

Senior Design 2024

Metalforms



COLLEGE OF ENGINEERING
LAMAR UNIVERSITY
Department of Industrial and Systems Engineering

SENIOR DESIGN 2024

Metalforms

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Metalforms
A Senior Design Project
Presented to
The Faculty of the Department of Industrial and Systems Engineering
Lamar University
by
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Hosted by Metalforms
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Abstract

The company Metalforms is looking for help from the team to aid with the need and desire to simplify vendor management, save money through bulk purchases, and expedite procurement procedures. Metalforms wants to create an exhaustive list of the precise welding consumables needed for their operations. In addition, Metalforms looks for assistance assessing bids from possible suppliers, considering elements like cost, terms, and conditions, as well as the dependability of the supplier. The team's prototype consists of the bid package, an ERP, and an Excel spreadsheet of the required consumables that Metalforms utilizes. The bid package will outline the project's scope, requirements, and specifications. It will allow contractors to develop an accurate and competitive proposal within the conditions outlined in the bid package. The VBA UserForm which acts as an ERP that the team created to assist Metalforms account for the inventory of their welding consumables. Also, the Excel spreadsheet consolidated all welding consumables that replaced the physical binder reducing paper waste. Utilizing all three components of the prototype the team provides a more efficient and convenient form for Metalform's operations.

TEAM MEMBER PAGE (All)

Each signature indicates the team member has contributed to the project and the report, reviewed the report, and agrees with the content in the report.

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Table 1: ABET Cross-Reference Table (CM & TM)

Outcome	Examples
1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	4.3, 6.3
2) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	1.8, 1.9, 5.5, 5.6, 6.15
3) An ability to communicate effectively with a range of audiences	1.1, 8.1, 8.2, 8.3, 8.4
4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	1.3, 2.8, 6.16
5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	3.7
6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	6.5
7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	4.1

1. Introduction

1.1 General Introduction (TM- Shilpa)

Senior Design serves as a culmination of academic journey and involves applying the knowledge and skills students have acquired throughout their studies. Senior design projects expose students to real-world problems. They learn to analyze, design, and implement solutions that address practical challenges. Senior design projects require students to manage their work effectively. They learn about project control, including scheduling, budgeting, and resource allocation. Students collaborate with team members, instructors, and sometimes external clients. Effective communication is crucial for successful project outcomes. In short, Senior design prepares students for their professional journey. Our team, Odessey Driven is a five-people group where there is a Project Manager (Justin Hernandez), Project Engineer (Guru Charan T Chapparapu), Systems Engineer (Daniela Arroyo), Technical Manager (Shilpa Mary Cherian) and Compliance Manager (Ye Sung Sohn). Our client, Metalforms needs us to create a comprehensive bid package to facilitate the selection of a single vendor. Our primary objective is to assist the company through recommendations to identify and evaluate potential vendors based on criteria such as cost, quality, reliability, expertise, etc., along with optimizing the procurement data storage system. Major deliverables for this project include the bid package document, eliminating a ring binder with a better reliable document, and implementation of an enterprise resource planning (ERP) database for future use.

The remainder of this section will cover the Explanation of Needs and Problem Statement, which explains the needs of the company in detail. Summary of Literature,

Scope of the project, Design process will delve deep into the processes used in the project. This section also included the social, cultural, environmental, and ethical impact of this project along with the mitigation steps.

1.2 Explanation of Needs (PM) Justin

Metalforms is seeking assistance in consolidating all of their welding consumables to a single vendor. Currently, Metalforms purchases welding consumables from multiple vendors, leading to potential inefficiencies, higher costs, and logistical challenges. The need arises from the desire to streamline procurement processes, achieve cost savings through bulk purchasing, and simplify vendor management. Metalforms aims to identify the specific welding consumables required for their operations and compile them into a comprehensive list. The company requires assistance in putting together a bid package for potential vendors, which involves specifying the quantity, quality, and delivery requirements of the welding consumables. Ultimately, the goal is to create a Bid List and ERP software for Metalforms.

Additionally, the selected vendor's capabilities, pricing, and terms must align with Metalforms' budgetary constraints and quality standards.

1.3 Problem Statement (SE) Daniela

Metalforms seeks assistance in consolidating their welding consumables to a database to help aid with potential vendors. The team's main deliverables are the bid package, ERP, and Excel spreadsheet of the required consumables that Metalforms utilizes.

After evaluating Metalform's need of assistance to provide an ERP alternative and consolidating all their welding consumable to a single software the team decided to have that software be Microsoft Excel also, creating a VBA UserForm as the ERP alternative for the convenience of having both needs easily accessible, and utilizing Microsoft Word with a bid package for potential vendors.

Table 2: Requirements and Constraints Analysis

Excerpts	Requirements and Constraints
Consolidating all welding consumables	<ul style="list-style-type: none"> • Choose database that is convenient for users • All welding consumables must be present
ERP	<ul style="list-style-type: none"> • Alternative ERP • Inventory conveniently accessible
Bid List Package	<ul style="list-style-type: none"> • Scope of work • Welding Consumables included

1.4 Summary of Literature (CM)

ERP stands for Enterprise Resource Planning and helps integrate core business departments into a unified system (*What is ERP?*, n.d.). The information allowed the team to better understand what ERP was and how to make an integrated system for

Metalforms. The National Procurement and Tender Administration (NPTA) is an important handbook giving guidance on evaluating bids (NPTA, 2009), which the team needed for creating a bid package template. The American Welding Society (AWS) is an organization that provides codes on structural welding. The team used the information provided on the regulations that welders and the companies associated with welding must comply with. The standard the team used was the AWS/ANSI Z49.1:2021 (AWS, 2019), which covered health and safety aspects in a welding environment. In the preliminary research, the outlook and further context of the welding consumables market was needed. It is a strong market with a projection of CAGR of 6% from 2023 to 2033 (FMI, 2023). One of the important elements to this project was the VBA UserForm. The Excel Manual provided by the University of Mary Washington provided information on how to do Macros, functions, and other useful tools found on Excel (2015).

Metalforms list their services and products on their website, which include shell and tube heat exchangers, pressure vessels, repair, and parts (Metalforms, n.d.). This assisted the team in the creation of the bid package template, which gave a better understanding of what the consumables will be used for. Supplier consolidation is the reduction of the number of suppliers used (Vecchio, 2022). This is exactly what the team was trying to do with the consolidation of the welding consumables. The benefits of vendor consolidation are volume discounts, consolidated invoices, and less contracts to manage for renewals (Paul, n.d.). The potential negatives were also given, which helped the team be better informed in its effort to help Metalforms consolidate their suppliers. Common welding equipment and consumables include shielded metal arcs and stick welding electrodes (Mason, 2022). This equipment and consumables are explained

thoroughly in detail. This helped the team greatly in understanding the consumables Metalforms were procuring. Human factors engineering and ergonomics played a role in the project. The information provided by Lehto & Landry (2013) assisted the CM to create a guideline on posture found in figure 10. Beaumont, TX's demographics and trends were needed for the societal impact and cultural factors sub-sections of section one. Data USA provided demographic and economy data of Beaumont, TX (*DataUSA*, n.d.). A sustainable logistics model study found that shipment consolidation consumed less fuel, leading to fewer emissions (*Stacker*, 2022). This study helped strengthen the case for the environmental impact of vendor consolidation for the project. These were the results of literary research.

1.5 Science Involved (PE-Guru)

VBA (Visual Basic for Applications) is a programming language developed by Microsoft and is primarily used for automating tasks and creating custom functions within Microsoft Office applications like Excel, Word, and Access. Automating tasks is vital for reducing human error, increasing efficiency, and making time for more complex tasks. VBA was of great use in aiding automation by allowing our team to write scripts that perform repetitive tasks, generate reports, and manipulate data automatically. With VBA, users like us can create macros to automate data entry, format spreadsheets, perform calculations, and integrate with other data sources, in effect increasing productivity and accuracy in the data.

One of the key applications of mathematics and science in this project was that our team developed a VBA UserForm, which included a line of code designed to streamline data.

```

ThisWorkbook.Sheets(UserForm2.ComboBox2.Value).Range(Cells(lastcell, 1),
Cells(lastcell, 40)) = Range(Cells(findmatch.row, 1), Cells(findmatch.row, 40)).Value

Else

MsgBox "not found"

End If

```

This code functions to check if the value in the ComboBox is present in any cell across the Excel spreadsheet. If the value is found, the row is highlighted, this aids in identifying and verifying the data. If the value is not found, a message with the "not found" notification will appear. The use of this code shows the different techniques that can replace traditional mathematical equations in the context of a procurement project. Even though our team's project did not involve difficult mathematical formulas, this code represents the most logical way to manage and verify large datasets quickly and efficiently, making sure of the accuracy and bettering user experience in the data procurement process.

1.6 Engineering Design Process (SE-Daniela)

In our project for Metalforms, we implemented a systematic engineering design process to create an efficient data management system. This process began with clearly defining design inputs, focusing on the need for accurate and organized data collection. The prototype was rigorously tested to ensure it met our design requirements. This

comprehensive approach ensured that the final solution was both practical and aligned with Metalform's operational goals.

1.7 Project Scope and Limitations (TM-Shilpa)

1.7.1 Project Scope (Shilpa)

The scope of this project is to create a comprehensive bid package to help Metalforms identify a single vendor, eliminate, and merge all welding consumables data from the ring binder to an Excel spreadsheet, and implement an ERP database within this spreadsheet for better usage of data in the future.

1.7.2 Items Outside the Project Scope (Shilpa)

Making a decision based on the Bid package provided by our team is Metalforms' responsibility and is outside of the project's scope. Ongoing monitoring of the selected vendor's performance, quality control, and delivery reliability is out of scope for this project since the team is unable to provide ongoing support. Confirming all consumables used by Metalforms is on the spreadsheet would be outside the scope of the project because the team does not have access to all that data. Maintaining and adding extra features to the ERP database is out of the scope of this project as the team has no control after handover. Training employees and allocating licenses to use the ERP database is solely Metalform's responsibility.

1.8 Societal Impact and Global Welfare (CM – Ye Sung)

This project will directly benefit Metalforms, but doing so will benefit society in numerous ways. Firstly, through this project Metalforms can potentially reduce costs and

increase profitability. Based on Metalform's employee reviews, the company has made notable reinvestments to its business, which in turn create new jobs. The population of Beaumont is decreasing with people moving to other cities (*Explore Census Data, n.d.*). The top cities people from the Beaumont metro region are moving to are Houston, Dallas, Lubbock, and Austin metroplexes (*Stacker, 2022*). Through this project Metalforms can make a positive impact by attracting talent, thus supporting the local economy. This ties into the need to create a positive social impact, with the issue of previous suppliers losing business with Metalforms. Although Metalforms isn't a mega-corporation, losing a client like Metalforms could potentially impact jobs in the local area. To offset this impact, once our team finished the bid package template, the team had only sent it out to potential vendors within Beaumont and the surrounding region. It does not negate the effect completely, but it does keep the same money Metalforms would have spent within the city. This project in the end will have a positive societal impact within the region, allowing Metalforms to be able to invest the resources saved from the prototypes: time & money with the VBA UserForm found in 6.3, and money with the bid package template. The time and resources saved can then potentially be used to further vitalize the local economy and create new jobs.

1.9 Cultural Factors (CM-Ye Sung)

The project affects the Beaumont, TX region, which is prominently lower-income and black. The black or African American population makes up approximately 45.3% of the Beaumont's population and the median household income is at \$53,745, a significant number lower than the median household income across the United States (*datausa, n.d.*)

2022). While the project's goal is to save costs and time while sourcing quality goods from a single vendor, the team made sure that the vendors who were selected to apply to the bid package were providing good wages to their employees. On the bid package is the evaluation criteria. One of the criteria is the vendor reputation, which is important to choose a vendor that pays fairly in order to support the community. One example is the company Gas & Supply. Through their career's website, the CM verified their jobs to see their benefits package and wages for new employees. The team had regular check-ups on each other's work to reduce potential biases from one person. For example, the CM verified the TM's section six work and had a discussion and traded perspectives. With a verification system like this, other people can detect hidden biases.

1.10 Environmental Impact (CM) Ye Sung Sohn

Environmental impacts stemming from this project will lead to paper reduction as an VBA UserForm reduces the need for physical printouts. Metalforms can save thousands of pieces of paper by utilizing a simpler and easier database. Another environmental impact will be the reduction of shipments and emissions by consolidating to a single vendor. Currently Metalforms is using six vendors, with locations ranging from close to far (e.g., Home Depot in Beaumont). By selecting one vendor, the shipments can be transported in bulk with fewer trips (*"Best Choice for Business"*, 2023). This reduces shipments and associated carbon emissions, while simplifying transportation logistics. A sustainable logistics model study found that shipment consolidation consumed less fuel, leading to fewer emissions (MDPI, 2023).

1.11 Ethical and Professional Responsibility (TM-Shilpa)

It is essential to evaluate vendors based on objective criteria (quality, cost, reliability, etc.) rather than personal biases. It is also important to make sure the ERP database fulfills its purpose and is easy to use. Our team was required to consult the company representatives throughout the creation of the ERP database to grasp their needs and demands.

Our Team has requested the company to thoroughly train any employee using the ERP database to prevent increased workload on employees and employee retention as part of ethical responsibilities. It is also important to avoid situations where personal benefits compromise objectivity when consolidating all welding consumables to a single seller. Ethical vendor consolidation should balance efficiency with fairness and transparency.

1.12 ABET Accreditation (CM)

The ABET Cross-Reference Table on page provides sub-section numbers where examples of work that demonstrates ABET student outcomes can be found.

1.13 Project Notebook (PM) Justin

The way we are documenting the project is by allowing the facilitation of each member of the team on a weekly basis will document the records of the outcome of the meetings with Metalforms as well as our internal meetings. They will then send the

briefing that they captured to every member via email. There is a calendar of who is responsible for the week on our Teams page, and it was sent via email to each member. Notes, important information, and records about the project were kept in our digital project notebook which was in the form of a shared OneDrive folder that the whole team could access.

1.14 Report Organization (CM – Ye Sung)

Section 1 serves as an introductory guide to what to expect in this project. From the explanation of needs, problem statement, project scopes and limitations, and overall impact. Section 2 delves into design inputs for the prototype and what those entails. Section 3 goes in-depth on the planning of the information given from sections 1 & 2. It addresses team approaches to the design, strategies to overcome potential challenges, and preliminary plans for the next section. This section has many elements from project management, which accounts for risk management, budget, and plans for thorough research. Section 4 contains most of the research for the project, which includes regulations, design inputs for the project, and the testing that will be done for the prototype(s). Section 5 is the preliminary design for the prototypes. It has plans for health, considerations for the general welfare of the environment and society, and matrixes that weigh and prioritize the features. Section 6 is the actual execution of the prototypes and explaining what they are and what it does. It is then put through verification testing. Section 7 is outside the scope of Team Odyssey's project. Section 8 is the conclusion of the report.

2. Final Design Description

2.1 Design Description Overview (TM-Shilpa)

Our team designed a comprehensive bid package (a document) which helps the company with their need to consolidate all their welding consumables to a single vendor. The bid package lays down all the different criteria provided by Metalforms to help the company make a better decision when selecting a vendor.

Bid Package for Welding Consumables

METALFORMS, LLC

Introduction:

Metalforms is a leading provider of custom engineered and fabricated solutions for gas and liquids processing, storage, and handling across a broad range of industries including Petrochemical, Refining, Specialty Chemical, Biofuels, and others.

We specialize in the delivery of custom engineered and fabricated Shell & Tube Heat Exchangers, ASME Pressure Vessels, Piping, and other equipment—in addition to a comprehensive array of maintenance, repair, and replacement services.

As part of the TransTech family of companies, we can offer an extensive range of fabrication solutions, field services, and 24/7 support services—including fabrication of large process vessels and process piping for our chemical and industrial clients—while leveraging fabrication assets and field services capabilities from locations nationwide.

Scope of Work:

Our company is seeking a single vendor to provide welding consumables. The scope of work includes the supply of various welding materials required for our operations. The selected vendor will be responsible for delivering high-quality consumables to our specified locations.

List of Welding Consumables: Please provide quotes and specifications for the following welding consumables:

1. Welding Electrodes:

- Type: CROWN ALLOY 1/8 E 316L-16 BR.PKG. STAINLESS STEEL ELECTRODE 1 LB TUBE
- Quantity: Thirty-five bundles of 1 LB Tube in a fiscal year basis
- Specifications:
 - MPN: SE316/EXO-BP
 - UPC: 412300641313

The team also merged all welding consumables data into an Excel spreadsheet to eliminate the ring binder currently in use. The ring binder is used in different departments to refer and store data and the team concluded that storing data on a paper source isn't efficient since this can cause data loss.

