SEATEC-An Innovative Approach to Engineering and Technology Curriculum Development

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Abstract

The South East Advanced Technological Education Consortium, SEATEC, provides a creative approach to curriculum development and delivery that improve engineering and technology education and revive student interests in pursuing these programs. This is one of the main objectives of this three-year NSF-funded grant (about $1.8 million). The consortium is a collaborative effort of five different teams from five colleges across Tennessee. Each team includes multi-disciplinary faculties, industry partners, university partners, and high school tech-prep teachers. The unique partnership with the industry along with the rigorous training of SEATEC participating faculty have produced work-based case-study models that are interdisciplinary, multi-media enhanced, open-ended, and use active and collaborative learning. The current paper provides a brief account of the various curriculum development activities throughout the SEATEC project. A sample multi-media enhanced case is also provided.

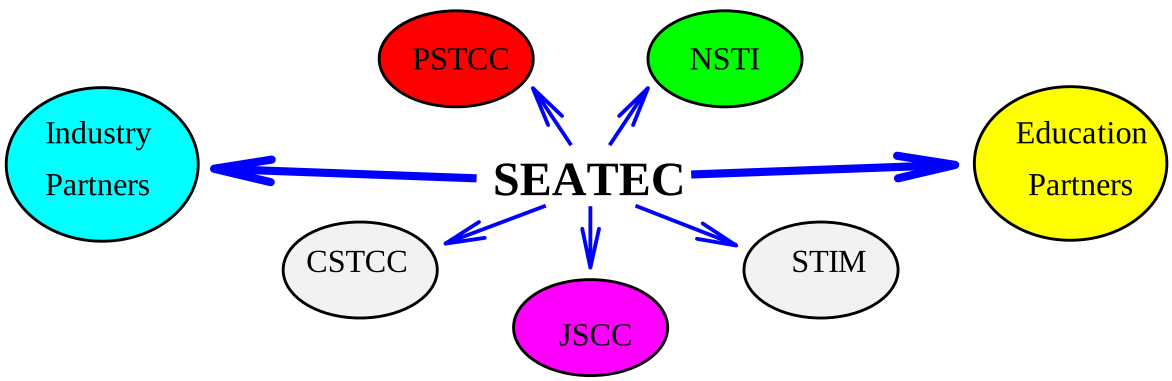
I. Introduction

The fast introduction of new technology in the workplace has greatly affected the daily operation of most industrial institutions. Automation, telecommunication, and computer applications have resulted in higher efficiency, reliability, and/or lower production cost. In face of this fact, however, companies currently encounter a new challenge: stay technologically current or risk falling behind the competition! A recent study by The US Department of Commerce indicated that firms that do not use advanced technology are less productive, pay lower wages, and offer less job security than similar firms that do. On the other hand, the implementation of new technology is often slowed down by the unavailability of skilled workers. Therefore, it is essential, particularly in small or medium size companies, that entry-level technical employees possess the required skills in order to be productive as soon as they join the workforce.

In order to address the increasing demand for a skilled workforce, a process was needed for the development and dissemination of a technology-based education curriculum that is both readily accessible and responsive to innovation and industry needs. As a result, a coalition of five two-year technical colleges in Tennessee with representatives from four-year universities, secondary schools, business and industry, and government institutions in Tennessee, Kentucky, and Alabama was formed (Figure 1). A grant proposal titled “The South-East Advanced Technological Education Consortium, SEATEC” was submitted to NSF for funding. The grant was funded for three years with the following goals:

1. To provide national leadership for the development and implementation of case-based instruction in technology and engineering education.

2. To provide opportunities for continuous and appropriate professional development of participating faculty.
3. To assess the effectiveness of the case study approach in teaching technology-related curriculum.
4. To nationally disseminate information related to SEATEC activities, materials, and results, including outcomes of the use of case studies in field-test setting.



TN Two Year Colleges	**Business Partners**	**Education Partners**
PSTCC - Pellissippi State	Sprint	Middle Tennessee State University
NSTI - Nashville State	Oak Ridge National Lab	East Tennessee State University
CSTCC - Chattanooga State	MCI Telecommunication	University of Memphis
JSCC - Jackson State	NORTEL	Murray State University
STIM - State Tech Memphis	TVA	Alabama A&M
	FED EX	Southern College of Tech.
	Time-Warner Cable	Memphis City Schools
	Technology 2020	Jackson-Madison County Schools
	Heatcraft	Farragut High School
	Colombia/Healthcare	Red Bank High School
	Cinetel	Hillwood High School

Figure 1. SEATEC Teams and Their Partners.

