Video Resources for Instruction in Introductory Engineering Thermodynamics

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DUE-9254005
FY 1993 $ 105,984
FY 1994 $ 99,255
FY 1995 $ 10,000
Engineering

This project is producing a series of 11 videotapes for use in undergraduate instruction in introductory engineering thermodynamics. The tapes use a combination of live-action video to illustrate important applications of thermodynamics and computer-generated graphics to illustrate fundamental concepts. Historical background on important people and events in the development of thermodynamics also is presented. Topics covered in the programs include energy, heat and work concepts, thermodynamic properties and processes in gases, liquids and mixtures, energy transformations and First Law analysis of closed and open systems, reversibility and irreversibility, Second Law analysis and entropy, isentropic processes and component efficiency, Carnot and thermodynamic cycle performance, and principles and applications of various power and refrigeration cycles. The tapes are being used in several core thermodynamics courses at the University of Texas at Austin with a total enrollment of 800 students annually. They will also be made available for use in a pilot evaluation at five other universities, and subsequently will be distributed nationally on a low-cost basis. When used nationally, these materials could impact more than 25,000 engineering students per year in introductory thermodynamics courses.

Design of Electromechanical (Mechatronic) Systems: An Integrated Interdepartmental Curriculum

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DUE-9354403
FY 1994 $ 100,000
FY 1995 $ 10,000
Engineering

The principal goal of this project is to develop an innovative curriculum in Electromechanical (Mechatronic) System Design that integrates electrical, electronic, mechanical, and computational engineering by introducing videos and computers into the classroom and laboratory. The curriculum emphasizes the use of a variety of CAD tools in engineering design and analysis and provides a realistic setting in the laboratory that enables students to address design and experimental issues in engineering. This integrated curriculum cross-lists many relevant electrical engineering and mechanical engineering courses and develops a Motion Control in Electromechanical Systems Laboratory that exposes students to the electrical, electronic, mechanical, and computational aspects of motion control and hybrid-electric vehicles. Students electing this curriculum receive a certificate of study in Electromechanical System Design and complete their senior design projects using the facilities available in the laboratory. Through this curriculum, undergraduate students complete capstone design projects in electromechanical systems. The design projects are realized through open use of the laboratory and with the participation of industrial sponsors who assist in defining projects.

Development of Materials Synthesis Courses and Their Innovative National Dissemination

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DUE-9354440
FY 1994 $ 47,795
FY 1995 $ 45,000
Engineering

There is a national consensus, as shown in the National Academy's 1989 study on Materials Science and Engineering, that the U.S. lags behind its competitors in the field of materials synthesis and processing.

Over an 18-month period, this project is developing two new courses in the area of ceramic materials synthesis. The courses are at the senior level, but also could be used for beginning graduate students and in industry. To encourage adoption of the courses, distinguished scientists from around the world will teach the classes, whenever possible.

The use of the Video Tape Live Audio (VTLA) method makes both the content and the delivery system a national model. VTLA involves a course videotaped in a studio (with all backup in the parallel text and readings) followed by a weekly 1-hour audio-only tutorial by the same teacher/lecturer. The VTLA process allows a university to expand the student body served to the national cohort by working with sister departments. This approach is also significant for faculty enhancement in fields where there is an identified shortage of faculty with adequate training, a situation true of ceramics in general and ceramic materials synthesis in particular. The project begins with faculty at Pennsylvania State University and is augmented later with distinguished international leaders in related fields. The initial group of participating departments was between six and ten for the first course (Spring 1995). Solicitation is accomplished via mass mailings and announcements in professional journals. Evaluation involves both formative and summative mechanisms, and results from course evaluations by both students and faculty will be included in final reports.

Enhanced Curriculum for Undergraduate Engineering Adult Learners in Industry

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DUE-9455466
FY 1995 $319,940
Engineering

In 1988, the School of Engineering and Mines of the University of North Dakota, in a partnership with industry, established three distance-learning undergraduate engineering programs: Chemical Engineering; Mechanical Engineering; and Electrical Engineering. This initiative gave access to an engineering education to students who, because of locations and schedules, otherwise could not pursue an engineering undergraduate education.

The distance-learning students, by virtue of their maturity and paraprofessional experience, have needs, expectations, motivations, knowledge, and skills which differ from those of traditional students. Thus, the curricula must be modified to meet students' needs efficiently, incorporating their experiential knowledge and skills, while simultaneously ensuring validated

compliance with ABET accreditation standards. It is also critical that faculty develop strategies for attaining maximum teaching effectiveness in the distance-learning environment.

