure 2: Office Ground Floor Plan

[redacted]

Figure 3: Office First Floor Plan

The rest of the building is the factory floor, including one office for the factory foreman and the storeroom (Figure 4). In the factory, there are many machines to aid in the fabrication of our products, including but not limited to a sheet metal punching machine, a guillotine, a press brake for bending sheet metal, a sheet roller, a couple different drop saws/mitre saws, five different welding bays for TIG, MIG and laser welding, as well as a robotic welding station.

2.3 Workspace Facilities and Amenities

Most of my time at Metal Concepts was spent in the ground floor office space and in the factory; I rarely went upstairs unless I asked one of the Sales team members a question about a project. I exclusively utilised the downstairs break room and bathrooms. There was also a lone bakery just two minutes away that I would frequent, given the sparsity of food options in the industrial area where our office is based.

In the design and production team where I worked, each team member had a desk, workstation PC with wireless keyboard and mouse. The computers were of varying age and quality, but all had workstation graphics cards sufficient for running intensive design programs like SolidWorks and AutoCAD.

There is one small meeting room in the ground floor office space, used for internal meetings with our team and external meetings with clients and potential suppliers. We also had weekly design team meetings every Thursday, where we would go through the work we had completed in the past week and talk about what work needed to be completed for the next week. This meeting room had a mounted TV that the manager would connect to their laptop during the meeting.

[redacted]

Figure 4: Factory Floor Plan

Most of the design and production team would spend lunch breaks in the downstairs break room that is shared with the factory. The break room has a typical kitchen area with everything except a dishwasher. The kitchen was also always stocked with coffee and milk in the fridge for anyone to use. The break room also has a large table that seats up to ten people, enough for either the downstairs office or the factory workers to take their lunch breaks, but not both groups simultaneously.

3 Staff Organisation

As the only design engineering intern, I worked alongside the rest of the design engineering team, working under the ERP & Product Development Manager. Figure 5 shows the hierarchical structure of all the roles I was aware of, with my position highlighted in green.

Under the Managing Director are the three high-level managers: the ERP & Product Development Manager, the Projects Manager and the Business Development Manager. They all report directly to the Managing Director, and some staff report to them. There is also the Executive Assistant who reports directly to the Managing Director and serves as the HR for the company as well as other duties.

Reporting directly to the ERP & Product Development Manager are the five Design Engineers (including me), the two Production Engineers, the Purchasing Coordinator and the Factory Manager. Then, under that, the factory foreman and all factory workers report to the Factory Manager.

Under the Projects Manager, there are three Project Managers, each managing their own collection of projects we are working on. Then there are also the Site Managers and the Site Workers/Labourers, whose primary role is to facilitate installing the final parts on site. I had very little interaction with the Site Managers besides when they would come into the office to ask for clarification on a design or installation drawing, etc.

The other department on the first-floor office is the business/sales team, led by the Business Development Manager. Under the Business Development Manager are two Estimators, the Sales Manager and two

[redacted]

Figure 5: Hierarchy Tree of Staff Members

Sales Engineers. Also in the first-floor office is the Accountant who manages the staff payroll and the purchase orders for the company.

Overall, there is around ten staff in the design and production team, around 15 staff in the factory team, around 15 staff in the first-floor office departments and around ten staff in the site team. Totalling to more or less 50 staff members employed at the company.

4 Work Completed during First Summer

The following section details my first work period at Metal Concepts Ltd, from 28th November 2022 to 24th February 2023. This work period is split into three main subsections; the first covers my introduction to the company and their methods. The second subsection describes the work I completed in the first couple weeks of my internship, where I worked on some small projects with the help of other design engineers while I was still learning the basics. The final subsection for the first work period details the Main Project I worked on during my internship, which I spent the majority of my time on.

4.1 Settling In

Working at Metal Concepts, there was a variety of programs I had to become familiar with before I could begin working on large projects. Microsoft SharePoint, which we commonly referred to as "The Hub", was used to store and manage all documents related to the projects we were working on. The Hub was available to all staff members using their company Microsoft account. Stored on The Hub was all information including but not limited to Contract Documents, Insurance Docs, Health and Safety Docs, Architectural Drawings and other drawings supplied by the client, Photos from on-site, the Tender agreement with the client, Costing Spreadsheet, Approval Drawing, Production Drawing, STEP Files. For the design team, we mainly used the Hub to upload our completed drawings and STEP files when a job would be released to production, as well as access architectural drawings.

