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Leveraging Expertise in Time of Economic Constraints

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Abstract

To address the need to improve the Commonwealth Graduate Engineering Program (CGEP) at Virginia Tech, the college relied upon the expertise of students completing graduate theses and group projects in the Industrial and Systems Engineering Department. This arrangement allowed graduate students to work on real problems as well as conduct applied research projects for an organization – the College of Engineering. The students benefited from the experience and the college benefited from the result. CGEP is a coalition of five Virginia universities that deliver engineering graduate degree programs through distance learning. Three years ago this program was under review by the State Council of Higher Education for Virginia. Given that the CGEP director and administrators were new to this program, it was a high priority to establish metrics to determine the program's success. Another high priority was to search for expertise in the area of performance measurements. During the past three years, progress has been made in creating a continuous-process improvement plan for the program through the application of management systems methodologies. This paper discusses how graduate student expertise was used to assist with improving administrative aspects of the CGEP. It also describes the progression of projects and how data was analyzed and used to establish future direction. The concept described in this paper is traditional, yet the success of the methods used to improve the Commonwealth Graduate Engineering Program offers a new way to apply management system methodologies.

Introduction

The Commonwealth Graduate Engineering Program (CGEP) is a distance learning graduate consortium that provides working engineers high quality post-baccalaureate engineering education and the opportunity to earn a Master's degree. The consortium is a collaboration among five universities in the State of Virginia: Virginia Tech, University of Virginia, George Mason University, Old Dominion University, and Virginia Commonwealth University.[1] By participating in CGEP, students can obtain Master's degrees, certificates, or non-credit seminar programs, either on campus or via interactive video conferencing.

This program has been inexistence since 1983 and has served the Commonwealth of Virginia well. Yet it was time to undertake a major self-study to ensure that the program continues to

meet the quality standards and needs of its customers. Therefore, in 1999 the State Council of Higher Education of Virginia (SCHEV), the agency that oversees the operating plans for CGEP requested the CGEP directors work together to develop a marketing and strategic plan for the program. Additionally, this was a unique opportunity for Virginia Tech to assess its program. This was a major challenge, given that the historical administrative data of CGEP were not available. The assessment of the Virginia Tech program began with the Assistant Dean for Distance Learning and Computing joining the College of Engineering in August 2000.

The mission statement of CGEP is "to serve as the Virginia distance-learning provider of post-baccalaureate education for practicing engineers and scientist who want to maintain and enhance their skills".[1] With this in mind the Assistant Dean's office, the Office of Distance Learning and Computing (ODLC), took it upon their selves to obtain the fastest understanding they could of the past and present program with limited amount of funds.

With the need to assess and improve the program, ODLC searched for help at Virginia Tech. The primary goal was to find a consultant with expertise in performance measurements, identify the most critical problems and begin implementing changes. ODLC recognized that graduate students were a tremendous resource for applying their knowledge and skills to solve practical problems. The graduate student consultants for the projects were pursuing either Master's or Doctoral degrees with the Industrial and Systems Engineering Department (ISE). By collaborating with ISE, the ODLC graduate student consultants were either paid graduate assistants or graduate students working on class projects. Whether a student contributed to the goal of assessing CGEP by working as a graduate assistant or completing a class project, the results of their efforts were used to improve aspects of the program.

Students as a Resource for Improvement

The use of graduate students as a resource to conduct research or solve practical problems is not a new practice but an expected aspect of the graduate experience. Many academic institutions use collaboration between the academic institutions and industries to enhance the students' learning. Students receive a real-life experience and enhance their portfolio of skills through these collaborations.[2] Industries receive "fresh ideas and potential solutions to problem situations" from student projects.[2] Organization improvement in educational service is also not a new initiative. For example, Al-Turki and Duffuaa[3] developed standardize performance measures for academic departments in Saudi Arabia, Modell[4] reported the development of performance measurements in the Swedish university sector. The use of students in the research side in universities is a common practice; however, the use of students in an administrative unit in education service is uncommon. Many university administrative units overlook the students as a resource and the possibility of benefits received from students' course work. This paper describes how university administrative units can take advantage of graduate students conducting organizational research.

Overview of Methodologies

There are many process improvement and change management methodologies to help organizations improve its performance. The well known methodologies include business process

reengineering, total quality management (TQM), benchmarking, six sigma and balanced scorecard. Among these methodologies, graduate students recommended CGEP use six sigma, macroergonomics, Malcolm Baldrige National Quality Award Criteria (MBQA), and performance measurements to help improve CGEP. The timeline for implementation of the projects are shown in Figure 1.

