

Two-University Cooperation: Paradigm for the Future of Statewide Engineering Education

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Abstract

To establish engineering education in a new location, a method of cooperation between universities is recommended as an alternative to the "build another college to satisfy local demands" mania. Motivation for this innovative method is presented with a concise history of an actual two-university cooperative engineering program. A model for a successful "virtual department" in two locations is proposed. Administrative structure, budget realities, and curriculum issues are discussed in some detail. Solutions are given for several difficulties that were encountered, including the reasons for seeking separate ABET accreditation for each location. The ideas in this paper outline a low-cost, high quality alternative for providing engineering education in multiple locations. The combined, coordinated resources from two universities form a system stronger than its parts. Innovative application of affordable advanced communications technology strongly enhances the program's unity and its curriculum. This experience suggests this cooperative model is a realistic alternative to the proliferation of multiple, but isolated, engineering colleges in a state or a geographic region.

Introduction

ASEE Prism recently noted a proliferation in the number of engineering programs offered in the United States.[1] Many of these are new, independent colleges or programs. While expressing appreciation for the increased recognition of engineering education's importance, concern for the survival of so many schools did appear in the Prism article. Very practical people have questioned the wisdom of building a new engineering school in every city that demands one. [1] The issue centers around the high cost of engineering education programs.

In the late 1980s, the Regents of the State of Idaho took a different and very innovative approach to local demand for an engineering college in Boise, the state capital. Rather than create a separate new engineering college in Boise, a cooperative relationship was established between the University of Idaho (UI) and Boise State University (BSU) for the purpose of offering engineering on BSU's campus. UI has more than a century of experience in engineering education in Moscow, Idaho, and BSU, without an engineering school, is located over 500 km of winding mountain roads to the south with most of the state's population and industry, as shown on the map in Figure 1. This cooperative arrangement is a large piece of a coordinated UI effort to deliver engineering education statewide.[3] Other locations of focused



need for engineering education include Idaho Falls, 800 km southeast of Moscow, and the Post Falls / Coeur d'Alene corridor 150 km north of Moscow near Spokane, Washington. Both of the other locations support significant concentrations of engineering industry.

This paper presents details of the cooperative engineering education program developed between UI and BSU. First, the motivations for establishing a program in this rather unconventional format are given. Second, the administrative structure, including formal agreements between the two universities is explained. Third, a history of the budget is reviewed, identifying sources of funds, and showing how this money is managed and controlled. Fourth, the curriculum is briefly discussed. The cooperative program is both innovative and unconventional, making it fertile ground for a young, energetic faculty to institute new methods of teaching, particularly with technology. Finally, a summary of interest from students and from industry, in the form of enrollment and job placement performance, is considered. A cooperative program is a viable alternative to building a new engineering college. This paper explains how Idaho universities made it happen.

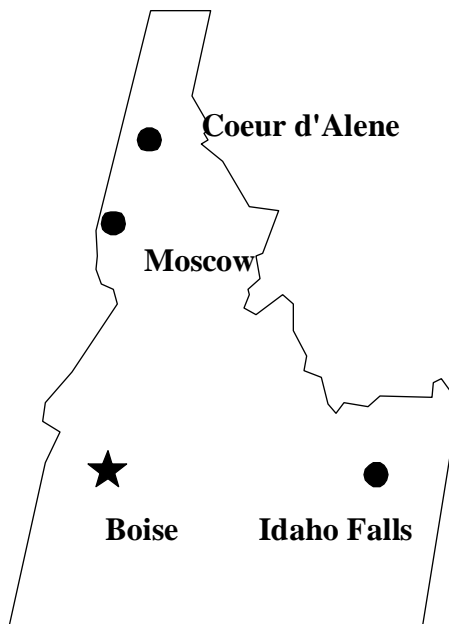


Figure 1. Location of the Idaho Campuses

Motivation

In the mid-1980's, industry in the Boise area began exploring options for more local engineering education. The status quo at the time resembled an efficient, coordinated junior college model. BSU delivered the courses that are normally included in the first two years of an engineering degree. Students then transferred to UI in Moscow for the final two years of a bachelor's degree. Close coordination of courses and requirements made this transition smooth for the students. The cost to the taxpayers was definitely less than for a complete engineering college in each location, but no courses above sophomore level were being offered live in Boise.

