ISyE 315 Final Project Report
Minocqua Manufacturing, Inc.

Team 6
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Executive Summary and Recommendation

After completing an in-depth capacity and payback analysis using a growth rate of 8 percent, we recommend that Minocqua Manufacturing continues to outsource welding operations and forego the option of bringing welding on-site. Regardless, the manufacturing company could benefit greatly from adopting the new efficient and environmentally-friendly facility we have designed.

The new building will minimize the waste of material flow between various departments and within the machine shop itself, include state-of-the-art material handling systems, create a welcoming and motivating environment for all employees, and ensure sustainability through the use of skylights, LED bulbs, and the repurposing of scrap. This building will encourage further growth and prosperity for Minocqua Manufacturing. The details of the plant layout and how we arrived at our recommendations can be found in the rest of the report.

Key Features

- Large aisles to accommodate forklift use within the plant
- Spacious machine shop to allow forklift travel
- Three-foot safety zones between machines for heat dispersion and worker safety
- Many overhead doors for ease of material transportation between departments
- Shipping and receiving in the corner of the building to allow for greater truck accessibility (two external walls to back up to instead of one)
- Painting department located in the corner to avoid spread of fumes or paint spray

- Large lunchroom with vending machines, ping pong, and pool table for employee satisfaction and relaxation
- Offices and conference room placed away from machine shop for quieter work
- Skylights for natural lighting, efficiency, and sustainability

Capacity Analysis

- Growth of Minocqua Manufacturing could range anywhere from a minimum of 5 to a maximum of 12 percent in the future
- We will assume a growth rate of 8 percent for the analysis (See Appendix A, Equation 1)
- Given last year's output of 18,000 parts and a growth rate of 8 percent, the required capacity is shown in Appendix A, Table 1
- An increase in required output over the years requires the purchase of additional machines to ensure utilization stays under its maximum defined level (see bullet below)
- A utilization level of 90 percent or higher will trigger the purchase of an additional machine
    - This will leave a reasonable capacity cushion of at least 10 percent, which helps adjust for sudden changes in demand, allows time for machine repair and maintenance, and minimizes waste of machine hours
- Summary of machine requirements to meet demands for the next 10 years is in Appendix A, Table 2

- First step in figuring out requirements is finding the effective capacity of each machine using the given utilization rate and forecasted demand of output for year 1 (see Appendix A, Equation 2)
- Capacity utilization rate is then calculated for each year, and a new machine is purchased when this rate is at or exceeds 90 percent
- A full table of information, including the effective capacity of each machine and the machine requirements for each individual year for years 1 through 10, can be found in Appendix A, Table 3

Payback Analysis

An in-depth payback analysis is required to see if on-site welding is justified financially. Using the current estimated equipment utilization rates and our growth rate of 8 percent, we are able to see what machine requirements are for welding operations. Minocqua Manufacturing's planning horizon is 10 years (the decision will be made after these 10 years), but we included an analysis of 15 years in Appendix B to see the full payback period. Our machine requirement calculations showed that 3 TIG welders, 3 MIG welders, and 3 surface grinders would need to be purchased in year 1, and then one of each of those machines would need to be additionally purchased in years 4, 8, 11, 13, and 15 to keep up with the company's growth (see Appendix A, Table 3). Net cash flows were calculated on the basis of the costs of the machines and the savings ($2.00 per unit) of having welding on-site. The net present value switches from negative to positive in between years 13 and 14, with a discounted payback period of approximately 13.76 years. Minocqua Manufacturing already had concerns for finding a viable workforce to maintain

on-site welding operations, but it is also not financially justified since the payback period is greater than 10 years. Because of these two reasons alone, we recommend that welding should not be brought on-site and welding operations should continue to be outsourced at an average cost of $22.00 per unit.