Figure 2

A	B	C	D	E	F	G	H	I	J	K
ACCC	ACCOUNT_DESCRIPTOR	BATC	BATC	BATCH_L	TRAN	TR	TRANS_CREATE_DATE	DEBIT	CRED	SUB_REFERENCE
6140	Fab Shop - supplies taxabl	16275	PUR	12/31/2023	104702		2024-01-17-14.16.21.1600	168.5		007658 - 132647-2 - GLOBAL SUPPLY
6140	Fab Shop - supplies taxabl	14991	PUR	2/28/2023	96419		2023-03-22-13.44.59.62	157.88		007800 - 129893 - GRAINGER
6140	Fab Shop - supplies taxabl	15185	PUR	4/30/2023	97810		2023-05-19-13.57.46.157	485.81		007800 - 130330 - GRAINGER
6140	Fab Shop - supplies taxabl	15185	PUR	4/30/2023	97810		2023-05-19-13.57.46.157	28.24		007800 - 130609 - GRAINGER
6140	Fab Shop - supplies taxabl	15813	PUR	8/31/2023	101342		2023-09-13-14.03.25.993	155		007800 - 131566 - GRAINGER
6140	Fab Shop - supplies taxabl	15813	PUR	8/31/2023	101342		2023-09-13-14.03.25.993	257.76		007800 - 131639 - GRAINGER
6140	Fab Shop - supplies taxabl	16275	PUR	12/31/2023	104702		2024-01-17-14.16.21.1600	98.2		007800 - 132638 - GRAINGER
6140	Fab Shop - supplies taxabl	14991	PUR	2/28/2023	96419		2023-03-22-13.44.59.62	61.85		008490 - 129353-2 - GAS & SUPPLY
6140	Fab Shop - supplies taxabl	15526	PUR	6/30/2023	99548		2023-07-19-16.25.37.490	189.2		008490 - 130979-1 - GAS & SUPPLY
6140	Fab Shop - supplies taxabl	15697	PUR	7/31/2023	100686		2023-08-14-16.18.18.577	1852.3		008490 - 131227 - GAS & SUPPLY
6140	Fab Shop - supplies taxabl	15813	PUR	8/31/2023	101342		2023-09-13-14.03.25.993	1011.1		008490 - 131478 - GAS & SUPPLY
6140	Fab Shop - supplies taxabl	15849	PUR	9/30/2023	101626		2023-09-22-10.12.03.900	457		008490 - 131640 - GAS & SUPPLY
6140	Fab Shop - supplies taxabl	16069	PUR	10/31/2023	102936		2023-11-15-10.37.58.507	382.15		008490 - 132025-1 - GAS & SUPPLY
6140	Fab Shop - supplies taxabl	16069	PUR	10/31/2023	102936		2023-11-15-10.37.58.507	592.46		008490 - 132193 - GAS & SUPPLY
6140	Fab Shop - supplies taxabl	16113	PUR	11/30/2023	103218		2023-12-04-13.34.52.687	1852.3		008490 - 132241 - GAS & SUPPLY
6140	Fab Shop - supplies taxabl	16113	PUR	11/30/2023	103218		2023-12-04-13.34.52.687	255.67		008490 - 132377 - GAS & SUPPLY
6140	Fab Shop - supplies taxabl	16275	PUR	12/31/2023	104702		2024-01-17-14.16.21.1600	296.53		008490 - 132645 - GAS & SUPPLY
6140	Fab Shop - supplies taxabl	15185	PUR	4/30/2023	97810		2023-05-19-13.57.46.157	115.88		013200 - 130606 - M & D SUPPLY INC
6140	Fab Shop - supplies taxabl	15849	PUR	9/30/2023	101626		2023-09-22-10.12.03.900	34.2		014900 - 131701 - MCMASTER-CARR SUPPLY COMPANY
6140	Fab Shop - supplies taxabl	16069	PUR	10/31/2023	102936		2023-11-15-10.37.58.507	34.2		014900 - 132021 - MCMASTER-CARR SUPPLY COMPANY
6140	Fab Shop - supplies taxabl	16069	PUR	10/31/2023	102936		2023-11-15-10.37.58.507	34.2		014900 - 132166 - MCMASTER-CARR SUPPLY COMPANY
6140	Fab Shop - supplies taxabl	14909	PUR	1/31/2023	95896		2023-02-22-14.05.04.887	197.98		029120 - CC4057-1 - WELLS FARGO CREDIT CARD
6140	Fab Shop - supplies taxabl	15086	PUR	3/31/2023	97121		2023-04-18-13.36.07.587	35.28		029120 - CC4117 - WELLS FARGO CREDIT CARD
6140	Fab Shop - supplies taxabl	15086	PUR	3/31/2023	97121		2023-04-18-13.36.07.587	95		029120 - CC4132 - WELLS FARGO CREDIT CARD
6140	Fab Shop - supplies taxabl	15526	PUR	6/30/2023	99548		2023-07-19-16.25.37.490	39.67		029120 - CC4180 - WELLS FARGO CREDIT CARD
6140	Fab Shop - supplies taxabl	15813	PUR	8/31/2023	101342		2023-09-13-14.03.25.993	37.93		029120 - CC4214 - WELLS FARGO CREDIT CARD
6140	Fab Shop - supplies taxabl	16069	PUR	10/31/2023	102936		2023-11-15-10.37.58.507	55.94		029120 - CC4253 - WELLS FARGO CREDIT CARD
6140	Fab Shop - supplies taxabl	14876	API	2/16/2023	95652		2023-02-16-15.14.22.950	13.03		129893 - 007800 - GRAINGER
6140	Fab Shop - supplies taxabl	15075	API	3/7/2023	97033		2023-04-12-15.05.32.583	2.62		130145 - 016055 - OFFICE DEPOT INC
6140	Fab Shop - supplies taxabl	15113	API	4/20/2023	97324		2023-04-20-10.15.37.700	40.08		130330 - 007800 - GRAINGER
6140	Fab Shop - supplies taxabl	15146	API	4/29/2023	97467		2023-05-03-10.18.47.377	9.56		130606 - 013200 - M & D SUPPLY INC
6140	Fab Shop - supplies taxabl	15152	API	4/30/2023	97497		2023-05-04-09.49.47.511	2.33		130609 - 007800 - GRAINGER
6140	Fab Shop - supplies taxabl	15748	API	8/31/2023	101039		2023-08-31-09.50.14.873	12.8		131566 - 007800 - GRAINGER
6140	Fab Shop - supplies taxabl	15844	API	9/20/2023	101580		2023-09-20-15.19.53.740	19.28		131701 - 014900 - MCMASTER-CARR SUPPLY COMPANY
6140	Fab Shop - supplies taxabl	16256	API	12/11/2023	104526		2024-01-10-16.05.30.527	8.1		132638 - 007800 - GRAINGER
6140	Fab Shop - supplies taxabl	14913	ADJ	1/31/2023	95953		2023-02-22-14.09.20.293	34		293892 - FBA0010 - STA-KLEER COVER LENS (100/BX)
6140	Fab Shop - supplies taxabl	14913	ADJ	1/31/2023	95953		2023-02-22-14.09.20.293	9.47		293893 - FBA0040 - #5011SHURLITE TRIPLE FLINT LIGHTER #45

Finally, an ERP database is built within the Excel spreadsheet using Excel macros. This saves the company money from their initial plan to buy commercial ERP software.

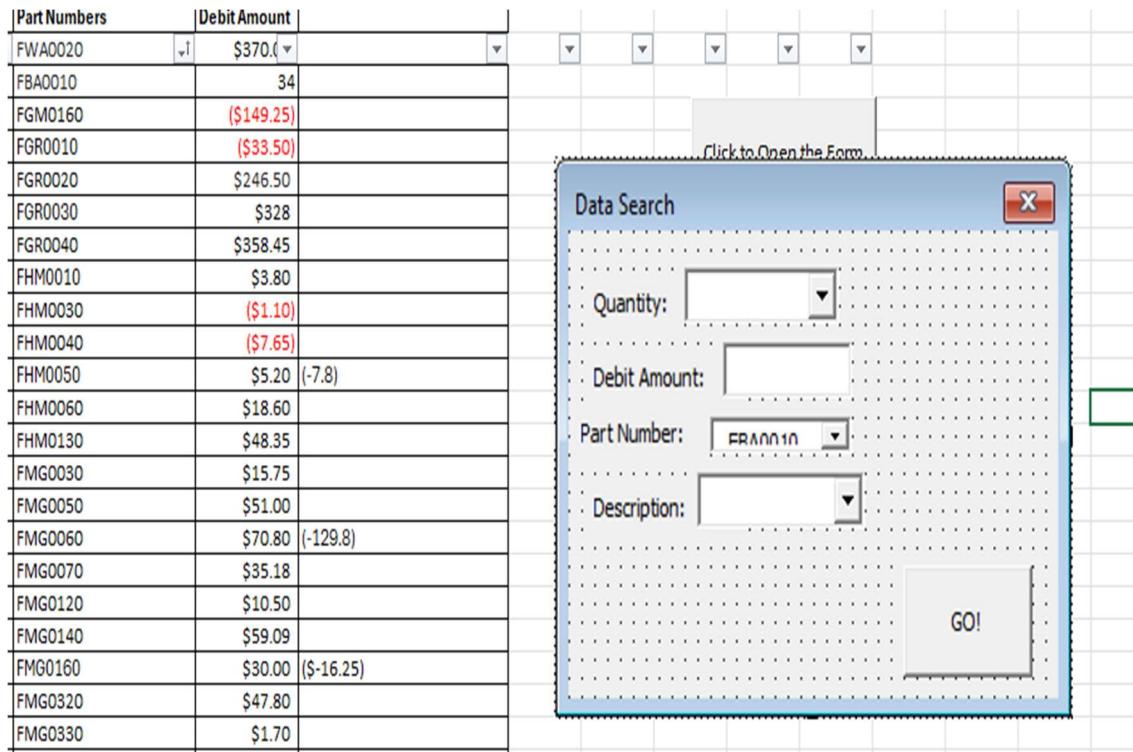


Figure 3

Overall, the prototype that our team built for Metalforms will assist them in solving their primary need of consolidating all welding consumables to a single vendor, providing a better data usage and storage system for the future in addition.

2.2 System Architecture Part Number, Part Description, Lowest Debit

Amount (SE – Daniela)

The main components for the prototype are the bid package, the VBA UserForm, and the Excel sheet. The bid package template consists of the scope of work that provides clear communication to a potential vendor of the needs of Metalforms for supplying welding consumables. Also, the bid package includes the list of welding consumables.

This section of the Bid List package provides a detailed inventory of required welding consumables, to guarantee Metalform's specific needs are being met by the potential vendor. The VBA UserForm is built into Microsoft Excel the VBA macro acts like an ERP database assisting the user in sorting and searching welding consumables. This is to be useful by recording the inventory, checking available, and quantity of the welding consumables. The Excel sheet with all the welding consumable data merged from Metalform's initial data collection as a physical ring binder is designed to be used by associates and management reducing time when searching for welding consumables and saving cost by having the data be electronic.

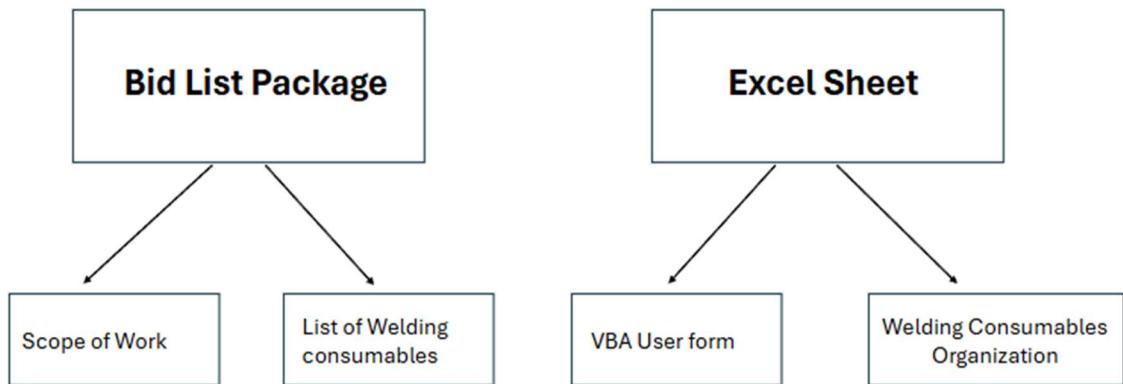


Figure 4

2.3 Method of Operation (PE - Guru)

In our project for Metalforms, the team created a prototype that includes a Bid List Package, a VBA UserForm, and an Excel spreadsheet system. The Bid List Package is designed to streamline the procurement process, this allows potential bidders to get detailed items specifications and prices. This facilitates informed and competitive bidding. The VBA UserForm enhances inventory management by providing an interface for data entry

and retrieval, this means it's basically acting as a substitute for more complex ERP systems. This tool helps manage inventory, track orders, and can streamline inventory operations. The Excel spreadsheet system is a big piece to our prototype because it serves as the primary platform for analyzing and organizing our datasets. We also included custom macros for data cleaning, which remove duplicates and irrelevant entries, making sure the data is accurate. Overall, the prototype not only enhances operational efficiency for Metalforms, but also simplifies data management.

2.4 Key Features and Benefits (SE – Daniela)

The key features are the aspects of the prototype that define its qualities or capabilities. They offer clear benefits by meeting user needs and accomplishing the team's project goals and design inputs. These features put the needs and satisfaction of the user first.

Table 3: Features and Benefits Bid Package

<i>Features</i>	<i>Benefits</i>
<i>Scope of Work</i>	<ul style="list-style-type: none"> - Communicates Metalform's main goal and gives prospective suppliers a comprehensive grasp of the project and its specifications.
<i>List of Welding Consumables</i>	<ul style="list-style-type: none"> - Ensures that bids are customized to Metalform's unique requirements by providing prospective vendors with a comprehensive inventory of required welding consumables.

<i>Quality Requirements</i>	- Ensures that possible suppliers are aware of the standards for welding supplies quality.
<i>Delivery Requirement</i>	- Aids with facilitating the evaluation of bids by outlining Metalform's delivery logistics requirements in clear terms, ensuring potential vendors can accurately assess their capability to meet these requirements.
<i>Bid Submission Instructions</i>	- A transparent and organized bidding process for Metalforms is ensured by precise and well-defined instructions for bid submission.
<i>Evaluation Criteria</i>	- Evaluation criteria make sure that choosing a vendor is predicated on enabling impartial bid comparison and appraisal.
<i>Excel Spread Sheet</i>	- Consolidated welding consumables reduces paper waste and convert to access and utilize
<i>VBA User Form</i>	- Acts as an ERP database assisting the user in sorting and searching for inventory recording inventory checking availability and quantity

2.5 Key Performance Results (PE)

The bid package template preliminary results was the price quotes from Gas & Supply company after sending them the bid package template. The methodology was finding the current expenditure of Metalforms, which was obtained by multiplying the quantity of an item (i.e., Carbide Bur) with the unit price of that said item. Although Gas & Supply does not provide all of Metalforms supply needs, the ones that are offered by Gas & Supply price quotes saved an average of 7%. One notable difference was the

prices of their 3/8" Carbide Burs (a welding consumable), which were given as \$20.07 each from Gas & Supply. Metalforms averaged paying for \$26.37 for the same type of Carbide Bur. This nets in 23.89% of savings.

**PFERD 24702 Tungsten Carbide
Radius End Carbide Bur, 3/8 Inch
dia., 3/4 Inch L, Tree**

\$20.07 / each

26.37

293900 - FGM0040 - SG-3 (DC) CARBIDE BUR

For the VBA UserForm, which is an inventory database with an ERP component, there were direct time savings when utilizing the system versus the paper-based system Metalforms utilized. The Compliance Manager ran a trial of attempting to find the part numbers via the paper-based system which took a total of 420 seconds to find 10 items within the database. The VBA UserForm on the other hand took a total of 94 seconds to find 10 items within the database. The following figure shows the percentage difference in efficiency (time saved). The data was collected from a series of tests with the average time of both the old and new prototype times conducted by each member of Team Odyssey with the Compliance Manager recording the times.

time (prototype)	time (old)	Percent
14.00	48.00	343%
7.00	26.00	371%
9.00	48.00	533%
11.00	35.00	318%
18.00	91.00	506%
5.00	50.00	1000%
7.00	19.00	271%
16.00	60.00	375%
7.00	43.00	614%
94.00	420.00	447%

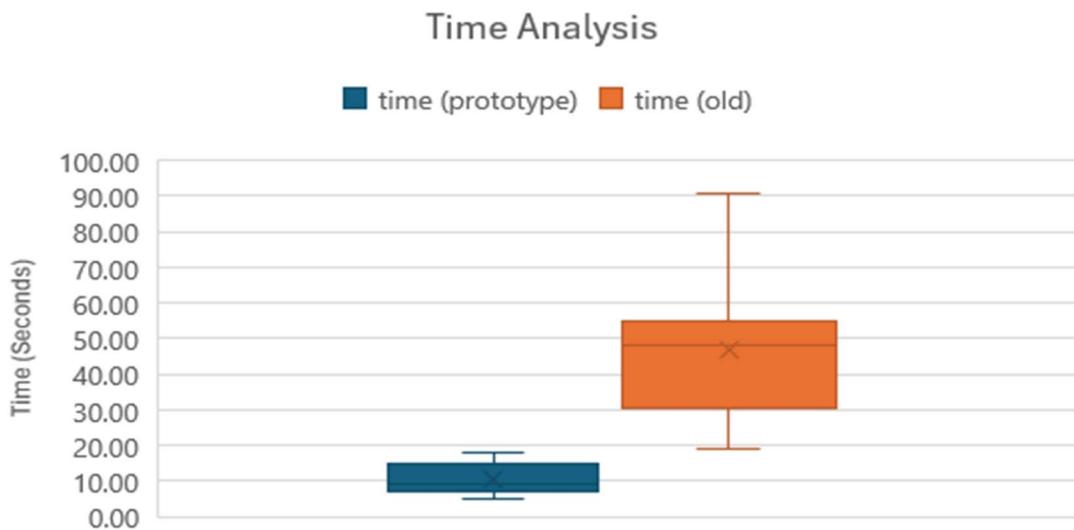


Figure 5

One non quantitative aspect of the project was using the weighted score method for the HOQ diagram. This method is considered to be qualitative due to its subjectivity from the team's priorities. This helped the team develop a criteria of which design inputs are considered to be more important.