As well as The Hub, which everyone could access, we used SolidWorks PDM in the design team only, PDM standing for Product Data Management. PDM creates a secure data vault that stores all the SolidWorks parts, assemblies and drawing files made by the design team. It can be easily accessed in the Windows file explorer if you are logged into PDM, and it also maintains a version history for each file. Using SolidWorks allowed everyone in the design team to access what everyone else was working on, assuming it was checked in after they had finished working on it. Some useful macros have also been set up in PDM, such as converting parts to STEP files or drawings to PDFs instead of manually exporting those files and saving them as different file types in SolidWorks. Another prominent feature of SolidWorks PDM that we used was the Data Card. The Data Card held important information relevant to each part/assembly, such as Item Code, Description, Project Number/Name, Job Number/Name and Revision. This Data Card information was also used to auto-fill some of the information put in the drawings when they were being created.

In addition to this specific application, we also used other programs from Microsoft 365, such as Microsoft Teams and Outlook, for our day-to-day communications, as well as Excel and Word.

After learning the basics for these applications, I was given my first task in SolidWorks, designing an outdoor gas bottle cover. The gas bottle cover was not for any official project but just something the Sales Manager wanted to be made for their house, but it was an excellent introduction to using SolidWorks and PDM. Although the gas bottle cover was a relatively simple assembly of folded sheet metal, it still took me a couple of days to complete as I was learning how to create sheet metal parts in SolidWorks, which was never taught to us while using CAD software at University. A significant factor in designing sheet metal parts is the limitation to work within, as defined by the machinery and sheet metal being used. The primary two machines used in sheet metal production are the Trumpf Punch, which punches the shape out of the sheet, and the Press Brake, which folds the punched parts. In the design of the gas bottle cover, I found out that the limited depth of the Press Brake meant that the top and sides of the cover could not be folded as one part, prompting me to split the lid into separate parts that are then laser welded to the body after being folded. The design of the gas bottle cover also included two-floor brackets, a simple one-fold part, that were bolted to the cover to create a hinge for the gas bottle cover to open when access was needed. Shown in Figure 6 is the exploded view of the gas bottle cover assembly I designed in SolidWorks.