Financial Analysis

- No extraordinary/unusual purchases were made
- We decided against bringing welding on-site due to the financial burden and long payback period
- Pool tables, foosball tables, ping pong tables, plants, vending machines, and coffee machines were justified despite the extra cost since they added aesthetic appeal to the layout and increase employee happiness
- Building a new facility is a huge financial commitment; a more in-depth analysis would need to be conducted to understand the details of all the costs associated with this project

Sustainability Analysis

As sustainability is a large consideration for Minocqua Manufacturing, we made sure to incorporate different features into our final design to ensure that the building is not only flexible and efficient, but also sustainable and environmentally-friendly. To help reduce electricity costs and minimize the amount of power being used, we implemented several windows and skylights throughout the building to increase natural lighting, which helps to reduce the amount of electricity needed to properly light the facility. To ensure that there will still be sufficient lighting when it is dark, there will be lighting fixtures throughout the facility, but these will also have

sustainability in mind. All of the lighting fixtures will use LED bulbs, which can use up to 75% less energy and last 25 times longer than traditional incandescent lighting (1). Along with reducing electricity costs and environmental impact, LED bulbs have also been shown to help improve employee morale and overall productivity by providing more uniform lighting, which helps decrease error and scrap (2).

Although scrap is reduced by using LED bulbs, there will still be mistakes that produce scrap. For this reason, we recommend that Minocqua Manufacturing ships any scrap that they cannot use back to the company that they purchased the raw materials from. The scrap will be transported in trucks that are already being used to transport goods from the supplier to Minocqua Manufacturing, so transportation costs will not be increased significantly. This method of re-selling scrap will not only help to reduce waste, but some companies give discounts or pay for scraps that are returned to them for repurposing, making this a win-win situation.

(1) https://blog.constellation.com/2016/03/25/led-vs-cfl-bulbs/

(2) https://www.specgradeled.com/factory-lighting-led/

Factor Analysis

The factor analysis chart is in Appendix F, with the measures of effectiveness described below:

- Safety - This is our highest weighted factor because safety in the workplace is absolutely essential to running a business, especially when dealing with potentially dangerous processes such as machining metals or dealing with harmful paint fumes. It is important that there is enough space between machines in the shop to move people and materials

safely, as well as keeping the paint shop isolated in order to not contaminate the entire plant with fumes.

- Space Utilization - This is a measure of how well the different departments fit together, creating a tight layout with very little wasted space. The second plant layout received a worse grade in this category because there were a few large gaps between departments, whereas the first one was very flush and had little unused space. This factor had a weight of only four because we have the ability to create the plant dimensions, so the space is not limited to certain square footage limits.
- Flow of Materials - This factor was a look into how effectively the flow relationship diagrams and charts were used in the layout design. It is highly weighted at eight because the flow diagrams were the main tool used when designing the layout, and it shows how efficient the design will be. Layout two etched out layout one for this factor because it matched the relation between departments as laid out by the relationship charts the best.
- Storage Effectiveness - Storage Effectiveness makes sure that when materials need to be stored, there will not be wasted time and energy transporting them into storage. This means keeping storage close to where materials would be being worked on as well as where they would be coming in and out of the plant. However, this was our lowest rated factor because it is unimportant when just looking at the machine shop, and the losses involved for the overall layout would be minimal.

Material Handling Systems

Forklifts (sit-down counterbalanced lift trucks) will be used to transport material between the shipping-and-receiving, machine shop, painting, assembly, and storage departments, which are the sections of the building that will be involved with material handling. Sit-down forklifts make workers more comfortable, and employee satisfaction is important to Minocqua Manufacturing. For this reason, there will be 13-foot aisles (as required by the sit-down version of the forklift) between these departments with minimal turns in order to maximize efficiency while minimizing risk. Forklifts are the best option because they are able to move several pallets/totes, which can transport and store small parts. They are also able to move larger products (e.g. table and chair sets), as well as any other products that a customer may request.

Once a forklift delivers pallets to the the machine shop, they are transferred to pallet or platform trucks, depending on what is being handled. These transport the parts between machines during the assembly of the product. Platform trucks are smaller than forklifts, which allows for easier maneuvering through the machine shop while still minimizing the amount of physical labor required for employees. When the parts arrive at a workstation, they will be put onto hydraulic lift/tilt/turn tables that are located next to the workstations. These tables lift the parts up and position them so that they are easily accessible to the machine operator without requiring heavy or repetitive lifting for the worker.