The economic situation in Idaho was one of no growth or slow growth at the time that the cooperative program was first suggested. Founding a complete engineering college in Boise was financially out of the question. However, by cooperating and using some imagination, the two universities could satisfy the demand for more local engineering education.

Cooperation

Under a formal agreement between UI and BSU, BSU offers math, science, humanities, and lower division engineering courses. BSU provides the physical plant and maintains it. From a UI-generated list of courses, BSU assigns classroom space. A description of the cooperative engineering program appears in the BSU catalog and BSU handles freshman matriculation. UI faculty, a combination of full time faculty and affiliate faculty from industry, teach the upper division engineering courses. Required core courses and high-demand electives are taught live on-site. Videotaped courses, produced at the main UI campus in Moscow, round out the elective offerings. UI faculty teach and supervise the graduate engineering program, much of which is still delivered on videotape from Moscow. UI administers the upper division and graduate budget, but BSU administers its own budget for lower division subjects. UI provides the administrative structure to support effective faculty research programs. The UI Assistant Director oversees student affairs and makes the administrative transition from lower to upper division (from BSU to UI) a smooth transition from the student's perspective.

There is a smooth, nearly seamless flow of students through degree programs that are a combination of classes from UI and BSU. As freshmen, students are regular BSU students taking only BSU courses, then later nearly all of the upper division engineering courses are UI courses. A cooperative arrangement between UI and BSU allows Boise students to register once each term through BSU, even though, for example, in the junior and senior years nearly all of the engineering courses are taught by UI. Student financial aid is administered through BSU for engineering freshmen through seniors. At the beginning of the junior year, students complete a transfer request form for formal admission to UI, which is approved routinely for all students meeting the normal requirements for junior level classes. At this time, BSU transcripts are automatically filed with UI so there is a minimum of paperwork for students to handle.

Joint committees supervise computation assets and handle space allocation. Though most laboratories are the domain of one or the other university, some share space: the main computer lab is shared and BSU circuits and UI electronics activities share space and equipment. BSU math and physics faculty coordinate the content in courses prerequisite to engineering with UI engineering faculty. A joint committee writes the EE certification exam, required for admission to UI upper division EE courses, regardless of the campus on which those courses are offered. BSU and UI faculty individually exchange teaching assignments from time to time, so the division of faculty assignments is not the strictly lower/upper division model.

BSU lacks an engineering library, so UI provides access to its collection in Moscow and to the Washington State University (WSU) libraries. WSU is located in Pullman, Washington, 10 km west of Moscow. Two dedicated terminals in a UI-maintained reading room provide direct access to both UI and WSU on-line library card catalogs. This arrangement provides a listing of the complete holdings of both libraries and extensive periodical listings by table of contents. Any Internet connection can obtain the same access as well, though some portions of the catalogs require a password for access, e.g., the table of



contents listing of periodicals. Faculty and students order what they want through the UI email system and receive it by FAX, overnight mail, or regular mail.

Administrative Structure

From the outset, the Boise Engineering Program was not envisioned to be a stand-alone or satellite operation, but rather an integral part of the UI College of Engineering. Although other universities have operated "satellite" colleges or departments, quite often these operations are considered second class citizens in relation to the "main" campus. The Boise engineering program was designed to be closely coupled, an extension of the College itself, rather than a peripheral operation. A unique administrative structure was designed to encourage this model.