2.6 Verification Matrix (SE – Daniela)

The prototype should have design inputs that can be testable and have target values for those tests to determine the success of the prototype. Based on the data provided to us by Metalforms we are able to construct the objectives and targets needed to be met.

Table 4: Verification Matrix

Design Input	Test Method	Pages	Test Results
Compile Consumable Data Needs to be Convent for Metalforms to Use and Access	Interval Survey	36	Yes
Prototype Must Include Part Number	Observational Test	36	Yes
Prototype Must Include Part Description	Observational Test	36	Yes
Protype Must Include Lowest Debit Amount	Observational Test	36	Yes
The Bid Package Will Include a Scope of Work Section	Observational Test	36	Yes
The Bid Package Will Include Welding Consumables	Observational Test	36	Yes
The VBA will be an Excel Macro	Observational Test	36	Yes
The VBA must include quality	Observational Test	36	Yes

2.7 Design Alternatives (SE – Daniela)

Many decisions were made throughout the design of the prototype such as database, organizing data, and data assistant (the ERP alternative). The team went through many different forms of designing a prototype to fulfill the design inputs. The team narrowed the design alternatives down to three options. Section 5.2 depicts the design functions and the options that were compared. The functions consist of what database the team could potentially use, how the data for Metalforms would be organized, normalization ensuring that all data is free from error checking data and codes used, and choosing which data assistant or ERP alternative the team would use. Ultimately going with the Microsoft Excel for the database rather than learning a new software like Infor Visual or getting familiar with Microsoft Access. Data organization we selected deleting excess data. Using a VBA UserForm was more convenient to use and customize rather than a simple macro or a conventional ERP.

Table 5: Design Decisions

Design Decision	Criteria	Decision Method	Pages
Microsoft Excel	<ul style="list-style-type: none"> - Cost efficient - Most familiar to team - Convenient to use 	Morphological Analyze Diagram	47

Deleting excess data	<ul style="list-style-type: none"> - Excess data causes confusion - Not necessary for quantity inventor 	Morphological Analyze Diagram	47
Excel VBA UserForm	<ul style="list-style-type: none"> - The most familiar coding to the team 	Morphological Analyze Diagram	47

2.8 Design Outputs (PE -Guru)

Design outputs are the results of the design process, including detailed models or drawings, specifications, and documents defining the resulting product. These outputs are critical for ensuring that all the components meet the required standards and can function as intended.

Table 6: Design Outputs

Design Output Description	Location
Bid List Package	Documentation
Bid packages for potential vendors	Documentation
VBA UserForm	Documentation
Excel Spreadsheet System	Spreadsheet

Bid List Package: A comprehensive document that consolidates consumable items from various vendors, detailing part numbers, descriptions, and purchase prices. This package is designed to streamline the procurement process and support decision-making.

VBA UserForm: An Excel-based form that serves as an interface for inventory management, helping Metalforms track stock levels and manage orders. This form functions as a simplified ERP system, facilitating data entry and retrieval. (Steve Rynearson, 8/1/24)

Excel Spreadsheet System: A centralized system for organizing and analyzing procurement data, equipped with custom macros for automating data cleaning processes. This tool ensures data accuracy and reliability, critical for effective decision-making.

Survey Feedback Results: Collected feedback from users on the ease of access and usability of the compiled consumable data, this also provides valuable insights for further improvement of the system.

These design outputs are very important to our prototype, each improving data management and procurement processes for the project.

2.9 Prototype (PE - Guru)

Our prototype is to help consolidate welding consumables procurement. The prototype serves as a critical tool for verifying the effectiveness of the proposed design before full implementation. Rather than a physical object, the prototype in this project refers to the comprehensive bid package developed for potential welding consumables vendors and our spreadsheet. This includes detailed specifications for quantities, qualities, delivery requirements, and pricing considerations tailored to Metalforms' operational needs

and constraints. The prototype allows for verification testing by evaluating vendor bids received for quality standards and vendor reliability. To document the prototype, extensive materials have been compiled and are available for review in the Design Output table.

3.0 Phase I: Project Proposal (SE-Daniela)

Section 3 is presented with the approval to consolidate Metalform's welding consumables to a single vendor, and aid in compiling bid packages. Section 3 addresses the team's approach, strategies, and objectives at this stage of the project.

3.1 Proposal Problem Statement (TM-Shilpa)

Metalforms faces challenges in efficiently managing and building a comprehensive Bid List for vendor selection. The current process is time-consuming, lacks standardization, and often results in suboptimal choices. The lack of optimization prevents Metalforms' ability to secure reliable automated data. The company requires a solution that not only automates welding operations data but also helps with the analysis and storage of vendor evaluation criteria, ensuring a data-driven approach to vendor selection. The goal is to optimize the procurement process, reduce costs, implement the use of an ERP software for data storage and future data collection. The project aims to develop a robust system that addresses these challenges and empowers Metalforms to make informed decisions, efficiency, and competitiveness in the field of metal welding.

3.2 Design Concept (TM-Shilpa)

The design concept for this project involves streamlining the vendor selection process for Metalforms through a comprehensive Bid List. The team will have to evaluate

and select the best vendor based on the constraints given by the company. To achieve this, the team will focus on developing a user-friendly database system that integrates seamlessly with the existing Excel sheet which contains the disorganized parts and vendor data. The database will facilitate efficient sorting and categorization based on key parameters such as item number, part number, description, vendor names list, quantity, and cost.

Our team will create a working model of the database system, showcasing its user-friendly interface and improved functionalities. This prototype will provide streamlined sorting and categorization features, allowing stakeholders to interact with the system and validate its effectiveness in handling the whole process.

A successful prototype will have a user-friendly and integrated database system. It should showcase streamlined sorting and categorization functionalities, effectively handling key data parameters such as item numbers, part numbers, descriptions, vendor names, quantities, and costs. The prototype should offer a clear improvement over the existing Excel sheet, by ensuring ease of use for stakeholders and by storing organized data for the future.

3.3 Proposed Design (PE-Guru Chapparapu)

The prototype our team built consists of several different components that are all built to be used together for efficient data management and procurement. A database management system, a user-friendly interface and integration with ERP software for future data collection and storage. The user interface provides access to numerous

features, which allows our team to view vendor opinions, input criteria for bids, and create detailed reports. The database management system (Excel) will have all our data stored and organized, creating a path for simple access. Integrating the ERP software should ensure that data is securely stored and can be integrated easily. Since the prototype also includes the vendor evaluation criteria, factors such as quality, reliability, and past performances can now be surveyed to see where the team could make more improvements or even changes. Our team used Excel to organize all the information that was given and arrange it accordingly based on the constraints. However, it's important to note that this design is preliminary and always evolving to meet the needs of Metalforms.

3.4 Strategies to Address Key Issues (CM - Ye Sung)

The team anticipates several major challenges in designing and implementing the bid package for Metalforms. Firstly, the team will need to conduct a thorough inventory and analysis of the current and projected welding consumables used by Metalforms across its various departments and projects. This will require collecting and organizing data from multiple sources, such as purchase orders, invoices, receipts, and inventory records. The team could also face certain challenges with utilizing data analysis tools, such as Excel and Minitab. If team members are not familiar with working with spreadsheets and ERP software, the other team members will assist and provide the necessary information to compile and process the data to generate a comprehensive list of welding consumables required by Metalforms.

Then the team will need to design and prepare a bid package that clearly communicates the needs of the company to potential vendors. Several team members

have no experience with bid packages. To circumvent the lack of experience, a bid package template was created by Ye Sung to highlight the potential needs of the company. The bid package will be created with the consultation of Metalforms' procurement team or any other necessary departments to ensure compliance with relevant policies and regulations.

Table 7: Key Issues and Strategies

Key Issue	Strategy
Taking inventory of welding consumables is time-consuming.	Use data analysis tools to compile and process the data while having several team members tackle to quicken the process.
Team members don't have the same level of experience with Excel and/or related data compiling software.	Team members with more experience in Excel will help team members with less experience to get help.

3.5 Technical Approach (PE - Guru Chapparapu)

The team used our range of skills and tools for building the system's different components. The major ones being the database system (Excel), user interface, and algorithms for vendor evaluation. Database management skills for storing and organizing data. The team showed expertise in data analysis by extracting information from the procurement data to drive efficient streamlining of the information. The integration of the ERP software in the project our team implemented required us to learn more about APIs and middleware technologies. The team's ability to communicate was vital to be able to effectively share our insights and opinions to convey recommendations, possibly

negotiate certain terms on the Bid List template, and ensure that the team is lined with Metalforms' objectives throughout the project. Our teamwork skills were also necessary for integrating the various components into a whole working prototype. This I believe showcased the ability of our team to meet Metalforms' challenges and provide them with insight to make procurement decisions efficiently and as accurately as possible in the metal welding industry.

3.6 Proposal Budget (PM) Justin

The funding for this project from the college (Lamar University) is valued at \$0, however the students will have to cover costs in the trip to Metalforms. However, the team will need to discuss with Professor Kelly to cover gas costs and lunch if we as a team travel to the Metalforms facility would be vary from \$185-225 from the college. That for each individual would be at the cost of gas and a \$20 food voucher in addition to a \$25 gas cost which would be a \$0.162/mile to and from Houston for online students to travel to the Metalforms facility. The student living in the Dallas-Fort Worth metropolitan area will receive \$56.70 using the same methodology from earlier. The students who live in Lamar would receive a \$3.24 for gas.

3.7 Project Management (PM) Justin

Everyone has agreed on putting in accountability and obligation for Metalforms to get the best and accurate product in order to submit the winner of the bid to fulfill Metalforms obligations. As a Project Manager, I take the time and input the data in the Excel sheet just like some software programs like Workday, SAP, or ADP provide the hours the individual is to work and what they actually worked that is where I put the

Project Labor Graph. The Gnatt Chart Schedule is where the Project Manager puts in an activity that the team is working on and plan the days in the week vs the actual days the team has worked in that week.

At the Weekly Team meeting we just recap what we did the previous week, talk about the waste to Lean out the fabrications of this project and develop a six-sigma way of managing the data we received from Metalforms in the duration of this semester. We talk with Lead Engineer Jeremy from Metalforms and Professor Kelly about the roundabout and what's going on with the project.

3.8 Risk Management Plan (CM) (Ye-Sung)

There are several potential issues that could negatively impact team performance. First, Ye Sung Sohn has military obligations as a reservist, during which he will work a minimum of 14-hour days. To mitigate this, he will notify the team of his drill schedule at least a few days in advance and complete any necessary tasks required by the CM beforehand. Furthermore, Shilpa is working full-time and has commitments to her family that could take priority. The team can ensure that Shilpa's workload is balanced to provide flexibility to accommodate unexpected situations. Additionally, Shilpa will communicate her availability and potential challenges and develop plans with the team if she faces any issues. The remaining members did not share any other potential issues that could have a negative impact on team performance.

Table 8: Risk Management Plan

Risk	Mitigation
Ye Sung's Military Obligations	Ye Sung will notify the team a few days in advance and complete any necessary tasks required by the CM beforehand.
Shilpa's time commitments to work and family	Communicate her availability and potential challenges regarding her work and family.

3.9 Plan for Preliminary Investigation (PM) Justin

During this project, we have discovered that we are to fulfill an Excel sheet that will prescribe us to submit an outcome of who is going to be the best to complete the bid of this project for Metalforms. In order to do that we must have an honest and non-biased opinion to fully understand that this will affect the way Metalforms decides on picking the company for their project. According to *OAS* (May 2009), “The evaluation work must be strictly conducted on a basis of impartiality and fairness, with due attention to considerations of economy, efficiency, transparency, and non-discrimination among eligible bidders, which are general principles laid down by Procurement Act and Regulations 2003.”

We as Team Odyssey will give our full open-minded thoughts to conduct an unbiased evaluation amount to help Metalforms pick the right candidate for them. In addition to optimizing the Bid List creation, the team will design a system for observing the current process, ensuring a thorough understanding of workflow inefficiencies, and identifying opportunities for improvement.

3.10 Phase I Approvals (All)

Section Approval Form

Team Name: Odyssey Driven

Project Name: Metalforms

Section Number and Title: Section 3.7, 3.9, 3.10, 3.6 and Review

I have read this section and approve the final version presented here.

Printed Name: Justin Hernandez

Role: Project Manager

Signature: 

Date: 2/25/2024

Section Approval Form

Team Name: Odyssey Driven

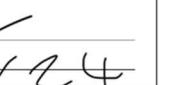
Project Name: Metalforms

Section Number and Title: _____

I have read this section and approve the final version presented here.

Printed Name: Guru Chapparapu

Role: PE

Signature: 

Date: 2/25/24

Section Approval Form

Team Name: Team Odyssey

Project Name: _____

Section Number and Title: _____

I have read this section and approve the final version presented here.

Printed Name: Ye Sung Sohn

Role: Compliance Manager

Signature: 

Date: 02/20/24

Section Approval Form

Team Name: Odyssey Driven

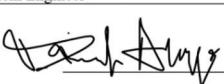
Project Name: Metalforms

Section Number and Title: Section 3.0 Phase I

I have read this section and approve the final version presented here.

Printed Name: Daniela Arroyo

Role: System Engineer

Signature: 

Date: 8/4/24

Section Approval Form

Team Name: Odyssey Driven

Project Name: _____

Section Number and Title: O.1 Proposal Problem Statement and O.2 Design concept

I have read this section and approve the final version presented here.

Printed Name: SHLPA MARY CHERIAN

Role: Technical Manager

Signature: 

Date: 02/24/2024

Table 9: Table of Changes to Project Proposal

Change	Location
The design concept has been updated by adding more details on the comprehensive Bid List.	Section: 3.2
The table was updated by making it more specific on the problems and strategies to overcome these challenges. For 3.8, the section was modified to make Shilpa's situation less personal.	Sections: 3.4 & 3.8
The quote was sourced and followed with an in-text citation.	Section 3.9
Updated the verbiage and manage to remove the waste that should have been in Section 3.10	Section 3.7 & 3.9

3.11 Project Proposal Review Summary (CM – Ye Sung)

Presently only the proposal for the project has been shared with the faculty mentor. Regarding the Excel file with all the welding consumables included, updates have been given to Jeremy from Metalforms. There were several concerns that were addressed during the review of the project proposal. In sections 3.4 and 3.8, there were concerns that a team member's situation was too personal for the project, so we made a revision to make it vague. Sections 3.1 and 3.2 were also raised during the review process of the proposal. Suggestions made by Dr. Bradley prompted a revision to talk about the actual Bid List more than the ERP software.

In section 3.9, a concern was raised about directly sourcing from another website and not citing it properly. The team went over how to properly cite sources through the references

in an APA format and followed it with an in-text citation directly next to the paraphrased or directly sourced quote.

4. Phase II: System Design (TM-Shilpa)

The deliverables for this project were the fully sorted Excel sheet, a comprehensive Bid package using our team's Bid List template, and an external ERP software implementation. However, the System Design section will remain the same as a historical document.

4.1. Preliminary Investigation (SE – Daniela)

According to Verghese (2023), the global market for welding consumables in 2023 was valued at about \$18.02 billion (about \$55 per person in the US) and is expected to reach a worth of \$ 32.27 billion by 2033. Welding consumables is a wide industry driven by technological advancements, increasing demand of infrastructures across multiple fields, and emphasizes on the quality of products and safety. This growing industry does have some challenges, for example, the increased price of raw materials due to the decrease in availability creates the complication of increasing budgets to purchase the raw material and, increasing end product price just to maintain the same profit for the company. Another complication in the industry is the scarcity of skilled labor, most of the welding that is performed in this industry is done by manual labor this issue then presents the question if the manual labor can be automated by machinery, in the case of Metalforms this is not an option because the welds they perform are catered to different projects. Which terminates the option for them to automate all their welding processes. The reason behind it is due to the complexity of welding demands. Automated

welding systems, such as robots, are designed to perform very specific tasks. In a statement made by Randy Williams (2020, April 6), if the task varies even slightly, the robot will have to be reprogrammed for an entirely new task. According to Mason (August 4, 2022), there are several types of welding processes, each with its own set of consumables. One that is particularly useful to note is the gas metal arc welding. This process uses a consumable wire electrode and shielding gas. It can be suggested that Metalforms engage in this type of process by their utilization of consumables such as the ER70S-6 wire.

The graph below is based on a thought experiment on the database that we are using for the prototype. As a team we are observing the database that will consolidate the welding consumables. The main issues that could come into play would be that data could be difficult to read, data could be duplicated, data could be deleted, and data could be incorrect. The biggest concern could be that that data is difficult to read because we want the database to be as convenient for Metalforms to navigate, ultimately to serve its purpose. This issue is to be mitigated by consolidating the data that was provided by Metalforms into a format that will organize the data into a digestible amount of data that will consist of Brand reference number, description, part number, lowest debit with this format it will allow the data to be effortlessly digestible.