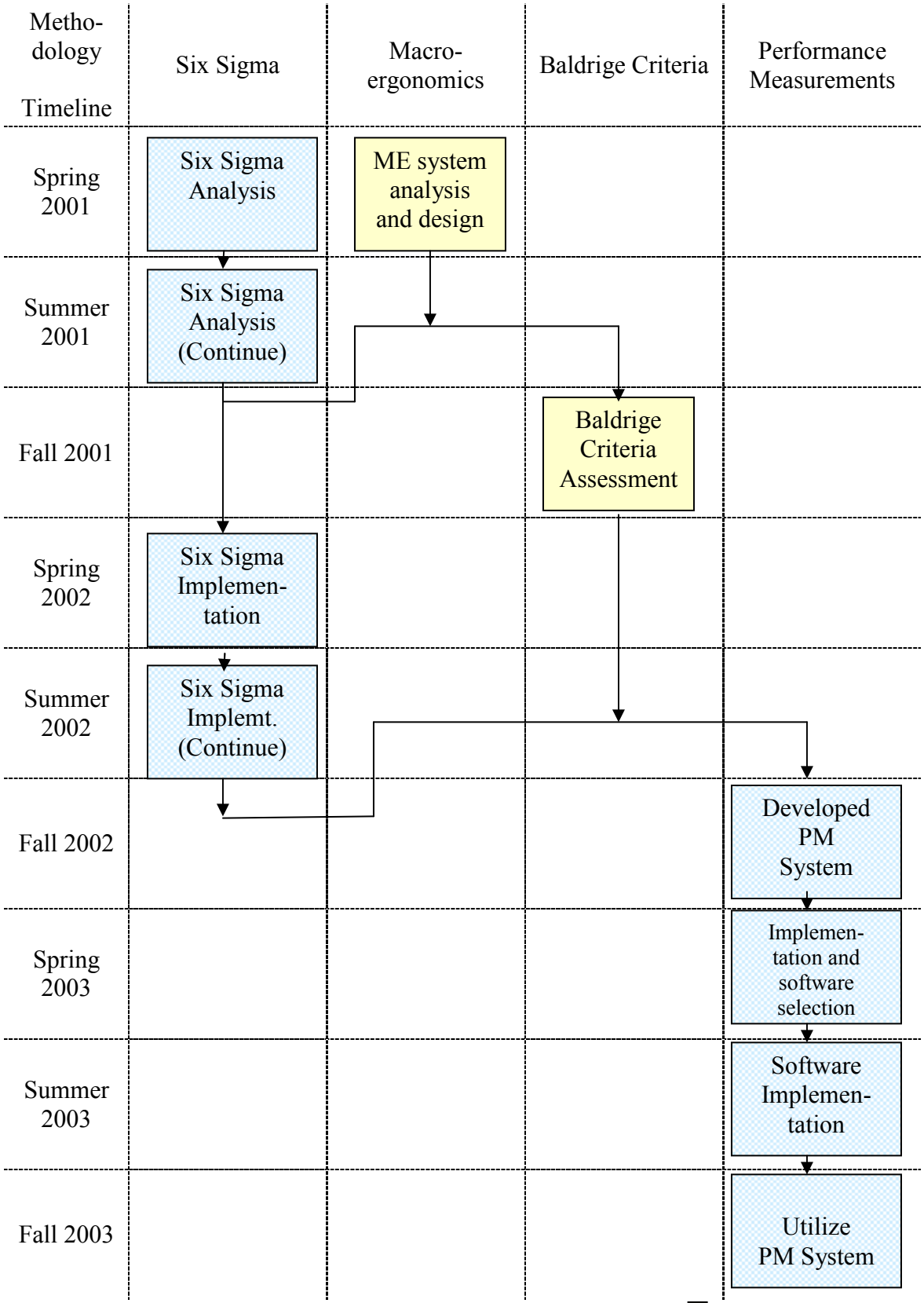

Figure 1: Students' projects with timeline

Six Sigma is the first improvement methodology introduced to CGEP. General Electric[5] defines six sigma as "a highly disciplined process that helps us focus on developing and delivering near-perfect products and services." Six sigma creates a process management, improvement, and design system that is sensitive enough to reduce variation and any inconsistency of a business system.[6] iSigSixma describes six sigma as "a disciplined, data-driven approach and methodology for eliminating defects (driving towards six standard deviations between the mean and the nearest specification limit) in any process".[7] The benefits of adopting six sigma include generating sustained success, setting a performance goal, enhanced value for the customers, an accelerating rate of improvement, creating a learning organization, and executing strategic change.[6] Six sigma steps of define, measure, analyze, improve and control developed by Motorola were used.

