2006-2642: ENGINEERING TECHNOLOGY STUDENTS: THEIR ROLE IN THE GLOBAL ECONOMY

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Technology Students: Their Role in the Global Economy

Abstract

The percentage of United States employment in the manufacturing sector has been slowly deteriorating over the recent decades. Additionally, the GDP/capita ratio in the United States is not growing at the rate of other countries. This continuing trend does not bode well for the future domestic economy or future opportunities for technology students. An increase of entrepreneurial activities is one possible solution to the reversal of this trend. Technology students need to become more versed in the use of Design for Six Sigma techniques used to develop new innovative ideas in addition to the use of non traditional technology areas such as lead user methodology. Development of classroom techniques and programs where these fundamentals are transferred is of the utmost importance to future opportunities for the current technology student in the future global economy.

Educational goals include providing the students with the fundamental skills to make decisions in the role of the financial manager using financial statements. Additionally, students will be exposed to differing management philosophies within the global economy. For example a recent survey of 378 managers from five countries provided the following results when asked “Whose Company is it?” The % respondents answering (“The Shareholders”/”The Stakeholders”) for each country are listed as follows: Japan (3%/97%), Germany (17%/83%), France (22%/78%), United Kingdom (71%/29%), and the United States (76%/24%). The same managers were asked the question, “Which is important, jobs or paying dividends?” The respondents answering (“jobs”/”dividends”) were as follows: Japan (3%/97%), Germany (40%/60%), France (41%/59%), United Kingdom (89%/11%), and the United States (89%/11%). The importance of student understanding of these differing global perspectives will allow them to be more effective in their development of innovative products to compete in the global economy.

Introduction

Some US based companies have been criticized for not being as innovative in their recent history as they were in their more distant past. For example, it has been reported that Ford being a company founded on innovation, has demonstrated a lack of creativity in its recent history. As a result Ford produced more vehicles in the year 2004 than consumers purchased resulting in excess inventory. This may lead to Ford having to reduce their workforce by approximately 30,000 jobs\(^1\) in coming years similar to General Motor’s (GM’s) planned workforce reduction of 30,000 workers by 2008.\(^2\) However, Ford is making strides to increase innovation by soliciting ideas from within.\(^3\)

GM has recently set a financial goal of annual cost reductions of $14 billion using their 2005 revenues as the basis for this calculation. As a result their structural costs will be reduced from its current value of 34 percent to 25 percent of company revenues by 2010. Currently, their cost-to-revenue ratio in North America is higher than the 34 percent average.\(^4\)
US companies have found that it is more cost effective to outsource than to own all stages of the production process. As a result an increasing number of US companies have outsourced jobs in an effort to achieve immediate cost reductions without having to incur the expenses or liabilities that accompany capital investments. However in addition to the outsourcing of manufacturing jobs, innovation is being outsourced as well. Boeing is co-developing software for navigation systems, landing gear, cockpit controls, and new aircraft designs. GlaxoSmithKline and Eli Lilly are teaming with Asian biotech research companies to reduce the cost of bringing new pharmaceutical products to market. Eli Lilly is able to perform research in China, using the Chinese company ChemExplorer, at approximately a 40% savings to performing the same research domestically. Firm’s following this practice will be able to achieve a greater profit margin and return on capital. As a result, outsourcing has become a significant part of any organization that plans to compete on a global basis.

Technology students graduating in the 21st Century are entering a workforce where a global mindset is imperative. They will need to have an understanding of businesses, industry sectors, and markets from a global perspective in addition to having a proper understanding of their role. The goal is to enable students to accurately identify the places that they will be able to make contributions within this changing universe. In order to achieve this they will need to understand the perspectives of others from cultures and communities unlike their own.

