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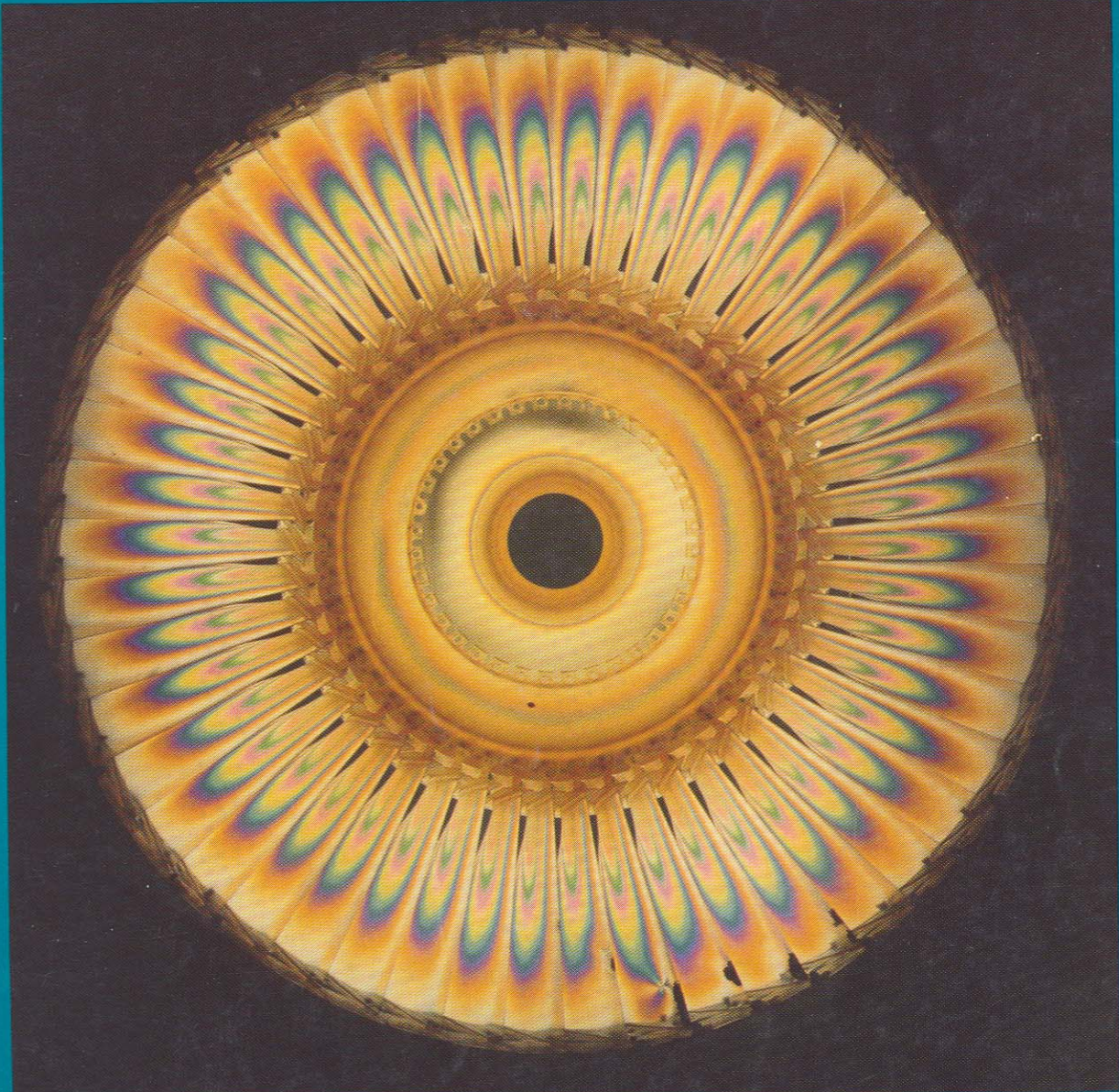
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A New Strategy for Education: Combining Manufacturing and Management

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ABSTRACT

Manufacturing industries are continually looking for graduates who have, in addition to their technical engineering education, co-op or some other form of industrial experience. Also, those engineering technology students who have had some training in business management, finances, and cost accounting are in even greater demand for future middle and upper-management positions. This paper describes the creative efforts of a group of faculty and students from Brigham Young University's College of Engineering and Technology and School of Management to develop an educational manufacturing student co-op. It also describes the very successful, student-run cooperative Alecoop, located at the engineering technical college in Mondragon, Spain, that is providing all of its graduates with both a pragmatic and a technical education.