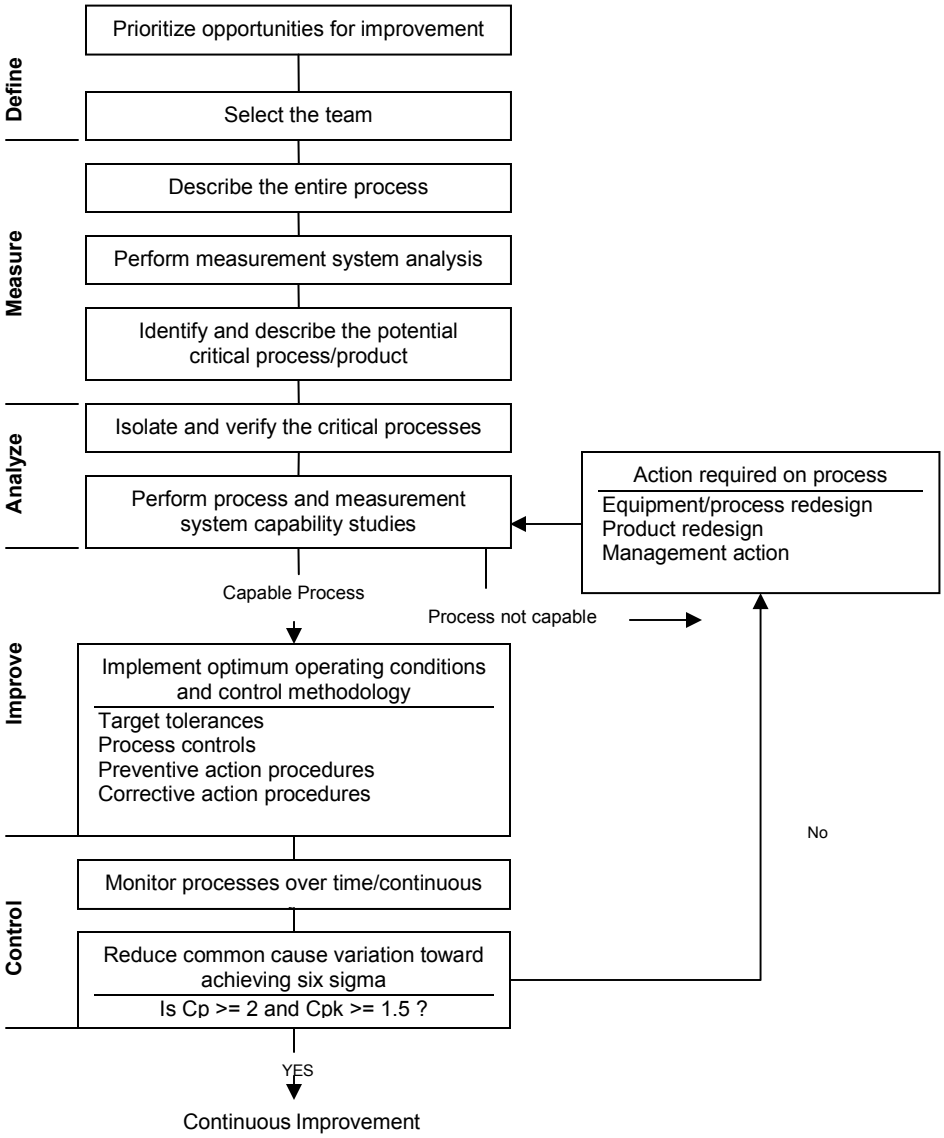

Figure 2: Product/process improvement flow diagram by Forrest W. Breyfogle[8]

Macroergonomics is another methodology suggested by a group of students in Fall 2001. Hendrick and Kleiner[9] define macroergonomics as

> the subdiscipline of ergonomics that focuses on the design of the overall work system. Conceptually, a top-down sociotechnical systems approach to the design of work system and the carry-through of the overall work system design characteristics to the micro-ergonomics design of human-job, human-machine, and human-software interfaces to ensure that the entire work system is fully harmonized.

Sociotechnical system is the concept that a work system is composed of 4 subsystems which are technological, personnel, external environment, and organizational design subsystems.[9] Macroergonomics can be used to improve an organization in various ways. For example, L.L. Bean used the macroergonomics approach and methodology to introduce total quality management in the company.[9] The company reduces lost-time accidents and injuries, increases employee satisfaction, and improves quality measures.[9] For CGEP, part of the macroergonomic analysis and design (MEAD) framework, a framework to help improve work systems, is used to analyze and design CGEP processes. The ten phases of MEAD framework are shown in Table 1.

