AC 2009-346: NEW GRADUATE COURSES DESIGNED TO PRODUCE ENGINEERS TO FACE THE CHALLENGING MODERN INDUSTRY

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New Graduate Courses Designed to Promote Future Engineers to Face the Modern Challenging Industry

Abstract

Today's strong global industrial competition requires our future engineers to have the ability to work in challenging and new industrial environment. It requires our students and future engineers to have the solid technical knowledge, strong leadership and better communication skills. Because a number of advanced industrial knowledge has not been included in the current engineering classes, some necessary curriculum and teaching reforms are needed. A new course titled "Manufacturing Strategy and Lean Manufacturing" has been developed at University of Bridgeport to provide our graduate students with the knowledge to face today's challenges. The instructor brings the extensive US industrial and engineering experiences to the class and all the advanced technology procedures introduced and discussed in the class can be applied to the industries to improve the plant performance in manufacturing flow, organizational functions, process control, metrics and logistics. Although this course was taught at the mechanical and manufacturing engineering majors, it can also be applied to the most areas of US industrial and engineering practices. In addition to several real industrial case studies, two advanced projects have been assigned in the course to help students to apply the skills learnt from this lecture.

Introduction

Some students enrolling into the engineering major might have some difficulties to select appropriate engineering disciplines[1-2]. One of the best ways is to cover the disciplines through multidisciplinary engineering study to provide students with the real industrial case study and potential solution[3-4]. The explanation of how engineers in different disciplines resolve the engineering issues could become the feasible way of educating the students on their future duty of engineering in each discipline[5-6]. The real engineering examples from industry are good resources for the students which can help them to understand the real engineering issues and show them how the technical concept can be used in real cases. Several examples from real engineering practices have been discussed in the class to help students to understand how the feasible engineering solutions improve the quality of industrial product. Some class case studies, which can help students understand more real and challenging industrial issues, are shown as follows:

Case study 1:
One small company has the business in an industry dominated by some famous companies including General Electric. In order to make this company more competitive in this industry, please make the proper strategies on following products with your opinion: 1st priority, 2nd priority, and 3rd priority:

A. Large products
B. Small products (normal delivery)
C. Small products (fast delivery)

D. Emergency product replacement

This case study can help students to gain the knowledge of how to build up the strategy for small companies to face the challenge. The strategy guidelines with focus on lean manufacturing will be discussed and learned from this case study.

Case study 2:

A small but well-organized company attempts to implement the strategy to strengthen the firm's competition. Please discuss and explain if the following strategies are properly planned for this company:

A. Inventory is very cost and should be reduced without other considerations.
B. There is no consequence in using of plant machines and equipments.
C. Production lines should have a straight-through flow for all products.
D. Manually operated machines are economically better than high-tech NC controlled equipment.
E. Lot scales should be reduced significantly.

This topic can help students to learn how to plan the business strategy for some small but well-known and aggressive companies, and to use lean manufacturing guidelines to assess the manufacturing / production process control and validation assessment.

Case study 3:

One manufacturer makes many types of consumer products. Recently this company has planned the strategies to build up many small work-cell and small production lines to handle their products. Please verify if it is true on the following results:

A. Proficient productivity within the work-cells
B. More products in inventory
C. Less organized in storage areas
D. More quality problems

This case study can help students to gain the knowledge of setting up the proper manufacturing strategy to improve the plant performance in manufacturing flow, organizational functions, process control, metrics and logistics.

Case study 4:

One company is planning to upgrade the following items in previous strategy to further improve its competition in today's industry. Please determine how you can help this firm to modify the following items in old strategy:

A. Work-cells set up and flow layout design:
   Products were being made in a long and high speed assembly production line. Split the long production line into sub-assembly areas to make orders of subassemblies before running the order on the full production line.
B. Production team set up:
   The informal production teams existed in the factory that was mainly based on person's technical skills and job classification. The tool and die makers were on the top of the operation lines, followed by the punch and

press operators, equipment setup men, machine operators, and assemblers.

C. Speeding setup:
A number of presses and equipments need to be set up along the assembly line before being applied to the operation. To minimize or reduce the setup time, product orders had been grouped by similarity and were run in sequence.

This case study will help students to use the technology of Failure Modes and Effects Analysis (FMEA) to upgrade the old strategy. The FMEA's basic idea is to spot risks and to initiate dedicated efforts to control or minimize risks to the manufacturing product. Knowing the risks can make production quality control plan more realistic. FMEA seems to work best when a team documents its knowledge on cause- and effect-relationships. In this analysis mode, the timely sequence of failure events should be worked out first, before entering results into a FMEA sheet. The students will learn how to apply this technology to improve the company's competition in today's market.

Class projects

All class formal projects, which are referenced from some U.S. famous and successful companies, are introduced and assigned to students to help them in learning and planning the manufacturing strategy in today's industry. The instructor has brought his extensive industrial experiences in the class to help students in their project preparation and learning process.

The sampled class projects are as follows:

Project 1: Establishing a new brand of cell phone with potential technology
The tough economic situation has hit the cell phone market. The products in many companies range from the simple to the complex. In fact the overall market is predictable, with larger companies staying at the top and less successful companies trying hard to get into the top competitors' market share. Please analyses what makes the difference between the most successful and less successful businesses, and how to meet the consumers' requirement by setting up the proper manufacturing strategy.

This class project will guide students to learn what manufacturing strategy the small / regular companies have to establish in order to be survival in this competitive world, especially many companies are facing the out-sourcing competition.