It is no secret that seniors who graduate from accredited university programs in engineering technology and business management receive more job offers and higher beginning salaries if they have practical experience gained by working for a company within their fields of study. Students who have participated in a co-op program often have the advantage when seeking employment and, in many cases, are offered positions after graduation by the same companies which provided their co-op experience.

A student co-op experience is defined as a "cooperative arrangement" between students and industrial or service organizations wherein the students leave school and are hired by firms to work for predetermined lengths of time. This program allows students to obtain practical manufacturing training, ample wages, and college credits all at the same time. After completing the work session for a semester or two, students return to the classroom with a wealth of new knowledge.

Recently, however, this arrangement has become a matter of considerable debate, causing some schools to abandon their extension of the classroom into the corporate world. Some university administrators have questioned the academic legitimacy of co-ops. Others have criticized them as "double dipping," as both credit-hours and wages are provided. Engineering technology faculty have been concerned because they can neither monitor nor adequately evaluate their students' work. On the other hand, some have argued that business management skills rather than technical education are needed.

At the same time, there remains the critical need for some practical, manufacturing experience. In reality, the people making the most significant contributions in corporate America need to have a knowledge of or experience in each of the following three areas.

1. The sophisticated theories and mathematical models of engineering

2. The application of these principles to the design of innovative products as well as the testing and the implementation of manufacturing systems for these products
3. The use of business management practices necessary to finance, produce, and market products successfully

In this context, it is sobering to realize that the trend in engineering education is one of nationally declining enrollments. The percentage of college freshmen choosing engineering programs declined from 12% in 1982 to 8.5% in 1987.¹ Currently, only 6% of American undergraduate degrees are in engineering, in contrast to 37% in West Germany.² At the same time, there is increasing recognition in society of the central importance that engineering and technology play in business.

What can be done to improve the quality of engineering education and to make the programs more attractive? Some advocate curriculum reform,³ while others argue that the problem is overspecialization and that integration of and more flexible boundaries between disciplines are needed.⁴

Another view suggests that co-op, a program that benefits students, universities, and corporations, may be a key part of the answer. Companies are often more interested in hiring former co-op students, as they are better qualified because of their additional work experience. This experience permits them to make immediate and useful contributions and to be initially more productive than those without co-op training.

Those students who have had an opportunity to work in the real world are better able to more readily define their professional areas of interest and to seek those job assignments that more perfectly match their interests and talents. They can clearly indicate to a job interviewer where they would like to work and why. Also, co-op helps students to define their career objectives and thus to select the kind of elective courses or additional classes that should be taken to better prepare themselves for a particular area of responsibility.

Faculty also benefit from the students' participation in co-op programs. As a result of their professional experiences, the students are more mature and demonstrate an increased personal commitment toward excellence and professionalism. We have observed that co-op students participate more in classroom discussions and project work. From their work sessions, they bring back important ideas and examples which they share with others in the classroom.

In light of these benefits of a strong, student co-op program, it is clear that wherever possible, such an experience should be available to all who would like to take advantage of it. In fact, stronger measures ought to be taken to ensure that co-op becomes a regular part of higher education. Some schools have already taken this approach; for example, Northeastern University *requires* its students to enroll in a co-op program. However, trying to implement co-op as a requirement for graduation becomes a difficult task at best, and at most institutions, an impossibility. The major deterrent is simply the unavailability of co-op openings for all as well as the means to administer such an effort.

CREATING A COOPERATIVE ORGANIZATION

One strategy for increasing the opportunities for co-op experience is to create an internal, university-based system. This approach offers the opportunity to take college courses and to gain co-op work experience without leaving the campus.

In the spring of 1987, a small group of Brigham Young University (BYU) faculty and students decided to launch a campus-based industrial cooperative. Professors from manufacturing engineering and technology, sociology, and organizational behavior combined their interests and, together with students—both undergraduate and graduate—started manufacturing metal bars and other parts for weightlifting equipment for a local entrepreneur. In the same year, the group began a second project: the design of the graphics and artwork for and the casting of commemorative bronze plaques and medallions for various organizations within the university community.