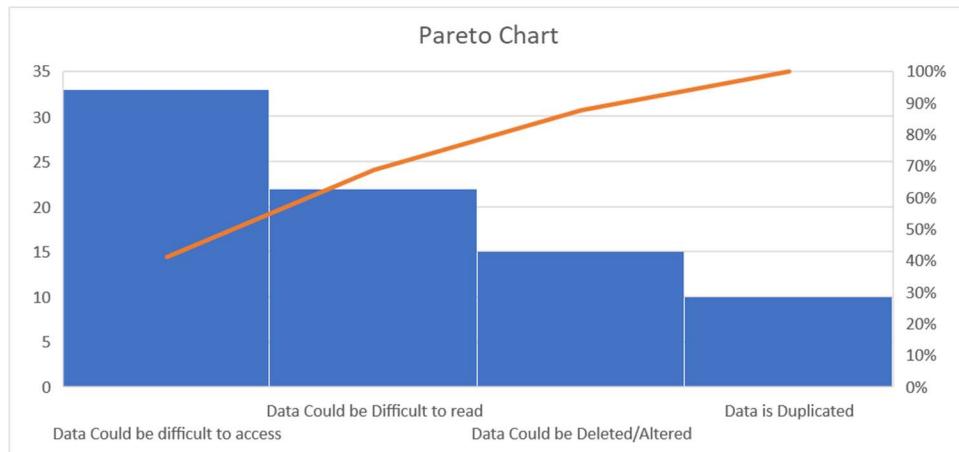


Figure 7

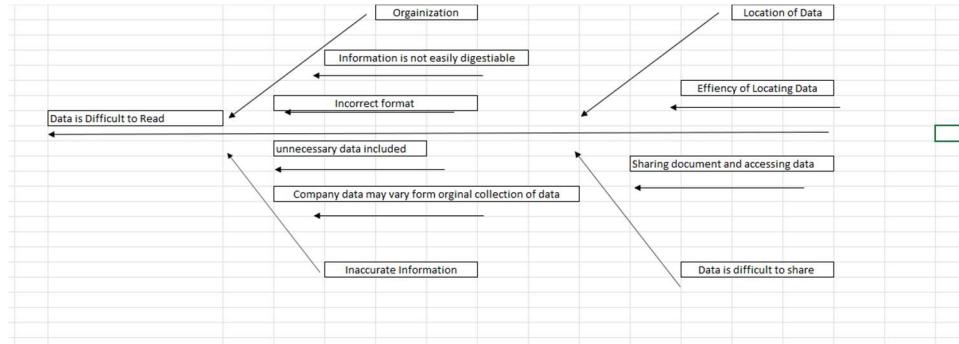


Figure 8

Metalforms currently specializes in custom engineered and fabricated Shell & Tube heat exchangers, which are devices that transfer heat between two fluids. It comprises of a shell with a bundle of tubes inside it. They also construct ASME pressure vessels while also offering maintenance, repair, and replacement services of welding equipment (Metalforms). With the current array of products and services Metalforms is offering, it is no wonder they are looking to further optimize their business by consolidating consumable purchases to a single vendor. A few advantages are cost savings, improved vendor relationships, and greater efficiency. By purchasing from a single source, Metalforms can negotiate better deals and buy in bulk resulting in higher

purchasing power (Vecchio, L. D., 2022, November 29). This also means fewer invoices, contracts, and complexity that increases business risk (Ella Paul). However, the disadvantages are the lack of flexibility and the risk of dependence on a single vendor. If a need arises and Metalforms must switch vendors for reasons such as supply, quality drop, or financial circumstances, Metalforms will be limited in flexibility due to locking in with a single vendor.

4.2 Regulations and Standards (CM – Ye Sung)

There is one standard that is relevant to our design and must be adhered to. It is identified through a letter list below.

- A. *The American National Standard for the structural welding code of steel (AWS D1.1/D1.1M:2020).*

This code covers the requirements for the design, procedures, qualifications, inspection, and repair of steel structures. This includes tubes, plates, and pipes. It is important to source from vendors that meet the standard set for safe operation for Metalforms. Several important factors are allowable stresses, welding qualifications, and heat treatments (AWS, 2019). Methods that can be used to prove adherence to the AWS standard are providing documentation on allowable stresses and using markings on their products to prove compliance. These methods used in conjunction and factoring in price sensitivities of Metalforms can allow for better selection for awarding the contract.

4.3 Design Inputs (SE – Daniela)

Metalforms has tasked our team to assist with creating a prototype that consolidates all of their welding consumables to a single vendor. The Team's major objectives consist of identifying and consolidating qualifying consumables, compiling bid packages for potential vendors, and evaluating bids.

1. Compiled consumable data needs to be easier for Metalforms to access compared to their older compiled spreadsheet. A survey will be conducted to find results.
2. Must include consumable part number
3. Prototype Must Include Part Description
4. Prototype Must include part lowest debit amount
5. Bid List will Include a Scope of Work Section
6. Bid list will Include Welding consumables
7. The VBA will be an Excel macro
8. The VBA Must Include Quantity

The strategy that the team used to ensure the design inputs are testable for the prototype to ensure success consist of referring to the objectives the team was tasked with, starting out with a broad goal and funneling to a design input but, ensure that there was enough ambiguity within each design input, and writing down detail explanation of prototypes and ask “why” there is a need for the specific abilities.

4.4 Prototype Features (PE – Guru Chapparapu)

1) Bid List:

- Scope of Work:
 - o Feature: Clearly define Metalform's need for a single vendor to provide welding consumables.
 - o Description: Shows Metalform's primary objective, providing potential vendors with a clear understanding of the project and its requirements.
- List of Welding Consumables:
 - o Feature: Include a comprehensive list of welding consumables, along with quotes and specifications. (e.g., Welding Electrodes, Welding Wires, Welding Gases)
 - o Description: This feature shows potential vendors with a detailed inventory of required welding consumables, ensuring bids are tailored to Metalform's specific needs.
- Quality Requirements:
 - o Feature: Specify quality requirements for welding consumables, emphasizing industry standards.
 - o Description: This feature ensures that potential vendors understand the level of quality expected for welding consumables.
- Delivery Requirements:

- Feature: Delivery requirements include lead times, packaging, and associated costs.
 - Description: This feature helps the bid evaluation process by clearly communicating Metalform's logistical requirements for delivery, ensuring potential vendors can accurately assess their capability to meet these requirements.
 - Bid Submission Instructions:
 - Feature: Provide detailed instructions for bid submission, should include detailed pricing, product specifications, include deadlines and any additional terms or conditions.
 - Description: Clear and specific bid submission instructions ensure a transparent and structured bidding process for Metalforms.
 - Evaluation Criteria:
 - Feature: Assess vendor bids, include cost competitiveness, product quality, delivery capability, and vendor reputation.
 - Description: Evaluation criteria ensure that vendor selection is based on allowing for objective assessment and comparison of bids.
- 2) *Color Coat Duplicates:*
- Once duplicates are identified, you can color coat them based on the number of times they repeat on the list.

3) *Identify Duplicates:*

- Use Excel's built-in functionality to identify duplicates in your data pool.
(University of Mary Washington, 2015).

4) *Incorporation of Part Numbers and Descriptions:*

- Feature: Include columns for consumable part numbers
- Description: Feature ensures that each consumable is accompanied by its corresponding part number.

5) *Integration of Price Information:*

- Feature: Incorporate a column for consumable prices.
- Description: Each consumable will be associated with its purchase price, providing Metalforms with clear pricing information.

The Bid List and the related features serve to streamline Metalform's procurement process for welding consumables. It begins with a clear Scope of Work, defining the company's need for a single vendor. The List of Welding Consumables offers a detailed inventory, aiding vendors in tailoring bids. Quality Requirements ensure adherence to industry standards, while Delivery Requirements provide clarity on logistics. Bid Submission Instructions ensure transparency and structure in the bidding process. Evaluation Criteria enables objective assessment of bids. Additionally, features like Incorporation of Part Numbers and Descriptions and Integration of Price Information enhance organization and

clarity. Lastly, the ability to Color Coat and Identify Duplicates aids in data organization and analysis, further optimizing the bidding process.

4.5 Quality Function Design (SE – Daniela)

The house of quality (HOQ) diagram is a diagram that establishes goals and aids with defining customer needs. In this example the company has tasked our team to create a database that consolidates Metalform's welding consumables to a single vendor and aid in preparing a bid list package for potential vendors. The HOQ diagram consists of the design inputs that are met to ensure the success of the project, the needs which are what the company is requiring from the project, and the design inputs targets which is the characteristics of the product the company wants.

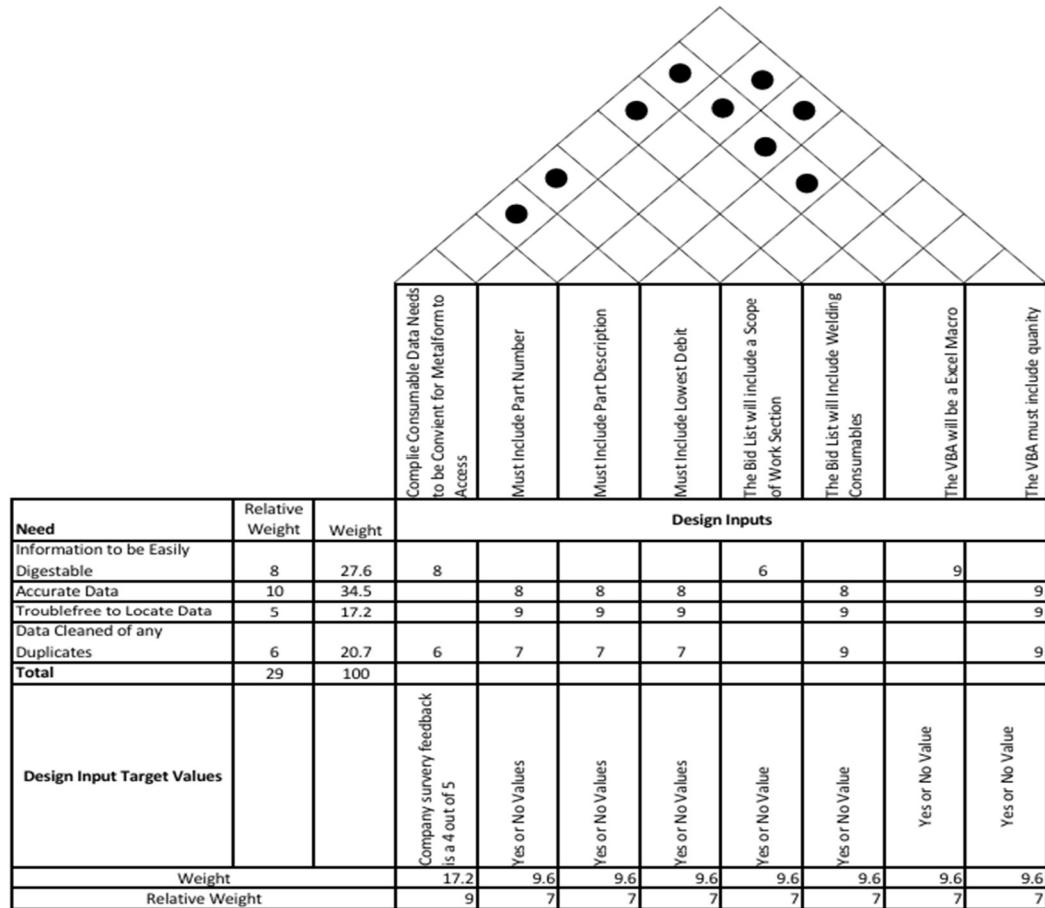


Figure 9

4.6 Design Input Verification Testing (SE- Daniela & CM – Ye Sung)

For most of the design input a verification test to define the prototype as successful would be as simple as an observation test for instance 2. Must include consumable's part number, 3. Must include consumable's description, 4. must include price of purchase consumable could be tested with a simple observation of the prototype. Design input 1. complied consumable data needs to be easy for Metalforms to access to test this design input for success the team would create a survey for Metalforms to voice their opinions on if the database is convenient to navigate. Specifically, the survey will be

internally by completing 5 tasks using a mockup of the binder and the same 5 task using the prototype. Aiming for 4 out of 5 tasks being more efficient by the prototype.

4.7 Prototype Feature Qualification (PE)

Validation Testing: While validation testing to confirm the final product's alignment with Metalform's needs is beyond the scope of our senior design project, for now, we will validate the accuracy and relevance of our prototype's features through feedback loops with Jermey and Cynthia. This will involve ongoing communication and collaboration to ensure that the prototype effectively addresses Metalform's procurement challenges.

Verification Testing: Verification testing will focus on ensuring that the prototype meets the specified design inputs. For example, we will verify that the list of welding consumables accurately includes correct part numbers and price information as outlined in Metalform's requirements. We will conduct checks and reviews to make sure that the prototype aligns with the defined criteria.

Qualification Testing: Qualification testing will entail a more detailed examination of individual components to ensure they function as intended. Specifically, we will conduct qualification tests on the accuracy of part numbers and prices for welding consumables. This will involve cross-referencing information from multiple sources, including manufacturer specifications and internal records, to validate the correctness of data. Additionally, we will implement data validation checks within our Excel spreadsheet to prevent input errors and ensure data integrity.

Through these testing processes, we will ensure that the components of our prototype not only meet Metalform's needs but also function accurately and reliably.

4.8 Validation Testing (PM) Justin

Under this project we have to determine that the validation is not possible for this as there is no original bid that we could compare this with. As we are assisting Metalforms to collect the data and restructure the design of how the bid will look. In order for Jeremy to give his managers what is needed to claim a bid that is best for Metalforms. This is outside the scope of our project to validate any tests.

4.9 Phase II Approvals (All)

<p>Section Approval Form</p> <p>Team Name: <u>Odyssey Driven</u></p> <p>Project Name: <u>Metalforms</u></p> <p>Section Number and Title: <u>Section 3.7, 3.9, 3.10, 3.6 and Review</u></p> <p>I have read this section and approve the final version presented here.</p> <p>Printed Name: <u>Justin Hernandez</u></p> <p>Role: <u>Project Manager</u></p> <p>Signature: </p> <p>Date: <u>2/25/24</u></p>	<p>Section Approval Form</p> <p>Team Name: <u>Odyssey Driven</u></p> <p>Project Name: <u>Metalforms</u></p> <p>Section Number and Title: _____</p> <p>I have read this section and approve the final version presented here.</p> <p>Printed Name: <u>Guru Chapparapu</u></p> <p>Role: <u>PE</u></p> <p>Signature: </p> <p>Date: <u>2/25/24</u></p>
<p>Section Approval Form</p> <p>Team Name: <u>Team Odyssey</u></p> <p>Project Name: _____</p> <p>Section Number and Title: _____</p> <p>I have read this section and approve the final version presented here.</p> <p>Printed Name: <u>Ye Sung Sohn</u></p> <p>Role: <u>Compliance Manager</u></p> <p>Signature: </p> <p>Date: <u>02/20/24</u></p>	<p>Section Approval Form</p> <p>Team Name: <u>Odyssey Driven</u></p> <p>Project Name: <u>Metalforms</u></p> <p>Section Number and Title: <u>Section 4.1,4.3,4.5,4.6</u> <input type="checkbox"/></p> <p>I have read this section and approve the final version presented here.</p> <p>Printed Name: <u>Daniela Arroyo</u></p> <p>Role: <u>System Engineer</u></p> <p>Signature: </p> <p>Date: <u>8/4/24</u></p>
<p>Section Approval Form</p> <p>Team Name: <u>Odyssey Driven</u></p> <p>Project Name: _____</p> <p>Section Number and Title: <u>Q.1 Proposal Problem Statement and Q.2 Design concept</u></p> <p>I have read this section and approve the final version presented here.</p> <p>Printed Name: <u>RILPA MARY CHIRAN</u></p> <p>Role: <u>Technical Manager</u></p> <p>Signature: </p> <p>Date: <u>02/24/2024</u></p>	

Figure 10

Table 10: Table of Changes to System Design

Change	Location
The paragraph was updated with information on how the team can monitor compliance with the regulation.	Section: 4.2
Design input 3 was given a more thorough explanation of how the survey will be a useful design input.	Section: 4.3 & 4.6

More preliminary research has been done. Information pertaining to the project has been added and the Parato chart has been updated.	Section: 4.1
The paragraph was reworded and inputted more details that a validation is not possible.	Section 4.8
Features of Bid List and design inputs were added, and section was redone. Redid 4.7 and included verification, validation, and qualification testing and made sure the prototype meets the design inputs.	Section 4.4 and 4.7
The Pareto Chart and Fish Diagram were corrected	Section 4.1
The House of Quality diagram was added	Section 4.5

4.10 System Design Review Summary (CM)

The completed Excel spreadsheet that focused on the 6150 tab was presented to Jeremy and Cynthia, alongside the bid package template. Section 4 was presented to Dr. Bradley and several concerns were raised based on the review. One was to be more specific how the regulations are being maintained and compliant with the regulations stated. Sections 4.3 & 4.6 were also brought up. Changes were deleting the first design input, explaining input #3 thoroughly to define it properly. For the preliminary research, concerns regarding the number of sources and information pertaining to the project were raised. The charts were also in need of updating. These concerns were promptly addressed by the team. Section 4.4 was entirely revamped and more in line with the design inputs and goes in-depth on the features of our prototype, which is the Bid List

package and the Excel sheet. Finally, a concern on 4.8 was made due to grammatical errors and the general direction of the section wasn't pointing at a right direction. It was changed with the prospect that validation is not in the scope of this project.