The three-year collaborative project addresses the following goals: complete a comparison of a broad range of cognitive and performance-based competencies of distance-education students and traditional students; enhance the curriculum to meet the unique needs of adult learners while adhering to ABET standards; develop faculty members' competencies needed to enhance teaching of non-traditional learners; evaluate program outcomes using qualitative and quantitative techniques; and disseminate results which document the evolution of an ABET accredited, undergraduate distance-learning program in engineering. The objectives are: (1) define what it means to be an engineer (focus groups, written questionnaires, and telephone interviews); (2) evaluate the current undergraduate engineering curriculum; (3) assess the competencies and knowledge base of distance-learners (problem solving/critical thinking, oral, written and listening communication skills, teamwork, computer literacy, research skills, self-directed learning, professional conduct, and flexibility); (4) determine gaps in the curriculum; (5) modify curriculum and design formal faculty development activities; and (6) continue to assess students' cognitive and performance outcomes (portfolios, interviews, written and oral assignments, and essay tests). Anticipated program outcomes include validation that the distance-learning program can effectively meet ABET accreditation requirements, evolution of enhanced techniques for measuring learning outcomes, and development of efficient and effective design and professional practice courses for distance learners.

Engineering, Technology and Culture: with an Emphasis on Race, Gender and the Individual

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DUE-9455422
FY 1995 $ 64,210
Engineering

The aim of this project is to make the social sciences and humanities more meaningful to engineering students, including women and underrepresented minorities. It is an effort to reform undergraduate engineering education by offering a unique interdisciplinary and multicultural diversity engineering course as part of the general education curriculum. The course, entitled "Technology and Culture", places specific engineering designs within the social and political context of race, gender and individuals. The course is designed to give technical students a better understanding of the cultural, historical and political context of their disciplines. At the same time it gives humanities and social science students a better understanding of the methods and capabilities of science and engineering. The project promotes new interdisciplinary teaching methods and encourages faculty to experiment with different ways of incorporating multicultural diversity and gender issues into their courses. It enlists the cooperation of faculty, departments and committees across the colleges of engineering and the liberal arts and sciences. It reinforces this cooperation through a series of faculty development workshops emphasizing cultural sensitivity training and interdisciplinary teaching methods. The project also serves as a catalyst for reform for the teaching of other courses that integrate engineering and science with disciplines in the humanities and the social sciences.

Enhancing the Environmental Content of Undergraduate Engineering Curricula

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DUE-9455399
FY 1995 $ 188,860
Engineering

This program introduces environmental issues into the curriculum of each traditional engineering discipline at Carnegie-Mellon University (CMU), focusing on the freshman and sophomore years. It enables students to gain exposure to environmental concerns and problem-solving methods in their discipline. Environmental units that can fit easily into several existing required courses are being developed, which form the basis for subsequent efforts focused on junior and senior-level courses as a follow-on to the current project. Throughout this effort, course materials that can be widely disseminated to other U.S. engineering colleges and universities are being developed. This approach is favored over the development of new or required environmental courses for several reasons. One is that modern engineering curricula already have a surfeit of competing demands for new or specialized courses; therefore, as a practical matter, it is difficult to introduce new requirements into the curriculum at most institutions. More importantly, however, environmental issues should not be seen as distinct from "mainstream" engineering issues. By integrating environmental considerations into basic engineering courses in each discipline, all engineering students will come to see that environmental factors are an inherent part of good engineering practice. Relatively small modifications in the curricula of existing core courses can have a significant impact on the environmental education of all engineers, not just those who choose to specialize in environmental engineering.

Undergraduate Curriculum Development on Mechatronic Systems Engineering

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DUE-9455395
FY 1995 $ 290,000
FY 1996 $ 113,280
FY 1997 $ 90,999
Engineering

The goal of this project is to satisfy an urgent need by industry for BS engineering graduates with multidisciplinary knowledge and skill in mechanical, electronic, computer and industrial and systems engineering. This need is becoming more urgent to the U.S. manufacturing industry than ever, due to the complexity of its products, and the global competition in marketing manufactured goods.