Table 1: Ten phases of macroergonomic analysis and design (MEAD) framework.[9]

Phase	Subsystem (s)
1. Scanning analysis	Environmental/ organization design
2. System type and performance analysis	Technological
3.Technical work process analysis	Technological
4. Variance data collection	Technological
5. Variance matrix analysis	Technological
6. Variance control & role analysis	Personnel
7. Organization, joint, & function design	Personnel, technological, and organizational design
8. Responsibility perception analysis	Personnel
9. Support system and interface design	All
10. Implement, iterate, and improve	All

The Baldrige criteria is recommended by students to be used as the next step for a CGEP improvement tool. The MBQA is given to outstanding manufacturing, service, education, and health care businesses in seven areas: leadership, strategic planning, customer and market focus, information and analysis, human resource focus, process management, and business results.[10]

A performance measurement system is an organization improvement tool. Robert Kaplan and David Norton introduce the concept of a performance measurement system by the balanced scorecard (BSC). The balanced scorecard (BSC) is a tool that "translates an organization's mission and strategy into a comprehensive set of performance measures that provides the framework for a strategic measurement and management system."[11] Instead of only measuring and monitoring an organization's performance through financial measures that provides managers with one perspective of the business, the balanced scorecard measures four

perspectives: they are financial, customers, internal business processes, and learning and growth.[11] The measurement system development process (MSDP) is used by a student to develop a performance measurement system for CGEP at Virginia Tech. The process is shown in Figure 3.

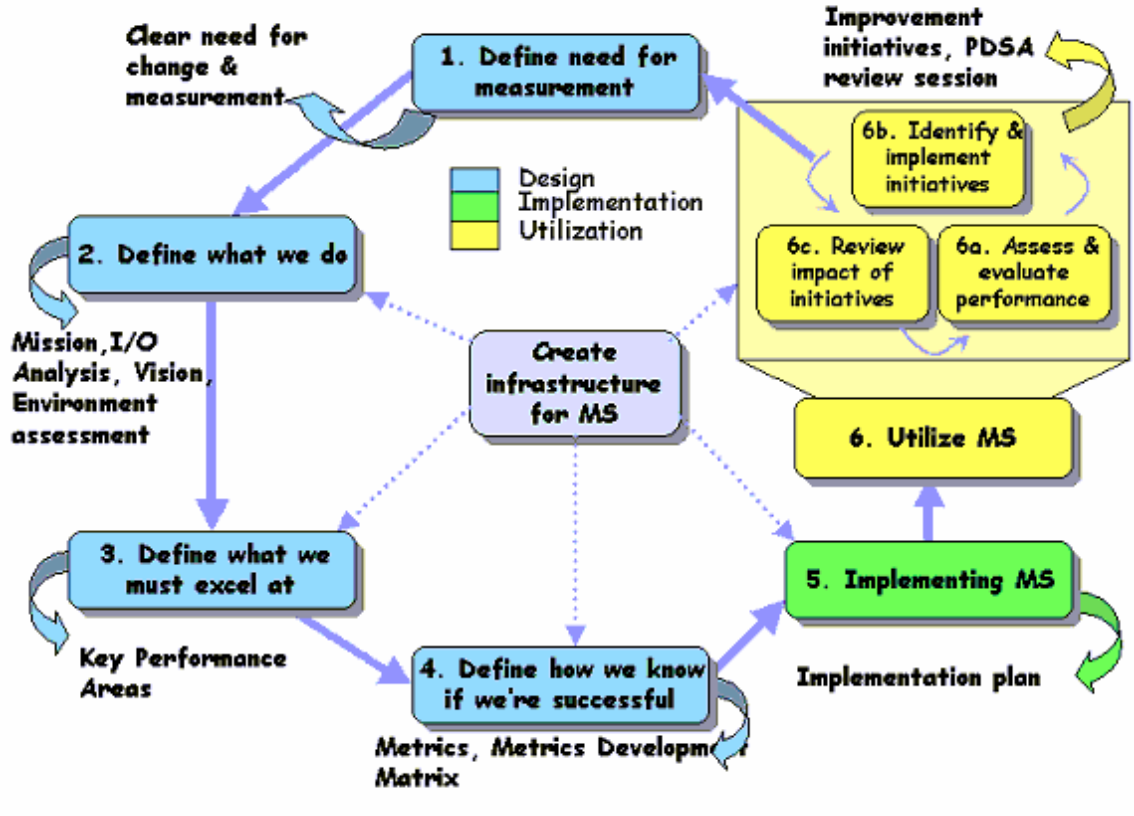

Figure 3: The measurement system development process (MSDP).[12]

Performance Improvement Projects

Six Sigma Analyses

The results from the graduate students' projects added tremendous value toward meeting the goal to improve CGEP. The students' projects started with the cooperation between ODLC and ISE in Spring 2001 to split fund a graduate assistantship (GA) position to work on a performance improvement project for CGEP. The graduate assistant applied the first three phases of the six sigma process (define, measure, analyze) to analyze VT CGEP.[8] This graduate student used this project as his master's project to fulfill requirements for his master's degree.