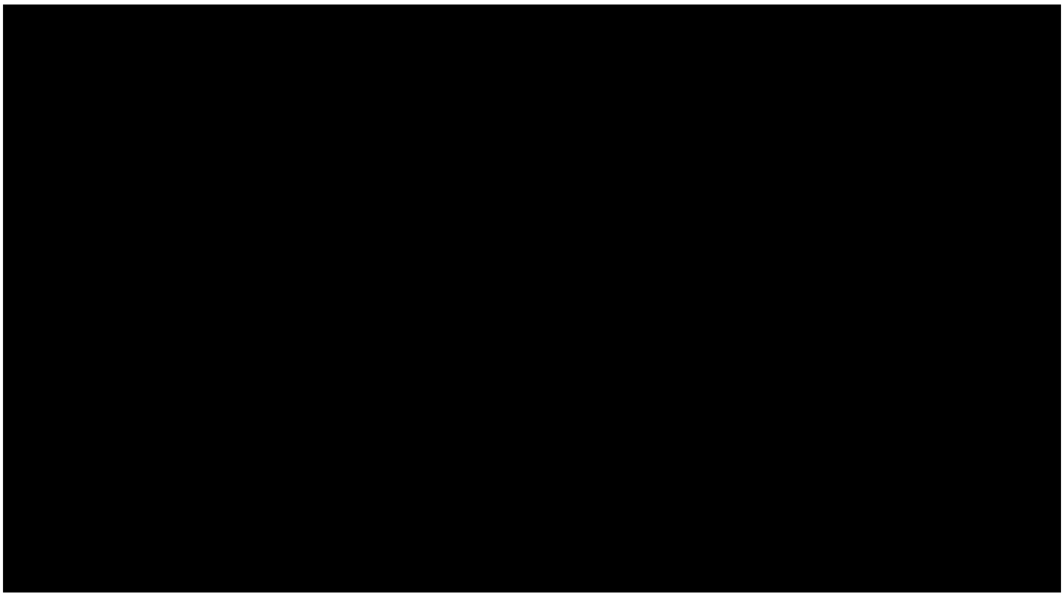

Figure 6: Gas Bottle Cover Assembly (Exploded) in SolidWorks

4.2 Introductory Mini Projects

4.2.1 Pivot Gate Frame Bracket

After learning the basic skills for product data management and product design, I was assigned to work on some smaller jobs in projects alongside one of the more senior design engineers. The first job I was assigned was to design a MagLock bracket for a large exterior security gate. The bracket was part of a larger assembly of the security gate itself that my coworker was designing simultaneously. The job was a part of the larger renovation project for Auckland Airport, which, for the time I was there, involved designing a balustrade for an external stairwell, which included the security gate on one of the levels. The purpose of the bracket was to attach the gates' MagLock to the structural steel of the stairwell and align it with the corresponding MagLock base plate attached to the gate. Figure 7 shows the Maglock System with the bracket to attach to the structural steel and the base plate attached to the gate frame highlighted in blue, with the MagLock and armature in between. When purchased, the armature comes with the Maglock and is attached to the base plate on the gate frame to allow the magnetic connection to the Maglock unit.

Figure 7: CAD Model of Pivot Gate MagLock Bracket System

Part of the design work for the Maglock bracket also involved sourcing the Maglock itself from a supplier. From my coworker, I was told of one supplier we commonly use called Co-Mac; Co-Mac supplies a wide variety of niche hardware with thousands of products on their website. The main specifications needed were that it was weather-resistant for outside use and that the holding force was strong enough so that no one could force the door open. Given the large size and weight of the gate, I found a heavy-duty maglock with a holding force of 580 kg.

The main work in designing the bracket was checking the Architectural drawings provided by another company to ensure the design met their specifications and that it fit in the correct location based on those architectural. I used the architectural drawings to check the position of the bracket connecting to the structural steel and to align the top holes in a position that would not conflict with anything.

4.2.2 Zoo Heater Weldment Frame

The next project I got to work on was a weldment frame and cover panels for outdoor heaters at Auckland Zoo. In the Auckland Zoo primate enclosure, they wanted a cover/frame for the outdoor heaters installed there. It had to be designed so that the primates could not reach or touch the heater while still allowing it to heat the enclosure effectively. For this project, I worked closely with the senior design engineer in our team to create a standard design for the multiple heater frames and assisted in the design of them from start to finish.

Because the heater frame was to be attached to the wall/ceiling of the enclosure and bore the load of the heater units themselves, it had to be structurally sound. Before we were tasked to design the frame for production, a third-party company had already completed a finite element analysis (FEA). This meant that our frame design had to closely match the architect's designs to be approved to be structurally

[redacted]

Figure 8: Architectural Drawing of Zoo Heater Frame

sound. A page from the architectural drawings outlining the frame dimensions we had to follow can be seen in Figure 8.

[redacted]

Figure 9: One Page from Approval Drawing of Zoo Heater Frame

Besides the frame itself, the design also included the perforated panels covering the sides of the frame and the mesh panel on the bottom. A mesh panel had to be used to cover the bottom of the frame, as that is where the heaters are directed. A large aperture mesh was chosen to stop the primates from putting their hand through while minimising the heat the frame would absorb from the heater, potentially damaging it over time.

Once the senior designer and I decided how the panels would fix the frame and what mesh to use, we began designing the covers. There were four different heat covers to make, two of them a simple rectangle shape, like the one seen in the approval drawing in Figure 9, and the other two were at an angle as the shape of the wall changed to create a parallelogram-shaped frame. I only worked on the design in SolidWorks of the more straightforward rectangle one.

4.2.3 Robot Welding Jig

After spending some time working on real projects and becoming more confident with SolidWorks and the other applications we used, I was given a job of my own. The job was to design a Welding Jig for the robotic arm welding station in the factory. The jig was needed for one of the jobs we were working on, where we were fabricating over 500 identical balustrade posts. Welded onto each post were eight tabs that would be used to fix the balustrades between the posts, an end cap plate for each end of the post, and a couple of other parts welded onto them. Given the large number of posts that had to be fabricated, we wanted to use our robotic arm welding station to reduce the man hours spent, for which we needed to create a jig to hold the parts in position while they were being welded.