The aim is to develop an ABET accreditable curriculum stem on mechatronic systems engineering in the mechanical engineering department consisting of five new courses and a new Mechatronics Systems Laboratory. These courses are being adopted as electives by other participating departments of electrical, computer, general and industrial, and systems engineering. The Physics Department will use the laboratory for instructions on electronics and mechanical systems for lower division engineering students.

Two of the five new courses and the laboratory are being developed in the first of the three-year period. Faculty members from all participating departments are involved. The project is

expected to be completed in February 1998. An Advisory Committee chaired by a senior leader from the local mechatronic industry has been established to oversee the progress. Membership of that committee includes three other leaders from the same industry and administrators from the College of Engineering. A professional evaluator has been hired to evaluate the progress of the project on an annual basis.

Results will be disseminated through conferences on eng ineering education, publications in relevant journals, and conference proceedings. Faculty Enhancement Workshops on the subject development have been scheduled for the Spring 1996 and the Fall 1997. Course outlines, printed notes, and lab manuals will be made available to institutions that are identified as potential beneficiaries of this development. Selected case studies and lab procedures will be documented in CD-ROMs which can be distributed through electronic links to receiving institutions, or through the National Engineering Education Delivery System (NEEDS) of the NSF-SYSTHESIS Coalition. The mechatronics curriculum is developed on the following: (1) the fundamental principles of mechatronic technology; (2) the hands-on experience; and (3) the application of mechatronic technology to the industry in the region. Thus, this model will benefit universities and industries in other regions who seek to develop similar models. It is conceivable that institutions in the Michigan and Ohio area may intend to develop item (3) for the automotive industry. This curriculum development is a result of close cooperation with the mechatronic industry in the Silicon Valley. Support in planning, implementation and equipment donations have been received from major industries such as the Hewlett-Packard Company, the Storage Systems Division of IBM, Quantum Corporation and a major robot manufacturer, Adept Technology, Inc. The success of this project will result in major impacts on engineering education in this country, in particular mechanical engineering education. It will also make significant contributions to the manufacturing industry, especially those involved in high technologies.

New Engineering Statistics Course with a Virtual Computer Laboratory

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DUE-9455393
FY 1995 $ 100,600
Engineering

A new engineering statistics course with a virtual computer laboratory addresses the problem of offering a computer laboratory-based course in a university with large enrollments and few computer laboratories. The aim of this project is to design and implement an integrated classroom and laboratory experience for junior-level engineering students who can communicate with fellow classmates and instructors using electronic mail and file transfer software from their residence or place of work. Computer modem access is the only necessary student hardware. Statistical solutions to multidisciplinary engineering problems are created by student teams using statistical methods discussed over the university's existing communication network. The statistical laboratory materials being developed by various researchers are integrated into this virtual laboratory setting, thus making all results accessible to a larger audience. Classroom, laboratory, and course assessments, comparing this new course to a traditional engineering statistics course, offer educators the opportunity to evaluate the validity of this integrated course for their technical course offerings.

Aerospace Concepts for Elementary Education Majors

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DUE-9455346
FY 1995 $ 120,000
Engineering

There is a critical need to improve the quality of science instruction in elementary school classrooms. This project addresses this need by having College of Engineering faculty offer a course for elementary education majors that focuses on current engineering topics and, more importantly, presents material in such a way that future teachers will be able to use the material in their classrooms. This is accomplished by first introducing the scientific principles of an engineering topic, then providing instruction in an appropriate teaching method, and finally completing the topic with a laboratory session that involves projects that can be used in an elementary classroom. The course is being developed by engineering and education faculty in collaboration with elementary school teachers. Each topic is being offered as a module to facilitate portability to the elementary classroom and to allow offering the course for either one, two, or three credit hours. Preservice elementary majors are being targeted although the course is suitable for inservice teachers and could be easily tailored to accommodate middle-school participants. The PIs are collaborating with College of Education faculty to overlap this course with their existing science teaching methods course. It is anticipated that participants will be more confident with science topics and, using this material, will be able to teach science more effectively. Dissemination of the developed materials will occur via presentation at professional meetings within the state and nationally. In addition, a textbook is being created to accompany the course. The effectiveness of the course will be evaluated by interviewing participants and College of Education faculty.

