120th ASEE Annual Conference & Exposition
FRANKLY, WE DO GIVE A D*MN
June 23-26, 2013

Paper ID #7015

Leveraging Scarce Resources to Preserve an Important, Low Enrollment Manufacturing Program

Dr. Bill D. Bailey, Southern Polytechnic State University

Dr. Bill Bailey is currently an assistant professor of industrial engineering technology and quality assurance at Southern Polytechnic State University. He holds a Ph.D. in Technology Management (Quality Systems Specialization) from Indiana State University. He also holds a Master of Science in Industrial Technology degree from North Carolina A&T State University, and a Baccalaureate degree in Psychology and English. Dr. Bailey has extensive manufacturing experience, including lean implementation and training and development. He has developed programs and taught in a community college for several years. He has served as an examiner for several Baldrige based quality award processes, including The Malcolm Baldrige National Quality Award, and state awards in North Carolina and Georgia. His research and consulting interests include the improvement of organizational performance through quality initiatives such as the Malcolm Baldrige National Quality Award Process, Six Sigma, Lean, etc., and the application of these initiatives to education, manufacturing, services and healthcare.

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Abstract:

Many manufacturing programs are resource intensive. They require considerable laboratory space, expensive equipment, and instructors for both day and evening courses. Although these programs are often very important to the institution and to local business and industry, they sometimes have low enrollment. This paper will describe strategies for leveraging existing resources to preserve important but low enrollment programs.

These strategies will be described in the context of a case study. The subject of the case study is a two year Tool, Die and Mold Making program. This program was very important to local industry, and as such was important to the community college which offered it. Although the need for Tool, Die and Mold Makers was a critical one, they were not needed in large numbers. Additionally, most students were full time employees, and could be on any shift. There was a resulting need to offer both day and evening courses.

In order to improve both the efficiency and effectiveness of the program, the course offerings were rearranged, combined labs and flexible lab spaces and hours were used, online learning was utilized for the classroom portion, and as a supplement to lab portions of the program. These strategies enabled the program to serve the all of its students with a minimum of resources.

Background

The community college which is the focus of this study had offered a one year machining diploma for many years. A second year was added to complete an associate degree program in Tool, Die and Mold Making. The addition of the second year was accomplished in part through the addition of a second laboratory space and the addition of a full time instructor, and a part-time evening instructor. The new laboratory space included conventional equipment that duplicated some of the equipment in the original laboratory, with the addition of CNC EDM, and CNC Wire EDM machines and some computers for CAD/CAM applications. The second year laboratory was located in a different, much newer facility than the original machining laboratory.

The two year associate degree in Tool, Die and Mold Making was important to local industry, and therefore to the college. The program acted as a standalone degree program, and as related training for local apprentices. Even though the need for Tool, Die and Mold Makers was a critical one, the numbers were not large. Additionally, most of the students worked full or part time and could be on any shift, creating the need for both day and evening programs. Shortly after this program was implemented a large company which was the largest employer of graduates had significant cutbacks. This did not cause the enrollment numbers to shrink dramatically, but it did suggest that enrollment growth in this program would be limited. In order to best leverage available resources for the program, a complete redesign of the combinations of course offerings, the physical resources, and the human resources was undertaken. Although local industry had a vested interest, and supported the redesign, this restructuring project was initiated and completed by the program's faculty.

Course Offerings (within the major)

Table 1 lists the major course offerings by semester and by lab as they were originally offered. This is a pretty traditional arrangement, and very similar to other programs in the system.

Table 1. Initial Course offerings

Year 1 (old lab)		
Fall	Spring	Summer
Machining I	Machining II	Machining III
Introduction to CNC	CNC Turning	
Blueprint Reading	Blueprint Reading Mechanical	
	CNC Milling	
Year 2 (new lab)		
Die Making I	Die Making II	
Mold Making I	Mold Making II	
CNC EDM	Mold Maintenance and design	

However, this arrangement did not make very effective use of physical or human resources. Each lab section was offered individually. First and second year students were in separate labs, and enrollment numbers were relatively low in most sections. This problem was compounded by the large number of required laboratory hours (Table 2). The decision was made by instructors to proactively address this problem. A redesign was initiated which sought to address the low enrollment, and to make the program more flexible and student centered at the same time.

Table 2 Laboratory Hours

Course	Classroom Hours	Laboratory hours
Machining I	2	12
Machining II	2	12
Machining III	2	12
CNC Turning	1	3
CNC Milling	1	3
Die Making I	2	6
Mold Making I	2	6
Die Making II	1	9
Mold Making II	1	9
CNC EDM	1	3
Mold Maintenance and Design	1	3

Redesign

In planning the redesign, instructors decided that the lab space and on-line offerings could be leveraged to accomplish the goals of the project. A new teaching strategy (Table 3) was devised. The new strategy called for two major changes. First, the lecture (classroom) segment of every course would be offered on-line. Previously, this had been done on a limited basis for second year courses only. The new structure also supported the development of student portfolios.