While the types of machines being used is very important to maximizing efficiency, safety, and employee satisfaction, the plant layout also plays a large part in material handling and overall material flow. Due to pallets being used to transport materials, we have left extra room in

each machine cell that is large enough to allow for the 4x4 foot pallets to be placed inside the cells. This makes material easily accessible to employees, and they will not need to walk far to obtain them, which allows setup and idle time to be minimized. The extra space in the machine cells allow Minocqua Manufacturing to expand and add more machines when demand increases.

The machine cells are organized in such a way that material can easily flow in a natural pattern throughout the machine shop as the final product is being assembled. Due to Minocqua Manufacturing wanting to maintain flexibility and the ability to make multiple different products, there are several walkways that connect all of the machine groupings so that there is not necessarily one specific path that material needs to flow, but rather multiple paths that can be utilized depending on the product. These extra paths will not only help to reduce the congestion of material movement, but they also allow Minocqua Manufacturing to remain flexible for fluctuations in demand.

Sensitivity Analysis

Variations in the analysis could greatly impact our recommendations to Minocqua Manufacturing. For example, if the welding machinery were less expensive or if the average savings per unit incurred by bringing welding onsite increased, the decision to do welding operations in-house could potentially be plausible. Having TIG and MIG welders onsite would change our machine shop layout slightly, but square footage would remain the same. We know this based on our capacity analysis and the calculation of the minimum square footage required for the machine shop, including TIG and MIG welders (Appendix A, Table 3).

We selected a “middle-of-the-road”, expected value growth rate, but a growth rate closer to either the minimum or maximum percentage could change our results significantly. A lower growth rate would lead to a smaller number of machines required, which would not impact the square footage planned for the machine shop. A high growth rate would lead to a greater number of machines required, which would increase the square footage needed for the machine shop and the total space of the new building, potentially changing the look of our entire layout.

Deciding to use different factors for our factor analysis or assigning different values to our competing layouts would change the look of our plant, but would not hinder operations or change them. Both options for the overall layout and the machine shop layout were logical and attended to the various relationships between departments and machines, so sensitivity in the factor analysis would not change our underlying ideas much.

Methodology

1. Complete the capacity analysis for a 10 year planning horizon; determine Minocqua Manufacturing’s future equipment requirements based on calendar year utilization rates and a projected growth rate of 8% (in Appendix A).
2. Complete the payback analysis (in Appendix B); calculate the net present value of the costs and savings associated with on-site welding. If the net present value is negative at year 10 (payback period is greater than 10 years), welding should not be brought on-site.
3. Adjust the capacity analysis as needed; remove machine requirements for the TIG and MIG welders if welding is continuing to be outsourced and not brought on-site.

4. Create relationship charts for the machine shop and overall layout (in Appendix C). Both flow and non-flow considerations should be taken into account for the machine shop.
5. Make relationship diagrams for the machine shop and overall layout (two possible candidates for each, in Appendix D).
6. Make block diagrams for the machine shop and overall layout (two possible candidates for each in Appendix E, made from their corresponding relationship diagrams).
7. Determine measures of effectiveness to evaluate the candidates; use factor analysis to choose the best candidate for the machine shop and overall layout (Appendix F).
8. Construct the chosen final layout and machine shop layout using Visio (Appendix G).

Lessons Learned

- A practical application to using Excel functions to make financial decisions such as whether or not to bring in an outsourced process and future plant growth
- How to use several softwares in creating the relationship diagrams, block diagrams, and plant layouts (e.g. Lucidchart, Visio)
- The different types of machines that can be used for material handling and the different costs, requirements, and benefits associated with them
- Different factors that must be considered when deciding whether to outsource or bring production onsite
- We should not try to justify something that is not financially viable

Appendices

ISyE 315 Production Planning and Control
Team Design Project

Progress Report / First Team Evaluation Form Due Date: March 16, 2018
Project Presentations: May 1 and 3, 2018
Final Report / Second Team Evaluation Form Due Date: May 4, 2018

Minocqua Manufacturing, Inc.

Minocqua Manufacturing is a contract manufacturer producing metal stampings and related fabrications/assemblies primarily from sheet metal stock[1]. One of their most popular products is a metal table and chair set similar to that shown in Figure 1. Currently, about 20% of the company's business is in the table/chair business.