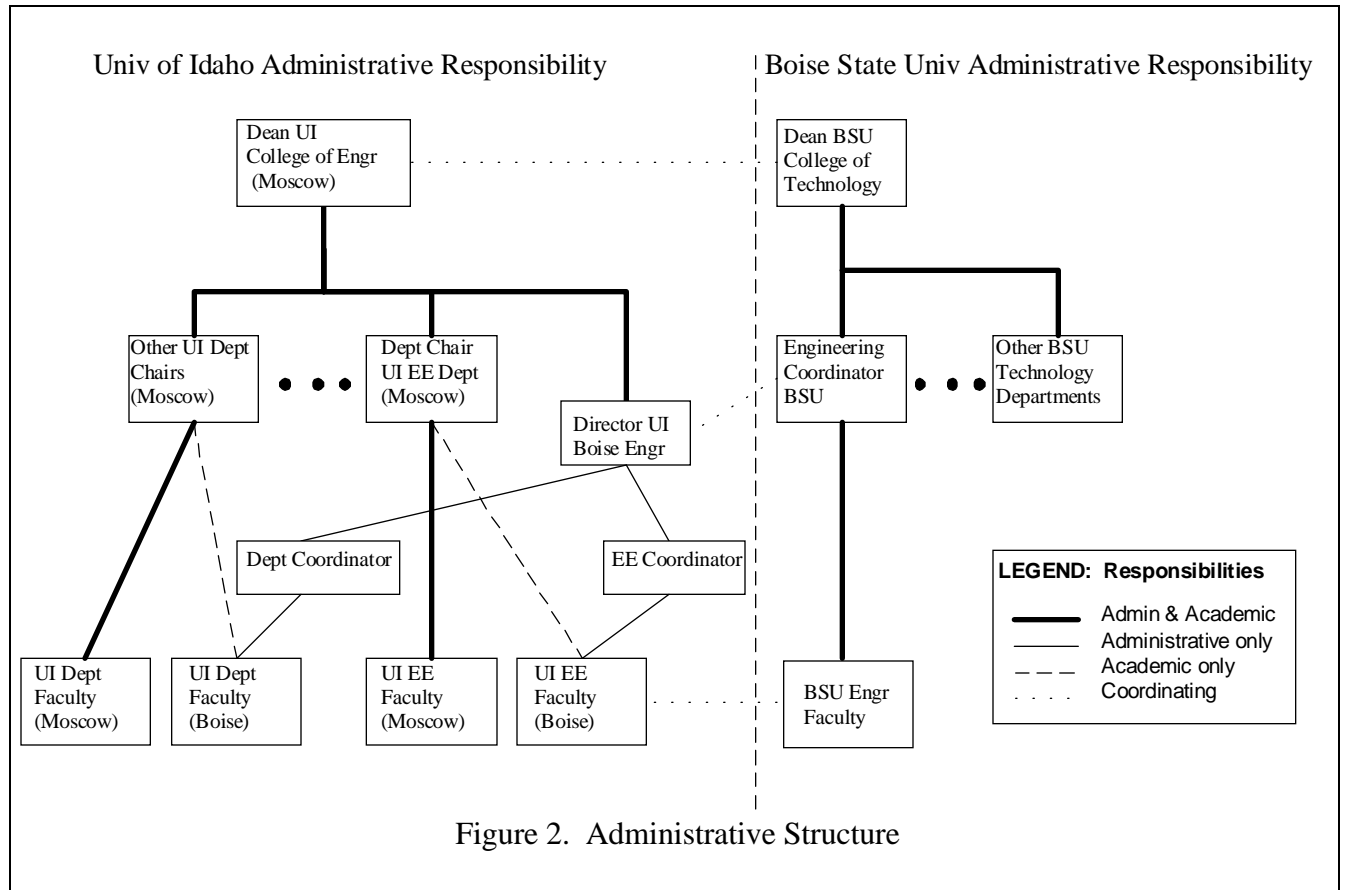
In Boise, a director handles the main administrative functions. The director is a faculty member in one of the UI academic disciplines. This person is responsible for the administrative functions involved with the Boise program, including management of the separately allocated budget. The support personnel, including secretaries and technicians, report to the director. Although the director reports to the UI dean of engineering, this support is administered at the local level, to maximize the responsiveness to faculty and student needs. Academic matters are handled by the respective department chairs in Moscow. For example, the EE faculty in Boise report to the EE department chair in Moscow for such matters as teaching assignments and curriculum development. There is only one EE department, the faculty of which happen to reside in two or more places. Boise faculty of both universities participate as regular departmental faculty members in curriculum development and on departmental committees, e.g., the power curriculum subcommittee, the digital electronics subcommittee, the laboratory development subcommittee, etc. Promotion and tenure requirements for UI faculty are identical at both locations. Unified procedures, including discussion and voting, and a single promotion and tenure committee at each level (department, college, and university) and a single administrative chain apply. BSU has its own promotion and tenure system for its assigned faculty.

With the faculty reporting administratively to the director in Boise, and academically to the department chair in Moscow, there are bound to be times of conflict, the "serving two masters" problem. Specific examples of such situations include salary determination, where the ultimate responsibility for the performance evaluation of a faculty member rests with the respective chair and appropriate college and university administrators, while the budget from which the faculty's salary is paid is the responsibility of the director. Another example is externally-generated research budgets, which may involve faculty in both Moscow and Boise. While the potential for problems exists, in fact the close working relationship between the director and the departmental chairs has, for the most part, eliminated any major conflicts.