5.0 Phase III: Preliminary Design (TM- Shilpa)

The preliminary design deliverables for this project are an Excel sheet with sorted data, the comprehensive bid list, and the implementation of an ERP database as the company currently uses a ring binder to store all welding consumables data. The team had planned to complete the spreadsheet by splitting up the data among teammates. The team has been working at an accelerated pace and has already created the spreadsheet. The quality assurance for the spreadsheet has been completed by each member of the team to make sure that the sorted sheet matches the company demands. The team plans to present this data at the coming weekly meeting with the company representatives. Work for the Bid List will be started once the team receives feedback from the company representatives on the sorted Excel sheet. Merging the welding consumable data into an ERP database would be the final step to follow.

5.1 Functional Block Diagram (PE - Guru)

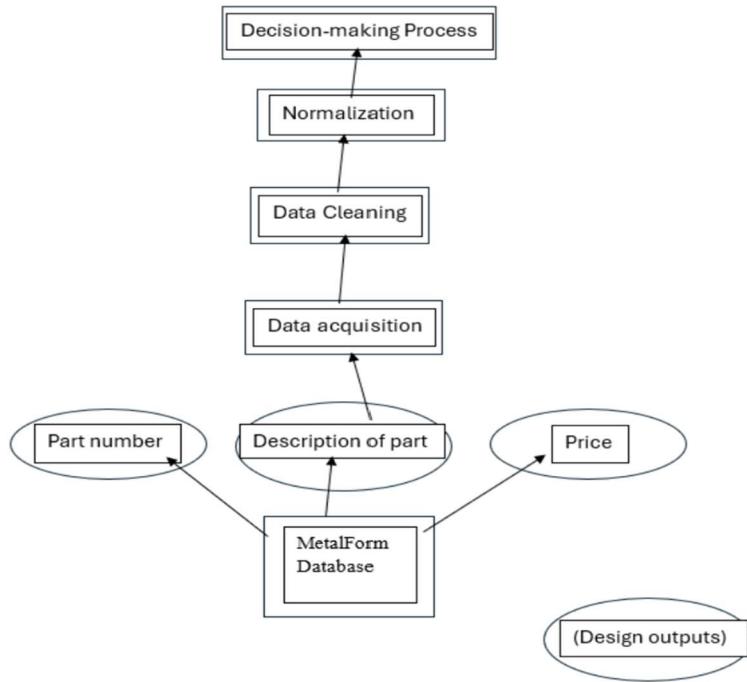


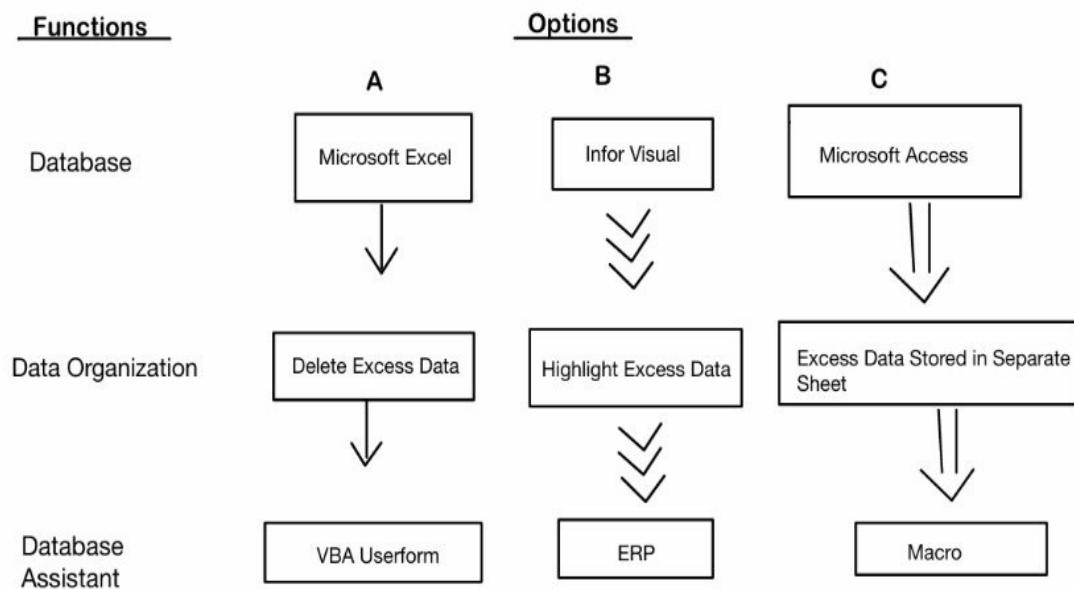
Figure 11

We receive information from Metalforms database which consists of excess information in which we must extract the part number, the description of the part, as well as the price of each part. Additionally, we also receive information from Metalforms employees, whom we have been working with throughout the project, which helps aid the data acquisition. The data cleaning block represents the acquired data being organized in a way that pleases Metalforms. For example, we can be told to not include any items from certain vendors or certain parts and even possibly a certain price range. The normalization block represents us ensuring that all the data is free from error by cross-checking through multiple sources as well as implementing custom Excel macros to check for repeated data. The decision-making block represents Metalforms using all the information we gathered

including our Bid List template to make calculated decisions based on their requirements.

5.2 Morphological Analysis and Decision Matrix (SE – Daniela)

A morphological analysis is the process of looking at potential solutions to complex, multi-factor, unquantifiable problems. The morphological analysis purpose is to take a problem and dissect it into its most fundamental components, or forms, when there are numerous known solutions. The function block diagram aids with indicating what the components are supposed to do without defining the exact part, while the morphological analysis diagram aids with creating alternative design inputs. The morphological analysis then is put into a decision matrix that aids with the ultimate decision for the team the option with the highest total ranking is the decision that will allow us to meet the design input target values and make the prototype successful.



Design Inputs	Weight
Complie Consumable Data Needs to be Convient for Metalform to Access	12
Must Include Part Number	12
Must Include Part Description	12
Must Include Lowest Debit	12
The Bid List will include a Scope of Work Section	11
The Bid List will Include Welding Consumables	15
The VBA will be a Excel Macro	13
The VBA must include quantity	13
Total	100
Total Weighted Rankings	

Design Alternative A		Design Alternative B		Design Alternative C	
Average Rank	Weighted Rank	Average Rank	Weighted Rank	Alternative Rank	Weighted Rank
7	84	3	36	5	60
7	84	4	48	7	84
7	84	8	96	7	84
7	84	7	84	4	48
6	66	9	99	3	33
10	150	7	105	9	135
7	91	7	91	7	91
7	91	7	91	7	91
	734		650		626

Figure 12

5.3 Preliminary Design Description (PE - Guru)

1. Metal Form Database

- Software: Receive data through Excel from Metal Forms
- Process: Manual data collection by extracting the part number, the description of the part, as well as the price of each part while cleaning original Metal Forms given data sheet on welding consumables. We also receive information on

vendors, pricing updates, parts, and more from Metal Form employees, Jermey and Cynthia.

2. Data Acquisition

- Software: Custom data acquisition through Excel from Metalforms
- Process: Manual data collection by extracting the part number, the description of the part, as well as the price of each part while cleaning original Metal Forms given data sheet on welding consumables. We also receive information on vendors, pricing updates, parts, and more from Metal Form employees, Jermey and Cynthia.

3. Data cleaning

- Software: Custom data acquisition through Excel
- Process: Data cleaning represents the acquired data being organized how Metal Forms would like the data organized. For example, we can be told not to include any items from certain vendors or certain parts and even possibly a certain price range to ensure we meet the objective set by Metal Forms.

4. Normalization

- Software: Excel
- Process: The normalization block represents us ensuring that all the data is free from error by cross-checking through multiple sources as well as implementing custom Excel macros to check for repeated data. We want to ensure any data they

don't want on the sheet isn't included by mistake as well as making sure to gather and include all the necessary information. (Vendors, parts, prices, part numbers, etc.)

5. Decision-making process

- Software: Using Excel for decision-making based on vendor evaluation results.
- Process: Utilize vendor evaluation outcomes and our Bid List, which includes a list of the welding consumables, quality, and delivery requirements, etc. to make informed decisions on vendor selection.

5.4 Failure Mode Effects Analysis (TM- Shilpa)

The Failure Mode Effects Analysis table identifies any potential failures in a design (ASQ, 2019). It is displayed below. There are four components: Part numbers, Price, Data Collection and Description. The component Price has the most severity and the highest likelihood of occurrence since automated price updates can only be implemented through a commercial ERP software. Once the mitigation is complete, the risk is low. The component Part numbers having duplicates has a very high severity due to risk of repurchasing. Since the team has done a great work on quality assurance, the likelihood of occurrence is low. Description misplacement also triggers the risk of repurchase but has low risk once the mitigation plans are implemented. Accidental deletion of the data collection spreadsheet is also a high severity component but the likelihood of occurrence and potential risk after mitigation is significantly lower.

ID Number	Component	Potential Failure Mode	Potential Effects of Failure	Severity, S	Potential Cause of Failure	Likelihood of Occurrence, O
2	Communication with MetalForms	No shows/ no responses by Company Reps	No updates/ feedback for team	9	Company reps repeat no showing up for weekly meetings and not communicating effectively.	9
3	Data Collection	Misplacement	Loss of sorted data	5	mistyping, accidental deletion or saving by teammates	2
4	Bid List Template	Reject by the company	Rework/ Skip	3	Changing demands of the company	8

Controls Designed Into Your Prototype For Detecting Failure Before Problems Occur	Likelihood of Detection, D	Risk Priority Number, RPN	Mitigation Recommended	Potential Severity After Mitigation, pS	Potential Likelihood of Occurrence After Mitigation, pO	Potential Likelihood of Detection After Mitigation, pD	Potential Risk	Priority Number after Mitigation, pRPN
Sending remainders	1	81	Onsite visits	9	8	1	72	
Quality assurance by all teammates	1	10	Copies saved	1	1	1	1	
Constant communication with the company	2	48	New template	1	1	1	1	

Figure 13

5.5 Health and Safety Plan (CM – Ye Sung)

This is a mostly computer-based project. The biggest health and safety concerns are the risk of wrist injuries and carpal tunnel syndrome. The best method is to implement human factors ergonomics, specifically with posture. The team is advised to adjust chair height to have it where their eye height is facing about 10 degrees down to the computer. Their laptop or monitor should be at arm's length. To avoid excessive repetitive movements, they are encouraged to move every 15 minutes and to physically get up every hour (Mark Lehto, 2013). It is also recommended to keep shoulder alignment

squared rather than being hunched forward. Not following these ergonomic guidelines can contribute to straining down your entire arm, including your wrists and hands. The following posture guide created by Ye Sung Sohn shows the most ergonomic posture while working on a computer.

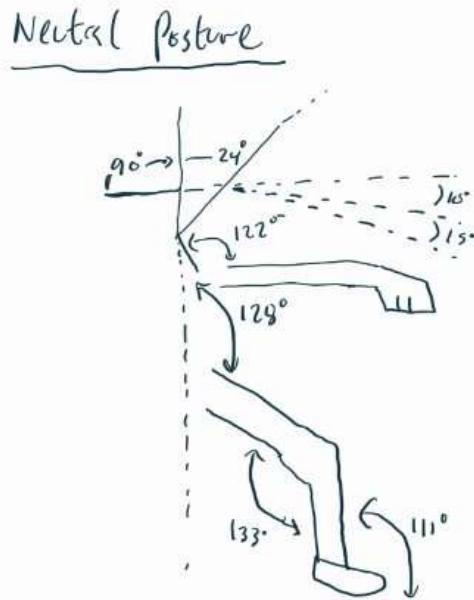


Figure 14

5.6 Environment, Societal, and Cultural Considerations (CM – Ye Sung)

Currently, the system Metalforms utilizes is all-paper based off their Excel spreadsheets. Environmental impacts stemming from this project can lead to paper reduction as an online database reduces the need for physical printouts. This digital interface plays a part in the overall goal of consolidating all the welding consumables to a single vendor by making the raw data easier to compile and digest. Another environmental impact will be the reduction of shipments and emissions by consolidating to a single vendor. Transportation logistics will be simpler and shorter, leading to less

fossil fuels being consumed. Instead of multiple locations being ordered from, it will be from a single location that has the best overall cost, efficiency, and quality standards. This ties into societal impact, where the previous suppliers will lose business with Metalforms. Although Metalforms isn't a mega-corporation, losing a client like Metalforms could potentially impact jobs in the local area. To offset this impact, our team will be giving further consideration to businesses owned by the local community and foster community spirit through its support and inclusion of marginalized communities. Another impact is through cultural means. This project has collaboration with several members of Metalforms. This can have a shift in organizational culture, which can promote the difference in work norms. The prototype will make it more accessible for employees to access data outside of the workplace, with the ability to be accessed by multiple employees at the same time. This is in comparison to their all-paper data system, where it can only be accessed in the workplace by one person at a time. An example by (Kerssens, 2018) further shows the cultural impact of the digitalization of data. This provides ordinary users that are non-programmers more freedom in relating stored items of data to take-away meaningful information, while reducing their dependence upon programmers.

5.7 Schedule for Phase IV (PM- Justin)

During phase IV, we have collected all of the information and data to pursue the next opportunity:

- Having the ERP database that Metalforms uses and delivering it to other vendors.
This will be done when the Bid List starts being created.

- We configured from Section 5.2 that Option A would be a better choice due to the single vendor that can provide all welding consumables would reduce stress and cost savings as buying bulk pieces of the welding consumables.
- The Bid List will start being compiled whenever Jeremy and Cynthia finish processing the 6150 data worked on by Team Odyssey. The timeline for this is approximately between the end of April to the beginning of May.
- Given another binder full of data we will have transferred over to doing the same implications that we had done during the semester.
- Received feedback and comments on the Bid List of 6150.
- Metalforms Engineers want to continue the partnership throughout the summer with Team Odyssey Driven.
- In addition, the Team is going to remain intact for the next class in Senior Design in Summer 2024.

5.8 Phase III Approvals (All)

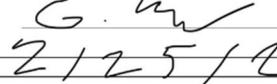
<p>Section Approval Form</p> <p>Team Name: <u>Odyssey Driven</u></p> <p>Project Name: <u>Metalforms</u></p> <p>Section Number and Title: <u>Section 3.7, 3.9, 3.10, 3.6 and Review</u></p> <p>I have read this section and approve the final version presented here.</p> <p>Printed Name: <u>Justin Hernandez</u></p> <p>Role: <u>Project Manager</u></p> <p>Signature: </p> <p>Date: <u>2/25/24</u></p>	<p>Section Approval Form</p> <p>Team Name: <u>Odesey Driven</u></p> <p>Project Name: <u>MetalformS</u></p> <p>Section Number and Title: _____</p> <p>I have read this section and approve the final version presented here.</p> <p>Printed Name: <u>Guru Chapparapu</u></p> <p>Role: <u>P E . m</u></p> <p>Signature: </p> <p>Date: <u>2/25/24</u></p>
<p>Section Approval Form</p> <p>Team Name: <u>Team Odyssey</u></p> <p>Project Name: _____</p> <p>Section Number and Title: _____</p> <p>I have read this section and approve the final version presented here.</p> <p>Printed Name: <u>Ye Sung Soh</u></p> <p>Role: <u>compliance Manager</u></p> <p>Signature: </p> <p>Date: <u>02/20/24</u></p>	<p>Section Approval Form</p> <p>Team Name: <u>Odyssey Driven</u></p> <p>Project Name: <u>Metalforms</u></p> <p>Section Number and Title: <u>Section 5.2</u></p> <p>I have read this section and approve the final version presented here.</p> <p>Printed Name: <u>Daniela Arroyo</u></p> <p>Role: <u>System Engineer</u></p> <p>Signature: </p> <p>Date: <u>8/4/24</u></p>
<p>Section Approval Form</p> <p>Team Name: <u>Odyssey Driven</u></p> <p>Project Name: _____</p> <p>Section Number and Title: <u>Q.1 Proposal Problem Statement and Q.2 Design concept</u></p> <p>I have read this section and approve the final version presented here.</p> <p>Printed Name: <u>SHILPA MARY CHERIAN</u></p> <p>Role: <u>Technical Manager</u></p> <p>Signature: </p> <p>Date: <u>02/24/24</u></p>	

Figure 15

Table 11: Table of Changes to System Design

Change	Location
Restructured the whole section for Phase IV	5.7
Restructured the morphological analysis and added the decision matrix	5.2
Added a picture guideline to follow	5.5

Included a more nuance societal and cultural impact on Metalforms	5.6
Added correct function block diagram and updated description	5.1
Updated the preliminary design description based on the functional block diagram	5.3
Rewrote section to model a planning phase	5.0

5.9 Preliminary Design Review Summary (CM)

Section 5 was presented to Dr. Kelly, which starts to form a concrete building block of what the prototype will look like and the work that is being done at that stage. The data in the Excel spreadsheet that was finalized was also sent out to Jeremy in Metalforms, who is now reviewing the data and will give further instructions on the Bid List package when ready. Several concerns were pointed out during the review stage of the preliminary design. In section 5.6, there was not enough information or the right scope regarding the impacts the prototype has. It was revised to provide full clarity of the environmental, societal, and cultural impacts the prototype will have. Another concern that was raised was for section 5.7, as it didn't provide a plan for phase IV, which is when the team will create the prototype. A revision was made that provided a plan on how and when Team Odyssey will create the prototype.