Minocqua Manufacturing also produces a variety of other metal fabrications based on customer specifications and part prints. This wide variety of parts comprises the other 80% of the business. Generally, these are small parts which are transported in bulk via totes and/or 4 ft x 4 ft pallets. Sales have been increasing by about 8% per year across all products, and this growth is expected to continue into the future. Reasonable estimates project a minimum growth of approximately 5% per year and a maximum of approximately 12%.

Figure 1

Historically, Minocqua Manufacturing has outsourced welding operations to a local job shop. Last year, 18,000 parts were sent to this job shop at an average cost of $22.00 per unit, and this volume of parts is expected to increase in line with the anticipated growth rates stated above. Management of Minocqua Manufacturing has recently learned that the job shop is planning a capacity expansion which should ensure its ongoing viability for years to come. However, Management believes that additional market opportunities could be obtained if Minocqua Manufacturing brought the welding operations on-site but there are concerns of finding trained and qualified welding personnel in the area for hire.

If welding operations were to be brought on-site, Minocqua Manufacturing would need to purchase TIG and MIG welding equipment to be incorporated into the Machine Shop. It is estimated that Minocqua Manufacturing could accommodate demand for next year with three TIG welders at a cost of $30,000 each and three MIG welders at a cost of $28,000 each. These costs include equipment purchase and installation. Welding and resulting in-house surface grinding could then be completed internally at an average cost of $20.00 per unit. Note that this per unit cost is "loaded" with ongoing labor and maintenance costs.

[1] Details of this project are fictitious and are not intended to reflect any actual organization, their operations, or market conditions. This project description was created for educational and illustrative purposes.

Parts could come to the welding area from any of the machine shop equipment with about equal frequency. Similarly, if the welding activity is brought on-site, Minocqua Manufacturing would see a decrease in the volume of parts moving from machine shop departments directly to shipping and receiving (to be trucked to the welding job shop) and in the volume of parts moving from shipping and receiving to assembly and painting (when returned from the welding job shop); the majority of parts would move to shipping and receiving from the painting department after being welded, grinded, and/or assembled in-house.

If purchased, the welding equipment has the footprints indicated below. Any on-site welding department would need to be close to the Surface Grinding equipment for final material preparation prior to painting. Bringing welding activities on-site would also result in an additional capacity load on the Surface Grinding equipment, resulting in the need for at least three additional Surface Grinders in Year 1 at a cost of $18,000 each.

Minocqua Manufacturing is moving its operations into a new building. Minocqua Manufacturing is looking for you to propose an efficient layout based on current and projected material flows and capacity considerations. They want the building to be large enough to accommodate them for at least the next 10 years.

Since the new building has yet to be constructed, Minocqua Manufacturing has great flexibility in terms of building size and dimensions, location of doors, orientation of the building in relationship to access roads, etc. The required departments and the From/To Chart for the last calendar year are shown on the following pages. However, Minocqua Manufacturing wants to retain as much flexibility in the manufacturing process as possible to address the needs of many customers and products.

Currently, the plant operates 24 hours a day for 320 days a year.

Minocqua Manufacturing is looking for you to propose an efficient layout based on current and projected material flows and capacity considerations. In addition, sustainability has been an increasingly important part of business philosophy at Minocqua Manufacturing. Management would like to use the move to a new building as an opportunity to make its facility more energy efficient, sustainably built and operated, and waste minimizing.

Assignment:

1. Evaluate the current capacity of the facility and the facility's ability to address future capacity needs for at least the next 10 years. Where appropriate, determine and state the number of machines required over the 10 year planning horizon. Identify the utilization level you recommend to trigger the purchase of additional machines.

2. Provide recommendations to Minocqua Manufacturing for whether to bring the welding operations on-site or to continue to outsource these operations. Provide details of estimated cost impacts (e.g., in purchasing, labor, and capital), as well as other factors which might influence the final decision. Determine the payback period for bringing welding on-site.

    - Payback period can be calculated based on a Minimum Attractive Rate of Return (MARR) of 18%. You might also include a calculation of a Net Present Value (NPV) at this MARR and Internal Rate of Return (IRR) over the 10 year planning horizon to aid in the decision.