After the student completed these three phases, it allowed for the root causes of defects and areas of improvement to surface. The student found that VT CGEP did not have a performance measurement system in place; the course evaluation needed to be reworded; there was a need for improvement in class scheduling; and a need for improvement in course selection. Fernandes recommended that the next step of six sigma was to collect data in 5 key areas of improvement:

(1) delay in responses from remote sites about availability of space for classes, (2) problems with the Course Request Numbers (CRN), (3) inefficient administrative coordination, (4) limited in course selection, (5) limited courses count toward degrees.[8] With the recommendations from the student, VT CGEP planned to implement the six sigma methodology in the coming year. Based upon the results of the study, ODLC was able to make several immediate changes. Meetings were held with the Registrar and Graduate School to implement simple yet important changes with scheduling distance learning courses.

Macroergonomics Analysis

In the same semester, an ISE 5694 student group project was initiated for the purpose of running a macroergonomics analysis of the CGEP. As a student group class project, there was no outlay of actual dollars, time was the cost factor here. Meetings were held to give background information of the program, to give input on structuring surveys to gain data, to participate in group status meetings, and to assist and guide students in research of this style. This first student group, the macroergonomics group, consisted of five graduate students.

Because of time limitation of sixteen weeks, this group used the two phases of MacroErgonomic Analysis and Design - (1) scanning analysis and (2) system type and performance analysis – to analyze VT CGEP. The scanning phase consists of four steps: [13]

(1.1) perform a mission, vision and principles analysis
(1.2) perform a system scan
(1.3) perform an environmental scan
(1.4) specify an initial organizational design

The second phase involved three steps:[13]

(2.1) define the production system type
(2.2) define performance expectations of the organization
(2.3) specific organizational design dimensions

After the macroergonomics group had completed phases 1 and 2, the group recommended the following:[13]

1. CGEP should offer certificates and non-credit courses to CGEP program.
2. CGEP has to be willing to make several changes of the program to best represent CGEP and its corporate universities, to create successful alliances.
3. A CGEP Director that will not have an affiliation with any member universities is needed to make sure that the director can devote 100% of his/her time to CGEP.
4. An industrial advisory board should be created. The primary role of the advisory board is to guide the CGEP Director on the technical educational needs in Virginia.
5. CGEP should create an organizational structure to foster communication and decision making among the members. The macroergonomics group also proposed an organization structure for CGEP which is shown in Figure 4.

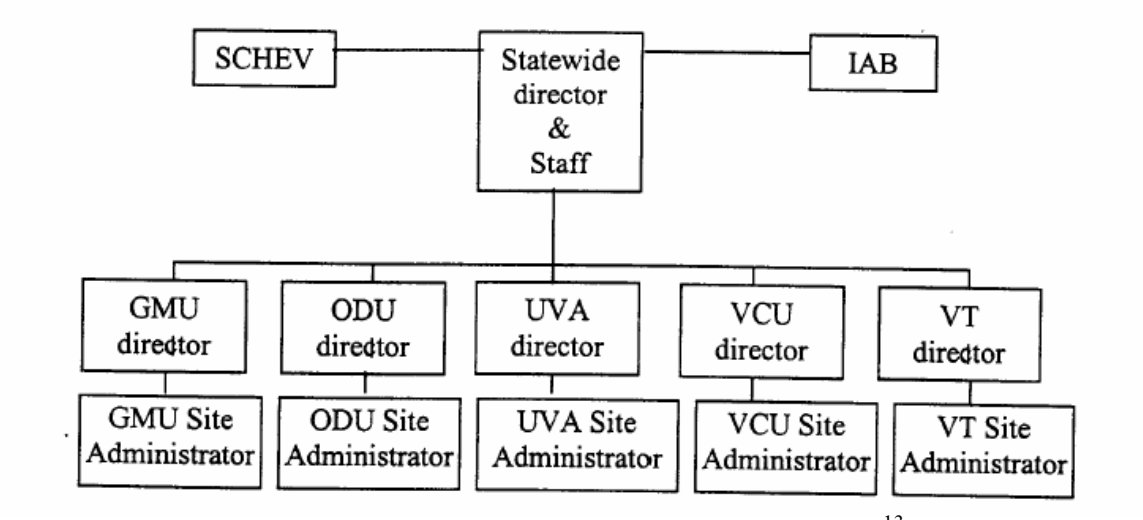

Figure 4: Proposed organization structure.[13]

6. CGEP should develop a performance measurement system for the program.
7. CGEP should improve communication by using intranet.
8. A CGEP statewide website should be developed to represent all member universities. A statewide website will also promote the programs that CGEP offers. Students will find information they need easier.