The main difficulty with designing the welding jig for the robot arm was that it was not possible to hold the post in one position so that the robot arm could weld all the necessary spots; the welds had to be broken down into multiple operations. After meeting with the design manager to discuss his ideas on the jig, it was determined that we would use the Siegmund Welding Table and would need at least three operations to complete all the welds on the posts. The Siegmund Welding Table is a heavy-duty steel table with a grid of holes, allowing the welder to mount clamps and stops anywhere on the table to position whatever they are welding.

The next step was then to break down the welding operations to weld one post fully. For this, it was essential to consider many factors in the welding process, such as fully welding one side of a tab, which will cause it to distort when it cools, or how to properly position the parts without blocking the robot arm from welding the part. For each post, eight tabs, two end caps, two square spacers and two crush tubes all had to be welded onto the post in exact positions (Figure 10).

[redacted]

Figure 10: Diagram of Welded Parts on Post

With all these welding requirements, I was able to define four operations of the welding process to fully weld a post on the robot arm welding station, as listed below. After each operation, the post is rotated 90 degrees and placed in the spot for the next operation. This allows the robot arm welder to weld four posts at a time, with a factory worker taking one finished post off and putting a new post on after every welding batch.

1. Tack weld all eight tabs, weld top of one end cap, weld two sides of spacers and top of crush tubes.
2. Fully weld four tabs on one side, weld top other end cap, weld third side of spacers.
3. Weld bottom of crush tubes, weld bottom of first end cap.
4. Fully weld four tabs on other side, weld bottom of other end cap, weld last sides of spacers.

Once the operations had been defined, I had to model the parts to create the jig itself. Most of the jig was very straightforward to design, I used sheet metal angles with notches for the posts to sit on and holes to attach the the welding table which set the height of the posts. For each operation, there was always a stop at one end to set the horizontal position of the post; the stops alternated sides depending on where the robot arm needed to weld. Another sheet metal angle was used to hold the end caps in position for the first two operations while being welded to the post. A small steel dowel was welded to the base angles of the jig, in line with all eight of the tabs that had to be welded on. On each tab being welded on was a hole which, using the dowel, could align those tabs while they were tack welded onto the post in the first operation.

The most complicated step in the welding jig was the crush tubes and square spacers, as the crush tubes had to be set at the correct depth in the post, and the spacers had to be held in place where they were still parallel with the post. To do this, I designed a lock-in-place sliding mechanism that could align the square spacers. The mechanism would slide in place on each side of the post, with four 'fingers' to hold each spacer in the correct position and lock into place with a twist lock handle connected to the table. This allowed the operator to slide that part of the jig out of the way while moving the posts.

The complete set-up of the welding jig can be seen in Figure 11, with the posts being blue, the weld locations highlighted in red, the fabricated parts of the welding jig being grey, the clamps for the Siegmund Welding Table being green and the stops yellow. Two of these welding tables were positioned around the robot arm, where one was being welded. The operator would prepare the other table for the next stage in welding.

[redacted]

Figure 11: Top View of the Welding Jig setup

One operator was needed to manage the machine so the robot arm could weld the posts. Initially, they would place posts already fabricated by hand in the welding jig and using the manual controls on the robot arm; they would track a path for the robot arm to follow. After this was set, the robot arm would be able to repeat the path, welding the posts on the jig. To prepare the posts in the jig to be welded, the operator needed to move all the posts up one, rotating each by 90 degrees and taking the completed post at the top out of the jig. Putting in the first post, the operator would place all the tabs and other parts in their positions and close the clamps in place. Using the two welding jigs and robotic welding arm meant that with only one worker's help, eight posts could be welded at once, saving hundreds of hours of labour in the factory.

4.3 Main Project: Supermarket Benches

Just before the Christmas break, I was introduced to the next project I would work on for the remainder of my internship. The project was to design 30 odd commercial-grade stainless steel benches for the new PaknSave being built in Warkworth. The primary goal was to design the benches to the specifications given in the architectural drawings. However, the secondary goal was to lay the foundations for a standard bench catalogue where future clients could pick what bench they want, simplifying the approval process we have to go through before manufacturing the benches. I also focused my design on ease of assembly and having common parts to simplify the benches' manufacture further.

The first step in the design process was to consolidate all the information about the benches from the architectural drawings. A 300-page document of drawings outlining every detail of the PaknSave being built was given to us, only some of which were relevant to what we were manufacturing. Figure 12 shows one page from the architectural drawings summarising the different 100 series benches needed for the supermarket. Reading through the drawings, I created a summary spreadsheet of all the benches. The spreadsheet listed each bench with the customer part code and description from the architectural drawings and outlined each bench's design specifications. The summary listed whether the bench had any shelves, cupboards, drawers, tray rails, splash-backs, or a drip edge and whether it had AdjustAFoot.