Table 3. New Instructional Strategy

Classroom (on-line)	Laboratory
Focus on Theory	Focus on Application
• Textbook	• Demonstration
• Illustration and Lecture	• Projects
Blackboard	Blackboard
• Reading assignments	• Lab forms and Templates
• Research	• Focused Instruction
• Assessment	• Writing assignments
• Design Projects	• Documentation (evidence)
Student Portfolio	

The second major change was physically combining the two laboratories. An inventory was taken of equipment in both laboratories. Outdated equipment was disposed of through the surplus process. The old laboratory was predominantly equipped with lathes and milling machines, as well as CNC machining and turning centers. The newer lab was mostly equipped with milling machines and surface grinders, and some EDM equipment. Some of the lathes, and milling machines were also disposed of, keeping the best equipment. Because the older laboratory space was larger, the combined laboratory was located there after some renovation.

There was also a change in the order of course offerings for second year students. Die Making I and Mold Making I were traditionally taught in the fall, followed by Die Making II and Mold Making II in the spring. In order to establish better continuity and depth within each subject, the schedule was changed so that Die Making I and II would be taught in the fall, in a split semester. Due to the distribution of lab and classroom hours, Die Making I was six weeks long, and Die Making II was nine weeks long. Similarly, Mold Making I and II were taught in the spring semester.

Combining the laboratories in this way allowed a different approach to teaching the laboratory sections. Since the enrollment numbers for each section were small, instructors decided that laboratory sections of various courses could be offered concurrently. Instead of having dedicated lab time for each course, they could all be combined (Table 4). Combining the laboratories was not as complex as it may appear. Although a student could take nearly any course in any semester they mostly followed the traditional schedule pretty closely. This meant that in the fall semester for example, students were either in Machining I, or Die Making I and II. In a laboratory populated by a larger number of students, this arrangement worked well, because first year students required more attention, while second years students worked more independently. Flexibility was also built into the lab hours to accommodate student work schedules and other course requirements. Both required and optional lab hours were established. Each course had some required lab hours to facilitate team projects and some group instruction. The remainder of the required lab hours could be fulfilled during the optional lab hours.

Table 4. Revised course offering

Combined Lab	
Fall	Spring
Machining I	Machining I
Machining II	Machining II
Machining III	Machining III
Die Making I	Mold Making I
Die Making II	Mold Making II
Blue Print reading I	Blue Print reading II
Introduction to CNC	CNC EDM
CNC Turning	CAD/CAM
CNC Milling	

The teaching load was split along the same lines as the redesign (Table 5). One instructor would teach all of the laboratory sections, and the other instructor would teach all of the classroom sections, and some other major courses which did not have a laboratory component. Since the laboratory sections required more contact hours, the classroom instructor assumed the responsibility of laboratory support using Blackboard. All course forms and templates (planning sheets, inspection sheets, etc.) were maintained on Blackboard and available through lab computers. Also through Blackboard, the classroom instructor assumed responsibility for written assignments associated with laboratory projects. Blackboard also became a receptacle through which students could accumulate evidence of their skills and develop a portfolio of their work. Finally, the classroom instructor would develop short focused instructional units for use in the lab.

Table 5. Teaching loads

Instructor 1 - Classroom	Instructor 2 - Laboratory
All lecture sections on Blackboard	Project Based Instruction
Blackboard support for all Labs	20% assigned lab time
	80% open lab time
Load	Load
Approximately 18 hours	Approximately 25 lab hours
Plus Lab support and development	

Benefits

The redesign provided multiple benefits to the program. Laboratory space was reduced by nearly 50%. Outdated equipment was disposed of, and the remaining equipment was better utilized. The total number of adjunct hours was also reduced. To accommodate students working various shifts, courses had been available in the evening as well, using part time adjuncts. After the redesign, the evening offerings were continued in a single laboratory offering. What had typically been two evening courses became one laboratory, and the classroom portions were taught on line, combined with the day time students.

The new approach also allowed the program to be more flexible and student-focused, and to better manage student outcomes. On-line classroom and flexible lab hours worked better to accommodate working students. The Blackboard support for laboratory sections resulted in better consistency through the development of standard forms, templates and rubrics. A skills matrix of both technical skills and employability skills made expectations clearer to students. Self-assessment through rubrics and other tools allowed for immediate feedback. Self assessment was combined with instructor assessment to personalize a skill development path for each student. The more structured and documented approach also became a tool for self

managed learning, which students could use to accumulate skill documentation and compile a portfolio for employment.

For the program and the institution, the program was able to continue with fewer physical and human resources. At the same time, the new organizational approach allowed better collection of data at student course, and program levels. This effort also created a potential model for program assessment and improvement. Informal feedback from local employers suggested that they were pleased that the program would continue, and that students had more flexibility.