With a recent expansion of the program in 1995 to include Mechanical and Civil Engineering, some of the liaison responsibilities of both the director and department chair have been delegated to departmental coordinators. This position is a part-time assignment held by a Boise faculty member in each discipline. The specific duties are defined as follows: coordinate the departmental program to include the class schedule, advising efforts, affiliate (adjunct) faculty selection and assignments, and day-to-day interface with other department coordinators and the engineering program director. The coordinator also has input to position descriptions and faculty/staff evaluations and is responsible for developing both short and long term plans consistent with both UI and BSU planning processes.



An assistant director, a person with expertise in academic counseling, was also hired. The initial plan was for the duties of this position to be primarily student advising and coordinating the articulation of courses and requirements between the two universities. This position has since evolved to include the coordination of all student services, serving as an ombudsman between the student, the academic departments, and the administrative and student services organizations of both universities. Students feel no ill effects from having to deal with two universities on a routine basis and feel that they are part of a seamless, four year degree program.



A Virtual Department

While some provision must be made for a difference in resources at one site or the other, in general the expectations and responsibilities of the faculty in Boise are the same as those of their counterparts in Moscow. There is one department with members at two or more sites in a "virtual department."

A significant advantage in the virtual department concept is that an overall strategy for hiring faculty can be used, rather than having to duplicate the expertise at each site. For instance, since the Boise program relates closely with local industry and one interest is in real-time control, some faculty hired in Boise have that expertise. This expertise is shared with students in Moscow and is not duplicated there. Similarly, more expertise in electromagnetic theory resides with the faculty in Moscow, which is then shared with Boise. Both sites benefit from this arrangement, since instead of counting fifteen

Electrical Engineering faculty in Moscow and five in Boise, the virtual department consists of twenty total faculty, collectively with a broader range of expertise.

The virtual department can only succeed if there is excellent and reliable communication between the two sites. Recent advances in modes of communication are the key to this. For example, faculty meetings have been held using a high quality speaker phone. Last year, a digital compressed video system was added. Meetings between collaborating researchers, supervision of graduate students, office hours for interactive video classes, and meetings of industry advisory boards are just a few of the host of opportunities for unity that such communications hardware provide. UI faculty in Boise are heavy users of email, telephone, FAX, and overnight mail to maintain close working relationships with colleagues in Moscow. In 1994, the UI extended its campus computer network to the Boise engineering program, using half of a leased T1 line. Interactive video uses the other half. Joint software licenses are negotiated for both locations and the files are distributed electronically. This works not only for research and teaching software, but also permits administrators and faculty in Boise to have the same access to the UI management systems and databases as their counterparts in Moscow. On demand, 24-hour, access to each of these systems allows the Boise faculty to fully participate in every aspect of departmental business.

Budget

The budget for the Boise program consists of two parts: the BSU part and the UI part. The respective parts are approved and allocated through the proper channels within each institution. At the State Board of Education level, where a unified higher education budget is presented to the legislature, the two parts are usually combined and presented as a single package by the presidents of both universities. Within the UI College of Engineering, the Boise budget is allocated and administered separately from the rest of the College.

The initial funding in 1988 came from two local industries: Hewlett-Packard and Micron Technology. In fiscal year 1989 (FY1989), the legislature approved state funding of \$283,000 for the program. This new money provided support for the director and assistant director, minimal support staff, one faculty member each in EE and ME, and support for affiliate faculty from industry. The budget remained at this level, except for cost-of-living salary adjustments, until FY1993, when the funds to support four additional EE faculty were added. The latest increase of \$1 million occurred in FY1995 to fund the full implementation of the Mechanical Engineering and Civil Engineering programs. Along with this latest increase, BSU also received an increase of \$1 million to meet the increased student demand for math, science, and humanities instruction created by the engineering program's growth. The FY1996 budget for the program is approximately \$722,000 for the BSU lower division engineering offerings and \$1.7 million for the UI upper division and graduate portion of the program. UI also reallocated an additional \$540,000 to Boise engineering for FY1996.

The costs for delivering engineering with similar quality via a separate Engineering College would be considerably higher. Engineering programs in public universities in the western United States have annual operating budgets between \$5 million and \$15 million for the same services. Startup costs of engineering education programs are estimated to be in excess of \$20 million. By utilizing the existing UI College of Engineering infrastructure, not having to duplicate faculty positions in many cases, and jointly utilizing the resources of both universities, a very efficient means for serving the Boise area has been



developed. Comparison of the numbers given above indicates that annual operating savings are significant over a comparable, but separately administered, engineering college in Boise.