[redacted]

Figure 12: Summary of Benches on Architectural Drawings

Overall, there were three main bench types: the standard bench (100 series) with a stainless steel top, a box section weldment body (optionally with one or two shelves) and adjustable rubber feet. Then there were the sink benches (500 series), similar to the standard benches except with a rolled-up drip edge in the stainless steel top and one or two sinks welded into the top. Then there were the cupboard benches (200 and 300 series), which, instead of being made of a box section weldment, the entire body was made of folded stainless steel panels riveted together. These cupboard benches had varying-sized single- and double-door cupboards, two-, three- or four-drawer sets, and sometimes sinks welded into the top.

In the initial design of 100 series benches, the box section weldment body was created entirely as one part, with all the legs, shelf frame and top frame being welded together simultaneously. It was determined that this kind of assembly would be far too complex and labour-intensive, as jigging a three-dimensional weldment together to weld it is not an easy task. To simplify this process, the weldment was split into separate two-dimensional parts that could be welded together before assembling the main bench weldment. The weldment was split into three different groups: the legs, the shelf frames, and the bench-top frame. Figure 13 shows an example of the bench weldment in one of the production drawings for the Weldment Frame Bench.

Breaking down the weldment into sub-parts allowed each part to be much more easily welded on a simple jig welding table. The legs would first be welded onto the bench-top frame to assemble the weldment, where only one distance had to be set in the welding jig. After the legs were welded on, the shelves could be slid into place with a box section sleeve that wraps the centre legs (Figure 13, Detail B), using the pre-drilled holes in the sleeves and legs, the shelves could be riveted to the legs without any need to set the position in a jig, then the shelves were welded to the outer legs for additional support.

With this design for the bench weldment, it also meant that there were many common parts that could be fabricated as a group. For example, if each bench had its own whole weldment, that weldment would have a cut list for the factory, and all the cut box sections for each bench would have to be cut one at a time, with the saw adjusted each time. With the sub-parts design, all the legs, for example, are one standard part, meaning that the factory could cut all the legs at once, saving time re-calibrating for

[redacted]

Figure 13: Production drawing of Bench Weldment Frame

different lengths or angled cuts.

As a part of the attempt to standardise the benches and consolidate parts, the majority of the benches were kept the same depth (800 mm) and height (1150 mm) unless they explicitly could not be. This meant that for any given bench width, we could have standard parts for each of the weldment sub-parts, and the different benches would just be different selections of these standard parts.

Other than the bench weldment frame, there were also the stainless steel bench-top or shelf-top parts. The benchtop is simply a sheet metal part that is folded around the shape of the bench and splash-back and then riveted to the weldment frame. The shelf tops were designed to fit in after the main weldment had been assembled, meaning that they had to be split into multiple parts to fit inside the weldment. Each part of the stainless steel shelf-top had cutouts to fit around the legs of the weldment and were also riveted in place to the weldment frame. The stainless steel parts were also glued down to the weldment frame to reduce any rattling sound between them and the weldment frame. Figure 14 shows a complete bench production drawing, where the stainless steel parts are assembled onto the weldment frame.

Considerable thought has been put into the item code numbering system, ensuring efficiency and ease of use. For instance, all standard product items for supermarkets are denoted by the code 'MC020', while '001' specifically identifies benches within the supermarket folder. Top-level benches are marked with 'Axxxx', each with a unique four-digit code. Sub-assemblies and parts are distinguished by 'Zxxxx'. The 'Z' codes are further categorised into 'Z04xx' for weldment frames, 'Z06xx' for shelf-top parts, and 'Z05xx' for bench-top parts, as illustrated in the Bill of Materials (Figure 14). The 'A' prefix for top-level bench assemblies and the 'Z' prefix for parts ensure that the final parts we sell or are more relevant appear at the top of the list in our ERP system, while the smaller parts making up the assemblies are listed at the bottom. This organised structure enhances readability and facilitates the creation of new parts.