This internal co-op functions in parallel with, although on a small scale, the external cooperative program which has existed at BYU in the College of Engineering and Technology for many years. The costs to the university for this program have been minimal because the only direct expenses have resulted from the use of existing equipment and space in the foundry of the engineering technology building.

The co-op, called Equitech, integrates values, such as equality and democracy, with basic technology. Further, it provides jobs and income for students, most of whom could not go to college without employment. Starting pay is \$4.60 per hour, and after forty hours of apprenticeship, wages rise to \$6.00 per hour. One-third of the students are female, and a number of the members are from Third World nations, including the People's Republic of China, Peru, Hong Kong, and Taiwan. Over one-half of these foreign students plan to return to their home nations and to establish cooperative-run businesses after their graduation.

Equitech's board of directors is composed of three faculty representatives and three students. Twelve people form the general assembly, in which majority rule governs. One student is the general manager; three others direct such functions as marketing, production, and finance. A mix of student backgrounds creates interesting interaction, as the students are from a variety of programs, including sociology, business, international relations, design and engineering technology, organizational behavior, law, accounting, and business administration (MBA).

The members of Equitech have reaped various benefits thus far. For BYU faculty, the co-op approach to education has led to an interdisciplinary exchange not common within conventional campus structures. This exchange has resulted in fruitful discussions (which at times force confrontation with one's somewhat myopic views) and a richer application of classroom theory, which can be personally tested in our own micro-organization.

The students have likewise benefitted. In addition to regular courses in their respective majors, co-op members also receive two hours of college credit for attending a weekly co-op class. The course covers basic business concepts, on which the students are later tested, as well as production planning for Equitech. They experience firsthand the struggle of attempting to establish a new firm. They deal with material handling, scheduling, production, quality control, customer satisfaction, etc. They also learn how to bid a job and to maintain financial records, and the students become aware

of the problem of cash flow. In short, they develop entrepreneurial skills.

Collectively, the co-op has become a mechanism for learning about organizational design, the theory and practices of democratic management, and the techniques of manufacturing. Business majors learn how to work in a foundry; engineering technology students learn the financial concerns of running a business as well as the benefits of good records and effective accounting. Faculty members are also learning. During many of the work sessions, they perform manual tasks with the students, such as operating grinders, preparing sand molds, and pouring castings. They report that a certain satisfaction results from moving beyond the cerebral level of academia to the more practical act of doing something tangible.

Our experience thus far suggests that cooperative education can play a legitimate role in higher education. At BYU, the emphasis has been on offering students an alternative to mainstream business management or engineering technology. However, the group has also engaged in considerable debate with more traditional faculty and students. Nevertheless, participation in the co-op has been exciting, and student and faculty participants have expressed the desire to continue to explore what further benefits can be derived from such a healthy, educational exchange.

The future direction of Equitech is uncertain. There is the possibility that more faculty members will become interested in the co-op and will collaborate on the project. As marketing expands, Equitech may grow and thus may be able to provide well-paying jobs and co-op experience for many more students. For those students involved in the program, there may be additional opportunities for alternative careers following graduation.

THE MONDRAGON CASE

The co-founders of the Equitech co-op were inspired by the success of a much larger co-op—the student-run Alecoop located in Mondragon, Spain. Currently, Mondragon is the center of a group of worker-owned industrial cooperatives in northern Spain.⁵

Approximately twenty years ago, a Basque priest, Don José María Arizmendiarieta, met with four students in the town of Mondragon. The students were unable to continue their studies because of financial hardship. After considerable discussion and planning, the four friends, all students in industrial mechanics, were able to borrow two welding machines and four handsaws. They started making coils for motor engines, repairing electrical wiring in local homes, and installing TV antennas. Within two years the group had grown to about thirty students who adhered to Don José's philosophy that "the student ought to be a worker and the worker ought to be a student." Instead of dividing life into distinct phases—education and work—the two activities became integrated.

As a result of its growth, the group evolved from an informal, voluntary, fledgling program to a more structured and effective organization. It was called Alecoop. Elected leaders of the newly organized firm obtained a \$15,200 loan and rented a larger building. Teachers were hired as part-time instructors to teach both theory and practical skills. Students and instructors became partners in a joint learning experience, deciding courses, work, ownership, capital, and wages. Legal statutes were prepared by Don José and then debated and ratified by the group.

