7.4) Appendix 4: Effect Analysis

7.4.1) Introduction/Purpose

This Appendix has been written as a separate entity from the original report. It is here to show what effect fully automating the process of modeling a spiral bevel gear could have on a company. It should also be mentioned that this portion of the report was not sponsored by CNC Software, but instead information that assisted in the writing of this section was provided primarily by Curtis Machining Co. with some supplementary information coming from Boston Gear. The overall goal for this appendix is to provide information on how the modeling program could assist a company if it were to be finished and was accurate enough to make custom gears suitable for commercial purposes and was implemented to its fullest extent.

As stated by the Worcester Polytechnic Institute curriculum, a Management Engineering Major Qualifying Project with a concentration in Mechanical Engineering must contain an aspect in both business and the area of concentration. In this case the main report satisfies the Mechanical Engineering component and this appendix will serve as the business component. This project provides an insight into business operations and financing by showing how something as small as a change in the method of making a model can have major impacts on a business.

7.4.2) Body

As most of the data for this appendix has come from Curtis Machining Co. it is necessary to have an understanding of what they do as a company. The company manufactures high quality gear boxes to be placed into larger machine units. Their products are used in a variety of machines, covering areas such as agriculture, transportation, flood control, food processing equipment, and more. The company is certified to meet the ISO 9001-2000 family of standards of quality management and meets all the code classifications of American Gear Manufacturers Association (AGMA), American Society of Agricultural Engineers (ASAE) and Society of Automotive Engineers (SAE). In the process of manufacturing their custom gear boxes it is not uncommon for them to need to design and machine custom spiral bevel gears as well. This is where the gear modeler could be of use.

To start off research a set of questions for a personal interview were drafted. After contacting many companies it was decided that Curtis Machining Co. would be the best fit for this appendix to be based on. The questions asked were as follows:

1. What is the demand you see for custom made spiral bevel gears? What would be a rough estimate of how many you sell over any given time period?
2. How long does it take to model a single gear?
3. What is the average salary of the design engineers who work on these gears?
4. How much to the gears generally sell for and how much of that price is profit?
5. What is the approximate labor cost per gear?
6. How would reducing the time to model a gear lower labor costs?
7. What other projects are the design engineers who would be modeling these gears also be working on?
8. How do you calculate the production costs from the start of the design process to the finished product?

Galen Kohn of Curtis Manufacturing Co. provided the following information in a personal interview over the phone. All of the following information came from Mr. Kohn unless specifically stated otherwise:

1. Demand is high, somewhere between 500-1000 custom gear sets are sold each month.
2. Curtis Manufacturing Co. does not actually computer model their gears but instead drafts them and makes calculations that are manually put into the machines that cut the gears. This process takes roughly three hours.
3. Mr. Kohn was not comfortable releasing this information, however in a personal phone interview with Frank Sultzman of Boston Gear it was learned that Boston Gear pays employees approximately $80,000 a year for going similar activities.
4. Total Production cost can range from [withheld at the request of Mr. Kohn] per gear depending on which materials are used and how the gears are heat treated.
5. Approximately 50% of the production cost is labor cost.

6. Due to the way the machines used at Curtis Manufacturing Co. operate, even with the gear modeler, an employee will need to manually enter all the parameters that define the gear into the machine to make the gear, so there will still be a decent amount of labor cost incurred. Mr. Kohl estimated that the modeler would lower the overall time spent making a gear by about 1.5 hours.
7. The design engineers also work on designing housing, shafts and other gears for gear box assemblies, both right angle and parallel shaft assemblies.
8. The way that the Curtis Manufacturing Co. calculates their production costs is complex, uses very detailed spreadsheets that they could not disclose, and was far too involved to explain over a phone call. In general, their costs are defined by incorporating the cost of materials, the cost of labor and the cost of any heat treatment that the gears may need after the machining is complete.

With this information we can now begin examining the impacts the gear modeler could have on the company. Because the labor cost is approximately half of the total production cost without the gear modeler and the labor cost would be cut in half by using the gear modeler we can assume that using the gear modeler would reduce the cost of making a single gear by approximately a constant 25%. Because of this we know economies of scale do not apply in this situation as the number of gears produced will have no effect on the production cost. The only thing that has the ability to effect production costs, other than labor, would be materials and heat treatment. There is no way to know what the costs are for each individual month as all the gears would be custom ordered and therefor the materials and heat treatment are completely random and are only based on customer needs.

7.4.3) Conclusions

As mentioned above, economies of scale will not apply to this situation as increasing production has no direct effect on costs. The only factors that truly impact the unit costs are materials and heat treatment which we have no control over. Although information about the salaries of the design engineers was found analysis has shown no use for that information in this study. The gear modeler will save the company roughly 25% of its monthly costs associated with spiral bevel gears and therefor will allow the company to increase profits by that amount or

lower the price of their products in an attempt to increase sales. A wise idea may be to do both and increase profits by 12-13% and then use the other 12-13% to lower the price of the product, however this decision would be based on information that was not provided for this report.

In the main report methods of making a gear modeler for spur gears and straight bevel gears were detailed as well. Curtis Manufacturing Co. also machines these gears. Modifying the modeler to work with these less complex gears could also be of some assistance, but it is doubtful they would have as great of an impact due to the fact that it takes much less time to do the calculations to make these gears.

A final overall recommendation would be to implement the gear modeler, as it would save the company 25% of their monthly costs for manufacturing spiral bevel gears. Further analysis shows us that, based on their average total production costs, the company could save anywhere from [withheld at the request of Mr. Kohn] per month based on demand, materials used and heat treatment in that month. This allows them to not only increase earnings but to also rededicate workers to other projects, such as the design and manufacturing of other types of gears and gear boxes. If 500-1000 custom gears were made and 1.5 hours was saved in the making of each gear then roughly 750-1500 man hours could be saved each month.

Although the analysis done in this appendix studied Curtis Manufacturing Co. and the effects the gear modeler could have on that particular company there is more that can be learned in general other than these specifics. As mentioned in the introduction, this information supports the idea that small changes can make a big difference. In this case many would consider the gear modeler to be a relatively large change, considering the amount of time and work that would go into the creation of such a program, its impacts would be enormous. Lowering the cost of delivering a product by 1-2% in most cases would be considered a great improvement; a 25% savings is almost unheard of. This stands to reason that making smaller changes that can save small amounts of time can still have a very valuable impact. This theory is supported by the studies of lean practices and their usefulness in business operations.

7.4.4) References

1) Galen Kohn, Curtis Manufacturing Co., 4/5/12, Personal Interview

2) Frank Sultzman, Boston Gear, 3/19/12, Personal Interview