

Flexibility in Manufacturing: A Proposal for Study

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Abstract

Manufacturing—evolved from Fordism to today's "lean" technologies—is set to integrate the information and automation technologies that have revolutionized other areas of business. Combining the flexibility of human workers with the efficiency of machines, flexible manufacturing is at once exciting and dangerous to prospective companies. The Gemstone Flexible Manufacturing Research Group will better understand the significance of the shift to flexible technologies by developing a plan for the study of the benefits and liabilities specific to flexibility in manufacturing.

to complete the aforementioned proposal. The complete proposal should be written by the time we have concluded our brief studies of several corporations in the third step.

The purpose of this proposed plan of action is to outline how we will proceed to gain knowledge and experience in the field of flexible manufacturing. It will aid us in formulating a final proposal for the project and fulfilling our project proposal goals. This proposal incorporates when and how we will gain information to make intelligent informed decisions about these topics, and how we will gain information concerning them.

Introduction

The Gemstone Flexible Manufacturing Research Team consists of six Gemstone Honors students in addition to two faculty mentors. The goal of our research project is to conduct a four-year study relating to flexible manufacturing and to develop new information and/or reach new conclusions about this subject. In order to accomplish this goal, we have developed a series of steps outlining our plan of action:

1. Select Companies for Brief Studies
2. Conduct Brief Studies of Many Corporations
3. Present Brief Studies About These Corporations
4. Determine Companies for Detailed Study
5. Formulate Research Paper Thesis
6. Conduct Detailed Study of Company
7. Decide on Product
8. Produce Research Paper and Product

At this time our research group does not have the experience, background, or information necessary to complete our project. Hopefully, following the steps described herein will help us gain the knowledge necessary

Background

To meaningfully discuss the important issues in the subject of flexible manufacturing we have created a background of general definitions of the subject matter from which to work. This base from which to work consists of several definitions:

Efficiency- For this research project, efficiency only has meaning when adaptable efficiency is required. It is only necessary to speak of greater efficiency when greater efficiency is possibly as a product of greater or less flexibility in manufacturing.

Flexibility- The ability to change output with a degree of variability that is adaptive; through the use of new methods or technology.

Flexible Manufacturing- Manufacturing techniques and technologies that can change or alter output with minimal adjustments in such a way as to be variable and adaptive.

Subject Company- This refers to a company that is willing to work with us, and allow us to examine their manufacturing system, whether it is flexible or not. We will present our findings to this subject company.

Detailed Project Description

Select Companies for Brief Studies

Have a variety of initial choices:

- Choose a dozen different industry areas
- Contact all possible leads
- Make sure to establish some relationship with at least one company in every industry selected
- Mass mailing
- Select organizations of different sizes in each industry
- Use contacts with organizations to get other contacts
- Get preliminary feedback on openness to suggestions
- Do not limit initial companies to areas to be pursued for the final project

Each person gets one or more contacts:

- Start with a list of possible organizations
- Assign companies to individuals
- Create a first contact general script
- Set deadlines to report back to the group, schedule tours, information sessions...etc.

As a first step in our research on flexibility in manufacturing, we plan to conduct brief studies of a multitude of companies in order to gain experience, build a greater knowledge base, and learn how we may proceed onto our more detailed studies. Having a variety of initial choices of companies to study is extremely important. No matter which companies we actually end up examining in later periods of research, having a variety of initial choices will help ensure that the final companies are involved in several different activities, and have several different plant setups, including both flexible and traditional. In order to make this variety a reality, we have come up with several guidelines that will help us to maintain a large variety when selecting companies. First of all, when selecting the companies, it is extremely important to choose companies from several industry areas. This would ensure, for example, that we not only look at producers of mechanical products, but also companies that produce software, or computer chips through VLSI manufacturing. Along the same lines, it is also important not to limit our initial choices to companies that are in areas that we plan to pursue for our final project. In other words, even if we are not considering studying "widget" construction at this point, it is important to still include it in our brief study. The reason for this is because the purpose of the brief study is to gain general knowledge about manufacturing. We may find through these studies that we would like to include a particular area that we thought was not applicable previously. In addition to selecting companies from different industries, it is also extremely important to select companies of different sizes. Big companies operate very differently from "mom & pop" organizations, and are also

completely different from mid-size companies. It is important to include all sizes of companies in our study because some techniques may work quite effectively for a large company but not a small company, or vice versa. Keeping this in mind, whether we propose to study a large company, a small company, or more general information, we would at least know to what kind of companies our research applies.