II. Curriculum Development Using Industry-Based Case-Study Approach

Case studies have been proven to be effective teaching tools in many fields ranging from business and finance to medical. Case studies are usually based on real-world problems that students can easily identify with and allow them to use their critical thinking and logic reasoning abilities. Collaborative education and team building concept can be used effectively in a case-study environment. The use of the sciences, mathematics, technical writing, and oral communication knowledge as well as the SCANS 2000 skills and competencies can be integrated easily in case studies. Finally, case studies can make classroom learning an enjoyable experience. The use of case studies in technical education, however, has been somewhat limited. Recently and after recognizing the importance of case studies, engineering and technology educators are trying to follow their counterparts in other fields. As a result, there is a growing need and interests in work-based case studies for engineering and technology education.

The SEATEC group has actually addressed the above-mentioned fact in an earlier NSF-funded project titled "Tennessee Exemplary Faculty for Advanced Technology Education, TEFATE." The primary objectives of which were: developing a group of faculty who provide leadership in curriculum development in emerging technology fields and developing an understanding of the cross-disciplinary needs through successful team strategies. The major outcome of this initial project was the development of twenty-five work-based case studies that are interdisciplinary and apply active collaborative learning and team building approach. These cases are currently being field-tested and finalized and are available for further refinements and external review from the SEATEC web page at: http://www.nsti.tec.tn.us/SEATEC.

III. SEATEC Partnership with Industry

The SEATEC faculty used the following methods to identify competencies and skills required by area industry:

1. Industrial Site Visits: Each team visited over 15 industrial sites. Team members identified the technical skills needed by observing the operational activities at each site and by continuous discussions with the technical and managerial staff of each company. These visits helped the teams gain the essential understanding of how their various disciplines are integrated into the workplace. An industry visit questionnaire was also developed in order to assure completeness and coherence of relevant data gathered form each site visit.

2. Faculty Internships: The mission of the TEFATE and SEATEC internship programs is to assist in faculty development and to prepare each faculty to utilize team-oriented and cross-disciplinary approach to curriculum development and delivery. Piloted internships allowed the faculty to identify successful techniques in developing and managing the internship activities as well as challenges.

3. Conducting DACUM (Develop a Curriculum) Studies: Several DACUM studies (http://www.uis.edu/~iscc/dacum.html) were conducted in order to develop a list of core tasks and skills for a specific field. Panels of experts from several regional and national industries identified the competencies and skills needed from current and future employees. The result from each study was a DACUM chart that includes a matrix of duties and tasks and the required knowledge/skills, tools/equipment/supplies, and worker traits/behaviors.

4. Industrial Partnership: Each team has two or more industrial partners that provide continuous support and consultation as well as direct involvements in curriculum development.

IV. Multimedia Enhanced Case Studies

The ever-increasing use and application of multimedia tools in education has indicated the effectiveness of this new technology. Various studies have continuously shown that students who use such tools will retain more knowledge and for longer periods. In addition, most students find these new teaching tools very attractive and entertaining as well as educational. Students can seek information at their own levels and pasts and may be able to fit education around their own schedules. The increasing availability of personal computers in schools and homes will make it even easier to apply and use new teaching tools. The Internet has become an integral part of our every day's life. More on-line classes are being offered daily and many "virtual universities" have been created.

Several areas that can be addressed by the use of CD-ROM technology and/or the Internet may not be addressed by the traditional "Chalk & Talk" method. As an example, students will be able to visualize current flow, simulate and solve electrical circuits, visualize heat transfer, observe the effect of various design parameters on performance, etc. A CD-ROM technology with a Web-Based configuration enables the student to navigate the case with the same ease as navigating the Internet. This format has many benefits such as:

- Most students are familiar and find themselves at ease "surfing" the web using the available browsers. Therefore, more time is used in conducting the actual case and minimal time is spent on teaching how this technology is used.
- This format makes it very easy to post the case on the Internet in the future if so desired.
- While most schools and homes have PCs with CD-ROM drives, many are not connected to the Internet yet. Therefore, if the case is developed solely for the Internet, many students may not be able to use it right away.
- The case is interactive which makes it exciting and attractive to students at all levels.
- Several software packages are available on the market with various levels to develop the case into an attractive multimedia-based case.