6.0 Phase IV: Prototype Creation and Verification (TM - Shilpa)

We are in charge of delivering the prototype in a timely manner including all components (the spreadsheet with welding data, bid package template and the ERP

database). All deliverables of this project are created according to the needs and requests of the company and was approved by the company representatives. This section serves as a historical document of the team's progress.

6.1 Brief Overview (PM - Justin)

Eliminating the ring binder was a priority which involved going through page after page to retrieve the data. It was then transferred over to an Excel sheet. The binder that Metalforms used held thousands of products and a lot of paper. We believe we can cut the usage of paper and transition it to an Excel sheet.

We then developed a bid package using Microsoft Office 365 software. With the Bid List you can find any product that was in the binder and see the different sizes of parts by different variety of colors that will not confuse the vendor in delivering excellent service and accuracy for that order. We then created a VBA in Excel that involves macros that are sufficient just as programs that Metalforms would have used like Infor 940.8.

6.2 Bid List Package Template (CM – Ye Sung & PE - Guru)

Work on the bid package for the welding consumables involved formulating our procurement process based on the information received from Metalform's original spreadsheet. The original spreadsheet was an Excel file. The original Excel spreadsheet contained the nomenclature, pricing, and date when it was purchased. There is a find and replace function built-in Excel that the CM and the PE used to find the total quantity of consumables used for a particular item.

Our team then reviewed and analyzed the data from the Excel spreadsheet to ensure it accurately reflected the specifications provided to the supplier. The specifications provide the vendors with an accurate description of a specific welding consumable listed on the bid package template. The first part of this component starts with the scope of the work section. This section includes the intent to supply Metalforms of various welding materials required for our operations. The scope of the work section provides the potential vendors with what to do.

Scope of Work:

Our company is seeking a single vendor to provide welding consumables. The scope of work includes the supply of various welding materials required for our operations. The selected vendor will be responsible for delivering high-quality consumables to our specified locations. |

Figure 16

The bid package was created as a Microsoft Word document. It is separated into sections, with the next part being the list of the welding consumables. This part of the bid package template is to provide the quantity and specifications for the welding consumables included on the Excel Spreadsheet mentioned earlier. This helps provide potential vendors with the type of consumable and specifications of what is needed for the vendor to compile a bid list. This makes the procurement process much simpler for both Metalforms and the vendor. For example, one of the high priority consumables that Metalforms goes through are the welding carbide burs. The information for a given consumable is found in figure 5, which gives the nomenclature, quantity given a fiscal year, and the overall specifications of the consumable are given to provide the most clarity possible to the potential vendors. The information mentioned is then translated

onto the bid package for the potential vendors to easily read through. Each type of consumable is color-coded on the document by the CM and the PE to avoid confusion on the type, quantity, and specification. The result is shown in figure 7. For example, there are three types of welding carbide burs. The first type's font is black, the second being red, and the third being blue. This is then applied to the quantity and the specifications. This lets the applicant read what quantity and specifications are applied to what type of carbide bur. The consumable with the most variations was the carbide bur. This design was tested against other methods, such as separating them entirely. However, the color coding was more effective at creating an easier to read bid package and was shorter and more concise.

3. Welding Carbide Burs:

- Types: SG-3 (DC) CARBIDE BUR, SG-5 (12) CARBIDE BUR", SG-15 CARBIDE BUR
- Quantity: Forty-five, Two hundred & fifty-eight, twenty-two
- Specifications:
 - Diameter: 3/8", Cutting length: 3/4", Shank Diameter: 1/4", Overall: 2-1/2", Cut: Double
 - Diameter: 1/2", Length of Flute: 1", Shank Diameter: 1/4", Overall Length: 2 3/4"
 - Diameter: 3/4", Length of Flute: 1 1/2", Shank Diameter: 1/4", Overall Length: 3 1/4"

Figure 17

Most of the research done for the bid package template was obtaining the relevant quality requirements and delivery requirements for Metalforms. Most of the research done on the quality standards came from the AWS/ANSI handbook and ISO standards. The specific standards listed on the package were the AWS/ANSI Z49.1:2021 and ISO 15607. The standards outlined by the CM were then brought forth for further verification through quality control engineers that the CM was acquainted with through Texas A&M University-Commerce. The applicants are stated on the bid package template that they must meet the standards that were listed and provide evidence through their certifications.

Quality Requirements: All welding consumables must meet or exceed industry standards and certifications. The specific standards that must be met are AWS/ANSI Z49.1:2021 and ISO 15607: The first standard focuses on safety in welding and cutting, as well as allied processes. The second standard defines general rules for the specification and qualification of welding procedures for metallic materials. Vendors are required to provide detailed specifications for each product offered.

Figure 18

The bid package template is complete as is by itself. A contractual agreement would finalize the process as it takes into consideration the bid package and the price offer of the vendors. However, the contractual agreement is outside the scope of this project. The reasoning is that we will not be doing section 7, which is implementation and validation. Instead, the team ran a trial with three potential vendors that would provide a price quote. It was explicitly written and provided orally that it is not an offer and not a legal commitment to a contract. This was done explicitly for the design inputs and verification testing for Senior Design. The chosen vendor's price versus Metalforms current expenditures will be explored in the design inputs section.

6.3 VBA UserForm (TM- Shilpa)

A Visual Basic Application (VBA) user form is built within the Excel spreadsheet with all welding consumables data merged from the original ring binder currently used at the company. While storing data on an Excel spreadsheet is better than using a ring binder, having a UserForm within that spreadsheet helps with effective usage of that data in the long run. Our team decided to implement this feature as this saves the company time and money from buying a commercial ERP software. The user form is created using Excel macros (VBA) and it acts like an ERP database assisting the user in sorting, searching, and adding data. For example, when a part is delivered to the shipping and

receiving department, an associate will enter the part number, quantity, and price on the spreadsheet. This will automatically be integrated into the UserForm. Any employee can access this UserForm to check if a part is available and to see the quantity available.

Once a department runs out of material, they can update the quantity left on the spreadsheet and the buyer can check the lowest quantity under the quantity ‘ComboBox’ feature of the user form to see what material needs reordering. This saves a lot of time by not having the associates walk to different departments to check on materials and search through the ring binder for materials, quantity, and price. This features helps the company eliminate the monthly inventory run, by providing readily available inventory data. Any data added to the spreadsheet will automatically be integrated into the user form. Deleted data will disappear from the combo box drop-down list automatically. An error message saying , “ Material already exists!” will pop up when duplicate data is entered. An advantage of using VBA macros is that it can easily be upgraded so the company has the option of adding more features in the future according to their needs. This component will replace Infor 940.8, a commercial ERP software that Metalforms was planning to implement, which costs about \$30k a year including set up charges, number of licenses and monthly fees. This excel spreadsheet can be accessed by multiple users at the same time once the company assigns the co-authorizing feature to the users. However, the VBA code cannot be executed by multiple users at the same time. So, the team suggests MetalForms to assign specific users to use the UserForm at assigned times. As of now, the spreadsheet has very minimal data compared to how much data an excel spreadsheet can handle (1,048,576 rows and 16,384 columns) and the team does not see any possibilities of the data going over the range. The data currently on the spreadsheet can

go even lower once the company selects a single vendor for all their consumables. There is a command button built on the spreadsheet when clicked opens the user form.

Figure 19

Part Numbers	Debit Amount
FWA0020	\$370.00
FBA0010	34
FGM0160	(\$149.25)
FGR0010	(\$33.50)
FGR0020	\$246.50
FGR0030	\$328
FGR0040	\$358.45
FHM0010	\$3.80
FHM0030	(\$1.10)
FHM0040	(\$7.65)
FHM0050	\$5.20 (-7.8)
FHM0060	\$18.60
FHM0130	\$48.35

Once the user form is open, the user is asked to select Quantity, Part Number and Description from a drop-down menu. A 'combo box' feature is used to create the drop down for these items. For Debit amount, a text box feature is used, so the user will need to enter the debit amount to search for.

Part Numbers	Debit Amount
FWA0020	\$370.00
FBA0010	34
FGM0160	(\$149.25)
FGR0010	(\$33.50)
FGR0020	\$246.50
FGR0030	\$328
FGR0040	\$358.45
FHM0010	\$3.80
FHM0030	(\$1.10)
FHM0040	(\$7.65)
FHM0050	\$5.20 (-7.8)
FHM0060	\$18.60
FHM0130	\$48.35
FMG0030	\$15.75
FMG0050	\$51.00
FMG0060	\$70.80 (-129.8)
FMG0070	\$35.18
FMG0120	\$10.50
FMG0140	\$59.09
FMG0160	\$30.00 (\$-16.25)
FMG0320	\$47.80
FMG0330	\$1.70

Figure 20

The user can choose to select/ enter items on all boxes or just

one. Once the user clicks on the command button 'GO!', the macros run to through the spreadsheet to find the items matching the user inputs.

The screenshot shows an Excel spreadsheet with a table of part numbers and debit amounts. A search dialog box titled "Data Search" is overlaid on the spreadsheet. The dialog box contains four dropdown menus: "Quantity" (with values 15, 15, 15, 15, 24), "Debit Amou" (with values 15, 15, 15, 15, 24), "Part Number" (with value 15 selected), and "Description" (with values 15, 15, 24). A "GO!" button is at the bottom right of the dialog.

Part Numbers	Debit Amount
FWA0020	\$370.00
FBA0010	34
FGM0160	(\$149.25)
FGR0010	(\$33.50)
FGR0020	\$246.50
FGR0030	\$328
FGR0040	\$358.45
FHM0010	\$3.80
FHM0030	(\$1.10)
FHM0040	(\$7.65)
FHM0050	\$5.20 (-7.8)
FHM0060	\$18.60
FHM0130	\$48.35
FMG0030	\$15.75
FMG0050	\$51.00
FMG0060	\$70.80 (-129.8)
FMG0070	\$35.18
FMG0120	\$10.50
FMG0140	\$59.09
FMG0160	\$30.00 (\$-16.25)

Figure 21

This screenshot is identical to Figure 21, showing the same Excel spreadsheet and search dialog box. The "Part Number" dropdown in the dialog box is now set to 15, and the "Description" dropdown also has 15 selected.

Part Numbers	Debit Amount
FWA0020	\$370.00
FBA0010	34
FGM0160	(\$149.25)
FGR0010	(\$33.50)
FGR0020	\$246.50
FGR0030	\$328
FGR0040	\$358.45
FHM0010	\$3.80
FHM0030	(\$1.10)
FHM0040	(\$7.65)
FHM0050	\$5.20 (-7.8)
FHM0060	\$18.60
FHM0130	\$48.35
FMG0030	\$15.75
FMG0050	\$51.00
FMG0060	\$70.80 (-129.8)
FMG0070	\$35.18
FMG0120	\$10.50
FMG0140	\$59.09
FMG0160	\$30.00 (\$-16.25)

Figure 22

Cells with the user input value will be highlighted.

The screenshot shows an Excel spreadsheet with a table of part numbers and debit amounts. A search dialog box titled "Data Search" is overlaid on the spreadsheet. The dialog box contains four dropdown menus: "Quantity" (with values 15, 15, 15, 15, 24), "Debit Amou" (with values 15, 15, 15, 15, 24), "Part Number" (with value 15 selected), and "Description" (with values 15, 15, 24). A "GO!" button is at the bottom right of the dialog. To the right of the dialog, there is a vertical sidebar with four input fields: "Quantity", "Debit Amoun", "Part Number", and "Description". The "Part Number" field is currently set to 15. The "Description" field also has 15 selected. The "Debit Amoun" and "Quantity" fields have their dropdown menus open, showing the same list of values as the dialog box.

#BR-7 OX RH13/16HX3/8-19 MD INT HOSE NUT	FHM0030	(\$1.10)
#AW-14 INERT ARC NUT, LEFT HAND	FHM0040	(\$7.65)
#BR-17 HOSE NIPPLE BARBED 1/4 ID 2-3/4"	FHM0050	\$5.20 (-7.8)
#AW-17 NIPPLE BARBED 1/4 ID (2-3/4" LG)"	FHM0060	\$18.60
#QD-10 (QUICK CONNECT)	FHM0130	\$48.35
500 #14H45 (HD) CONTACT TIP <TWECO>	FMG0030	\$15.75
50 #24AT-37-SS TAPERED NOZZLE <TWECO>	FMG0050	\$51.00
50 #24FN-62-S <AD> FIXED NOZZLE <TWECO>	FMG0060	\$70.80 (-129.8)
50 #34FN NOZZLE INSULATOR <TWECO>	FMG0070	\$35.18
50 #54A GAS DIFFUSER TWECO	FMG0120	\$10.50
#44-116- <15' WIRE CORE W/ ASSY-OPTIMUM>	FMG0140	\$59.09
500 #14T35 TAPERED TIP	FMG0160	\$30.00 (\$-16.25)
50 COOL HAND FIRED RIFLE GRIFFIN# 1000A	FMG0200	\$17.80

Figure 23

Our team faced several challenges as part of creating this component. Our primary challenge faced while creating this user form is learning a new programming language and understanding logic. We had no previous coding background, so as part of our project we taught ourselves how to code and wrote the VBA macro from scratch. The work included debugging and fixing errors, and we referred to several YouTube videos, and examples on (Stack overflow, n.d.) and (GitHub, n.d.), which helped us understand the concept. The Technical Manager and the Systems Engineer collaborated to develop the code but encountered communication problems within the code due to different naming conventions for variables and code logic approaches, we resolved the issue by having regular meetings to list down the variables used and discuss each other's logic. This made merging the two files easier compared to previously causing the program to crash several times.

6.4 Prototype Assembly and Operation (TM-Shilpa)

The Excel spreadsheet (component 3) with all welding consumables data merged from the ring binder is designed to be used by the associates as well as management at Metalforms. An associate at the shipping and receiving department will enter the delivered material data on to the spreadsheet upon arrival. This data is then accessed by other associates and management using the user form(component 2) build within the spreadsheet.