Using these standardised designs, I created all of the 100 series benches relatively simply, only needing to copy previous parts and adjust a couple of dimensions. The same was done for the 500 series benches, except extra consideration had to go into the sinks' position to not conflict with the weldment frame of the bench. For the 200 and 300 series, i.e. the cupboard benches, a new design was entirely different from the 100 series.

A major part of designing the cabinet benches was communicating with the architect to agree on some degree of standardisation. From the original architectural drawings, there were nine different cabinet benches, each with slightly different width cabinets and drawers, meaning that each small part would

[redacted]

Figure 14: Production drawing of complete Bench

have to be unique for all of the benches. Working with the architect, we got all of the drawers the same width, the only difference being that they were two, three, or four set drawers. For the single and double door cabinets, some were able to be made to a standard size, but other had to be custom sizes to fit in sinks or to fit the specific width needed for the bench. Figure 15 shows the SolidWorks model of one of the benches with a cabinet, sink and drawers.

[redacted]

Figure 15: Bench with Cabinet, Drawers and Sink

At the end of my internship, I was able to release the production packages for the 100 and 500 series benches (standard and sink benches). However, I handed over the development of the 200 and 300 series benches (cabinet benches) to one of my coworkers in the design team.

5 Work Completed during Second Summer

The following section details my second work period at Metal Concepts Ltd, from 13th November 2023 to 23rd February 2024. Since I had already interned at the company before, I could jump right into a new project without any training needed. This work period is split into two subsections; the first subsection describes some of the smaller projects I worked on during the summer, where I was migrating, updating and redrawing outdated products into our new system in SolidWorks PDM. The second subsection is the main project I worked on during the second summer, where I continued the work of a previous design engineer to develop a set of standard AC Unit Covers designed to fit any brand and size of AC unit.

5.1 PDM/ERP Mini Projects

On my return to the design team at Metal Concepts, I was tasked with migrating and updating old products with outdated models and drawings from our old drive into our SolidWorks PDM vault. These products were standard OEM (Original Equipment Manufacturers), meaning they were manufactured for another company and were unlikely to change the design. Because of this, the files had never been updated, and some even only had two-dimensional AutoCAD drawings available, and they did not meet our current SOP for design and production.

The main batch of products I worked on migrating was the Aquatech pipe sleeves, which were a rolled sheet metal sleeve with adjustable straps welded onto the side. The sleeves came in a wide range of sizes, which we had only previously made a handful of. Using the old drawings (Figure 16) and a spreadsheet denoting all the size variations for the sleeves, I remodelled the sleeves in SolidWorks, matching our current design structure.

[redacted]

(a) Old AutoCAD Drawing

[redacted]

(b) New SolidWorks Model

Figure 16: Aquatech Sleeve Old vs New

The sleeve assemblies also needed new item codes to match our current system, similar to the development of the supermarket bench item codes. There was a 'Z' code for the pipe sleeve part and weld-on strap part, as well as an 'A' code for the top-level assemblies, as opposed to Metal Concepts Standard Products, OEM products item codes and denoted by their respective company. For Aquatech, the code was 'AQT', and a three-digit code was used for each sleeve assembly with padding between each to allow for new codes to be created that would fit in between.

Another short project I worked on was the production release for some folded sheet metal panels that had already been modelled. These decorative panels were designed by an old designer in 2019 before the project was put on hold, and they have over 100 unique panels. Each panel needed its own production drawing and STEP file to send to production. Initially, I created a production drawing for one panel as a template (Figure 17).

The majority of the panels were very similar except for a few critical dimensions and angles that differentiated them. Because of this, I thought I could copy the template drawing and replace the model in each drawing with the next panel, saving time by creating the same drawing repeatedly for

[redacted]

Figure 17: Production Drawing for Panel

each panel. After some research, I found a SolidWorks Macro posted on the SolidWorks help forum that automatically takes a drawing and generates the same drawing for a list of different parts (Figure 18).

[redacted]

Figure 18: SolidWorks Macro to automate drawings

Using this macro, I could leave my computer running and generate individual SolidWorks drawings for all 100 or so panels. After all the drawings had been generated, I went through each and tidied them up so that all the dimensions were referenced and the drawing view was positioned neatly.

5.2 Main Project: AC Unit Covers

My main project I worked on for the second summer at Metal Concepts was continuing the design of standard AC Unit Covers (Figure 19). The AC Unit Covers are a common product for which we have sold in a couple of different projects before. The purpose of the work I was continuing was to create a standard set of designs and sizes of AC Unit Covers so that they could be readily sold in a product catalogue, similar to the goal of the supermarket benches. There was also the intention to make them avaliable to anyone to install, coming in a flat-packed box and having easy screw together panels.