SEATEC faculties have found that case-based instruction in technology education is a great way to involve all student-learning styles in a classroom experience. Case studies, especially the multimedia-enhanced ones, offer students the opportunity to learn basic technical and general education skills in a workplace context. Adding multimedia to written cases only enhances the activity level of the students while adding even more workplace exposure to the learning experience. Video clips, photographs, and sound clips allow the student to view the work site and interact with the employees even if the industry is located hundreds of miles away. Adding software components to cases allow the student to perform directed research via the Internet, take quizzes on key technical concepts, and receive immediate computer-generated feedback. Students soon find that they are the facilitators of their own educational experience and can choose how they maneuver throughout the case without following the one "right" path. SEATEC team members are currently adding multimedia components to these case study models and two cases are being produced in CD-ROM format, with plans for more CD-ROM versions to be created in 2000-2001.

V. Field Testing and Assessment

For the purpose of constructive assessment of the SEATEC approach to curriculum development, the Learning Technology Center (LTC) http://peabody.vanderbilt.edu/ctrs/ltc/ at Vanderbilt University was contracted to assess the effectiveness of the case study approach in technology education. Each of the SEATEC teams identified the courses where field-testing will be conducted. Assessments are currently being performed at community colleges and four-year universities across Tennessee, Alabama, and Kentucky. A National Advisory Committee was also formed to monitor the progress in meeting this objective.

Initial field-testing instruments indicated that students often feel as if they are employees at the job site in which the technical problem is taking place. Since case-based instruction is student-centered, students have more responsibility for their own learning, thereby allowing instructors to spend more time facilitating than lecturing. Students graduate with marketable skills and virtual industrial experience. Employers who have participated with SEATEC in the case writing process are enthusiastic about the graduating new workforce who is trained in problem-based and case-based learning using an interdisciplinary approach, with critical thinking and problem solving skills, and who possesses the required communication tools.

Another job skill easily explored through case-based instruction is teamwork. Cases are often assigned as small group work to be completed both in and outside classroom. Groups must share resources and work toward a common goal. This reflects the problem-solving method most often employed in industry: interdepartmental committees. Each of the TEFATE and SEATEC case studies has components that are easily adaptable for small group work such as communications assignments (reports, memos, and/or oral presentations).

VI. Participation by Other Faculties

In order to support and develop instructors who want to use the case method in their classrooms, a Professional Development Team was formed from SEATEC members. Thus far, the Professional Development team has conducted campus-wide inservice sessions, which introduced approximately 625 faculty members from universities, community colleges, and K-12 faculties to the case method and tenants of active, collaborative, problem-based learning. Numerous industrial site visits continue to expose SEATEC faculty to the latest technological practices in area industry and provided the basis for new “real-world” based problems which will be used in case studies, further fueling the Professional Development Team’s mission of providing current methodology to technical and general education faculty.

VII. Dissemination

Finally, SEATEC members who have published several papers and presented at various international, national, and regional conferences are disseminating the preliminary results of this grant. A web site has been also created to electronically disseminate materials related to the grant. For additional information or to sign up for the SEATEC newsletter and mailing list please check the following: http://www.nsti.tec.tn.us/SEATEC/

VIII. A Sample Multi-Media (CD) Enhanced Case Study

THE CASE OF THE GUMI'S A Multi-Media (CD) Enhanced Case Study

Prepared by Jim Barrott, Richard Seehuus, Stuart Hilton, and Tom Williams
Chattanooga State Technical Community College in Cooperation with Brach and Brock
A Project Sponsored by SEATEC and Funded by the National Science Foundation-NSF/ATE

Applicable Courses
Manufacturing Processes, Manufacturing Management, and Manufacturing Plant Layout.

Student Objectives

Upon completion of this manufacturing case study, a student should be able to…

1. Understand and describe the basic elements of a manufacturing process for producing a food product like Gumi Bears.
2. Recognize a need for an automated design solution in a manufacturing facility and the effect that space limitations has on the solution.
3. Apply design principles to a manufacturing problem.
4. Apply problem-solving techniques by comparing the benefits of multiple solutions and presenting the best solution.
5. Be a productive member of a student design team.
6. Develop oral and written presentations in a multi-media format.

