Application of Lean Management to Improve Educational Operations

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ABSTRACT

Public awareness of global environmental problems such as global warming and ozone depletion has increased, to become one of the biggest issues for the new millennium, since the concept of sustainable development has attracted public attention as the greatest concern of the late twentieth century. According to this concern, some action and counter planning to solve the regional and global environmental problems have occurred. As part of these efforts, several international environmental conventions have been conducted, and their final goals are focused on the reduction of fossil energy consumption and development of alternative energy.

It is viewed, therefore, that sooner or later every country in the world should take part in the international agreements voluntarily because they are essential in dealing with the global environmental problems, even through the socioeconomic situation of each country is different.

It is not sufficient for a business to merely complete a task in order to survive in today's competitive environment. The business must complete the task better than its competitors.

Successful industries must show that it provides unique capabilities, or core competencies, if it is to maintain its current mission and function. There should be a quantitative comparative assessment that enables an orgnisation to track its internal performance over time and compare it with that of the best performing organisations.

Paper shall introduce Lean Management as a total business approach designed to identify and eliminate forms of waste in the process of producing goods, services, or combination of both. Typical forms of waste include defects, rework, transportation, overproducing, waiting, unnecessary processing, unnecessary movement, inventory, and behaviour (Emiliani 1998).

The elimination of waste will enable business to improve quality, lower costs, and sustain market competitiveness while at the same time adding customer value and responsiveness, increasing employee morale, and improving customer satisfaction.. The implementation of lean management principles in service business may increase efficiency and reduce project costs but may consequently reduce revenues (due to

reduced billability) unless the firm is able to capitalize on its newly available resources and attract additional work.

The paper will relay on five established fundamentals of lean management:

(1) specify value; (2) identify the value stream; (3) flow; (4) pull; and (5) perfection (Womack and Jones 1996). Initially, customers must provide the definition of *value*, which is how the customer determines whether or not the service provided satisfies their needs. Once the value desired by the customer has been appropriately specified, the *value stream,* consisting of all actions (encompassing the problem-solving, information management, and physical transformation tasks) required to produce value, must be accurately identified. It is at this step that operational modifications will be made to identify and eliminate all actions that may not create value to the customer. The concept of *flow* is then applied to the new value stream to enhance the efficient addition of value through the operational stages and ultimately to the customer. The newly created value stream can then be used to shift from "*push*", when production and delivery instructions originate from upstream supplier locations regardless of downstream customer conditions, to *pull,* where cascading production and delivery instructions are implemented at upstream supplier locations only when signaled by downstream customer (Womack and Jones 1996). In other words, the system will accommodate the production of the good or service in response to the customer demand as opposed to the traditional production system, where production takes place in anticipation of demand. The final fundamental concept in lean management is the continual striving to achieve *perfection* through radical and continuous improvement orts in the generation and delivery of the product or service to the customer.

Although lean management systems are appropriate to manufacturing industries, it can also be applied service industries such as education (Cromm 1999)

This paper will explore the applicability of lean management principles to improve educational operations. It will also present the five fundamental concepts of lean management so that educational and training sectors can use them to reduce waste and enhance their business operations.

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Application of Lean Management to Improve Educational Operations Case Study: Marine Propeller Course

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Intended category: Tools for managing sustainability

ABSTRACT

The paper explored the applicability of lean management principles to improve educational operations. The five established fundamentals of lean management described as: (1) specify value; (2) identify the value stream; (3) flow; (4) pull; (5) perfection, are applied to the chosen course in marine propellers. This course provided an opportunity to employ collaborative learning with active learning techniques. The students engaged in a variety of activities in teams comprised of members from two groups. In addition to team laboratory exercises and homework assignments, the students work together to process their efforts. They engaged in meaningful discussion among themselves concerning their activities and implications of the various results. The students also act as teachers by preparing lectures and exercise on topics from their discipline to the other fellow students.

This paper describes the learning techniques employed in this course, as well as the interpretation of the results from the students.

Keywords: Lean management, collaborative and active learning, discipline specific knowledge, application.

INTRODUCTION

The development of lean management principles originated in Japanese manufacturing companies during the post World War II era (Emiliani, 1998). Led by Eiji Toyoda and Taiichi Ohno of the Toyota Motor Co. and Shigeo Shingo, the lean production philosophy was established in response to the deficiency in human material, and financial resources (Emiliani, 1998). Lean management established the following five elements: (1) specify value; (2) identify the value stream; (3) flow; (4) pull; and (5) perfection. The concept is applied to a new value stream to enhance the efficient addition of value through the operational stages and ultimately to the customer. This newly created value stream can then be used to shift from "*push*", when production and delivery instructions originate from upstream supplier locations regardless of downstream customer conditions, to *pull,* where cascading production and delivery instructions are implemented at upstream supplier locations only when signaled by downstream customer (Womack & Jones, 1996). The final stage in lean management is the continual striving to achieve *perfection* through radical and continuous improvement. Although lean management systems have since been predominantly implemented in manufacturing industries, Cromm(1999) reported that service industries such as education have similarly been improved using lean management systems.