Washington State Manufacturing Technology Standards, Competencies and Curriculum Development

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DUE-9453739
FY 1994 $ 429,680
Engineering

South Seattle Community College, Boeing Company, Eldec Corporation, Clover Park Technical College and 12 other organizations are developing a process for determining specific workplace standards for manufacturing education and training in Washington State. These standards will, in turn, lead to an industry-guided manufacturing technology core curriculum. The curriculum will begin in high schools and will feed into a 2+2 Tech Prep post-secondary community college program. A workplace-based internship will also be an integral part of the curriculum. This comprehensive, innovative project has strong support from both labor unions and industry. It will help bridge the gap between secondary school technical education and the requirements of the industrial workforce.

Development of an Interdisciplinary Curriculum in Electronic Materials and Devices: Cooking Without Recipes

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DUE-9551520
FY 1995 $ 224,000
Engineering(LLD)

An undergraduate engineer is expected to possess a wide variety of skills and knowledge beyond the fundamental engineering content of his or her course work. The need for improvement of student skills in communication, problem solving, integration of knowledge and teamwork is commonly understood. Some of this need can be met by a change in the techniques used in the teaching of laboratory courses. The traditional method of laboratory instruction frequently degenerates into a "cookbook" method, a mode in which students follow a "recipe" for experimentation from their lab book. Such exercises do not teach students to conduct an independent scientific experiment, or to record and communicate to others the information obtained during the course of an experiment. The "cookbook" method also fails to teach students to derive information explicitly from measured parameters or to properly apply statistics. In short, most laboratory instruction does not contribute to the development of the student as a critical thinker. One solution to this problem is to abandon the "cookbook" in favor of a sequence of team-oriented, open-ended laboratory experiences. In this mode of laboratory instruction, students are given a problem, trained to use the experimental apparatus, and taught the fundamental concepts necessary for understanding the problem. They are required to design the experiments and analyze the data without recourse to recipes. Since it is believed that these skills cannot be taught in a single course of instruction, the objective of this project is to develop independent exercises for introducing experimental design skills into two prerequisite classes on semiconductor devices and electronic properties (MatE 153 and EE 128), followed by an interdisciplinary, team-oriented design course in semiconductor process engineering (EE/MatE 129). The latter course will simulate the engineering roles of industry, where interdisciplinary teams are the rule, and open-ended experimentation is a fact of life.

Publishing Conference Proceedings on Mosaic

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DUE-9552585
FY 1995 $ 12,000
Engineering

The Institute of Electrical and Electronic Engineers' (IEEE) Educati on Society and Computer Society and the American Society for Engineering Education's (ASEE) Educational Research and Methods Division (ERM) are producing the proceedings of the 1995 Frontiers in Education (FIE) Conference in electronic format for distribution via World Wide Web, CD-ROM and conventional computer disk. The FIE conference represents a major forum for dissemination of curricular innovations in engineering education, including many projects developed with NSF support. Additional co-sponsors in this activity include SONY Corporation, Purdue University, and the Illinois-Indiana Section of ASEE.

Course and Curriculum Development: Integrating Pre-Engineering Curriculum

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DUE-9455566
FY 1995 $ 75,000
Engineering

This project focuses on developing a year-long, team-taught pre-engineering program titled "Math and Physics: Tools for Careers in Engineering." The program emphasizes students working collaboratively to apply concepts taught in physics and mathematics to the kinds of problems encountered in the engineering profession. The planning and integration of an interactive physics and calculus laboratory into the curriculum is addressed.

By scheduling a daily three-hour block, the three faculty members in physics, calculus and engineering integrate their coursework in a two-quarter sequence which provides students with 10 credits in calculus, 5 in engineering physics and 9 in engineering problems, statics and circuits. The program is structured to accommodate students who need remediation in particular skills with learning assistance. It also is designed to create a classroom climate that promotes the pursuit of careers in science and engineering among women and underrepresented minorities.

To bring such a significant change to the curriculum, the three faculty investigators are devoting time to curriculum research during the first of the two-year project. They are consulting with two faculty experienced in developing an interdisciplinary program in science and engineering at the Evergreen State College, Olympia, WA; conferring with Professor Denny Davis at Washington State University, who developed a large-scale engineering curriculum project with DUE support; and visiting model interdisciplinary programs in science and engineering being developed at other institutions. In developing collaborative, small group approaches to instruction, they are guided by the expertise of the Washington Center for Improving the Quality of Undergraduate Education, a consortium of 42 colleges and universities that focus on learning communities as a means of reforming the undergraduate curriculum.