Background Information

"We have to find a way to automate the process AND keep the Gumi Bears from becoming one big ball of candy", proclaimed Brian Morse to his staff. "Reliable labor is expensive and difficult to find plus we are loosing too much money on wasted product. We must find a low-cost solution to this manufacturing process problem. I know we can design the right system if we work together as a team. George and Pat, I want your team's best solutions within the month." After the meeting, George Morgan and Pat Patterson greet each other with enthusiasm. "Pat, this is the project we have been waiting for", grinned George. "With your electronics expertise, I know we can design a successful solution. I believe we need to explore the feasibility of a design similar to the one we saw last month." Pat nods and adds, "But let's make sure that we explore all of our options with our team members so that we can design the most cost-effective and efficient system."

Brach and Brock Confections makes a variety of candies for shipment all over the world including "Gumi" type candy products such as Gumi Bears. Brian Morse, George Morgan, and Pat Patterson are in the engineering department at the Chattanooga, TN Plant. In **FRAME A** Brian and George are discussing design ideas with Stuart Hilton and Tom Williams, faculty members at Chattanooga State Technical Community College.

The manufacturing process of making "Gumi" candies is not a complex process; however, space limitations, a slippery product, and labor issues can complicate it. The process begins with a mixture of ingredients that constitutes the liquid version of the Gumi product and starch molds created from a pattern for the candy that is to be made. The hot liquid mix is poured into the starch molds as shown in **FRAMES B, C, and F**. The liquid solidifies into a Gumi candy and cured over a 24 hour time period. A machine that puts moisture and heat into the starch presses the starch molds from a pattern designed for the candy being made. (**FRAME D**.) Maintaining the right temperature and moisture is critical to maintaining the strength of the starch molds and the curing of the candy. A sensor detects if the correct temperature and moisture levels are in the starch molds. (**FRAME E**.) **FRAME F** is showing the hot liquid mix being fed into the starch molds. After the Gumi candy has solidified, the candy is separated from the starch molds and then conveyed to a machine that tumbles the candy to knock off any last clinging particles of starch. (**FRAME G**.) Notice the white coating on the candy as shown in **FRAME H**. Next, the candy is conveyed to a machine that coats the candy with a light vegetable oil. (**FRAME I**.) From the oiling process, the product is taken to the area where it is transported to the second level, see **FRAMES J and K**. On the second level are the weighing machines that prepare the candy for bagging. Notice the candy sticking on the side panels and also notice the construction of the conveyor belt. Once the candy is on the second level, the product is distributed (**FRAME L**) to several machines that weigh the candy and when the correct weight is obtained it is then disbursed to the bagging machines. (**FRAME M**, be sure to click on the movie clip to see one of these machines in action. The movie clip is of a newer sorting machine.) Once the candy is weighed, it is dropped through the ceiling (**FRAME N**) to the bagging machines on the first level (**FRAMES O and P**, be sure to click on the movie clip to see one of these machines in action.) **FRAME Q** shows the computer station where statistical reports about the bagging operation can be viewed.

Problem Description

The candy is transferred to the second level by dumping the candy from the conveyor into trays (**FRAME R**) that are then elevated onto the second level. (**FRAME S and T**.) The trays must be shallow so that the candy won't stick together from the weight of the candy being piled into the trays. Workers on the first level then stack full trays onto pallets that are placed on an elevator and transported to the second level. Once on the second level, workers dump the trays of candy onto the conveyor system that carries the candy to the weighing machines. (**FRAME U**.) Brach and Brock Confections wants to automate the process of transporting the candy to the second level thus eliminating both product waste and human labor. Product waste can result from candy clumping together (**FRAMES V and W**.)

This occurs from primarily two ways 1) too much candy flowing on top of each other and 2) steep inclines or declines in the design of conveyors. Too steep of an incline or decline results in candy rolling together and creating balls of candy. Brach and Brock engineers (**FRAME X**) have found that a conveyor designed with an incline or decline of greater than seven degrees creates a balling up problem.

From the point on the first level to the point on the second level where the candy needs to be transported, space is a key factor. The available area for a transporting system is 12'x10' and the distance from the first level to the point of connection with the second level conveyor is 18 feet. You have been called as an expert to assist with the design of an automated solution to this problem. Experts wear red coats while in the plant. (**FRAME Y**.)