Curriculum

An integral part of the virtual department concept is that the curriculum in each location is identical. But more than that, control of the curriculum rests with a single curriculum committee at each administrative level. In the following discussion, the Electrical Engineering curriculum is the vehicle. The ME and CE curricula follow a similar model, though delayed by two years in the implementation calendar. The EE department curriculum committee at UI has members in Moscow, Boise, and Idaho Falls. Any proposed EE curriculum action must first receive a recommendation, favorable or adverse, from the EE curriculum committee before being forwarded to the EE faculty for discussion conducted on compressed video and a vote. If approved by the EE faculty vote, it is forwarded for action to the College of Engineering Curriculum Committee, the Engineering Dean, and a College of Engineering faculty vote. If approved at the college level, the action goes to the University Curriculum Committee before receiving final approval by the Provost. BSU controls the lower division courses through a similar curriculum approval process, keeping them well within prerequisite standards for quality and content requested by the UI.

The same degrees (BS, MS, and Ph.D.) in the same disciplines (EE, ME, CE) are granted in the UI name at both locations. Degree requirements are identical, regardless of location. Technical electives in the various curricula provide the flexibility in undergraduate degrees to align programs with local industry needs and with faculty expertise. One catalog, the UI general catalog, prescribes all degree requirements.[4] Students earn “resident credit” at either location and are not required to spend a portion of the time at the main UI campus to complete degree requirements.

Growth Affects Curriculum and Staffing

The FY1993 expansion allowed all core EE courses to be taught by full time EE faculty, while adjunct faculty contributed primarily specialty electives. This approach has allowed the program to be rich in industrial insight while remaining strong in the core and foundation courses.

By hiring in disciplines to meet needs in Boise and complement strengths of Moscow, the entire EE undergraduate curriculum could be presented live or interactively on video. The faculty in Boise teach graduate subjects and supervise theses by interactive video. By 1994, the number of graduate courses per faculty member taught in Boise matched the analogous number in Moscow. Also within the same year, the first of several thesis defenses on interactive video occurred, with committee members in both Boise and Moscow.

Though EE is the example given above, ME expanded using the same model. There were 1.5 full time faculty in 1994, allowing ME to offer the junior year's core courses with the help of adjunct faculty. In fall 1995, ME expanded to six full time faculty, offering the entire range of undergraduate courses and beginning graduate courses as well. ME committed to complete the ABET accreditation self study during the 1995-1996 academic year. Concurrently, CE expanded to two full time faculty with plans to follow the EE and ME models.

Expansion of Teaching and Research



The virtual department operation is evident in interactive video courses that have students in both Boise and Moscow. On occasion, there is a faculty member in both Moscow and Boise and the course is a team effort, but many times one faculty member (located in either Moscow or Boise) teaches elective courses to students in both locations via the live video/audio link.[5,6]. By 1994, there were typically three EE courses each semester being taught in this manner. Demands for courses delivered at all sites increased with the ME expansion in 1995.

A discussion of important issues and instructional methods for initiating and presenting instruction on a compressed video system will be presented by UI faculty at the ASEE 1996 Annual Conference.[7].

Faculty visit each other typically once or twice per semester to maintain personal contact. Faculty from both sites found opportunities to collaborate in research. Much of the industrial activity in the state is in the Boise area. With local industry connections, numerous small projects quickly developed: sponsors included Hewlett-Packard, Morrison-Knudsen, Idaho Power Company, Preco, Santa Clara Plastics, Intel, and J.R. Simplot Company. Often these took the form of senior design projects that have been a catalyst for significant student-industry interaction.[8,9] Also, some senior design projects have led to funded research projects with industry sponsorship.

Student Demand

Two indications of program size are the graduation numbers and the overall enrollment numbers. As shown in Figure 3, graduation numbers are those who graduated in the year indicated, with 1996 estimated. Enrollment numbers shown in Table 1 are total declared engineering majors at all levels in the cooperative program. In the five years that Boise students have taken the national Fundamentals of Engineering examination, their success rate has been 88.9%.

Table 1
Enrollment Statistics

Year	Declared Majors
87	187
88	232
89	310
90	371
91	444
92	483
93	505
94	483
95	463

Every engineering graduate from Boise has found employment within a reasonable time, nearly all of them with local industry. Employers interviewing students in Moscow and in Boise quickly took advantage of the compressed video for job interviews, saving the expense of a visit to the other campus. The hiring of a placement officer in August 1995 who strongly supports internships and cooperative education has dramatically improved communication between employers and students. Since her arrival, coop students have had a large increase in opportunities.