Dissemination of Results from NSF-Supported Engineering Education Projects

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DUE-9452911
FY 1995 $ 49,808
Engineering

The American Society for Engineering Education (ASEE) is publishing the results of NSF/DUE-sponsored research and innovation in engineering education in ASEE's *Journal of Engineering Education*, The Institute of Electrical and Electronics Engineers' (IEEE) journal, *Transactions on Education*, and other appropriate learned journals. In keeping with the scholarly spirit of these journals, funding from NSF will assure valuable dissemination of the results of NSF-funded research. Thus, findings from NSF-funded research by principal investigators in the field of engineering education would be assured of the broadest possible dissemination in scholarly journals dedicated to expanding the body of knowledge that supports engineering educators nationwide.

An Advanced Undergraduate Laboratory for Microfabrication

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DUE-9551869
FY 1995 $ 217,273
Engineering(LLD)

This project is for the development of a laboratory-based undergraduate course in general microfabrication techniques and processes. Microfabrication was originally developed by the microelectronics industry to batch-fabricate miniature integrated circuits. Only recently has it been applied to other fields and disciplines. The slow infiltration of microfabrication technology into the non-electronic disciplines is due to the fact that microelectronic fabrication techniques have traditionally been taught only to graduate electrical engineering students or undergraduate students specifically studying microelectronic devices. In order for non-electronic interdisciplinary applications of microfabrication to be developed, an appropriate transfer of this technology to the interested audience needs to take place. The laboratory course being developed serves as that missing link by introducing this versatile and powerful technology to a broader audience base. Microfabrication can do for the mechanical and physical world what microelectronic fabrication did for the electronic world. The world of microfabrication has tremendous potential, and numerous applications to a wide spectrum of disciplines are possible. However, the majority of those applications will never be realized unless microfabrication is exposed to a broader audience and introduced earlier into the academic curriculum.

Development of a CD-ROM Based Multimedia Teaching Package for Introductory Materials Science and Engineering

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DUE-9455333
FY 1995 $ 100,000
FY 1996 $ 100,000
FY 1997 $ 93,000
Engineering

In a typical classroom environment, most of the time is spent in transferring information from a professor to a group of students, i.e., in a lecture format. In spite of the fact that it is well known that much more learning occurs when students are actively engaged in a discussion, as in the Socratic method, the lecture has been found necessary. This is because most students are either unable or disinclined to gain the "entry-level" information on their own from printed matter, in preparation for a tutorial type of classroom experience. This three-year program is developing a CD-ROM-based multimedia package for the teaching of an introductory course in materials science and engineering. This package will serve most of the purposes of the lectures in a traditional course so that the classroom time can be devoted to the activities normally carried out in tutorial or recitation sessions. The motivation for this is the substantially higher teaching effectiveness of such sessions, compared to traditional lectures. The package is being built around animations created with Multimedia Director and ancillary programs and video segments showing excerpts from videotaped laboratory experiments created in a separate project, as well as videotaped lecture demonstrations. The techniques necessary for the creation of the animations and

for computer-based editing of videotapes have been developed at the University during the past year, and the equipment and software necessary for this are already available. The first two years of the project are devoted mainly to creation of animations and video segments and to evaluating them by classroom use. As the materials are developed they are being used in the classroom and independently by students at the University and are being exported to other institutions via CD-ROM for their use and evaluation. The continuous feedback from this use is being factored into the ongoing creation of new material, so that final adjustments and modifications can be made during the period of the project. The teaching package is based on a new textbook, which is part of the development of a new approach to the subject. This is a departure from the traditional type of course in that it reorganizes the subject into two large case studies, one on structural materials, using the bicycle, and the other on device materials, using the Walkman. Experience has shown this to be more effective that the traditional method in an introductory course, especially for non-majors in materials science and engineering. It is anticipated that the development of this teaching package is enabling the subject to be taught in a variety of institutions currently not equipped to offer it in the traditional manner. In addition, this package should serve as a model for the development of similar packages for other subject areas.