Once we have developed a list of companies to contact, it is important that we contact every single lead. Leads could include anything from previous personal contact to a name in the phone book, but each and every one of these leads must be contacted and we must follow up on them. The actual contacting could include phone calls or mass mailings. The mass mailings should contain a standard package which includes a brief letter about our project in general, a more detailed proposal, information on the Gemstone Program, as well as a contact phone number, address, and stamped return envelope. For phone calls, we should establish a script for everyone to use as well as a general information sheet to answer questions so that all companies will receive the most up to date information we have regarding our project and flexible manufacturing.

Once the initial list of companies has been made, each person should make several contacts. This can be accomplished by assigning a group of companies to specific individuals, and specific individuals would serve as a liaison from our group to their respective companies. The person in charge of contacting given companies will have several responsibilities in order to maintain a large variety of companies as well as to ensure a successful project. Each person must get some sort of feedback from the companies they contact as to their openness to our suggestions and willingness to participate in our project. This feedback will be crucial in helping us determine which companies to actually include in our study. Positive feedback would indicate the possibilities of developing a strong relationship with a company. Even if a particular company is not responsive to the possibilities of our project, it is still possible to benefit from this company. The contact person should ask the company if they know anyone who we could talk to that may be able to help us. It is extremely important to try to use the contacts we have to generate new contacts in this way. Through this technique, we can develop a large network of corporations that are actually interested in participating in our project. While developing the relationships between our group and other companies, it is also important to ensure that we establish some relationship with one company in every industry area. This means at the very least that we must be talking regularly with one company in every industry area, whether or not we are conducting a brief study on that company. Doing this will also result in a larger variety of companies. Finally, there will be several companies that are interested in working with us. It is important that each individual have deadlines to report back to the group about these companies. Additionally, this person will be responsible for setting up tours and information sessions

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with these companies after checking on times/etc. with the rest of the group. If these guidelines are closely followed, the selection of companies to conduct brief studies with should be very smooth and effective.

Perceived Problems. As long as we stick to the guidelines, there should not be too many difficulties with the selection of companies for the brief studies. Keeping to the guidelines provided will ensure that our initial choices cover a wide base of industries, company sizes, and levels of technology. The one major obstacle that we may encounter would be that no companies are willing to allow us to participate in any kind of study. If this is the case, then we would need to redefine our plan of action. Hopefully, this will not occur. The process for selecting these companies should take approximately one month of solid work, at least 5-6 hours per week. It is important to keep in mind, however, although many companies may not be willing to participate, some companies probably are. This means that we will need to contact a great number of companies in order to be left with a few that will allow us to study them.

Conduct Brief Studies

Look at parallels between companies we are studying:

- Similar techniques and equipment used
- Determine factors to look for, what makes the companies different, effects on performance...etc.
- Similar products and/or performance

Make sure study is comprehensive:

- Get information from sources other than the company
- History of previous consulting/changes record
- Define breakdown of the study for each person
- Projects and papers done by other students

As our group conducts brief preliminary studies for our project we will have two main objectives: To examine the parallels between the companies we have studied and to insure the comprehensiveness of our studies.

When we look for parallels, we will consider what similar techniques and/or pieces of equipment are used. Other parallels will be based on the similarities of the company's products or the performance of the company. Also important in recognizing the parallels between the companies will be to determine exactly what factors to consider and examine. We need to keep in mind what makes the companies different.

We will take several steps to make sure our initial studies are comprehensive. We will check our information against information collected from outside the company. We will examine any records of previous consulting done for the company. Lastly we will try to obtain and examine any papers done on the company by other students or researchers.

Perceived Problems. As we conduct our brief studies we may find that the companies we have selected through our

brief studies may not lend themselves to the type of studies we are prepared to make. We may find that the companies we have selected are too alike and that comparisons between them are not very useful. It may be discovered that the companies are too varied to allow us to make any definite conclusions. In an attempt to make sure our studies are comprehensive, we may not be able to find any sources other than our own to verify our research. The companies we study may be unwilling or unable to provide our group with records of past consultations or changes. In dividing the duties of the study between our group members we may keep our scope of tasks for individuals too narrow and we may have to reassign different people to different tasks.

Present Brief Studies with Generalized Findings

Compare and contrast companies in each category:

- Venn diagrams
- Determine what the categories are
- Trend analysis
- Summary chart
- Rating System
- Define most crucial parts of the general findings
- Decide on weak parts of generalized findings
- Confirm with the company about accuracy of findings
- Discuss what we have learned so far

The major focus of this presentation will be the comparison of several possible target companies, across a variety of similar factors of existence. To this end, the determination of the categories is a necessary first step. Creating a summary chart, rating system, or a Venn Diagram will be helpful in our comparison, as will our analysis of the companies' trends in the areas of interest. After the companies in question have been compared to one another, feedback from the companies concerning the accuracy of our analysis will be collected. Finally, we must decide what parts of our general findings are weak, what parts are most crucial, and conduct a thorough discussion of our findings and comparisons.