A	B	C	D	E	F	G	H	I	J	K
	ACCOUNT_DESCRIPTI	BATC_L	BATC_R	BATCH_LC	TRAN	TRN	TRANS_CREATE_DATE	DEBIT	CRED	SUB_REFERENCE
6140	Fab Shop - supplier taxabl	16275 PUR	12/31/2023	104702	2024-01-17-14 16.21 8000	160.5	0078000 - 1305330 - GRAINGER			
6140	Fab Shop - supplier taxabl	16275 PUR	12/31/2023	104702	2023-09-22-13.44 53.62 8000	160.5	0078000 - 1305330 - GRAINGER			
6140	Fab Shop - supplier taxabl	15185 PUR	4/30/2023	97810	2023-05-19-13.57 46.157	485.81	0078000 - 1305330 - GRAINGER			
6140	Fab Shop - supplier taxabl	15185 PUR	4/30/2023	97810	2023-05-19-13.57 46.157	28.24	0078000 - 1306039 - GRAINGER			
6140	Fab Shop - supplier taxabl	15185 PUR	4/30/2023	97810	2023-05-19-13.57 46.157	357.57	0078000 - 1306039 - GRAINGER			
6140	Fab Shop - supplier taxabl	15813 PUR	8/31/2023	101342	2023-09-13-14.03 25.933	257.76	0078000 - 1316339 - GRAINGER			
6140	Fab Shop - supplier taxabl	16275 PUR	12/31/2023	104702	2024-01-17-14 16.21 8000	98.2	0078000 - 1326338 - GRAINGER			
6140	Fab Shop - supplier taxabl	16275 PUR	12/31/2023	104702	2023-09-22-13.44 53.62 8000	98.2	0078000 - 1326338 - GRAINGER			
6140	Fab Shop - supplier taxabl	15823 PUR	6/30/2023	99548	2023-07-19-16.25 37.49	189.2	008490 - 1305793 - GAS & SUPPLY			
6140	Fab Shop - supplier taxabl	15823 PUR	7/31/2023	100695	2023-08-14-16.10 19.577	189.2	008490 - 1312272 - GAS & SUPPLY			
6140	Fab Shop - supplier taxabl	15823 PUR	8/31/2023	101342	2023-09-13-14.03 25.933	189.2	008490 - 1316440 - GAS & SUPPLY			
6140	Fab Shop - supplier taxabl	15849 PUR	9/30/2023	101626	2023-09-22-10 12.03 900	457	008490 - 1316440 - GAS & SUPPLY			
6140	Fab Shop - supplier taxabl	16019 PUR	10/31/2023	102396	2023-11-16-10 37 507	582.15	008490 - 1326251 - GAS & SUPPLY			
6140	Fab Shop - supplier taxabl	16068 PUR	10/31/2023	102396	2023-11-16-10 37 507	532.46	008490 - 1326251 - GAS & SUPPLY			
6140	Fab Shop - supplier taxabl	16113 PUR	11/30/2023	103218	2023-12-04-13.34 52.687	1652.3	008490 - 1322441 - GAS & SUPPLY			
6140	Fab Shop - supplier taxabl	16113 PUR	11/30/2023	103218	2023-12-04-13.34 52.687	255.67	008490 - 1322441 - GAS & SUPPLY			
6140	Fab Shop - supplier taxabl	16113 PUR	12/31/2023	104702	2024-01-17-14 16.21 8000	308.09	008490 - 1322441 - GAS & SUPPLY			
6140	Fab Shop - supplier taxabl	15185 PUR	4/30/2023	97810	2023-05-19-13.57 46.157	155.88	013200 - 1306006 - M&D SUPPLY INC			
6140	Fab Shop - supplier taxabl	15185 PUR	9/30/2023	101342	2023-09-22-10 12.03 900	34.2	014300 - 1305330 - GRAINGER			
6140	Fab Shop - supplier taxabl	16068 PUR	10/31/2023	102396	2023-11-16-10 37 507	34.2	014300 - 1326251 - MCMASTER-CARR SUPPLY COMPANY			
6140	Fab Shop - supplier taxabl	16068 PUR	10/31/2023	102396	2023-11-16-10 37 507	197.96	014300 - 1326251 - MCMASTER-CARR SUPPLY COMPANY			
6140	Fab Shop - supplier taxabl	15086 PUR	3/31/2023	37121	2023-04-18-13.36 07 587	95	029120 - CC4132 - WELLS FARGO CREDIT CARD			
6140	Fab Shop - supplier taxabl	15086 PUR	6/30/2023	37121	2023-04-18-13.36 07 587	33.97	029120 - CC4132 - WELLS FARGO CREDIT CARD			
6140	Fab Shop - supplier taxabl	15086 PUR	9/30/2023	101342	2023-09-13-14.03 25.933	37.33	029120 - CC4241 - WELLS FARGO CREDIT CARD			
6140	Fab Shop - supplier taxabl	16069 PUR	10/31/2023	102396	2023-11-16-10 37 507	55.34	029120 - CC4253 - WELLS FARGO CREDIT CARD			
6140	Fab Shop - supplier taxabl	16069 PUR	12/31/2023	104702	2024-01-17-14 16.21 8000	130.95	029120 - CC4253 - WELLS FARGO CREDIT CARD			
6140	Fab Shop - supplier taxabl	15075 API	3/7/2023	70733	2023-04-12-16.05 32.583	2.62	130495 - 0869585 - OFFICE DEPOT INC			
6140	Fab Shop - supplier taxabl	15115 API	4/20/2023	97324	2023-04-20-10 15.37 707	40.09	130330 - 0078000 - GRAINGER			
6140	Fab Shop - supplier taxabl	15115 API	4/20/2023	97324	2023-04-20-10 15.37 707	9.06	130330 - 0078000 - GRAINGER			
6140	Fab Shop - supplier taxabl	16252 API	4/30/2023	97497	2023-05-04-09 43 47.51K	1.33	130609 - 0078000 - GRAINGER			
6140	Fab Shop - supplier taxabl	15748 API	8/31/2023	101342	2023-08-31-09 50 14.873	12.8	131566 - 0078000 - GRAINGER			
6140	Fab Shop - supplier taxabl	15748 API	9/30/2023	101342	2023-09-13-14.03 25.933	19.37	131566 - 0078000 - GRAINGER			
6140	Fab Shop - supplier taxabl	16256 API	12/1/2023	104526	2024-01-10-16 05 30.527	8.1	132638 - 0078000 - GRAINGER			
6140	Fab Shop - supplier taxabl	14913 ADJ	1/31/2023	95953	2023-02-22-14 09 20.23K	34	233692 - FBA0010 - STA-KLEER COVER LENS (100BX)			
6140	Fab Shop - supplier taxabl	14913 ADJ	1/31/2023	95953	2023-02-22-14 09.20.23K	9.47	233693 - FBA0010 - # 501 SHURLITE TRIPLE FLINT LIGHTER #45			

Figure 24: Component 3

Any worker can check the status of received materials, cost, available quantity etc., using this user form. A production associate/ area manager if they are running low on a material, can update the quantity of that material on the spreadsheet. While a buyer can see the updated quantity using the user form and place an order for that material. This automates the process by eliminating unwanted human interactions, saving time and motion.

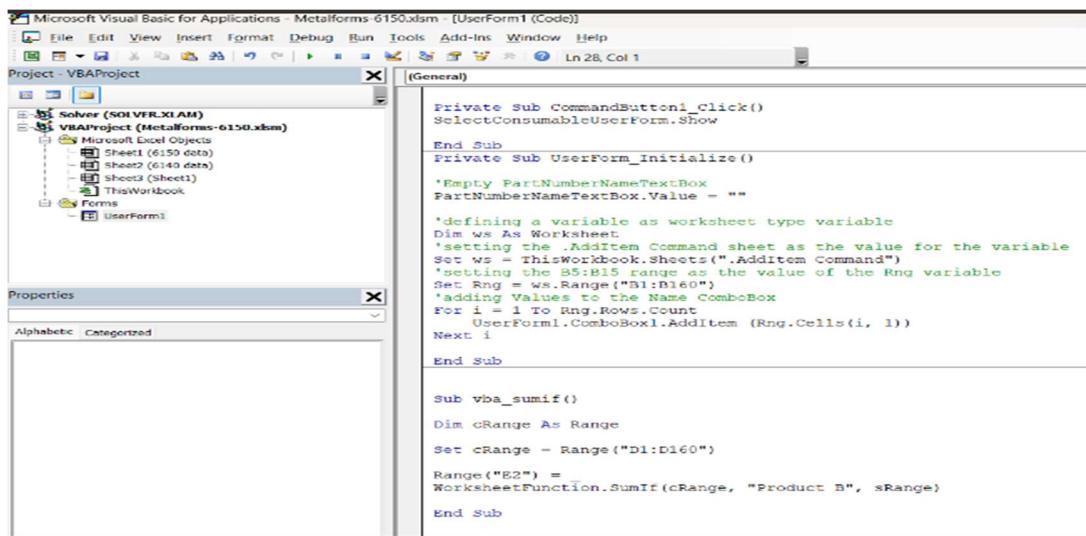


Figure 25

The bid package template (component 1) traced from the Excel spreadsheet, once implemented will streamline MetalForms' vendors to just one. The spreadsheet contains all welding consumables data merged from the ring binder. This data is used in developing the Bid package (Figure 15) for listing the vendor criteria. This will highly improve the procurement process as the company will now have a single trustable vendor. This will also help the company specify the material requirements like quantity, quality, etc. effectively. Metalforms is hoping to save money on bulk orders and deliveries once they select a single vendor.

Bid Package for Welding Consumables

METALFORMS, LLC

Introduction:

Metalforms is a leading provider of custom engineered and fabricated solutions for gas and liquids processing, storage, and handling across a broad range of industries including Petrochemical, Refining, Specialty Chemical, Biofuels, and others.

We specialize in the delivery of custom engineered and fabricated Shell & Tube Heat Exchangers, ASME Pressure Vessels, Piping, and other equipment—in addition to a comprehensive array of maintenance, repair, and replacement services.

As part of the TransTech family of companies, we can offer an extensive range of fabrication solutions, field services, and 24/7 support services—including fabrication of large process vessels and process piping for our chemical and industrial clients—while leveraging fabrication assets and field services capabilities from locations nationwide.

Scope of Work:

Our company is seeking a single vendor to provide welding consumables. The scope of work includes the supply of various welding materials required for our operations. The selected vendor will be responsible for delivering high-quality consumables to our specified locations.

List of Welding Consumables: Please provide quotes and specifications for the following welding consumables:

1. **Welding Electrodes:**

- Type: CROWN ALLOY 1/8 E 316L-16 BR.PKG. STAINLESS STEEL ELECTRODE 1 LB TUBE
- Quantity: Thirty-five bundles of 1 LB Tube in a fiscal year basis
- Specifications:
 - MPN: SE316/EXO-BP
 - UPC: 412300641313

Figure 26

6.5 Verification Testing (SE-Daniela)

The goal of verification testing is to confirm that the prototype complies with the required design inputs being successful in the real world. We'll carry out inspections and assessments to make sure the prototype satisfies the established standards.

6.6 Inspection Verification Tests (SE-Daniela)

The team's design input for the prototype has some observational test meaning that the design input can be tested if successful, a simple observation inspection. While others will need a more specific pass/fail test to verify the success of the prototype.

Figure 27

<i>Inspection</i>	<i>Pass/Fail</i>
<i>Prototype Must Include Part Number</i>	Compile Consumable Data Needs to be Convent for Metalforms to Use and Access
<i>Prototype Must Include Part Lowest Debit</i>	
<i>Amount</i>	
<i>The Bid List Will Include a Scope of Work</i>	
<i>Section</i>	
<i>The Bid List Package Will Include</i>	
<i>Welding Consumable</i>	
<i>The VBA Will be an Excel Macro</i>	
<i>The VBA Must Include Quantity</i>	

6.7 Compiled Consumable Data Needs to be Convenient for Metalforms to Use and Access Verification Tests (SE-Daniela)

The Complied Consumable data needs to be convenient for Metalforms to use and access. The verification test for this design input was originally intended to be a survey sent out to Metalforms employees and the team's goal was to reach 70% of the respondents to rate our system better than the previous system utilized. The team decided to instead perform the survey internally by completing 5 tasks using a mockup of the binder and the same 5 task using the prototype. The 5 tasks consisted of having multiple users at once, being able to sort inventory with ease, being able to search for inventory with ease, being able to update data with ease, and being able to navigate with ease. The results surpassed the 4 out of 5 tasks being successful with all 5 tasks being more efficient. Making the design input successful.

6.8 Prototype Must Include Part Numbers Verification Tests (SE-Daniela)

Prototype Must Include Part Number design input pass the verification test. A convenient search of a welding consumable is more often searched by the product's part number, which is possible with the VBA UserForm that was created. Instead of using ctrl + f users have a direct and simple inventory search. The convenience of searching a welding consumable by part number aids with sorting and updating material while not having to flip through a physical binder.

The screenshot shows a Microsoft Excel spreadsheet with a table of data and a VBA UserForm overlaid on it.

Table Data:

Part Numbers	Debit Amount
FWA0020	\$370.34
FBA0010	(\$149.25)
FGR0010	(\$33.50)
FGR0020	\$246.50
FGR0030	\$328
FGR0040	\$358.45
FHM0010	\$3.80
FHM0030	(\$1.10)
FHM0040	(\$7.65)
FHM0050	\$5.20 (-7.8)
FHM0060	\$18.60
FHM0130	\$48.35
FMG0030	\$15.75
FMG0050	\$51.00
FMG0060	\$70.80 (-129.8)
FMG0070	\$35.18
FMG0120	\$10.50
FMG0140	\$59.09
FMG0160	\$30.00 (\$-16.25)
FMG0320	\$47.80
FMG0330	\$1.70

UserForm:

The UserForm is titled "Data Search". It contains four dropdown menus labeled "Quantity", "Debit Amount", "Part Number", and "Description". A "GO!" button is located at the bottom right of the form. The "Part Number" dropdown has "FRA0010" selected.

Figure 28

6.9 Prototype Must Include Part Description Verification Tests (SE-Daniela)

Prototype Must Include Part Description this design input is needed for the purposes of ensuring the correct part is to be received. This design input passes the verification test including the part description by allowing users to use the drop-down box in the VBA UserForm in Excel. Meeting the standard Metalforms needs by providing a simple ERP alternative.

6.10 Prototype Must Include Part Lowest Debit Amount Verification Tests (SE-Daniela)

The prototype Must Include Part Lowest Debit Amount this aspect of the prototype is important to both Metalforms and the vendor due to Metalforms wanting the best price and also communicating with the vendors on their expected price for welding consumables. Metalforms originally gave the team an excel sheet of all purchased welding consumables over the past year the team was asked to organize the data with multiple materials purchased the team identified the lowest possible cost for all welding

consumables. The figure below shows the end product of the lowest debit amount for a specific welding consumable showing the design input is successful.

ACCOU	ACCOUNT_DESCRIPTION	BATCH	BATCH	BATCH_DATE	TRANSI	TRA	TRANS_CREATE_DATE	DEBIT	CREDIT	SUB_REFERENCE
6140	Fab Shop - supplies taxable	16273	PUR	12/31/2023	104702		2024-01-17-14.16.21.160000	168.5		007658 - 132647-2 - GLOBAL SUPPLY
6140	Fab Shop - supplies taxable	14991	PUR	2/28/2023	96419		2023-03-22-13.44.59.627000	157.88		007800 - 129893 - GRAINGER
6140	Fab Shop - supplies taxable	15185	PUR	4/30/2023	97810		2023-05-19-13.57.46.157000	485.81		007800 - 130330 - GRAINGER
6140	Fab Shop - supplies taxable	15185	PUR	4/30/2023	97810		2023-05-19-13.57.46.157000	28.24		007800 - 130609 - GRAINGER
6140	Fab Shop - supplies taxable	15813	PUR	8/31/2023	101342		2023-09-13-14.03.25.993000	155		007800 - 131566 - GRAINGER
6140	Fab Shop - supplies taxable	15813	PUR	8/31/2023	101342		2023-09-13-14.03.25.993000	257.76		007800 - 131639 - GRAINGER
6140	Fab Shop - supplies taxable	16275	PUR	12/31/2023	104702		2024-01-17-14.16.21.160000	98.2		007800 - 132638 - GRAINGER
6140	Fab Shop - supplies taxable	14991	PUR	2/28/2023	96419		2023-03-22-13.44.59.627000	61.85		008490 - 129353-2 - GAS & SUPPLY
6140	Fab Shop - supplies taxable	15526	PUR	6/30/2023	99548		2023-07-19-16.25.37.490000	189.2		008490 - 130979-1 - GAS & SUPPLY
6140	Fab Shop - supplies taxable	15697	PUR	7/31/2023	100686		2023-08-14-16.18.18.577000	1852.32		008490 - 131227 - GAS & SUPPLY
6140	Fab Shop - supplies taxable	15813	PUR	8/31/2023	101342		2023-09-13-14.03.25.993000	1011.11		008490 - 131478 - GAS & SUPPLY
6140	Fab Shop - supplies taxable	15849	PUR	9/30/2023	101626		2023-09-22-10.12.03.900000	457		008490 - 131640 - GAS & SUPPLY
6140	Fab Shop - supplies taxable	16069	PUR	10/31/2023	102936		2023-11-15-10.37.58.507000	382.15		008490 - 132025-1 - GAS & SUPPLY
6140	Fab Shop - supplies taxable	16069	PUR	10/31/2023	102936		2023-11-15-10.37.58.507000	592.46		008490 - 132193 - GAS & SUPPLY
6140	Fab Shop - supplies taxable	16113	PUR	11/30/2023	103218		2023-12-04-13.34.52.687000	1852.32		008490 - 132241 - GAS & SUPPLY
6140	Fab Shop - supplies taxable	16113	PUR	11/30/2023	103218		2023-12-04-13.34.52.687000	255.67		008490 - 132377 - GAS & SUPPLY
6140	Fab Shop - supplies taxable	16275	PUR	12/31/2023	104702		2024-01-17-14.16.21.160000	296.53		008490 - 132645 - GAS & SUPPLY
6140	Fab Shop - supplies taxable	15185	PUR	4/30/2023	97810		2023-05-19-13.57.46.157000	115.88		013200 - 130606 - M & D SUPPLY INC
6140	Fab Shop - supplies taxable	15849	PUR	9/30/2023	101626		2023-09-22-10.12.03.900000	34.2		014900 - 131701 - MCMASTER-CARR SUPPLY COMPANY
6140	Fab Shop - supplies taxable	16069	PUR	10/31/2023	102936		2023-11-15-10.37.58.507000	34.2		014900 - 132021 - MCMASTER-CARR SUPPLY COMPANY
6140	Fab Shop - supplies taxable	16069	PUR	10/31/2023	102936		2023-11-15-10.37.58.507000	34.2		014900 - 132166 - MCMASTER-CARR SUPPLY COMPANY
6140	Fab Shop - supplies taxable	14909	PUR	1/31/2023	95896		2023-02-22-14.05.04.887000	197.98		029120 - CC4057-1 - WELLS FARGO CREDIT CARD
6140	Fab Shop - supplies taxable	15086	PUR	3/31/2023	97121		2023-04-18-13.36.07.587000	35.28		029120 - CC4117 - WELLS FARGO CREDIT CARD
6140	Fab Shop - supplies taxable	15086	PUR	3/31/2023	97121		2023-04-18-13.36.07.587000	95		029120 - CC4132 - WELLS FARGO CREDIT CARD
6140	Fab Shop - supplies taxable	15526	PUR	6/30/2023	99548		2023-07-19-16.25.37.490000	39.67		029120 - CC4180 - WELLS FARGO CREDIT CARD
6140	Fab Shop - supplies taxable	15813	PUR	8/31/2023	101342		2023-09-13-14.03.25.993000	37.99		029120 - CC4214 - WELLS FARGO CREDIT CARD
6140	Fab Shop - supplies taxable	16069	PUR	10/31/2023	102936		2023-11-15-10.37.58.507000	55.94		029120 - CC4253 - WELLS FARGO CREDIT CARD
6140	Fab Shop - supplies taxable	14876	API	2/16/2023	95652		2023-02-16-15.14.22.950000	13.03		129893 - 007800 - GRAINGER
6140	Fab Shop - supplies taxable	15075	API	3/7/2023	97033		2023-04-12-15.05.32.583000	2.62		130145 - 016055 - OFFICE DEPOT INC
6140	Fab Shop - supplies taxable	15113	API	4/20/2023	97324		2023-04-20-10.15.37.700000	40.08		130330 - 007800 - GRAINGER
6140	Fab Shop - supplies taxable	15146	API	4/29/2023	97467		2023-05-03-10.18.47.377000	9.56		130606 - 013200 - M & D SUPPLY INC

Figure 29

6.11 Bid List Will Include a Scope of Work Section Verification Tests (SE-Daniela)

The Bid List Will Include a Scope of Work Section is a successful design input below the scope of work is pictured that is included in the Bid List. This design input clearly defines the responsibilities, expectations and tasks leaving no room for miscommunication and or misinterpretations with the search for a potential new vendor. Passing the design input as successful.