It is clear from a review of recent literature that engineering curricula internationally are recognizing the need to develop engineers proficient across traditional engineering fields [1,4, and 6]. At UNITEC Applied Technology Institute (UATI) we have developed the Marine courses to exploit the strengths found in its discipline and its applied nature.
In his "Cone of Learning", Dale 1997… suggests that people learn and retain 20% of what they hear, 30% of what they see, 50% of what they see and hear, 70% of what they say, 90% of what they experience directly or practice doing. Because of the applied nature of the Marine Propellers course, there are many opportunities to engage students in active learning through laboratory/workshops and design exercise. It is then a relatively easy leap for students to accept other practices of active and collaborative learning in the classroom setting.

In our syllabus we describe Marine Propellers, as a discipline technical area comprised of synergistic integration of Fluid Mechanics and intelligent computer control in the design and manufacture of industrial products and processes. Given that the technical area is a disciplinary one, we saw a benefit to direct students in two groups. The intent was to draw on the strengths of the students in their disciplines to advance the learning of the entire class. The class provided the opportunity for students to reinforce their discipline-specific knowledge and integrate it with new knowledge and applications.
We also focused on the applied nature of propellers. The design-directed course covered topics such as: boundary layer, wing theory, propeller characteristics, and cavitation. Rather than start with theory, we focused on how to specify, integrate, and use propeller element in a system. Theory was provided as supporting information. A larger emphasis was placed on discerning the advantages and disadvantages among alternative elements and appropriate selection for a desired application. Students explore alternative

approaches through a variety of exercises in the classroom, the workshop and the design setting.

This paper describes the collaborative and active learning techniques employed in this course using the five elements of lean management.

APPLYING FIVE FUNDAMENTAL CONCEPT

The same five fundamental concepts used in manufacturing and other service industries may be used to provide a framework for implementation of lean management in the educational environment sector. This will address how lean management principles would be applied to an educational sector by examining the collaborative and active learning techniques employed at one of the Bachelor of Applied Technology courses (BAT) delivered at UNITEC Applied Technology Institute (UATI), Auckland, New Zealand.

Specify Value:

Lecturing to a classroom of students is probably the most common form of "information transfer". This method places undue pressure on both the tutor administrating the lecture as well as the students forced to identify and process important concepts in the presentation. On the other hand, collaborative learning removes the tutor as the so-called expert on the course material and empowers students with control of their own understanding of both basic and advanced concepts. Implicit with collaborative learning in addition to higher retention is the student's ability to achieve a deeper understanding of the subtle concepts and procedures [UATI 2003]. One of the main concepts involved in collaborative learning is the emphasis of having students work together to get a job done. This is best realized by five basic tenets [Smith, 1991(a)]:

- Positive interdependence: exists when students believe that they are linked with others in a way that one cannot succeed unless the other members of the group succeed.
- Face-to-face promotive interaction: exists among students when students orally explain to each other how to solve problems, discuss with each other the nature of the concepts and strategies learned, teach their knowledge to classmates, and explain to each other the connections between present and past learning.
- Individual accountability: requires the tutor to ensure that the performance of each individual student is assessed and the result give back to the group and individual.
- Collaborative skills: are those students must have and use the needed leadership, decision-making, trust-building, communication, and conflict-management skills.
- Group processing: involves a group discussion of how well they are achieving their goals and how well they are maintaining effective working relationships among members.

Identify Value Stream:
After a value is specified, the current value stream should be identified. Depending on the specific goals of the lean initiatives, this value stream may encompass all actions and interactions conducted during different stages, or may target one specific task.

We designed our course (Marine Propellers – Marine Department, UATI) to place students in the best possible position to both actively learn the course material as well to work collaboratively to achieve in-depth understanding of complex concepts. This includes everything from studying and processing complex data sheets to developing team-oriented lectures in a disciplinary environment. According to Smith (1991(b)) collaborative learning may be incorporated into course through the use of: 1) informal learning groups 2) formal learning groups and 3) collaborative base group. Informal learning groups are often less structured and thus last for a short term. Formal learning groups are more structured and normally last until a task is done. They normally last from one class period to a few weeks. The method we employed implements the collaborative base group idea where groups are carefully constructed and stay together for a majority of the course duration. In our case, we assigned two groups of four and six students that stayed together up to the final phase of the course.

We approached group processing with both in-class and out-of-class assignments. Students were asked to find information jointly as a group and then compare and contrast the advantages and disadvantages of the competing components, systems, and processes. For example, one assignment required each student to locate a data sheet for a particular propeller shape and explain each of its specification terms. Students then gathered into groups of two to review their work. Processing took place by having students compare and contrast the characteristics of the propellers while recognizing that the primary function of the propeller was to receive input from the environment to produce the thrust required to move the boat forward. The students submitted individual assignments that deciphered their particular propeller data sheet and a group report that compared and contrasted the propellers presented by each group member. After small group discussions, the class as a whole discussed the numerous propellers found by all groups during the assignment in order to gain a better appreciation for design options in the future.