Based upon the recommendations of this group project, CGEP implemented procedures to launch a state web page and external advisory board. The work from this project was valuable towards the improvement of the major state-wide program.

Baldrige Criteria Assessment

With the recommendations of the first student group project, an assessment of the program was needed. The ISE professor for ISE 5015 course: management of change, innovation and performance in organizational systems also required a student group project. With no money outlay again an assessment of CGEP was listed as a student group project. The cost was time but less of it having the other project reports to reference as background information. The student group used the Baldrige criteria as a tool to assess the VT CGEP. There were four students from the ISE department working in this student group

In this project, six areas of VT CGEP were assessed: leadership, strategic planning, customer and market focus, information and analysis, human resource focus, and process management. Strengths and weaknesses in these areas were identified. Some of the important weaknesses identified by the Baldrige group follow:[14]

- VT CGEP did not have a mission statement. The mission was adopted from the statewide CGEP mission.
- VT CGEP's goals are not associated with organization, financial, and supplier effectiveness.
- VT CGEP did not have enough formal measures on organization performance and the current measures were unbalanced.

- VT CGEP did not have a formal strategic plan and the state plan is lengthy and might prove to lack up-to-date and flexible strategic planning.
- The connection between VT CGEP performance, goals, and missions is not clear.
- VT CGEP did not have a system to obtain feedback from employers
- VT CGEP did not have a system to assess the current market.
- VT CGEP did not track the lost students.
- VT did not have a reward system that rewards people on their VT CGEP related work.
- There are no systematic processes for identifying problem areas for improvement
- There is no formal target goal for increasing enrollments; making it difficult to measure if the goal was attained.
- There was a lack of clear cause and effect relationship between processes and results and even the team members' job performance measures were not tied to CGEP performance.

Many of these problems at VT CGEP stem from the lack of a performance measurement system or a balanced scorecard. This makes it hard "to understand where the organization is and where it is going, and the success of change initiatives cannot be assessed."[14] With these weaknesses, ODLC targeted to develop a performance measurement system for VT CGEP. This was the next critical step – establishing a performance measurement system began in 2003.

Six Sigma Implementation

After advisement to set up performance measurements a search was on to acquire a student group for the next semester using ISE 5016, the sequence course of ISE 5015, which focuses on developing a performance measurement system. It was decided that a single master's degree graduate project would provide the best results. While waiting for the right graduate student that had expertise in this area, a second graduate student project evolved from ISE at a half GA position cost to be housed in the ODLC office. The graduate student would work on the implementation of the six-sigma project completed earlier.

The student identified the problems and implemented the solutions to solve these problems. The solutions for some of the problems identified by the student follow:[15]

- A site coordinator manual and standardize policies for CGEP should be developed to improve information flows between sites and eliminate other problems such as rooms unavailability and delayed exams.
- VT CGEP should use the best practices to improve class interaction between student and faculty.
- VT CGEP needs to build partnerships with employers to increase industry contacts.
- To increase visibility of the program, VT CGEP should keep contact with the alumni.
- To collect data needed and expand contacts with the industries, VT CGEP should get the site coordinator involved in the strategic functions.
- VT CGEP should expand to the different distance learning formats and organize with different departments to increase the number of course offerings.
- VT CGEP should contact the department of Continuing Education at Virginia Tech to discuss possibility of offering certificate courses.
- VT CGEP should increase marketing efforts such as developing distance learning days and a distance learning council.

As a result of these recommendations, ODLC joined with the Director of Outreach of Virginia Tech to visit industry sites to make CGEP more visible in key engineering workforce areas. At these visits a commitment was received from the COE or Training Coordinator of the company to complete an annual survey designed by CGEP to give information on the latest trends in their industries. This project also set other procedures in motion towards development of a distance learning council.

Performance Measurement System

Next, a half GA position was granted to another ISE graduate student, to work on developing a performance measurement system for CGEP at Virginia Tech. This assignment is directly related to the recommendation identified by the group conducting the Baldrige Criteria Assessment. This project will also fulfill this student's master's degree requirements.

The graduate student developed a performance measurement system for VT CGEP by using the MSDP process. Four Key Performance Areas (KPAs) were identified by using the balanced scorecard as a guideline.[16] A Key Performance Area is an area you need to assess and measure that will drive an organization to achieve its goals and vision.[17] The four KPAs developed for VT CGEP are internal processes, customer satisfaction, visibility, and financial viability.[16] Fourteen metrics are also developed for the four KPAs. The metrics were identified under each KPA to indicate what have to be measured to achieve the goals for each KPA. Fourteen metrics were recommended for VT CGEP. The KPAs and the metrics are shown in Figure 5.