Interactive Tutorial for Engineering Mathematics with Applications in Electrical and Computer Engineering

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DUE-9156103
FY 1992 $ 86,727
FY 1993 $ 88,154
FY 1995 $ 19,575
Engineering

This project develops and tests tutorial software which demonstrates basic topics of engineering mathematics necessary for entry level engineering courses. It also provides demonstrations of typical engineering applications. This tutorial software helps students understand and use these mathematical concepts in their engineering courses. The software is developed for terminals or workstations using XWindows and should be easily portable to many universities. The software is designed for low overhead use with no knowledge of programming languages, operating systems, or database structures required of the user. The first electrical circuits course is being used to evaluate the effectiveness of the tutorial software, and results of the evaluation will be used to improve the design and content of the system. The feasibility of using stored video recordings of real experiments for use with computer generated visualizations is being explored. The structure of the tutorial software is being documented so that others can add modules to the system. Distribution of the software will be handled by the Office of Continuing Education at Santa Clara University and through Sun Microsystems' Catalyst Education Program.

Freshman Laboratory for Product and Process Engineering

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DUE-9550927
FY 1995 $ 200,000
Engineering(LLD)

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A Product and Process Engineering Laboratory has been established for freshman engineering students. The purpose of the Laboratory is to bring students together in teams of three in order to explore fully-operative, familiar devices (e.g., videocamera, videocassette recorder, photocopier, bar code scanner) by playing the successive roles of user, assembler, and engineer analyst. The lab places emphasis on a "hands-on" approach to each device and on working in teams. Results from pilot offerings in Summer 1993 (12 students) and 1994 (18 students) indicate that this method creates an atmosphere in which students teach each other effectively, and in which women and minorities feel very comfortable and receive a positive and inclusive introduction to engineering. The objective of the project is the demonstration of a cost- efficient manpower design and scale-up of this novel freshman laboratory to handle a full cohort of up to 216 students per year for two years. Three 24-student sections/semester are offered in 1995-96 and five sections/semester in 1996-97. The method of laboratory execution involves roles for students, undergraduate and graduate teaching assistants, and the faculty director. The students, working in teams of three, examine each of six devices or processes. The senior undergraduates provide lab assistance and are selected so that they serve as role models for women and minority freshmen. The graduate teaching assistant (one per section) has general instruction and lab maintenance responsibilities for each section, and serves as back-up technical consultant to the seniors. The faculty leader provides an initial week of hands-on training of seniors and graduate assistants with the lab devices prior to each semester, leads the student discussion sections on outside readings, and maintains oversight of the laboratory operations. The project is significant because it provides an immediate "hands-on" introduction to engineering to freshman students in a manner which includes teamwork, oral communication and presentation skills, and is conducive to the recruitment and retention of underrepresented groups.

1995 National Engineering Faculty Forum: An Interactive Teleconference Series to Share Best Practices in Undergraduate Engineering Education

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DUE-9550462
FY 1995 $ 117,000
Engineering

Sharing and communicating the "best practices" in undergraduate engineering education is the goal of the project. Undergraduate college engineering educators are the targeted audience. College educators sometimes operate and teach in relative isolation, interacting with each other once or twice a year and usually on a research topic rather than educational practices. This project addresses the need for engineering educators to interact specifically to gain the tools and techniques necessary to provide the engineering student the highest teaching standards available, no matter where the educational institution is located. Each telecast features an innovative "best practice" that can be adapted by a participant. The extensive experience and facilities of the National Technological University (NTU) are being applied to this project. Virtually all of the 11 years of NTU's history has focused on providing for the graduate and continuing education needs of today's busy engineers, scientists and managers.

The Division of Undergraduate Education (DUE) staff is working with the NTU staff to identify topics and presenters. Key teachers from the NTU network and nationally recognized

experts and educators are being invited to present. Dr. Lionel V. Baldwin, President of NTU and Project Director, review the potential topics and speakers and consult with the DUE staff to make final decisions. The result is a plan for eight one-hour interactive telecasts offered on the third Tuesday of each month, starting in March, 1995, scheduled from 4-5pm ET. The telecasts are delivered on both C-band analog and Ku-band compressed digital video. This dual method allows for the most successful receiving options nationwide.

Each registered site receives a set of reproducible notes with references for more in-depth study when appropriate.

Several new marketing initiatives are being implemented. In addition to direct mailings, advertisements are placed in appropriate magazines and the series is described in the NTU Internet server on Gopher and the World Wide Web.

NTU considers the quality of the experience as evaluated by the participants a critical benchmark. NTU is developing the evaluation form using a faculty focus group to assure relevance and simplicity. NTU provides summary data after each telecast and a final report.