Perceived Problems. Possible problems with this stage of the project would be overly long discussion of the differences between the companies and relevance of the particular differences, difficulty getting rapid feedback from the individual companies, and differences of opinion concerning the importance of certain parts of our findings. Of these problems, the only one that is not in our direct control is getting feedback from our target companies, and hence that is the problem most likely to cause delay and confusion in this stage.

Determine Company(s) for Detailed Study

- Define ideal company
- Compare examined companies to ideal companies
- Present findings to group

To determine the suitable companies for study we propose to examine a number of companies and detail certain comparable traits on a chart. In evaluating the companies we will create a series of traits that define our ideal company and evaluate each company as to how it lives up to our ideal. In an effort to broaden our ideas, we will speak with both managers and workers in the companies we are investigating and determine some of their concerns with respect to manufacturing flexibility. This information will be integrated into the chart of traits and can be used to create new categories of traits if necessary. We will use the chart in a discussion to compare the companies examined, and through this discussion we will arrive on a choice or choices for a company or companies we wish to use in our research. The discussion will take the form of a presentation and appraisal model, where the people who did the investigation of the companies will present the information gathered to the rest of the group. This will then be followed by an appraisal of the information and a choice of company(s).

Perceived Problems. When comparing the companies from our brief studies, we may have difficulty selecting specific characteristics of a company that we perceive to be ideal. There will be a large range of various traits to examine, some only relevant to certain companies, and it may be hard to make legitimate comparisons between companies in some areas.

Formulate research paper thesis

- Evaluate people to whom we have access
- Brief research to fill in gaps in understanding
- Determine audience for thesis
- Form groups of two to three to generate theses

After choosing the appropriate company, our preliminary investigation will provide us with a good idea of what is feasible to study at the company we select. We should evaluate what people in the company we have access to, as this will in part determine the possible scope of our research. If any more information is desired concerning the company, or their particular field of industry, we will conduct brief research to better understand the areas of the field that might benefit from our efforts. Two to three groups of three or two people respectively will be formed to generate theses that will be evaluated at the end of this phase of the project. We will follow the presentation and appraisal model that we have used in the past. Each group will present their thesis, followed by a discussion by the group that will culminate in a decision on one thesis.

The form of the research paper as well as the audiences to which it is addressed must be determined, be they the Gemstone community or any audience beyond. Once this audience is determined, we will use the information collected about the company to determine the available options for research topics. The people we have access to at the particular company will be important to the research

topics we might choose. If we have access to a particular department, for example, it would be foolish to choose a research topic that can only be investigated with the cooperation of another department. There could be circumstances where this might not be true, and it would be worthwhile to pursue a research topic aside from the areas we have access to, but this should be considered as a special case. Combined with the brief research conducted into the industry area of the particular company, an evaluation of the particular strengths of the members of our group, and the people we have access to at our company of choice, the possibilities for our research thesis will be narrowed further.

It is important in the formulation of the research thesis to compose a thesis that is a complex question, and not a question with an inherently desirable outcome. In other words, the question should provide interesting research whether our thesis is correct or not. In addition, it is important to define the items of the thesis that must be tested, and those that we might want to test, but are not imperative for the success of the project. We should establish a project plan throughout this portion of the project, using some form of project planning tool that evaluates resources and tasks (Microsoft Project, for example). This would help with planning, deadlines, and other organizational duties within this phase and those following.

Perceived Problems. It will be very important for us to ensure that the research paper thesis will be useable and worthwhile despite the outcome of our research. We must also make it practical and within our scope of limitations. If we do not regard these items, we may not have problems at this stage, but it could cause a lot of extra work and backtracking in future stages.

There are also the larger problems of a desired company not willing to be the subject of our detailed study and management and/or workers being uncooperative with our study.

Conduct Detailed Study of Company

- Present proposal to interested companies
- Collect feedback from workers and managers
- Examine competition to company, how do they do things different

Our group will first propose its thesis and specific project outline to the specific company(s), keeping in mind that we need to have a backup in case of unforeseen problems (i.e. A company backing out at the last minute). After our thesis is formulated and approved by the company(s) of study, we will begin implementing means by which to collect data. In doing so, we will take key ideas from the brief studies and further expand on them, but at the same time being careful to identify specifically how our detailed studies will differ from these brief studies. While collecting data, it is important that we focus on only relevant information that is a direct result of our controlled

variables, and that we do not get carried away with information overload. Keeping our goals in mind and the limitations the company is setting on us, we could most effectively use our time and theirs. After evaluation of our data, we will have to decide on whether or not our data is relevant or useable, and if it could yield conclusions applicable to our thesis. Additionally, before deciding on a product to implement, worker feedback from the lower and upper level positions within the company is very important. These are people that work in the factory every day and those people would have the best indication of what "needs" to be made flexible. Furthermore, we will want to examine other similar companies in an effort to gain relevant information, as well as determine the status quo of our company under study.