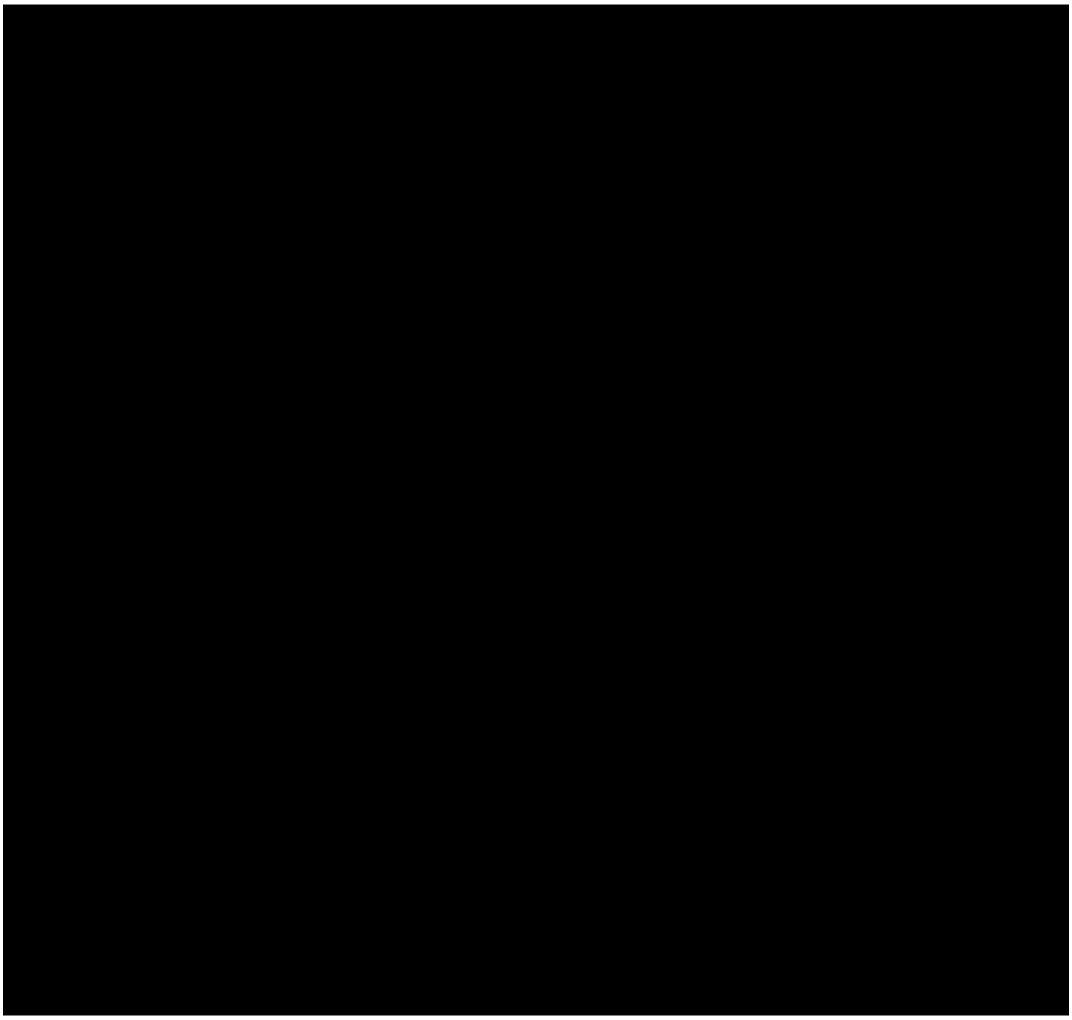

Figure 19: Floor Mounted AC Unit Cover

For the AC Unit Covers we had set four different sizes to fit majority of the different brands and units used. The four sizes were, Compact, Standard, Tall and Double Stack. There were also six different standard styles of AC Unit Cover, with more possible using different combinations of parts. Of the main six types, half were floor mounted and half were wall mounted. Of the floor mounted there was the, Flat Top, the Wood Top and the Sloping Top. Of the wall mounted AC Unit Cover there was the No Top, the No Top with Skirt and Flat Top with Skirt. There was also the option of two different types of wall brackets to use. These six types were selected based on the most requested designs from previous projects but with all the different sized AC Unit Covers and different styles, there are a potential 80 different AC Unit Covers.