**Manufacturing Cost and Innovation**

The percentage of jobs in the manufacturing sector has slowly been decreasing since the 1940’s decade. In the early 1940’s, over 30% of all US employment was within the manufacturing sector declining to 11.0% of all employment by the end of 2005. Additionally, US employment in manufacturing sharply decreased from a steady value of approximately 17 million to approximately 14.5 million between the years 2000 and 2004. (Figure 1).

![Employment in manufacturing, 1995 - 2004](image-url)

*Figure 1. US Employment in Manufacturing: 1995-2004 (Source: Bureau of Labor Statistics)*
It is important to note that while the percentage of jobs in the manufacturing sector was steadily decreasing in the US, the same thing was taking place in other nations as well. Germany, France, Japan, and the UK all experienced significant steady decreases in their percentage of employment in the manufacturing sector between the years 1967 and 2002.\(^1\) China lost a total of 15 million manufacturing sector jobs between the years of 1995-2004 while the US lost two million jobs during the same time period. Overall, the world lost 22 million manufacturing sector jobs from 1995-2004.\(^2\)

Although the US has lost a significant number of jobs from within the manufacturing sector over the past half century, productivity has increased by a factor of more than eleven during the same time period. This increased productivity has allowed the US and other countries to accomplish more in less working hours. The US is not amongst the countries with the highest productivity growth rate nor amongst the group of countries with the lowest growth rate.\(^3\) The opportunity for technology students to contribute is available if they are able to use their skills to not only appropriately perform work more efficiently but also provide processes and product that are desired by the market.

It is important to understand that managers in different countries have different perspectives. Students need to understand what is important in each market not only to be able to make contributions but also to formulate their own values on what is of importance for the US and each country to make contributions in the global economy. For example, US managers represent one extreme by placing a greater emphasis on the needs of shareholders and dividends while Japanese managers represent the other by placing a greater emphasis on the needs of the stakeholders and their employees.\(^4\) (Figure 2 and Figure 3)

\[\text{Whose Company Is It?}\]

** Survey of 378 managers from 5 countries

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The Shareholders, All Stakeholders

Figure 2. Survey of Managers from Five Countries (Source - Yoshimori 1995)
Not only is it important for students to be aware of the values of each player in the global marketplace, it is also important for the student to be able to meet the needs of the customer. Identification of lead users is one method students should be made aware of. Lead users are individuals that have product or service requirements that are ahead of the needs of the average consumer. Many times the lead user will create a novel product or process to provide this need which may lead to a commercial product.15

Proper use of lead user information/involvement has demonstrated a significant positive effect on both new product development speed and firm profitability.16 Short new product development lifecycles are not only associated with higher productivity and lower levels of inventory and working capital17, but also with reducing the occurrence of value migration. “Value migration occurs when value leaves economically obsolete business designs and flows to new business designs that more effectively create utility for the customer and capture value for the producer.”18

The use of customer input in the development of an incremental design change is very different than the customer involvement of a lead user in the development of a fundamentally new product19, 20. Some of the market research tools used in incremental innovations such as quantitative user questioning, (virtual) focus group discussions and sophisticated conjoint analysis techniques21, 22, provide the same value when attempting to generate a breakthrough innovation. These techniques build on the fundamental tool of Analysis of Variance (ANOVA) that is used by all technology students.

Depending on the market that the product is being developed for, the percentage of users in the market who improve prototypes or develop new solutions ranges from
approximately 10% to 40% of the actual users. Medical surgery equipment users (n=261) from 2003, resulted in 22% of the users developing solutions for their own use. Almost 50% of these innovations is currently marketed or will be marketed in the near future by a medical device or equipment manufacturer.

These lead users have been found to be easily differentiated from ordinary users by two characteristics:
1. They have customer needs requiring new characteristics or parameters from a product earlier than other customers in the market.
2. They benefit greatly from innovations that provide a solution to those needs.

Lead users input is valuable only if we can make the assumption that new needs gradually flow across all markets and market segments, rather than impact all customers simultaneously. It has been proven that the high profitability of an innovation is not realized by all customers in a given market at the same time.

