VALUE ENGINEERING AS AN EFFECTIVE TOOL FOR IMPROVING THE PERFORMANCE OF STUDENTS AT THE COLLEGE OF ENGINEERING - KING SAUD UNIVERSITY

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ABSTRACT

Value Engineering (VE) as a problem solving technique capitalizes so much on team-work, function analysis and creativity, which are all skills that engineering educators try hard to establish in their students. The practice of VE, requires good command of other supporting skills, such as work discipline and communication skills

Graduates from the different Saudi colleges of engineering are in real need for such skills to claim their share of jobs in the local private industries. The adaptation of VE concepts in the engineering education in our engineering programs constitutes a good tool that can support our efforts in Saudizing the engineering sector.

This paper describes the evolution of value engineering education at the college of engineering at King Saud University. It details the format and procedure by which VE concepts were integrated in a general engineering course. This paper also describes a new experience in VE education, were a group of cap-stone project students have practiced the VE technique in a team format on a real life project for an entire academic year. Several engineering professors from different engineering disciplines worked with the student-team as advisors.

Positive results were measured in this experience. Students have demonstrated better interaction in team-work. Improvements in the group's functional analysis/ creativity and communication skills were observed as well. A controlled test was used to judge the improvements in the group under the study.

Keywords: *Value Engineering, Student Performance, Engineering Education, Saudization Efforts, King Saud University.*

الملخص

المنهج القيمي كتقنية لحل المشاكل، يعتمد على التحليل الوظيفي والعمل الجماعي والتحفيز الإبداعي في تحسين القيمة. وتعتبر كل هذه مهارات يسعى معلموا الهندسة دائما نحو إكسابها طلابهم. ومما هو جـدير بالـذكر هنـا أن التطبيـق الصحيح للتحليل القيمي يتطلب مهارات مساندة أخرى، مثل الانضباط في العمل ومهارات الاتصال.

الخريجون من مختلف كليات الهندسة هم في أشد الحاجة إلى مثل هذه المهارات والتي يعتبرهـا الموظفـون متطلبـات أساسية للالتحاق بمؤسسات القطاع الخاص. وعليه فقد يكون في تبني مفاهيم الهندسة القيمية في برامج التعليم الهندسـي دافع فاعل يدعم جهود السعودة في القطاعات الهندسية.

هذه الورقة تلخص نتائج دراسة أجراها المؤلف، في جامعة الملك سعود بالرياض. تبدأ الورقة، بعرض وتحليل المفاهيم القيمية في المنهج الدراسي بكلية الهندسة بالجامعة. ثم تناقش محتويات مقرر هندسة عامة تقدم من خلاله بعض المفاهيم القيمية. وأخيرا تستعرض الورقة نتائج تجربة عمليه تم من خلالها تدريب مجوعة من الطلاب نظريا وعمليا على كافة المفاهيم القيمية. حيث أختيرت مجموعة من طلاب مشاريع التخرج من أقسام مختلفة بالكلية للقيام بدراسة قيميـة علـى مشروع حقيقي. ولقد تولى كل طالب جزءا من المشروع يتناسب مع تخصصه. ولقد شـارك فـي الدراسـة القيميـة المشرفون الأكاديميون للطلاب.

كانت لهذه التجربة نتائج إيجابية متعددة، فلقد أظهر الطلاب تفاعلا مميزا في العمل الجماعي واستيعابا أفضل لأنظمة الفروع الهندسية الأخرى. كما أظهرت التجربة تحسنا ملموسا في قدرات الطلاب على الاتصال والتفكير الإبداعي. هذا وقد تمكن الطلاب من الاستفادة من التحليل الوظيفي كمبدأ قيمي في تقديم بدائل جيدة للمشروع محل الدراسة.

1. INTRODUCTION

Value Engineering is an effective problem solving technique. It is also known as function analysis, value analysis, and value management. Value engineering is essentially a process, which uses function analysis, team- work and creativity to improve value [Miles, 1972]. The technique was developed some 40 years ago by L.D. Miles and proved to be so effective. VE as a problem solving technique capitalizes so much on teamwork, function analysis and creativity, which are all skills that engineering educators try hard to establish in their students. The practice of VE requires good command of other supportive skills, such as work discipline and communication skills [Sperling, 1998].

Graduates from the different Saudi colleges of engineering are in real need for such skills to claim their share of jobs in the local private industries. The adaptation of VE concepts in the engineering education in our engineering programs constitutes a good tool that can support our efforts in Saudizing the engineering market.

1.1 VE Education At The College Of Engineering At King Saud University

The idea of using the college campus as a forum for value training is neither new nor a unique initiative (Zabych, 94). Ample evidence exists to show that value specialists have been teaching some form of value courses in the United States and several other countries since at least the 1970s (Amos, 96). Unfortunately, some of these early VE/VE/VM college courses have been discontinued as their primary instructors or sponsors have moved on to bigger and more profitable pursuits, passed away, or just lost interest. Yet, enough of the courses have

survived, and new courses were initiated to give the impression that all is not lost, as long as some body in academia still believe of the value of VE.