Scope of Work:

Our company is seeking a single vendor to provide welding consumables. The scope of work includes the supply of various welding materials required for our operations. The selected vendor will be responsible for delivering high-quality consumables to our specified locations.

Figure 30

6.12 Bid List Will Include Welding Consumable Verification Tests (SE-Daniela)

The Bid List Will Include Welding Consumables the importance for the Bid List to contain the welding consumables is for the reason that the vendors receiving the Bid List are needing to know what welding consumables that are being requested and are able to fulfill the request. The design input is passed and successful with the Bid List below includes the welding consumable welding carbide burs the specific type, quantities, and any further specifications leaving minimal room for question and miscommunication on the welding consumables needed.

3. Welding Carbide Burs:

- Types: SG-3 (DC) CARBIDE BUR, **SG-5 (12) CARBIDE BUR", SG-15 CARBIDE BUR**
- Quantity: Forty-five, **Two hundred & fifty-eight, twenty-two**
- Specifications:
 - Diameter: 3/8", Cutting length: 3/4", Shank Diameter: 1/4", Overall: 2-1/2", Cut: Double
 - Diameter: 1/2", Length of Flute: 1", Shank Diameter: 1/4", **Overall Length: 2 3/4"**
 - Diameter: 3/4", Length of Flute: 1 1/2", Shank Diameter: 1/4", **Overall Length: 3 1/4"**

Figure 31

6.13 The VBA will be an Excel Macro

The VBA UserForm was selected to be produced through Microsoft Excel for convenience and the simplicity to aid in meeting the need of Metalforms of finding an ERP alternative. Also, beneficial for the team considering it is the more familiar software to the team. VBA UserForm has the ability to be more customizable and controlled. The figure below shows the coding the team used to create VBA UserForm. The design input passes the verification test.

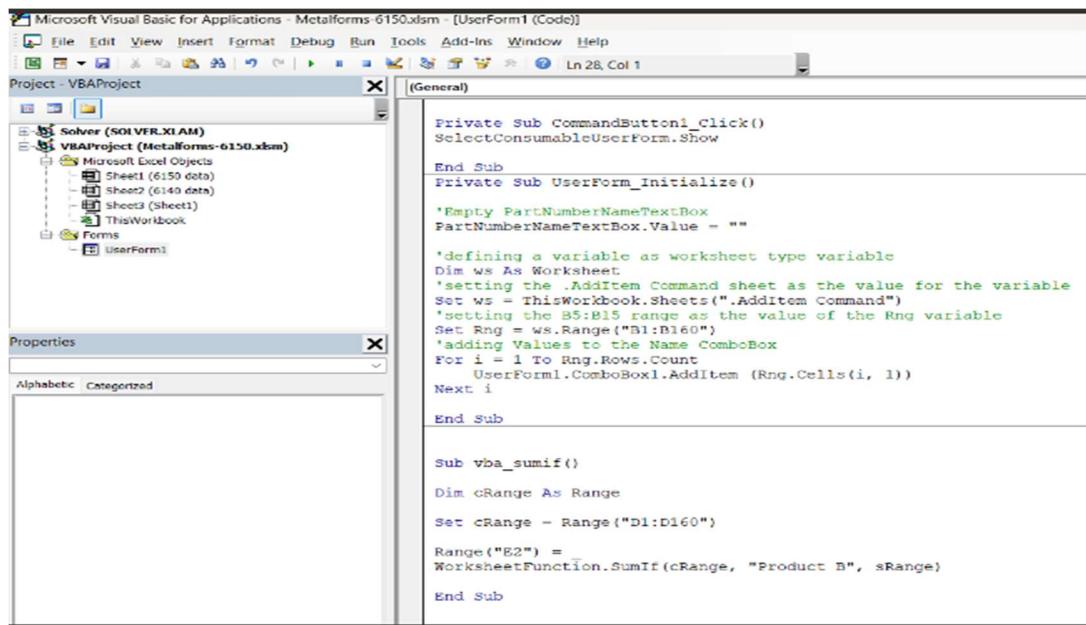


Figure 32

6.14 The VBA Must Include Quantity

The VBA includes a quantity this is useful when the user needs to update inventory of a welding consumables. A user would need to fill out the quantity and part number or part description for searching the welding consumable to locate how much is in inventory needing to outsource more inventory or updating the database. The design input has been met.

#BR-7 OX RH13/16HX3/8-19 MD INT HOSE NUT	FHM0030	\$1.10
#AW-14 INERT ARC NUT, LEFT HAND	FHM0040	(\$7.65)
#BR-17 HOSE NIPPLE BARBED 1/4 ID 2-3/4"	FHM0050	\$5.20 (-7.8)
#AW-17 NIPPLE BARBED 1/4 ID (2-3/4" LG)"	FHM0060	\$18.60
#QD-10 (QUICK CONNECT)	FHM0130	\$48.35
500 #14H45 (HD) CONTACT TIP <TWECO>	FMG0030	\$15.75
50 #24AT-37-SS TAPERED NOZZLE <TWECO>	FMG0050	\$51.00
50 #24FN-62-S <AD> FIXED NOZZLE <TWECO>	FMG0060	\$70.80 (-129.8)
50 #34FN NOZZLE INSULATOR <TWECO>	FMG0070	\$35.18
50 #54A GAS DIFFUSER TWECO	FMG0120	\$10.50
#44-116- <15' WIRE CORE W/ ASSY-OPTIMUM>	FMG0140	\$59.09
500 #14T35 TAPERED TIP	FMG0160	\$30.00 (\$-16.25)
50 COOL HAND FIRING RIFLE GUNNING 1000A	FMG0200	\$17.80

Figure 33

6.15 R&D Labor (PM - Justin)

The TM (Shilpa) collaborated with the SE (Daniela), & the PM (Justin) to combine the ERP, macros, and the Complied Consumable data. The CM (Ye), the PE (Guru), and the PM (Justin) lead in the progression of the Bid List. The PM (Justin) looked through the Bid List and ERP which was impressive by the way it was handled. Not to mention that the time consumption of the Bid List was done days earlier than expectations.

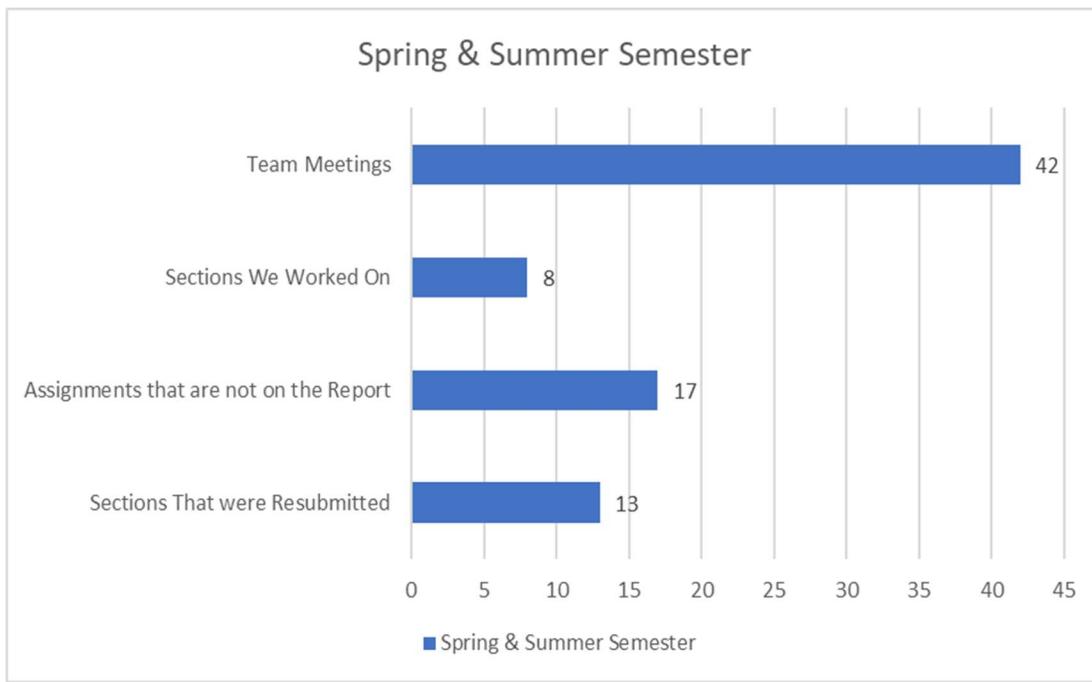


Figure 34

This team has done an amazing job in continuous improvement with the way of developing the ERP, to mastering the Bid List, and the calculated designs of the macros.

6.16 Safety (CM – Ye Sung)

The safety concerns are minimal due to this being a remote project involving the Bid List package, Excel UserForm, and Excel spreadsheet. The safety concerns have remained the same since section 5.5. The following safety concerns and procedures to mitigate them

are as follows. The biggest health and safety concerns are the risk of wrist injuries and carpal tunnel syndrome. The best method is to implement human factors ergonomics, specifically with posture. The team is advised to adjust chair height to have it where their eye height is facing about 10 degrees down to the computer. Their laptop or monitor should be at arm's length. To avoid excessive repetitive movements, they are encouraged to move every 15 minutes and to physically get up every hour (Mark Lehto, 2013). It is also recommended to keep shoulder alignment squared rather than being hunched forward. The team discussed this issue at length and have completed an ergonomic posture video for further reference. The team has followed the guidelines the CM has set for them and makes sure to take breaks.

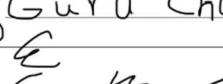
6.17 Environmental and Social Considerations During R&D (CM- Ye Sung)

Metalforms had assigned Team Odyssey to provide a usable working prototype. As Engineers-prospects, we wanted to make sure that the prototype was aligned with the code of ethics by the NSPE and the values we individually hold in the team. One of the values that we decided to champion from the NPSE was to have sustainable development to protect the environment. To be specific, environmental impacts stemming from this project will lead to paper reduction as an online database reduces the need for physical printouts. This digital interface plays a part in the overall goal of consolidating all the welding consumables to a single vendor by making the raw data easier to compile and digest. Another environmental impact will be the reduction of shipments and emissions by consolidating to a single vendor. Instead of numerous locations being ordered from, it will be from the single awarded vendor. This reduces shipments and associated carbon

emissions while simplifying transportation logistics. This ties into the need to create a positive social impact, with the issue of previous suppliers losing business with Metalforms. Although Metalforms isn't a mega-corporation, losing a client like Metalforms could potentially impact jobs in the local area. To offset this impact, our team selectively chose potential vendors within Beaumont and the surrounding region. It does not negate the effect completely, but it does keep the same money Metalforms would've spent within the city.

6.18 Phase IV Approvals (All)

Section Approval Form	
Team Name:	Odyssey Driven
Project Name:	Metalforms
Section Number and Title:	Section 3.7, 3.9, 3.10, 3.6 and Review
I have read this section and approve the final version presented here.	
Printed Name:	Justin Hernandez
Role:	Project Manager
Signature:	
Date:	2/25/2024

Section Approval Form	
Team Name:	Odessey Driven
Project Name:	Metalforms
Section Number and Title:	
I have read this section and approve the final version presented here.	
Printed Name:	Guru Chapparapu
Role:	PE
Signature:	
Date:	2/25/24

Section Approval Form	
Team Name:	Team Odyssey
Project Name:	
Section Number and Title:	
I have read this section and approve the final version presented here.	
Printed Name:	Ye Sung Sohn
Role:	Compliance Manager
Signature:	
Date:	02/20/24

Section Approval Form	
Team Name:	Odyssey
Project Name:	MetalForm
Section Number and Title:	Phase 1: Project Proposal
I have read this section and approve the final version presented here.	
Printed Name:	Daniela Arroyo
Role:	Systems Engineer
Signature:	
Date:	2/25/24

Section Approval Form	
Team Name:	Odyssey Driven
Project Name:	
Section Number and Title:	Q.1 Problem Statement and Q.2 Design concept
I have read this section and approve the final version presented here.	
Printed Name:	Sophia Mary Cheenan
Role:	Technical Manager
Signature:	
Date:	02/20/24

6.19 Prototype Creation and Verification Review Summary (CM - Ye)

Several changes were made to section six. For 6.2, there was added clarity for the reader on what the bid package is, the context for creating one, and how does it work. For 6.3, the VBA UserForm was explained further and what the spreadsheet is supposed to do and what its functions are used for. The verification tests explained if it passed or not. The titles were also replaced from Design input <insert letter> to their respective names. Gantt charts were added to show the amount of work the team members put in.

7. Phase V: Implementation and Validation (PM – Justin)

Section 7 was outside of the scope of the senior design project.

8.0 Conclusion

8.1 Project Outcome (TM - Shilpa)

As Metalforms requested assistance in consolidating all their welding consumables to a single vendor, our team has designed a comprehensive bid package listing out different criteria comparing all vendors to help them decide. Metalforms also wanted a better data storage system, for which our team merged all welding consumables data from the ring binder currently in use to an Excel spreadsheet. Since the company had shared its plan to buy a commercial ERP database to store and manage this data, our team decided to create an ERP system within the Excel spreadsheet using VBA macros.

8.2 Major Challenges Addressed (SE - Dani)

A major challenge that was faced was providing Metalforms with a low-cost and convenient ERP alternative. With not much knowledge of what an ERP was at first the team did extensive research on what an ERP was and what alternative would best fit our

design inputs. Many solutions were considered, ultimately the team decided to use a Microsoft Excel VBA UserForm being cost efficient and the software the team is most accustomed to.

8.3 Team Performance (PM- Justin)

The team pledged in the spring semester 6 hours per week totaling 402 hours for the semester. The team's spirit was great and supportive in collaborating to understand the ERP and Bid List. In the Spring semester, the team accumulated over 401 hours.

Table 12: Table of Hours Pledged Spring Semester

Week	Total Pledged Hours for The Week	Cumulative Pledged Hours	Total Labor Hours for the Week	Cumulative Labor Hours
1 & 2	0	0	0	0
3	12	12	25	25
4	30	42	30	55
5	30	72	13	68
6	30	120	26.59	94.59
7	30	132	14.33	108.92
8	30	162	31.23	140.15
9	30	192	31.79	171.94
10	30	222	24.45	196.39
11	0	222	0	196.39
12	30	252	38.62	235.01
13	30	282	40.26	275.27
14	30	312	65.93	341.2
15	30	342	15.15	356.35
16	30	372	15.79	372.14
16 & 17	30	402	29.37	401.51

The team pledged in the summer semester 4 hours per week totaling 180 hours for the semester. The team's spirit remained the same as the previous semester. We are

thrilled to work together again, and the morale is high in assuring to verify the Microsoft Excel VBA UserForm software. In the spring semester, the team accumulated over 230 hours. A 28% increase in productivity.

Table 13: Table of Hours Pledged Summer Semester

Week	Total Pledged Hours for The Week	Cumulative Pledged Hours	Total Labor Hours for the Week	Cumulative Labor Hours
1 & 2	4	40	43.82	43.82
3	4	60	21.83	65.65
4	4	80	20.7	86.35
5	4	100	49.22	135.57
6	4	120	26.1	161.67
7	4	140	23.7	185.37
8	4	160	21.3	206.67
9	4	180	23.92	230.59

8.4 Lessons Learned and Skills Developed (PE - Guru)

Our team learned many lessons completing this project. The biggest lesson was how important it was to be able to collaborate with each other for efficient teamwork and coordination. Coordinating tasks, sharing information, opinions and addressing challenges as a team taught us the value of clear and open communication. This was vital when integrating the different components of our prototype, the main being the VBA UserForm and the Excel spreadsheet system. On the engineering side the team gained knowledge in procurement and the skills to implement custom Excel macros and VBA scripts. Overall, the project enhanced our technical ability and developed a strong sense of responsibility and teamwork among the team members.

8.5 Final Comments (CM - Ye)

The team's overall feeling was positive about the senior design project. The team learned a lot of useful skills that can be translated into real-world experience. In particular, the CM found the Gantt Chart and the FMEA analysis to be particularly useful for project management-related jobs. Tools that are commonly used in the workplace were utilized often in the project, which was essential to parts of the project. Having a common work channel to communicate and share files on Teams facilitated workflow. Excel was also a very important tool to formulate the second prototype, which was the VBA UserForm. Several members of the team are now translating the skills learned from this project to the workforce or applying for engineering positions where the above-mentioned skills are needed. In conclusion, the senior design experience is an important project that the team had to apply the skills and knowledge learned from other senior-level courses. The team learned and applied themselves feeling positive through the experience.

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Appendix A: Bid Package

Appendix A is the final bid package prototype that was used for verification testing.

Digital Attachment

[Bidpackage.docx](#)

Appendix B: Spreadsheet and VBA code

[Metalforms-6150_ERP.xlsm](#)