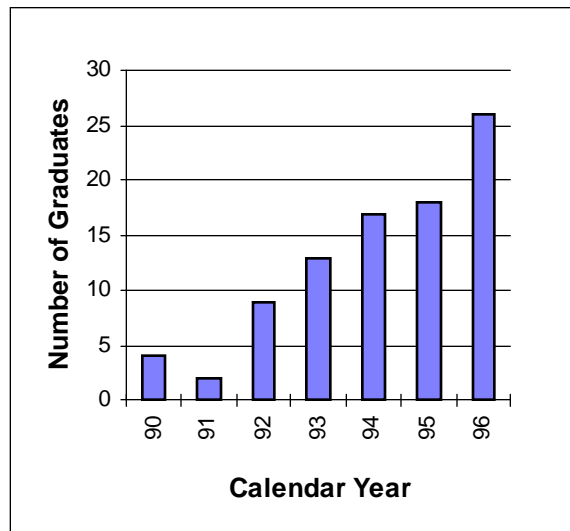


Figure 3. Graduation Data

Accreditation Considerations

Achieving accreditation has been a goal throughout the development of the Boise program. Electrical Engineering was the first program to meet the minimum ABET requirements. The concept of a "virtual department," along with the use of identical admission and graduation requirements, suggest that the Boise program is truly a part of the established program and should therefore be reviewed for accreditation as part of the program in Moscow. However, the 500 km separation between programs, the potentially different experience in the first two years, and the possibility of a different mix of students (more non-traditional students in Boise), would indicate that a separate accreditation is appropriate. Discussions with various experts within ABET yielded different opinions. Considering the major political implications in failing a single unified accreditation inspection, a "safe" approach seeking separate accreditation was pursued.

While our model is to treat the Boise program as an integral part of the UI College of Engineering, and as such it enhances the strength of the entire college, the Boise program also needs to be strong enough on its own to be separately accreditable. The inspection visit for the EE program occurred in the fall of 1995, only two years after the program was fully funded. We feel confident that the outcome of the visit will be favorable. Visits for ME and CE will be requested for fall 1996 and fall 1997, respectively.

Conclusion

We have presented a model for delivering a high quality engineering education to students who do not reside on the "main" campus, a model that we feel is very innovative and cost effective. With more technology available every day, the concept of the "virtual department" is an idea that allows groups of geographically isolated colleagues to come together and form a faculty that is stronger than the individual parts. In states like Idaho, which are long on miles but short on funds and on faculty resources, the ideas

described here provide an efficient means for delivering education. We hope that our experiences can serve as a model for others with similar circumstances. Our solution may be one which will help solve the problem of proliferation of separate engineering colleges with their attendant high cost.

A program having most of the features of our program has been established in St. Louis by Washington University and the University of Missouri.[2] A similar cooperation for engineering and technology education was established in September 1995 by the New Jersey Institute of Technology and Burlington County College.[10]

Epilogue

Shortly after the proposal for this paper was accepted, the Idaho State Board of Education (SBOE) voted to reverse its affirmation of January 1995 to continue and expand the cooperative program. Instead, the current program will be terminated on June 30, 1996. It will be replaced with a separate engineering college that will be the exclusive domain of Boise State University, restricted to offering only Bachelors degrees in EE, ME, and CE.

Very few of the cooperative program's faculty or students will be part the exclusive Boise State University engineering college. Hence, the latter to some degree fits the model of a separately chartered engineering college beginning from scratch. Though it was definitely not the intent of the SBOE to provide an experimental basis for comparing time and costs required to build and operate each type of engineering college, such data will be available in a few years.

Acknowledgments

The Boise Cooperative Engineering Program is greatly indebted to the exceptional generosity of Hewlett-Packard Company, who supported the program's laboratories with more than two million dollars in instruments, workstations, personal computers and other hardware, and software. John Fluke Company, Intel Corporation, Idaho Power Company, and the local chapter of the Institute of Electrical and Electronics Engineers (IEEE) also assisted by donating equipment for the laboratories. These donations encouraged talented faculty to join the program and attracted capable, hardworking students. Initial funding, as mentioned in the paper, came from the Hewlett-Packard Company and Micron Technologies.

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