Curriculum Development - Manufacturing Systems

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DUE-9455764
FY 1995 $ 169,585
Engineering

This project is Phase II of a two-phase project to develop a two-course sequence in Manufacturing Systems. The sequence is serving as a model for manufacturing systems nationally. The project involves the New Jersey Institute of Technology (NJIT) as the lead institution for the North/Central Educational Technology Educational Consortium and Camden County College as lead institution for the Southern CIM Technology Consortium. The consortia operate fully articulated programs aimed at the AAS and BSET degree in Manufacturing Engineering Technology. The consortia involve all community colleges in New Jersey, thirteen in the Northern Consortium and six in the Southern Consortium. Articulated curricula of the two consortia include a two-course sequence in Manufacturing Systems. The sequence is critical to the success of the program. Significant deviations in course content and emphasis amongst the consortial colleges have been noted. This project involves faculty from the consortial colleges in development of model curricula and training modules for the Manufacturing Systems sequence. It also identifies possibilities for sharing of laboratory resources in support of the model. The first phase of the project, which involved soliciting input from the manufacturing sector on required skills which should be attained from the sequence, is complete. It also involved the development of the model curricula and training modules for the first course in the sequence, Manufacturing Systems I (Introduction to Manufacturing Systems). Draft copies of the first modules have been distributed to consortial colleges and were also distributed at the NSF Project IMPACT Conference held in June 1994 in Washington, DC. The second phase of the project involves the development of model curricula and training modules for the second course in the sequence, Manufacturing System II (Advanced Manufacturing Systems). It also involves identification of laboratory resources throughout the consortia and procedures for arranging use in support of the model. Pre-publication editing, printing, and distribution of the final products are also included in this second phase.

Multimedia in Manufacturing Education—MIME

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DUE-9453883
FY 1994 $ 599,603
Engineering

Traditional classroom-based engineering education is often inadequate in preparing students for the complete process of manufacturing—the cycle of design, engineering, production, marketing, and delivery of goods. Some shortcomings include: restricted access to manufacturing experts because of the high cost of bringing them to the classroom; curriculum demands that do not permit the inclusion of rapidly emerging issues of vital importance to manufacturing; and few opportunities to experience or participate in an actual manufacturing process while in school.

MIME addresses these shortcomings through rapid development and deployment of a technology-enabled curriculum. Advanced media technologies are being exploited to create virtual, time shifted, and/or remote visits to real-world manufacturing systems. These efforts are based on the belief that learning is a constructive process in which the learner builds a personal representation of the world around him or her. The project uses technology to create greater opportunities for students to experience the real context of manufacturing systems and thus encourages the transfer and connection of classroom-based instruction to the real world.

The project is centered on three main activities: (1) creation of a manufacturing-focused multimedia development resource; (2) rapid infusion of educational technology into the manufacturing curriculum; and (3) production and dissemination of interactive courseware. Industry will be actively involved in all phases of the project through existing partnerships at the Georgia Institute of Technology. Initially, MIME is targeting students returning to Georgia Tech to pursue a new degree program in product realization. The PI's intent is to produce materials which can be easily adapted to needs of industry as well.

Detailed classroom experimentation and revision are used to evaluate the learning and cost effectiveness of the materials. MIME represents one of the first attempts to apply interactive educational technology across a complete multidisciplinary engineering curriculum. Since the project focuses entirely on software-based learning modules, all materials generated can be made available for public use via the Internet. The final products also will be distributed through existing publishing channels. Finally, results will be shared through technical conferences and appropriate publications.

SILICON RUN I.2 - An Educational Film on the Manufacturing Process of Integrated Circuits for Undergraduate and Adult Education

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Engineering

Integrated circuits and the computers they drive are an integral part of modern electronics. The continuous introduction of faster, more powerful computers is increasing the demand for a highly skilled workforce and an educated public. Increasing an understanding of manufacturing in the semiconductor and computer industry is an educational challenge, which is greatly enhanced by

the use of visual images. Field trips to manufacturing sites are, unfortunately, not available to students and educators outside of industrial regions. When tours are possible, industry's clean room restrictions allow viewing only from a distance and through glass windows.

The SILICON RUN two-part film series takes its viewers through these windows and allows them to visually experience the beauty and ingenuity of manufacturing. Step by step, using live footage, closeups, animation, and special effects, the two films provide a clear overview of complex processes in semiconductor and computer manufacturing. SILICON RUN I, produced in 1986, explores crystal growth through IC wafer fabrication. SILICON RUN II, produced in 1993, continues with testing and packaging, through system assembly.