It was illustrated that much of the confusion with propellers was not in students' ability to sense the outside environment, but rather in their ability to be interfaced to blade characteristics. Group processing allowed students to discuss and resolve issues concerning interfacing propellers to the boat industry. An additional benefit with group processing was that the total amount of propeller types covered actually increased. This type of activity allowed students to interpret a large number of alternative applications of propeller components than if they had acted individually.

Flow:
The concept of flow is then applied to the desired value stream to enhance the efficient addition of value through each stage of the learning process. This concept may be applied to all aspects of institutional operations, from the entire organizational and educational management structures to specific tasks necessary to collect environmental samples.

The five tenets of collaborative learning guided our process for designing and evaluating homework assignments for the course. Specifically, we developed assignments that promoted responsibility by each member of the group. Our task was to design assignments that were dependent such that members of the group had to talk with one another. The most popular assignment was to have students use the Web or library to research propeller components and sub-systems that are available from manufacturers. We did this for propeller characteristics, boundary layer, wing theory, and cavitation. A large part of our processing of what the students were able to find was a broad discussion of what components and systems make sense to include in realising an efficient propeller system. All homework had both an individual and group component.

The practical and laboratory activities were developed around five broad design-oriented laboratory assignments. We carefully selected workshops (labs) and visits to manufacturers sites centered around:

(1) Introducing different types of propellers
(2) Test tanks
(3) Hydraulic tunnels using high speed motors
(4) Visual control of cavitation
(5) Maintenance aiding facilities and techniques.

The strategy employed was necessary to maximize the back-grounds of students in the class while also empowering the students to learn a lot of complex material to a depth sufficient for use in real propeller/boat design.

Laboratory groups consisted of the same cooperative-base groups presented in the previous section. A positive finding through the laboratory portion of the course was the consistent emphasis we placed on both system design and design methodologies (i.e. research approach).

Pull:
Once the organizational and management structures have been put in place to accommodate lean operations, and systems have been developed to achieve flow within the desired value stream, the entire system can be set up to allow for a pull-oriented course flow. This pull-oriented philosophy will enable the institution to reduce the amount of waste caused by conducting unnecessary work.

Because we had a unique opportunity to have a class that was composed of students related to marine industry, we decided to incorporate students teaching as a viable method for student learning. Two of the topics covered in the class were a review for half of the students (boundary layer theory, and propeller characteristics). As noted earlier, through the cone of learning the average retention rate of students is 90% when students teach others. Having students teach the tutors helped to reinforce the material that have been learned in a previous class. Half of the group taught the other half concepts on wing theory and propeller characteristics. While the other half taught the boundary layer theory and how to detect cavitation along propeller blades.

In both cases the students exceeded our expectations and showed us the level at which they can understand and digest complex information.

Group (A) gave an overview of the wing theory and then provided several illustrative demos on propeller characteristics. This was a hands-on tutoring where the group was organized into four sub-groups where each sub-group was given a specific task to cover. This group even developed a Web page to assist students outside of normal class hours. During the first session, students from group (B) lead the class through the proper sequence to establish communication among their sub-groups, and those in group (A), to understand the boundary layer theory and prepared a laboratory that incorporated knowledge gained on cavitation concepts allowing students to interface with developed theories.

The first group introduced their topics through a series of four 25-minute mini-lectures. The intent of the lectures was to introduce the topics and increase awareness of the possible uses within the industry. The first sub-group taught about characteristics of flow over a wing section. The second sub-group described the lift-drag forces involved. The third sub-group presented a variety of linkages in relation to the performance of wing under different settings and flow conditions. The fourth sub-group taught about propeller characteristics including items like terminology, material, pitch, blade twist, number of blades, blade shape, rake, introduction to propeller design and propeller maintenance.

The second group introduced their topics on boundary layer theory and the concept of cavitation through a series of two 40-minutelectures. The first sub-group introduced the boundary layer theory and conditions of separation on a smooth flat surface. The second sub-group taught about causes of incipient cavitation and effect of damages caused by developed cavitation along the surface of propeller blades.

Perfection:
The institution must apply the final fundamental concept in lean management and continually strive to achieve perfection in the generation and delivery of the service to the student. This concept will require the development of systems designed to accurately measure and evaluate the effects of lean initiatives.

The final stages of the course were devoted to the design and implementation of a working propeller system. The design experience helps them to integrate their knowledge of propeller systems and apply it to a real problem. Students formed their own teams of four students. We wanted to give the students the opportunity to assess individual strengths and form teams on their own.

Students were allowed to select their project from a variety that we had described. We prescribed the project alternatives because we wanted to control the scope based on the short time-frame. The projects varied in emphasis, but each contained all elements of the course. Students were required to prepare a complete design report and give a presentation that included the demonstration of their working systems.

CONCLUSION

This paper described collaborative learning techniques using the five fundamentals of lean management and employed for a course on Marine Propellers taught within the BAT degree at UNITEC Applied Technology Institute. The authors have found that there is a definite benefit to include teams along with the subject matter. Collaborative and active learning techniques proved effective in establishing desired levels of competencies in the students. Students also report that they believe the format is effective as well as enjoyable.

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