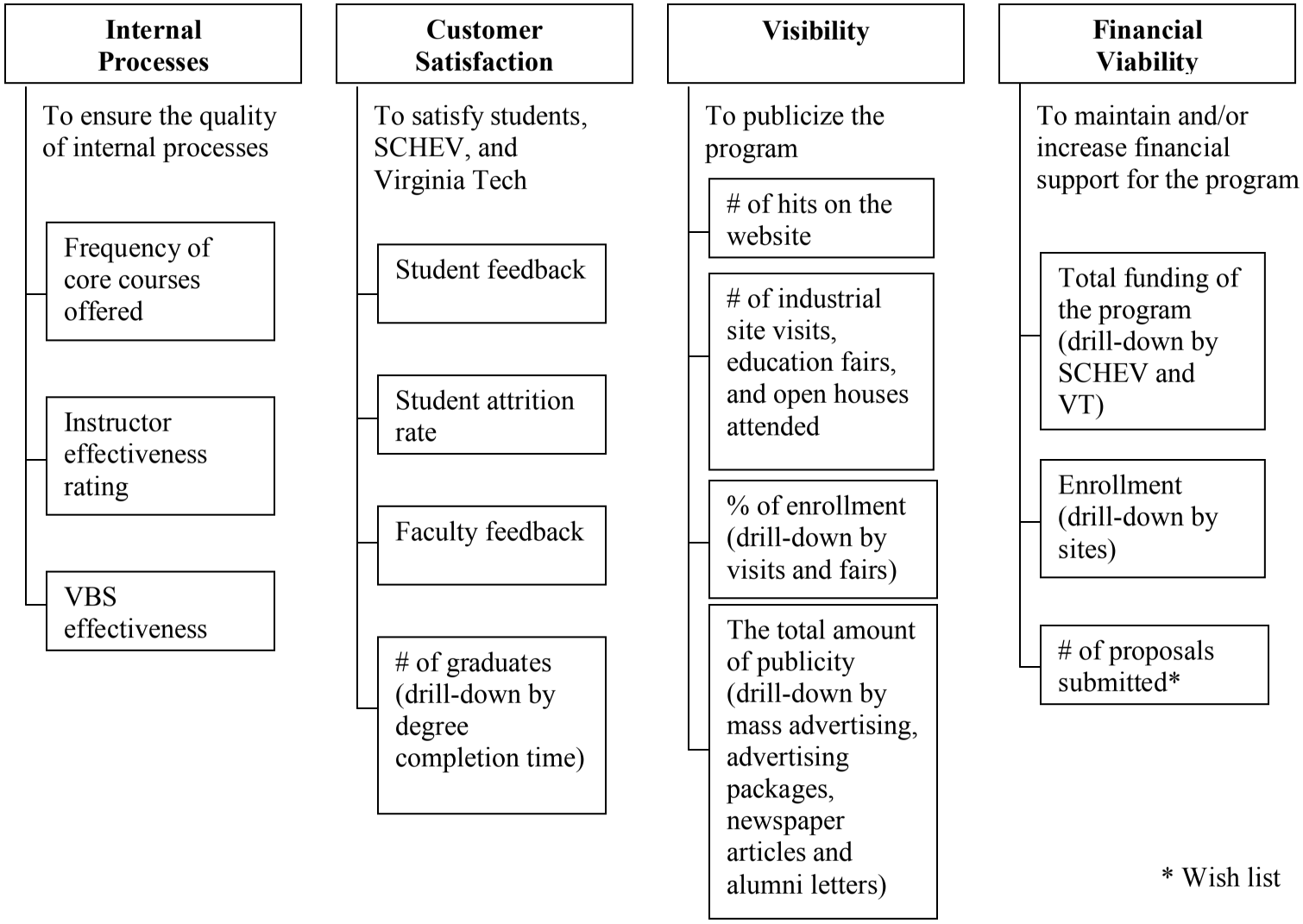

Figure 5: VT CGEP's KPAs and metrics.[16]

After the performance measurements were developed, the graduate student implemented the performance measurement system for VT CGEP. In the mean time, an ISE faculty matched another ISE graduate student with ODLC to find a software program to automate the performance measurement system. This student was not funded by ODLC except during a summer. The student set up criteria to evaluate performance measurement software packages available in the market. The criteria were cost, user friendly, balanced scorecard approved, and number of users. A software package was purchased that met these criteria. This project will be completed with the master's project report in Spring 2004.