    - If your team is unfamiliar with the concepts of ISyE 313 (Engineering Economic Analysis), you can alternatively calculate a simple (non-discounted) payback period for the initial investment in welding activities.

3. Based on (1) and (2) above, design an effective detailed plant layout following the Systematic Layout Planning guidelines presented in class. If necessary, include a welding department as determined above. Also provide Minocqua Manufacturing with a sustainability strategy focusing on at least two initiatives such as material handling (ex: automatic conveyor shut-off), lighting, Energy Star and LEED certifications, final product transportation, recycling and waste minimization programs, etc., and explain how these sustainability initiatives impact Minocqua Manufacturing's business and financial considerations.

From/To Chart at Minocqua Manufacturing (number of loads; last calendar year)

TO: / FROM:	Shear Press	Laser Cutter	Vertical Milling Machine	Horizontal Milling Machine	Press Brake	Punch Press	CNC Lathe	Surface Grinder	Drill Press	Pipe Bender	Horizontal Band Saw	Painting	Assembly Area	Shipping/Receiving	TOTAL (FROM)
Shear Press		150			150	150		50	50				50	25	**625**
Laser Cutter			50	75	150	50	50		50	75		75		25	**600**
Vertical Milling Machine		50		50		75		125				50	125	25	**500**
Horizontal Milling Machine		250	50			25		125				50	25	50	**575**
Press Brake			75	100		150			50		25	75	75	50	**600**
Punch Press			75	75	100			75	50			25	50	50	**500**
CNC Lathe		50	25	75				50		50	75	100	75	50	**550**
Surface Grinder			75	50					100		100	250	250	75	**900**
Drill Press				50				150			75		25	50	**350**
Pipe Bender								100				150	100	75	**425**
Horizontal Band Saw			100	100			100	75	50	100				50	**575**
Painting													1500	700	**2200**
Assembly Area												1250		1300	**2550**
Shipping/Receiving	600	100			200		400	150		200	300	175	250		**2375**
TOTAL (TO)	**600**	**600**	**450**	**575**	**600**	**450**	**550**	**900**	**350**	**425**	**575**	**2200**	**2525**	**2525**	

- Note that material may be moved to/from the inventory storage area from any manufacturing area due to scheduling and material requirements.

- The Excel file From-To Chart is embedded in this document below.

From-To Chart.xlsx

Required "Departments" and Estimated Area Needed (For 10 Year Horizon)

"Department"	Estimated Area Needed (Sq. Ft.)
Administrative Office	3000
President's Office	1500
Conference Room	2500
Manufacturing Engineering	2500
Lunch Room	3000
Rest Rooms	1500
Quality Laboratory	1500
Sales/Accounting	2000
Computer Server	500
Production Manager Office	1000
Machine Shop	26000
Painting	3000
Assembly Area	3000
Tool Storage Area	2000
Inventory Storage Area	5000
Shipping/Receiving	2000

Required Machines in Machine Shop and Estimated Machine Footprint (including potential welding equipment)

Machines	Estimated Machine Footprint (ft x ft)	Sq. Ft.
Shear Press	16' x 12'	192
Laser Cutter	18' x 18'	324
Vertical Milling Machine	10' x 10'	100
Horizontal Milling Machine	11' x 10'	110
Press Brake	12' x 14'	168
Punch Press	8' x 8'	64
CNC Lathe	12' x 10'	120
Surface Grinder	9' x 9'	81
Drill Press	6' x 8'	48
Pipe Bender	8' x 12'	96
Horizontal Band Saw	10' x 10'	100
TIG Welder	12' x 12'	144
MIG Welder	14' x 14'	196

Current Estimated Equipment Utilization

Machines/Departments	Current Number of Machines	Current Calendar Year Utilization (Average % per machine)
Shear Press	3	72%
Laser Cutter	2	70%
Vertical Milling Machine	3	80%
Horizontal Milling Machine	2	84%
Press Brake	4	76%
Punch Press	2	82%
CNC Lathe	2	77%
Surface Grinder	3	72%
Drill Press	3	76%
Pipe Bender	2	82%
Horizontal Band Saw	4	70%

Note: If brought onsite, Year 1 welding equipment utilization is estimated to be 75%. The utilization of additional surface grinders is estimated to be similar to current surface grinder utilization.