At King Saud University, two courses are taught at the college of engineering that deal with the value concepts. One is a general engineering course: Engineering management (GE 301) and the other is a graduate course: Value engineering (CE 578), which was initiated during the mid 80s.

The graduate course covers the following topics: introduction to value concepts, the concept of functions, FAST diagramming and creativity, function – cost/ worth, value engineering versus cost control theory, life cycle cost theory and implementation / organization considerations. The objectives of GE301 are shown in appendix 1. Both courses utilize the concepts of VE to enhance the performance of the students. Both courses play an important role in delivering the objectives of the civil engineering department for quality of program and graduates.

1.2. VE Concepts In A General Engineering Course

The engineering management course is a general engineering course. In this course, students from different engineering departments are introduced to the basic process of management. The VE – concepts taught in this course (figure 1), being the team work, and creativity make the common dominator between the course and the department objectives (see appendixes 1, 2).

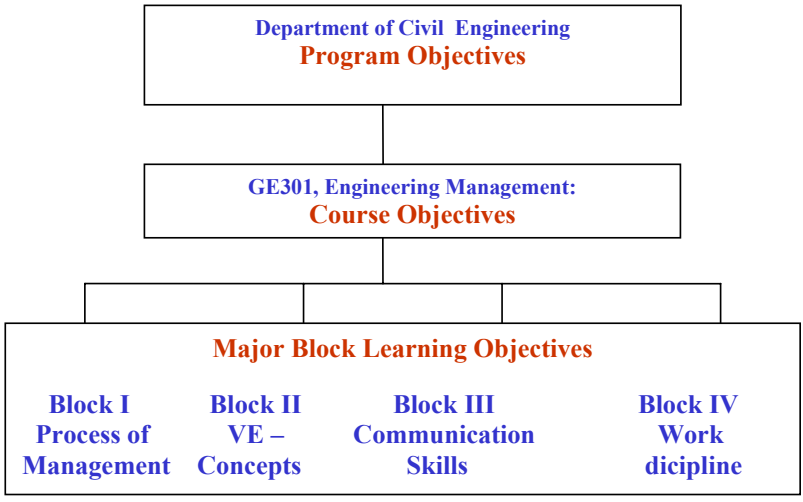

Fig. 1 VE- Concepts in GE 301

1.3. VE In Capstone Projects

Typically, capstone projects are handled by individual students. An undergraduate student picks a topic with the help of his advisor to work on it during his senior year. The work is either an application or lab work in one of the engineering sub-specialties (i.e. in civil eng., Construction, Structures, transportation, geotechnical engineering, environmental and water resources). Students, generally end up doing the entire work by themselves, with no interaction with other students.

It was the author's idea to use the capstone project as a vehicle to satisfy the project's goals along with other under-served goals in the engineering program. Such goals include teamwork, communication skills, and the creative thinking.

Engineering professors from different departments were contacted to join the new experience. Each one of them was required to participate in the team capstone project according to the following:

- The project is a value engineering study for a small residential compound.
- Each student will deal with an aspect of the project: structural system, mechanical/ electrical systems, and construction management system.
- The project leader (the author), gives the students a crash course in VE theory, and introduces them to the project.
- Each professor will support his student in the subject matter of his specialty.
- Students have to work as a team throughout the project.
- Student evaluation will be of two parts, the common work evaluation, and the specialized work evaluation.
- Other required disciplines for the study will be made available through other volunteering professors (such as architectural engineering).

Two professors agreed to join the project, making, a team of three students, dealing with three engineering disciplines: structural, electrical/mechanical, and construction.

2. DISCUSSION

Dedicated students (not necessarily with outstanding GPA) were selected for the project. The project leader (the author) requested to interview the candidates before they were admitted to the project.

The course started by scheduling a meeting for the introduction of the VE-theory. Some positive experiences were encountered at this stage. Dedication has paid nicely when odd times for the meetings (6-8 am.) made the only possibility for the team members. The three dedicated students have attended the early morning classes and were quite alert. The students, have also, demonstrated good cooperation in coordinating the necessary meetings between themselves to handle the common work. Students, shortly after being introduced to the case study, have started to read the design sheets and educate themselves, with the support of their advisors, about the different system's alternatives. The experience, have made them more aware of other fields of engineering.

Students, even-though, are all seniors and all have gone through a two-month summer training, have shown a real weakness in familiarity with real engineering systems, not in other related engineering fields, but also in their own fields. Proper arrangements were made to have the students gain some exposure to projects through a flexible link with the university project and maintenance department. This arrangement has compensated the students in their lack of experience in construction. Better understanding of the process and the flow of work was hoped to be gained.