Project 2: Organizing the transition of product from research to development stage

Preparing for product launch at the emerging technology companies can be a very challenging task. Currently their first commercial product is normally research-based, with a mission to generate the proof-of-concept data. Please set up the proper manufacturing strategy to quickly and smoothly make the product transition from research to development stages.

This project is selected to help students to learn what are the critical rules that today's researchers or engineers must follow in their development of new products. The students will also learn how to manage in transferring new R&D projects to development stage products, that is the critical stage to produce the final production products.

Class portfolio and discussion

The lectures in this class cover the topics of most recent techniques in establishment of the manufacturing strategy and lean manufacturing in today's industries. It illustrates and explains the fundamental of manufacturing strategy and manufacturing strategy with performance measurement. All these topics will help students to understand the theoretical basics and importance of manufacturing strategy, and learn to apply this technique to today's industries.

1). Fundamental of manufacturing strategy
Manufacturing strategy could be applied to a company's manufacturing function and aimed at keeping medium and long term to secure the business's competition over others. The manufacturing function requires a strategy to keep a match between the business's markets and the existing/future capabilities of its manufacturing system. Manufacturing strategy usually includes the issues as follows:

- Firm's Organization
- Application of technology
- Production planning / materials control
- Production facilities
- Manufacturing capacity
- Quality control
- Vertical integration

It is generally accepted that the better manufacturing function in an organization is very critical for its success. Having a good manufacturing strategy that aligns with full business strategy and other functional strategies in an organization is very important. Also, the strategic proposal must be combined with an effective approach to continue its improvement at an operational level if a firm needs to make production at the quality, quantity and cost that keeps its competitiveness over others in the markets.

The current issues discussed in the class include:
. Competition from countries with low labor cost:
A critical part of a manufacturing strategy is to verify whether products are to be made at the regular manufacturing location of the companies or if it might be beneficial to build up manufacturing facilities in a low labor cost countries. Although it might be attractive to build up the facilities in low labor cost areas, the organization must take account of the practical and logistical difficulties and consider the financial complex to set up and run facilities in remote and underdeveloped countries.

. Outsourcing manufacturing resources**:**

Since it is now more easily to locate the suppliers and contract outsourcing manufacturers over the world, many firms add the outsourcing manufacturing into their strategy planning. It looks very attractive if the product cost is the only factor to be considered but requires to ensure the issues such as the product quality are properly recognized and manufacture control must be addressed.

. Properly meet customer requirement:
To achieve reduced costs and improve profitability in a business, the management should focus its business activities on a certain range of technologies including quantity, products and markets. Many customers are now indicating more demanding about the cost, quality and performance of their purchased products and asking for more variety of the products. All these require companies to well develop manufacturing strategies with good production technologies including automated and flexible manufacturing processes that allow organizations to increase manufacturing flexibility and capability to quickly and cost effectively meet the customer demands.

2). Manufacturing strategy being verified with performance measurement
Currently the strong competitiveness of manufacturing industry can be seen in the market. All the issues, coupled with the desire to have short term financial results, have caused a strong cost cutting which might lead to the less capital investment. Such decisions may have the short-term profitability, but lead to reductions of the resources used in companies, and do not provide the long-term firm's future. This indicates that the manufacturing strategy in some businesses is not properly planned.

Today a lot of businesses rely solely on market perspectives to plan their strategies which might satisfy customer needs but do not keep the proper leverage of a firm's technological and production resources. The problem raised here is the lack of judgment of how to incorporate manufacturing into a business strategy and how to verify its performance in a strategic measure not solely on financial decision.

This new class is designed to explain and address all these problems to the students – our future engineers, by providing a professional and feasible way of planning a strategic approach and applying practical lean tool to the manufacturing business.

. Objectives and results
The major objectives of this class have been to develop and verify processes for planning of manufacturing strategy and developing of performance measurement system. The emphasis is to help students to gain practical knowledge that can be applied in an industrial context.

. Performance measurement
The performance measurement process is very critical and it must parallel the strategy activity in the organization. The organization will have no effective way to determine the extent to which their proposed objectives have been achieved in the organization if the performance measurement system is not properly aligned to strategic objectives.

Therefore it is necessary to develop performance measurement systems that are well aligned with their business strategies and objectives.

The performance measurement systems include the processes as follows:
. Classifying the business into different product lines, categories, families and markets;
. Providing the strategy and objective definition;
. Deciding the top level performance measures connected to the business objective;.
. Connecting the measures from top levels to lower levels by determining the drivers of performance and the keys;
. Verifying the measures for drivers;

The performance measurement systems determine the factors that affected the long term selection of performance measurement systems. It verifies the main drivers, hurdles and show-stoppers for the performance measurement systems. The driver includes senior management commitment that represents the factors for performance measurement to succeed. The hurdles are factors all businesses faced. The show-stoppers include parent company interventions. Among the above, the senior management commitment is the key part in determining and verifying the management literature for the success or failure of business projects. This class will also teach students how other factors can impact and influence the senior management commitment in deciding and processing of the business projects, and provide students with a more comprehensive understanding of the main factors influencing the company's success.

Conclusion

The curriculum reforms have been brought to this new graduate class. The reforms have focused on the potential programs that provide students with more challenging technologies. This course, currently taught at the mechanical / manufacturing engineering majors, was designed to introduce professional issues associated with today's US engineering practice. It also brings the Lean Manufacturing, Six Sigma, and other important industrial standards to examine the multiple industrial issues that associated to the engineering project delivery processes. In addition, this course explains and applies other necessary support arrangements & technological procedures including standard operation procedures (SOP) and ISO 9001 standard.

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