Additional Information & Requirements

- For your capacity analysis, you may assume that the growth rate projections will impact the ***hours of utilization*** on each machine equally. Be sure to consider compounding growth over the planning horizon and include growth rate projections on welding equipment (if brought onsite).
- Base your relationship chart on both flow and non-flow considerations. Use common sense (e.g., welding should be separate from painting; storage areas should be close to shipping/receiving; the Production Manager's office should be close to the Machine Shop, etc.).
- Minocqua Manufacturing prides itself on being an employer of choice in the area, and would like to develop an attractive building layout to both attract/retain quality employees and to impress current/future customers.
- All machines must be a minimum of 3 feet from any other machine or object (wall).
- Any painting and welding areas should be enclosed with sufficient ventilation for fumes.
- All department sizes (specified in square feet above) are estimates. The size of the departments, and in particular the machine shop, that you specify in your layout should be reflective of the departments that you actually design. There is some flexibility in the actual size of these departments, but target the minimum requirements. You can create additional functions, if desired, based on available space. Also note that the size of the Machine Shop will vary depending upon whether you bring welding onsite.
- Indicate current equipment/machines in your detailed layout. Also identify space for machines to be purchased "long-term" to address future growth. You may want to indicate where these additional machines will be placed. Be sure to consider logistical constraints in placing additional machines in the future.
- The Machine Shop and Assembly Area requires extensive material handling coverage within its departments. Within the machine shop, detail the material handling system (aisles and/or cranes). For the other departments, the material handling system only need to reach the department but need not be detailed within the department. Please design overall material handling systems and layout in such a way that material flow is smooth and coordinated within the plant.
- The choice of material handling systems is open but use good judgment in selecting material handling equipment. A brief introduction to material handling equipment is given below.
- Aisles with forklift coverage should be 9' wide minimum. All other aisles should be 6' wide minimum. Curves, jogs, and non-right angle intersections should be avoided. Generally, aisles should be straight and lead to doors.
- While cost is always a consideration, the Management of Minocqua Manufacturing is looking for an effective and attractive layout proposal. As a result, a detailed cost justification or financial analysis is not required. However, you should make efforts to justify any extraordinary recommendations (e.g., robotic material handling systems, RFID systems, subterranean worker breakroom/resort/spa, extensive landscaping, daily visits by circus clowns, etc.)
- Other relevant estimates may need to be made – **state and justify your assumptions**!
- While the use of MS Project is not required, your team can receive bonus points for doing so. If used, be sure to include MS Project output in the appendices of your final report.

Material Handling Equipment Information

Material handling equipment (MHE) is used for the movement and storage of material within a facility or at a site. MHE can be classified into the following five major categories:

I. *Transport Equipment*. Equipment used to move material from one location to another (e.g., between workplaces, between a loading dock and a storage area, etc.). The major subcategories of transport equipment are conveyors, cranes, and industrial trucks. Material can also be transported manually using no equipment.

II. *Positioning Equipment*. Equipment used to handle material at a single location so that it is in the correct position for subsequent handling, machining, transport, or storage. Unlike transport equipment, positioning equipment is usually used for handling at a single workplace. Material can also be positioned manually using no equipment.

III. *Unit Load Formation Equipment*. Equipment used to restrict materials so that they maintain their integrity when handled a single load during transport and for storage. If materials are self-restraining (e.g., a single part or interlocking parts), then they can be formed into a unit load with no equipment.

IV. *Storage Equipment*. Equipment used for holding or buffering materials over a period of time. Some storage equipment may include the transport of materials (e.g., the S/R machines of an AS/RS, or storage carousels). If materials are block stacked directly on the floor, then no storage equipment is required.

V. *Identification and Control Equipment*. Equipment used to collect and communicate the information that is used to coordinate the flow of materials within a facility and between a facility and its suppliers and customers. The identification of materials and associated control can be performed manually with no specialized equipment.

For detailed information visit http://www.ise.ncsu.edu/kay/mhetax/index.htm

You may also find helpful

- http://en.wikipedia.org/wiki/Material_handling_equipment

- Appendix 5.B “Material Handling Equipment” of Tompkins, White, Bozer, Tanchoco’s “Facilities Planning” (2003, John Wiley and Sons; ISBN-13 978-0-471-41389-9; ISBN 0-471-38937-4 (WIE)).