The new production, SILICON RUN I.2, updates the first film of the series so it reflects the technological changes of the past decade. With non-profit sponsorship from the Film Arts Foundation and the collaboration of Stanford University's Electrical Engineering Department, the goal is to re-film the industrial manufacturing footage so the series can continue providing viable information about today's manufacturing.

The series is used for education and training—thousands of students in universities, colleges, technical schools and industrial training programs view these films every year. SILICON RUN I.2 will be disseminated to its present users, which include the membership of the National Electrical Engineering Department Head Association. Dissemination goals are to distribute to the following departments: Electrical and Computer Engineering, Manufacturing Engineering, Engineering Technology, Electronics Technology, Industrial Technology, Computer Technology, Computer Science, and Physics and Science Departments.

Hands-On Engineering Homework: A New Approach to Out-of Class Learning

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Engineering

This project pioneers a new way to provide experimental complements to theoretical courses. The goal is to train students to use what they learn to examine all that they see and as a result, to question. The fundamental idea is to create a suite of simple experiments which can be done in the home and assigned like homework problems. Such simple, but elegant experiments, are dubbed Hands-On-Homework (HOH) which encourages students to use engineering theory to explain everyday phenomena, and to compare their observations to theoretical prediction; provides open-ended opportunities to explore engineering questions using readily available materials and familiar experiences; trains students to conduct "reality checks" and naturally apply theoretical analysis to experimental observations; and provides continuous opportunities for students to empirically explore engineering questions throughout their college careers and develop habits contributing to life-long learning. This project is tied to curriculum changes planned for the new Integrated Teaching Laboratory. Hands-On-Homework is liberally sprinkled throughout the entire curriculum, primarily in the first three years, including introductory mathematics and physics courses. Initial disciplinary courses such as statics, dynamics, thermodynamics, and circuits benefit, as well as more advanced courses such as fluid mechanics, heat transfer, control theory, or materials. HOH problems are piloted in two courses while doing an outreach to identify further courses. Evaluation is done by holding consensus groups during the semester and comparing

performance of students with and without HOH. Results will be presented at meetings and reviews. Ultimately, a user's guide will be produced containing all the Hands-On-Homeworks as well as the performance evaluations. Because HOHs are low-cost, they can be easily replicated and the results of the project widely exported.

An Innovative Course on Elements of Manufacturing Systems for Non-Engineering Students

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Engineering

This project involves the design, development, and implementation of an introductory course on manufacturing systems for non-engineering students. In this project, innovative teaching and learning styles suitable for teaching manufacturing concepts are identified and incorporated in the course to motivate students to learn, understand, and appreciate the role of manufacturing in today's society, its impact on the economy, and its career potential. This course builds on the background and skills of first- and second-year university students, to give them a better understanding of the value of basic courses in mathematics, physics, and chemistry, in learning engineering concepts. It also introduces non-engineering students, especially women and underrepresented minorities, to manufacturing in a non-intimidating manner. It is hoped that this exposure will strengthen their confidence, dispel their fear of technology, and motivate them to choose an engineering career.

A preliminary study conducted through pilot sections of the course offered at Northern Illinois University during Spring and Fall 1994 to assess the need for this course and its potential benefits resulted in positive outcomes and gave the impetus for developing this course fully. The project methodology involves the identification of manufacturing life cycle concepts suitable for this course and its target audience, and the design and development of course activities, lesson plans, laboratory experiments, and instructional aids that accommodate different teaching and learning styles so that the course material can be conveyed effectively to a non-engineering student population. The progress of the project is evaluated by a team consisting of members from academia, including the Director of Diversity for the College of Engineering and Engineering Technology at Northern Illinois University and faculty from education, physics, and curriculum and instruction, and the manufacturing industry.

The course material developed for this project, the teaching and learning techniques that are used in conveying the material to students, and the results of the study are of great value to educators everywhere interested in offering similar courses to non-engineering students. The developed course gives students the motivation and the reason for learning basic mathematics and science topics and dispels their fear of science and engineering courses. The emphasis placed on teaching and learning styles also helps students to understand their own preferred learning styles and improve their performance. This course also serves as a vehicle for non-engineering students to experience and explore what engineering has to offer without actually joining an engineering program and see for themselves if they can be successful in an engineering career.