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ABSTRACT

The Master's Degree Program in Cybernetic Systems was proposed a decade ago as an interdisciplinary problem-solving oriented educational effort. Implemented seven years ago, it has developed into a successful continuing education vehicle for mid-career professionals. Those proposing the program recognized that without guidelines to follow, it must be developed using feedback gained from students, faculty, and professionals. As presently offered, the program is flexible and open-ended in terms of electives and theses topics. Graduates have developed emphases in a wide range of subject matter and have applied their newly learned tools to improve their current situations or to redirect their careers. Out of the 100 graduates, about 30 have engineering backgrounds. Some of the coursework is delivered over instructional television (ITV) via the Association for Continuing Education (ACE) and the Stanford ITV Network. It is anticipated that ACE will assume a regional leadership role in the certification and recertification of professionals. It is believed that the concepts of the cybernetic systems program will be extended to levels of education both below and above that of the current master's level. (LS)

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THE DEVELOPMENT OF A CONTINUING EDUCATION PROGRAM

for

MID-CAREER PROFESSIONALS

by

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Abstract

The Master's Degree Program in Cybernetic Systems, now seven years old, has proven to be an effective continuing education vehicle for professionals of diverse backgrounds of education and experience. Based on tools from cybernetics, systems and computers, the flexible program is especially attractive to mid-career engineers. The more than 30 graduates with engineering education backgrounds have gained new tools with which to attack complex problems whether in their current job or in planned redirection of their careers. With few guidelines to follow, the program has been developed in phases with a constant use of feedback from faculty, students and area professionals in making adjustments to courses and sequences. To meet changing needs, some coursework is offered at off-campus sites and over the Stanford/ACE ITV Network. Even though well accepted by students and area professionals, tradition-bound institutional administrators and committees have been skeptical of the innovative program. The next phases of development anticipate extending the basic concepts to both the undergraduate level and the doctorate level, the latter in the area of "systems studies" to be offered jointly with a senior institution.

Presented at the Annual Meeting of the American Society for Engineering Education, Ft. Collins, Colorado, June 18, 1975.

INTRODUCTION

Complex societal problems require unique interdisciplinary problem solving efforts. Teams made up of individuals having backgrounds of education and experience in the disciplines pertinent to the problem at hand but sharing a common language and set of problem solving tools must be formed. Lip service is given to this need for interdisciplinary effort but attempts to provide educational opportunity often are hampered in discipline oriented educational environments.

The Master's Degree Program in Cybernetic Systems of San Jose State University, proposed a decade ago and now seven years old, provides a case study in lessons learned when proposing unorthodox curricula and achievements that can be realized with the help of understanding faculty, receptive students, and off-campus supporters. Of special interest is the opportunity the Program has provided the mid-career professionals, especially engineers, to develop new problem solving tools and thus new career paths.

This paper reviews the proposal of the mid-60's, the development from 1968 to date, the program of 1975-76, and its success as a continuing education vehicle with some of the coursework offered off-campus and over ITV. Projections are made of its future which includes an expanded ITV delivery and extension of its concepts to both undergraduate and doctoral levels.

THE VISION OF THE 1960's

The introductory paragraph of a paper delivered in 1965 expressed the concern of a few engineering faculty of San Jose State University. This paragraph bears repeating. "The impact of technology on the social, political, economic, and moral structure is evident from the increasing use of such terms as 'automation', 'the computer revolution', 'cybernation', 'man-machine morality', and the 'technological society'. These describe areas of concern and challenge which demand new educational patterns in engineering as well as other disciplines."[1]

In considering the above, questions such as "is full employment achievable in an automated society?", "what about developing nations and advancing technology?", and "how do we get people together to attack such complexities from a base of common language and problem solving tools?", were paramount. There were conflicts of views, an absence of answers, and a lack of direction a decade ago. Few would say that the situation has improved since.