Although most of these unique AC Unit Covers had not been made yet or requested by customers, part of my work was to structure the item codes for the AC Unit Covers and subsequent parts which meant I had to plan for these potential covers in the item code structure. For the item codes the prefix 'MC030' was used referring to all standard product ac unit covers, within that there was 'A' for the top level assemblies of the ac unit covers and 'Z' for the parts. For the four different sizes the covers were split into the A1000, A3000, A5000 and A7000 series AC Unit Covers, leaving padding for new potential sizes in the future. Within each thousand series, the different cover styles were grouped into wall mount or floor mount and then each indivial code for each AC Unit Cover. An example of an item code for a AC Unit Cover would be 'MC030-A1403', the '1' denoting that it is a Compact size AC Unit Cover, the '4' denoting that it is a Wall Mount with Skirt and the '03' denoting it has a Flat Top. Using the four numbers from 'Axxxx', each possible permutation of AC Unit Cover can be encoded with space for future sizes or styles.

Part of the design intention was to create a flat-packed AC Unit Cover that could be sold to and installed by anyone. Given the large size of the parts, a custom box was needed. In the past, boxes like 5-Panel-folders or Regular Slotted Cartons had been used but did not work well for our needs. The new type of storage/transportation box we decided to try was a Box and Lid type. With a box and lid it mean that the sides were double thick, allowing the boxes to be stacked and not crumple. It also meant that the boxes could be easily opened and broken down after being used on-site. To find what size box was needed, I placed all the AC Unit Cover parts flattened in an assembly (Figure 20), measuring the volume each different size and style took up.

Figure 20: Modelled flat-packed AC Cover

Given the very large size of the double stack AC Covers, we did not plan to create a flat-packed box for them. Since the Standard size was by far the most popular currently, we sized the box only for those (also fitting the Compact AC Covers). I contacted a number of suppliers of custom cardboard boxes to get their quote. The size box I decided to order was 1150x850x200mm which would fit all Standard and Compact AC Unit Covers.

6 Reflective appraisal

Overall, I enjoyed the time I spent working at Metal Concepts Ltd, and both internship periods provided invaluable experience and insight into how a real-world engineering fabrication company operates. This was my first time working at an engineering company, and it has greatly broadened my understanding of the engineering world.

The internship provided me a platform to familiarise myself with industry-standard software and tools, primarily SolidWorks and SolidWorks PDM. During my study at the University of Auckland, we only used AutoCAD Inventor, which requires a noticeably different thought process for designing compared to SolidWorks. I also significantly developed my skills in designing sheet metal and weldment parts, which we did not learn at all in university.

One of the highlights of my internship was the opportunity to work on a diverse range of projects alongside experienced design engineers. I was actively involved in real-world engineering tasks. Collaborating with senior engineers provided me with mentorship and guidance and fostered a sense of teamwork and camaraderie within the workplace.

Throughout the internship, I encountered various challenges that necessitated creative problem-solving approaches. For instance, in designing the welding jig for the robotic arm welding station, I had to devise innovative solutions to accommodate the complexities of the welding process. This experience honed my ability to think critically and adapt to unforeseen obstacles, essential skills for any aspiring engineer.

Looking ahead, I intend to build upon the foundation laid during my internship by seeking opportunities for continuous learning and skill development. I am eager to explore advanced topics in mechanical engineering and contribute meaningfully to future projects, leveraging my academic knowledge and practical experience gained from the internship.

Overall, my internship at Metal Concepts Ltd has been a transformative experience, equipping me with invaluable skills, insights, and experiences that will undoubtedly shape my future career as a mechanical engineer. I am grateful for the opportunity and look forward to applying the lessons learned to excel in my academic and professional endeavours.

7 Conclusions

I thoroughly enjoyed my internship experience at Metal Concepts Ltd. With the various projects I worked on I was able to expand my knowledge many aspects including, SolidWorks sheet metal and weldment design, problem solving and logical thinking, designing products for standardisation, ERP and information managing systems.

Overall, my internship experience has provided me valuable insight into the manufacturing industry and has helped me expand my knowledge further than the theoretical of university study.

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