Grading/Evaluation

- Progress Report: 15%
- Presentation: 15%
- Final Report: 70%

Progress Report Requirements (15%)

- Capacity analysis to address growth requirements for at least the next 10 years
- Machine requirements for the 10 year planning horizon
- Payback analysis for welding operations and decision whether to continue to outsource or bring welding on-site
- Relationship charts including flow and non-flow considerations
  - If welding is brought on-site, an updated from/to chart should be developed to present assumed flows.
- At least 2 Relationship Diagram candidates for machine shop
- At least 2 Relationship Diagram candidates for overall layout
- At least 2 Block Diagram candidates for machine shop
- At least 2 Block Diagrams candidates for overall layout
  - Note: Block diagrams must be drawn to scale with proper labeling and dimensions. Block diagrams need not specify detailed material handling systems, but should identify outlines of aisles, etc., for evaluation purposes.
- Complete factor analysis explaining the meaning of selected factors for the evaluation of the proposed layout alternatives (e.g., material handling, safety, flow).
- Identification of the primary material handling strategies within the facility.

Note: Please include your team number in the report cover page.

Presentation Requirements (15%)

- Executive Summary
- Capacity Analysis Summary
- Factor Analysis Summary
- Block diagram(s) for machine shop and overall layout
- Final detailed layout for machine shop, including detailed material handling systems and sustainability considerations
- Key features

Maximum allotted time per team: 10 minutes

Assume that you are making this presentation to the top management of Minocqua Manufacturing. As such, you need to sell your recommendations! Don't spend an inordinate amount of time explaining options that you didn't choose, and be aware of the need to explain methodologies used to a management team which may not be familiar with Systematic Layout Planning principles. Be reminded of top management's goals, objectives, and financial considerations. Necessary supporting details of your analysis should be in the Final Report, and not necessarily in the presentation.

Upload your presentations in your "Project Presentation Dropbox". Name your file as: "Team # – Any description you need"

All files required for your presentation must be uploaded to the dropbox in advance to minimize changeover time between teams. Additional or updated files will not be considered on your presentation date.

Final Report Requirements (70%)

- **Written Documentation**: 10 Pages Maximum (Written Portion). This doesn't mean you have to fill all 10 pages. Use Times New Roman, font size 12 with double line spacing to write your report. A maximum of 25 pages of appendices or attachments is allowed in addition to the 10 page maximum, but the written portion must include the following.
  - **Executive Summary and Recommendation**
  - **Key Features**: Highlight the key features of your final layout. Bullets, numbering and table format is preferred.
  - **Capacity Analysis**: Provide a brief description of your capacity analysis, including machine/expansion requirements over the planning horizon and potentially beyond. Briefly state any conclusions derived from the capacity analysis. Bullets, numbering and table format is preferred.
  - **Payback Analysis**: Provide a brief description of your payback analysis and recommendations for the future of the welding operations. Provide details of estimated cost impacts, as well as other factors which might influence the final decision.
  - **Financial Analysis**: Provide a brief description of any extraordinary financial aspects considered for comparison, along with any assumptions made. Briefly state any conclusions derived from financial analysis. Note that a detailed overall cost analysis (e.g., NPV) is not required. Bullets, numbering and table format is preferred.
  - **Sustainability Analysis**: Provide a brief description of strategies focusing on at least two initiatives to make its facility more energy efficient, sustainably built and operated, and waste minimizing.
  - **Factor Analysis**: Provide a brief description of the factors and your ranking of the factors. Briefly state any conclusion derived from factor analysis. Bullets, numbering and table format is preferred.
  - **Material Handling Systems**: Explain your material handling system for the plant. Explain total area for aisles, dimensions of the aisles, and coverage of departments. If you are using any other material handling system, please explain total area coverage and which departments are covered.
  - **Sensitivity Analysis**: What possible changes in your analysis would impact your recommendations (e.g., changes in cost parameters, volume, space requirements, and cost of capital; sensitivity in the factor analysis; etc.). For example, what would happen if you used a different growth rate? How would the number of machines and square footage be affected?
  - **Methodology**: Logically describe the steps involved in this project that helped you come up with your recommendation. Flow diagram is preferred.
  - **Lessons Learned**: Lessons learned from the analysis, teamwork, drawing tools, etc.
  - **Drawings**:
    - Relationship chart including flow and non-flow considerations
      - If welding is brought on-site, an updated from/to chart should be developed to present assumed flows.
    - At least 2 Relationship Diagram candidates for machine shop
    - At least 2 Relationship Diagram candidates for overall layout
    - At least 2 Block Diagrams candidates for machine shop
    - At least 2 Block Diagrams candidates for overall layout
      - Block diagrams must be drawn to scale with proper labeling and dimensions
    - Final layout
      - Final layout must be detailed with material handling systems and machine/office templates. You can choose any appropriate office templates.
      - Include space for any machines which may be required in the future based on the capacity analysis.
      - Show exits, safety equipment, ramps etc., and indicate operator locations
      - Dimension your final layout.
- If any changes were requested based on the progress report and/or presentation, please provide the modified diagram or document.
- Upload a copy of your report and final layout (picture or Visio format) to the course website dropbox. You do not need to submit a paper copy.
  - ***Everything should be in one Word or PDF document including all appendices. The only exception is you may additionally upload any Visio / image files that are unclear in the appendices. Anything that is not included in the one final report document will not be considered for grading.***
- The following will be used as a guide in grading your final report.