Instructor Lead Discussion Questions

1. What are some of the ways management can reduce labor costs on a manufacturing shop floor? What would be different in a union plant?
2. What elements must be considered in the manufacturing processes of a candy or other food product versus the manufacturing process of discrete parts?
3. What are some government regulations a candy manufacturer might have to consider?
4. Do you think that the starch can be reused once it has been separated from the candy? Why or why not?
5. What effect does temperature and moisture have on the starch molds?
6. What is the white coating on the candy as noticed in FRAMES G and H? What does the removal of this coating have to do with customer appeal?
7. What special considerations should be given to the surface of the conveyor belts for transporting Gumi products?
8. How could the conveyor belts be cleaned and how often should this be done? (FRAMES K and L.)

9. What effect would too much or too little of a vegetable oil coating have on the Gumi product? On the conveyor belts?
10. Why does the product stick to the panel sides and not to the conveyor belt as seen in FRAMES J and K?
11. Why would plant workers have to wear protective clothing in a candy making facility as shown in FRAMES X and Y?
12. What kind of statistical data/reports on the bagging operation (FRAME Q) would plant managers, engineers, and shop floor workers be interested in seeing?
13. Why is space such a critical factor in a manufacturing process?
14. What factors should be considered when choosing one solution over another?
15. What benefits do plant technicians and engineers gain by working in teams?

Team Questions and Activities

1. In seven steps, describe the manufacturing elements in the production of a Gumi Bear. Include a flowchart.
2. Generate three solutions to the design problem.
3. What would you change if space were not a factor?
4. Prepare a presentation for the Brach and Brock management team that outlines your three solutions and highlights your team's best option. The presentation will include both written and oral proposals using a multi-media format. The written proposal should contain an executive summary. The written proposal should take the format of an introduction that includes a statement of the problem, a short description of the three solutions with a discussion of the pros and cons of each one, a detailed description of the preferred solution with design parameters and constraints, tools used by the team to determine their solutions, and a conclusion. The oral presentation should not be any longer than twenty minutes.

INSTRUCTOR GUIDE

Introduction

The FRAME's referred to throughout the case are on the companion CD. It is advisable that the instructor goes through the frames of the CD several times to become familiar with the various pictures and movies of the manufacturing processes. The folder on the CD labeled 'BRACH' can be copied from the CD onto a hard drive if needed. Inside the 'BRACH' folder are many files. Double clicking on the 'INDEX.HTML' file will automatically open your current web-browser and begin the process of viewing the FRAME's. Either NETSCAPE or EXPLORER can be used. Those files used in presenting the case are listed next.

README.TXT	- Instructions for use.
INSTRUCTOR-GUMI-CASE.doc	- The Instructor's Guide.
STUDENT-GUMI-CASE.doc	- The Student's Guide.
INDEX.HTML	- Begins the process of reviewing the FRAME's
'.JPG' and '.HTML' files	- Used to present the FRAME's.
'.MPG' files	- Movie files in some of the FRAME's.

Suggested Teaching Approach

Teaching this case is best accomplished if the instructor proceeds in three stages. In the first week, the instructor should present the processes used in team problem solving including concepts of teamwork, brainstorming, and solution finding. Decision tools such as fishbone diagrams should be demonstrated. In the second week, the instructor should present the case to the students and lead the discussion questions. The discussion questions can be answered as a whole class; the teams may be assigned to answer the questions; or, a combination of both. In the third week, teams present their findings and then the instructor presents the Brach and Brock solution. The FRAME labeled SOLUTIONS is the last FRAME before the Brach and Brock solution is presented. When presenting the case, it is best that the instructor stop the presentation and not reveal the actual Brach and Brock solution as shown in FRAMES Z, Z1, Z2, Z3, and Z4. Two movies in these frames show the spiral conveyor in action.

Solutions Guide

Once the teams have presented their solutions, the instructor should show students the real solution that is presently in operation at the Brach and Brock Plant in Chattanooga, TN. When discussing the Brach and Brock solution, the following points should be made:

1. What is the belt design? When following a spiral path, belt design is critical. The belt manufacturer of the belt used in this design specifies that the radius of the spiral must be greater than 2-1/2 times the width of the belt. In the working solution at Brach, the belt is 10” wide and the radius is 25”.
2. What is the purpose of the internal cage? The belt has a tendency to collapse onto itself when following an upward spiraling path. The internal cage keeps this collapsing of the belt phenomenon from occurring.
3. What is the purpose of the drive shaft coming out of the motor at the top of the spiral? The conveyor at the top has to move at a different speed than the conveyor coming up the spiral due to following a linear path rather than a spiral path.

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