2.1. The Performance Improvement Test

A test was conducted to measure the amount of improvement in the students' performance. The following factors were selected as indicative measures:

- Familiarity with engineering concepts in practice.
- Ability to identify functions of components in a familiar object.
- Ability to provide alternatives to satisfy a function of a component of a familiar object.
- Communication skills as measured by ability to fully describe a familiar object.
- Familiarity with the concept of team work / ability to plan collaborative work for a team.

It should be noted that, the VE-team was trained and has practiced the skills listed above. Students, in no other situation, get to receive similar training in these skills. Accordingly, it was possible for one to assume that the presence of such skills is the direct result of the VE-exercise. There is a strong direct correlation between enhanced performance of students and good command of the above skills (good scores in the above points).

The results of the controlled test were as follows:

Table (1) The results of the performance test for the team members, Before (at beginning of the course) and After (75% into the work).

Question	VE-team scores % (Before)	VE-team scores % (After)	Remarks
Select the correct function of each component of a flash light	68 student#1 70 student#2 55 student#3 AVE.= 64%	88 student#1 89 student#2 70 student#3 AVE.= 82%	28% Improvement
How can you substitute for a missing battery cover	30 student#1 40 student#2 20 student#3 AVE.= 30%	50 student#1 60 student#2 50 student#3 AVE.= 53%	76% Improvement
Select out of the attached list, five titles to describe in detail how the flash light works	40 student#1 50 student#2 30 student#3 AVE.= 40%	70 student#1 80 student#2 40 student#3 AVE.= 63%	58% Improvement
Fill out the attached table with the different roles you require from each of your team members to organize a field trip for ten friends	60 student#1 50 student#2 30 student#3 AVE.= 46%	80 student#1 90 student#2 70 student#3 AVE.= 80%	74% Improvement

Table 1, show the results of the test. A clear improvement in the students' abilities in function analysis, creativity, communication skills, and team work can be noted. Some skills were improved better than others. Creativity and team work skills were improved most, while the communication skills and function analysis improved in a less dramatic way. Even-though, one can argue against the accuracy of the test and the degree of objectivity of the findings, we can all agree on the results as being indicative of a reasonable degree of improvement in the students' performance.

3. CONCLUSIONS

The cap-stone project findings confirmed the importance of a VE- experience for engineering students, whether in the format of a course or a team project. A VE-experience will have the following benefits:

a) Provide an experience in multi-disciplinary problem solving.

b) Develop teamwork.

c) Introduce and apply the structured methodology of VE to real world problems.

The VE-experience has proven effective in enhancing the performance of the students. Students, as a result of this experience, have improved their skills in teamwork, creativity, functional analysis, and communication. Students, through this experience, have gained practical familiarity with other engineering fields, made professional contacts outside the university, and above all, improved self-confidence. On the other hand, professors who have participated in the study had the chance to practice a form of action education. Professors, have appreciated what this method of teaching can offer compared to the classical instruction techniques. More professors were convinced to try the VE-cap stone project again.

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Appendix 1, Civil Engineering Program Objectives

Produce Civil Engineering graduates who demonstrate:

- **Creativity**
- **Proficiency in mathematics, calculus-based physics, and general chemistry**
- **The ability to apply the engineering thought process**
- **The ability to design CE components and systems to meet desired needs**
- **Proficiency in structural engineering**
- **Proficiency in environmental engineering**
- **Proficiency in hydrology & hydraulic engineering**
- **Proficiency in geotechnical engineering**
- **Proficiency in construction engineering**
- **The ability to design and conduct experiments in different civil engineering discipline areas**
- **The ability to function in multi-disciplinary teams**
- **An understanding of the roles and responsibilities of civil engineers and the issues associated with professional practice**
- **The ability to use modern engineering tools necessary for engineering practice**
- **The ability to write and speak effectively**
- **Knowledge of contemporary issues**
- **Broad education and understanding of the impact of engineering solutions in a global/societal context**
- **The preparation for and willingness to pursue continued intellectual and professional growth**

Develop and maintain a faculty team that is a model of professional excellence for the students

Top

Appendix 2, GE301, Engineering Management Course Objectives

- **To be introduced to the mission of management**
- **To understand the management process and the concepts of management Strategy.**
- **To understand the planning process, the Organizing process and the effects of the human factors in that regard.**
- **To be introduced to the concepts of motivation and leadership and creativity.**
- **To have a working knowledge of the basic elements of control.**
- **To have a first hand experience in the whole process by conducting field interview for executives in a company of the student choice.**
- **To have a practical exercise in team work through the term project which is conducted by teams.**
- **Sharpen the student communication skills in preparing for multimedia presentation and a written report.**