Team Name: _____

ISyE 315 Design Project

(i) Capacity Analysis:

Machine/Expansion requirements for 10 year horizon	_____/10
Make or buy decision for welding operations	_____/5

(ii) Layout Analysis:

Relationship Charts	_____/5
Relationship Diagrams	_____/5
Block Diagrams	_____/5
Measures of Effectiveness	_____/5
Factor Analysis	_____/5
Financial Considerations	_____/5
Sensitivity Analysis	_____/5

(iii) Reasoning (pros & cons) for selection of the final layout _____/5

(iv) Detailed Layout

Proper use of templates, etc. (see next page)	_____/5
Sustainability considerations	_____/5
Overall quality of layout (see next page)	_____/20

(v) Organization, Clarity and Presentation of Written Report

(10 pages max double spaced; minus 1 for each extra page) _____/5

(vi) Completeness of Total Solution _____/10

_____/100

Team Name: _____

Categories for Proper Use of Templates

No.	Contents	Good		Poor	
		-0	-1	-2	-3
1	Consistent Use of Templates				
2	Area Labeling				
3	Use of Grid Sheet or Scaled Drawing				
4	Dimensions Clearly Labeled				

Categories for Overall Quality of Layout

No.	Contents	Good		Poor	
		-0	-1	-2	-3
1	Material Handling Methods/Equipment				
2	Space Utilization/Size of Plant				
3	Support Areas (Lunch, Restroom, etc.)				
4	Easy Access to Machines				
5	Easy Access to Storage				
6	Separation of Undesirable Areas				
7	Aisle Locations & Size				
8	Number of Machines Correct				
9	Operator Working Conditions/Safety/Accessibility				
10	Distance Between Machines (min. 3 ft)				
11	Areas for Expansion				

Unique Features (Gains)

No.	Contents	Gains
1	Use of CAD or Visio for Final Layout	
2	Financial Analysis based on net present value	
3	Sensitivity Analysis	
4	Use of MS Project	
5	Other:	

Team Evaluation

While the project will result in a team grade, the attached "Team Evaluation Forms" will be used to determine if all members of the team will get the same grade. All team members must submit the Team Evaluation Form with their Progress Report **AND** with their Final Report. Note the two separate files to be used at these two stages. The following evaluation guidelines will be used, subject to the discretion and final decision of the instructor and TA:

- Mostly A: 100% of the team grade
- Mostly E: 92% of the team grade
- Mostly I: 87% of the team grade
- Mostly O: 82% of the team grade
- Mostly U: 70% of the team grade
- Mostly X: 60% (or less) of the team grade

For Progress Report:

Progress Report
Team Evaluation Form

For Final Report:

Final Project Team
Evaluation Form.doc