Outcomes and Cost/Benefit of the Student Projects

Recommendations by the student projects lead to multiple accomplishments during the Spring 2001 to Fall 2003 timeframe moving this program forward. From the students' recommendations, ODLC has accomplished the following:

- An annual conference was started in 2002 and the monthly teleconferences were broadened to include all in the distance learning programs of the five universities.
- Summer courses are being added to increase the number of course offering and reduce time constraints for students.
- A shared vision and mission statement was developed.
- A VT CGEP mission statement was developed.
- A customer service initiative was initiated to respond promptly to phone and emails.
- The advisory board was established and the first meeting was held April 2003.
- The CGEP statewide web page was designed and went live June 2002.
- Strategic plan for CGEP was developed.
- ODLC sent out a market survey in 2001 and ODLC will repeat this in 3 years.
- A process is in place to track non-returning students each semester.
- A site coordinator manual was developed for the web.
- Travel expenses were authorized for faculty to travel to the receive sites during the semester and have a pizza party for the students before or after class.
- Visits to key industries were made in the summer of 2002 in the areas employing degreed engineers resulting in several college days hosted by the industries.
- Emails were sent to all students and news students were sent Hokie Pads and pens.
- A tracking process and database were designed for information at the open houses.
- A meeting took place with key entities to discuss the new delivery formats.
- A new certificate policy was established by the university.
- A performance measurement system has been developed; the software has been identified and implemented.

With these dramatic improvements, ODLC has utilized resources available to its best. Table 2 summarizes the funding ODLC spent and the benefits ODLC received from student projects.

Table 2: The cost and benefit of students' projects.

Project	Dollar Cost			Time Required of ODLC Personnel				CGEP Benefit	Student Benefit
	Cost Outlay by COE($)	*Cost Outlay by ISE Dept*	*ISE Faculty Expertise Consultations*	*Meetings*	*Interviews*	*Material Review*	*Presentation*		
Six Sigma Methodology	½ GA/semester $5500	½ GA/semester $5500	2	8 hrs	6 hrs	3	2	Process Flowcharts Implementation Recommendations Next Steps	Master's project Real life issue Ser Org Interaction
Macroergonomics	0	ISE Grad. Student (5) Group Project	1	16 hrs	4 hrs	1	2	State Review Report Recommendation to do an Assessment	Group Project Real life issue Ser Org Interaction
Assessment	0	ISE Grad. Student (4) Group Project	1	5 hrs	3 hrs	1	2	VT CGEP Report Recommendation to establish matrices	Group Project Real life issue Ser Org Interaction
Application of Six Sigma	½ GA/semester $5500	½ GA/semester $5500	2	8 hrs	6 hrs	4	1	Implementation Report Resolving the Gaps	Master's project Real life issue Ser Org Interaction
Performance Measurement	½ GA/semester $5500	0	2	16 hrs	0 hrs	3	2	Performance Report Matrices established Data collection commenced	Master's project Real life issue Ser Org Interaction
Balance Scorecard Software	GA wages $3825	ISE Grad student Master's Project	1	2.5 hrs	0 hrs	1	3	Scorecard Report Software Purchased Scorecard Setup Targets Established	Master's project Real life issue Ser Org Interaction

Conclusion

ODLC, an administration unit at Virginia Tech, has taken advantage of resources available on campus. By cooperation with faculty in the Industrial and Systems Engineering department, ODLC is able to use graduate students and graduate class projects to improve the performance of ODLC. These projects use the organization improvement methodologies available today to improve VT CGEP performance. These methodologies are six sigma, macroergonomics, the Baldrige criteria, and performance measurements. In a tight budget situation, the outcome from these projects help VT CGEP move forward. The achievement of this process is the creation of continuous improvement that delves into the core of VT CGEP. The performance measurements of VT CGEP are well balanced.

The next step for ODLC is to use the performance measurement software to automatically transfer VT CGEP performance data into information that can be further analyzed. Earlier, enrollment was the only VT CGEP measure that was reported to the funding agency. Now, all aspects of VT CGEP performance can be reported and monitored. ODLC is expanding the performance measurements to cover the entire engineering distance learning program at Virginia Tech.

The use of students as a resource is not new. Faculty have been using students to assist in their research as part of the educational experience for years. The aspect of using graduate student expertise that is new and worth looking into, is that of university administrative units taking advantage of this resource. Whether the unit is in a tight budget situation or not, the students provide a great resource to improve the unit performance. The students bring fresh minds with a different perspective to the table that allow for creative thinking and solutions that might range 'outside of the box'. They offer the latest concepts and methodologies that are being taught to them giving the administrative unit an opportunity to be on the cutting edge of their service.

During a time and financial crunch it gave this administrative service unit the insight it needed to show progress to key decision makers. It has set up formal performance measures that allow targets to be set and a balanced scorecard to give guidance for the overall betterment of CGEP. It gave the ODLC team the opportunity to get up to speed on the workings of CGEP and insight in how to immediately make major improvements based upon a scientific process. The experiences of working with the graduate students is the beginning of what is hoped to be a long term relationship which in turn benefits CGEP's customers, the working engineers in the state of Virginia.

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