The lead user process is made up of four distinctive steps: (Figure 4) Starting the Lead User Process, Identification of Needs and Trends, Identification of Lead Users, and Concept Design. It is important to identify the methodology that will be followed in the identification of the lead users. In general, there are two methods that can be followed; a qualitative, standardized screening approach or a qualitative, non-standardized networking search process. The screening approach surveys a large number of product users for the presence of identified Lead User indicators. On the other hand, the networking approach identifies new Lead Users by informal references from known Lead Users.

![Figure 4. Lead User Method Process (Source - Luthje - 2004)](image)

**The Lead User and Design For Six Sigma**

The two concepts, lead user and Six Sigma are actually very synergistic concepts. Although, lead user identification is primarily associated with the marketing function of the organization, technology students have the skill set allowing them to identify these
lead users. As a result they will be more aware of customer needs and able to make significant contributions in the global marketplace.

Six Sigma is generally recognized as a measure of quality where a process can’t produce more than 3.4 defects per million opportunities. When most people refer to Six Sigma, they are referring to the DMAIC methodology which is most used in stable or iterative process changes, not innovative processes. The DMAIC methodology is made up of five distinct phases: Define the project goals and customer (internal and external) requirements, Measure the process to determine the current performance, Analyze and determine the root causes of the defects, Improve the process by eliminating defect root causes, and Control future process performance.30

However, Design for Six Sigma (DFSS) has significant importance in the development of innovative products. DFSS has been successfully used in the development of innovative medical devices. GE Medical Systems Division, under the leadership of Jack Welch, successfully developed a Lightspeed Computed Tomography (CT) system allowing clinicians to capture “multiple” images of a patient’s anatomy simultaneously at a speed six times faster than a traditional scanner. This product was the first GE product designed using DFSS. As a result of the overwhelming success, Jack Welch announced that all GE products subsequently designed would follow the DFSS approach.31

DFSS is used to design or re-design a product or service from its inception point. While the process requirement of Six Sigma is 3.4 defects per million, DFSS is not as stringent allowing one defect per 1000 opportunities. The methodology for DFSS is expressed through the acronym DMADV. The five phases of DMADV are defined as: Define the project goals and customer (internal and external) requirements, Measure and determine customer needs and specifications (benchmark competitors and industry), Analyze the process options to meet the customer needs; Design (detailed) the process to meet the customer needs; Verify the design performance and ability to meet customer needs.

Customer needs is mentioned in each of the five phases of DFSS. Not coincidentally, customer needs also plays a significant role in lead user methodology. Technology students made aware of these tools will be more prepared to participate and contribute in the global economy.

Implementation of Globalization in Engineering Technology Curriculums

The implementation of globalization subject matter into the engineering technology curriculums could be successfully accomplished in essentially one of three different ways. The decision to follow one of these particular strategies depends on several factors specific to the educational entity at hand. These factors include program resources, school and program size, faculty, curriculum, degree offered, etc. The three strategies are:

1. Requiring students to take related courses found elsewhere on campus.
2. Requiring a core of related electives within the technology curriculum.
3. A unique combination of both of the above.
Conclusions

There are three levels where globalization can take place: customer need, customer benefit, and product features. Technology students have the fundamental skills to contribute on all of these levels. However, it is important that they understand the importance of financial, operations, and design fundamentals to do so. For example, the fundamental rule for maximizing net income by setting marginal revenue to marginal cost can be applied to all operations management and cost of quality concepts presented in the classroom.

Additionally, students should be made aware that innovation can lead them down the entrepreneurial path. Sectors expected to experience significant growth are mobile technology and security and privacy to name a few. The increased productivity that comes from innovation can lead to contributions in many varied arenas. Technology students only need to be provided a global perspective and methods to use the fundamentals they have learned to achieve success. The goal as educators is to find a way to tap into this potential for everyone on the globe has something significant to contribute to the global cause.

References

31 Evans-2005.