The students spent one-half of each day in the classroom and the other half in the factory manufacturing their products.

Working capital was initially provided through loans from several regional industrial cooperatives that also contracted work to Alecoop. As the students succeeded in generating revenues, the loans were repaid and the remaining funds were used to purchase better equipment. The introduction of new technologies provided students with a state of the art learning environment and also enabled increased production.

As Alecoop grew, a board of directors was formed with equal representation from three key groups: students, faculty, and outside industrial co-ops. The board continues to meet monthly to set policy and to review programs, and it holds a quarterly general assembly meeting which is attended by all members of Alecoop. Major decisions are voted upon using the cooperative principle of one person/one vote.

Today, Alecoop has 601 students and 33 faculty. Courses are offered in manufacturing technology and engineering as well as in conventional business practices such as accounting, business management, and cooperative theory. After graduation, students either leave the co-op or, if they prefer, remain at Alecoop for up to six additional months.

As in any organization, there are occasional difficulties. Production suffers from the annual 25% turnover because of graduation; this loss of experienced members contributes to a higher than desired scrap rate. Under-capitalization is an additional problem for the co-op.

Alecoop, however, is economically and educationally successful. Its two major product groups are prefabricated electrical installations—for assembling electrical equipment—and didactic equipment targeted for courses in automation, electronics, robotics, information systems, and alternative energy uses which are taught at other engineering and technical schools. Sales last year totaled \$9.2 million. In addition to providing parts for other industrial co-ops in the region and products for educational use, Alecoop is currently under contract to do work for conventional companies such as Mercedes-Benz, Ltd.

In the surrounding region, in and beyond the town of Mondragon, there are approximately ninety-six industrial cooperatives where many graduates of Alecoop are employed as worker-owners. Some of these cooperatives are fairly large, such as Ulgor, which has 6,400 members in twelve factories. Of some one hundred new co-ops begun in the past several decades, only eight have failed, an enviable record when compared to American achievements.

The cooperatives demonstrate impressive resilience and flexibility. For example, during the global recession of the early 1980s, mass layoffs were the norm in most countries, including the United States. In contrast, workers in hard-hit firms in Mondragon were retrained and then employed in co-ops not hurt by the crisis. Sales, profits, and employment all increased significantly, while most other industries had to cut back and retrench.

CONCLUSION

Although unique cultural factors obviously have contributed to the success of the Mondragon system, the Alecoop model may have relevance for engineering technology educators in the United States. Creative approaches to technical training are necessary in order to reverse the present decline in engineering technology enrollments. A recent article in *The Wall Street Journal* suggests that there will be a shortage of 560,000 engineers and scientists by the year 2010 unless change occurs.⁶

The small, beginning effort at BYU is one example of how new programs might function in American higher education. With the changing structure of our economy and the growing challenge of how to provide students with both a theoretical and a practical education, the creation of a student work cooperative may become a useful educational tool in the future.

Based on BYU's experience, and that of Alecoop itself, we have concluded that such an effort is not all "sweetness and light." There are a number of significant challenges to be overcome when creating a student/worker co-op. Faculty and students from diverse areas neither speak a common technical language nor necessarily share the same values and assumptions. University administrative support (or at least tolerance) is essential because of the legal issues that an internal co-op raises. It is important to have an atmosphere of creativity in which one may experiment, discard those ideas that do not work, and retain those things that are successful. The sheer demand of building an alternative education/work structure, concurrent with one's regular duties as a professor, requires the sacrifice of numerous nights and weekends to meet with co-op students and to help plan the co-op's future.

Yet such a venture has a certain sense of the adventure and the excitement of entrepreneurship. It is exciting to work with students in a "grassroots" way rather than from "ivory towers" which commonly typify universities. Our experience to date suggests that establishing a student co-op not only provides greater learning but also is just plain fun!

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Warner Woodworth received his Ph.D. from the University of Michigan. He was a visiting scholar at the University of Rio de Janeiro and the Institute for Labor Studies in Geneva, Switzerland. A consultant to a number of Fortune 500 firms, unions, and various government organizations, he currently teaches in the Marriott School of Management at Brigham Young University, where he is department chair of organizational behavior. Dr. Woodworth is the coauthor of *Industrial Democracy* (Sage) and *Managing by the Numbers* (Addison Wesley).

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