Perceived Problems. There is again the possibility that the company(s) chosen for our detailed study will back out of the agreement. We may need to investigate any legality involved if such a situation occurs this far into our research.

Decide on product

- Establish resources available for final project
- Decide on medium
- Conduct a discussion to decide on product

In determining the final product for our research, we must choose the best medium to display our collected findings. Our choices might include, but are not limited to an academic paper, a poster, a video, a working model, or an addition to an existing technology. To help in choosing our final product(s), we should determine the capabilities of the members of our group as well as the resources they have access to. This is a very important step because for some products such as working models and additions to existing technology require mechanical fabrication, and thus if we do not have access to the facilities to manufacture the product it would be a bad choice.

Our product should be an exhibit of the variables we studied, and should provide insight into the problem that we have considered. We could also ask the company we are studying, or other companies in the same area the type of product they would be most receptive to, be it a seminar, a paper, or some other product. In this same vein we should consider how our product would be received by companies other than the one under study, so that our product might have more general appeal. Once ideas for products are presented, several criteria are significant in deciding upon the product(s) we will produce. One significant criterion concerns the feasibility of the product: can we make it? Also, if it is a suggested improvement to a company system or tool, will they implement it? Because of these concerns, it is very important to keep the product as simple and realistic as possible, because this will most likely result in a well developed product. Though the product could be complex and robust, it is certainly much more difficult. Finally, we should remember that it is not a

poorer project if our final product is not a physical entity. A paper, seminar, or presentation is just as valid as a model or a device.

Perceived Problems. Not every group member will be investigating the same areas. Therefore, everyone might have a different idea as to which product will be best to build. Everyone should be involved in the decision making process and it is important that ideas are shared and explained thoroughly.

Produce Research Paper and Product

- Produce a good paper as well as a good presentation, most people will only see the presentation.
- Have meetings where each subgroup updates others on current work to avoid overlap
- Give company updates on work with preview presentations
- Complete paper and presentation for defense

The first rule that our group must keep in mind is that we should always allow plenty of time for the unexpected. Our presentation and product is going to be the component of our research project that will best represent our group, assuming only a handful of people will read our thesis. To make our presentation flow and be impressive, the presentation tasks should be broken down among all group members, yet through collaboration on the project our group will take the necessary steps to prevent overlap and redundancy. This can best be accomplished through periodic meetings with the whole group. It is important that the company under study knows what to expect during the presentation, therefore a preview of the final presentation and/or product will be given to them. In preparing the presentation and product, we must remember not to neglect the research and thesis paper.

Perceived Problems. The estimated time in this stage is very dependent on the complexity of our product and the medium we chose in Stage 7. For example, a physical product will take much longer to construct and we will encounter a different set of problems than if our final product was in the form of a paper or seminar. There will also be a problem if we discover that we have insufficient or incomplete data when writing our research paper. The company may also disagree with our findings and not will them to be published.

Anticipated Impact

There are many possible benefits to our research endeavors, which may include but are not limited to implementation of a flexible manufacturing design in a specific area of industry, a thesis highlighting our research data, and conclusions for increased productivity in manufacturing. Since our group is focusing on flexible manufacturing, and more specifically on how to increase the flexibility of less flexible manufacturing processes, we

are prepared to develop a theory that companies could easily implement to increase productivity, adaptability, and reduce changeover costs. Through our research we will be working intimately with one or several companies in an effort to evaluate reasonable and applicable theories the field of flexible manufacturing. Furthermore, through implementation of the conclusions yielded by our research, we are aiming to increase worker satisfaction and product quality.

Additionally, we are striving to learn as much as we can about flexible manufacturing and then synthesize our knowledge into ideas that can benefit a company or even industry in general. It is our goal to enhance the flexibility of a company, so that production adaptability is easier as well as cheaper. We are seeking out all possible means by which industrial manufacturing could be made simpler, with aspirations that our research will yield results that are meaningful. We hope to be able to educate our audience in the field of flexible manufacturing, with the hope that our research will yield new ideas and spark new interest in the field.

Conclusions

This proposal outlines how we will proceed to gain knowledge and experience in the field of flexible manufacturing. The most crucial part of this plan of action is the process by which we will establish a relationship with a suitable company and examine the company in depth. Following this is the formulation of our research thesis, the completion of which is highlighted by a product and presentation. Included in the proposal is a list of possible problems associated with each major phase of the project. These problems are reflected in the timeline, which details the project into the spring of 2000.

This proposal represents the combined efforts of all six of the student members of the Gemstone Flexible Manufacturing group. Through this proposal we establish a rigorous schedule that will enable us to proceed steadily towards our goal of a final research product. More importantly, it serves as a vehicle to enable the successful completion of this project.