The projections of Donald N. Michael in his booklet, "Cybernation: The Silent Conquest", seemed to be especially perceptive.[2] Based on the foresight of Michael and others, a single course entitled Cybernation and Man was started in 1964. With the experience of developing and offering the course as a foundation, integrated baccalaureate and master's degree programs to be called Cybernetic Systems were designed and proposed to the institution. The intent was to bring disparate disciplines together through the languages of cybernetics, computers and systems, and have them work as teams on complex problems.

In terms of the intended breadth of the Program, the title Cybernetic Systems seemed appropriate. To Norbert Wiener of MIT who coined the word, cybernetics was the science of communication and control, whether applied to the living world or to the inanimate machine. In his writings, he used the term cybernetic systems to describe situations ranging from the simple feedback relationship existing between he and his secretary during dictation or to the most complex social or technical systems. "Systems", long in the domain of the engineer, were understood to be made up of components having individual attributes with all system components interrelated and each having effects on other components.

If the interest and support of students and faculty from non-quantitative based disciplines was to be gained, titles such as "systems engineering", "operations research", "systems analysis", "information science", "systems science", etc., had to be avoided. Everyone had to be able to relate their interests and background to the title. People from the soft sciences and the arts had to be accepted as equals to those from mathematically based sciences, with opportunity provided the former for attainment of a reasonable level of mathematical awareness. The breadth inferred by the words Cybernetic Systems made it a logical title, even though it existed nowhere else in higher education. As learned in the process of proposal, implementation, and survival, it is much easier to copy than to be unique.

FROM PROPOSAL TO IMPLEMENTATION, 1965-68

Cybernetic Systems as a concept with potential for all was introduced to the campus in 1965 and those with interest were invited to join the initial cadre. There was some understanding and support, but by and large administrators and faculty tended to draw their discipline based wagon trains into tighter circles. Students and off-campus professionals gained an appreciation for the concept and kept pressing faculty to take that one more step.

School of Engineering faculty were largely skeptical, contending that any systems based educational program should require all participants to have had courses such as differential equations. Fortunately, the proposal was identified as interdisciplinary and if approved was to be administratively housed other than in Engineering; thus, the Program did not fall under the control of an engineering curriculum committee.

Support from professionals of the high-technology community surrounding San Jose State University began developing and a number of meetings to include an industry sponsored luncheon for the skeptics were held. Through persistent effort, the proposal was finally permitted to be forwarded to the Office of the Chancellor and the Trustees.

Chancellor's Office personnel were receptive to the Master's Degree aspect of the proposal but rejected the undergraduate level on the basis that further fragmentation of proliferating disciplines was unwise. The advocates counterargument that the concepts of cybernetic systems would in the long view tend to bring disciplines together and discourage continuing fragmentation didn't prevail.

The presence on the Board of Trustees of Dr. Simon Ramo, internationally respected engineer and industrialist, was a key factor in finally gaining approval. Based on the awareness of the power of the systems approach in attacking complexity, as expressed in his book " Cure for Chaos",[3] he understood the intended thrust of the proposal and recommended approval to his Trustee associates. But then, even though approved for implementation in 1968, local administrators and committees wanted to delay until 1970 in order to gain more time for study. Pressure of students and faculty brought the implementation back to the 1968 date.

PROGRAM DEVELOPMENT, 1968-1975

Those proposing the Program recognized that without guidelines to follow, it would have to be developed in phases, always using feedback gained from students, faculty, and professionals in constant revision of courses and sequences. There were books written for courses in systems engineering, operations research, and information science but practically all assumed a highly mathematical stance and assumed the users to be of a common mold in terms of backgrounds and objectives. In practically all courses of the Program, portions of a number of textbooks as well as up-to-date articles from journals and proceedings had to be used. The situation still exists, although there are a growing number of texts appropriate to the interdisciplinary nature of the Program.

Faculty teaching in the Program have been and are intentionally drawn from diverse discipline and experience backgrounds from both on

and off campus. These individuals bring to courses their own versions of cybernetic systems and this has provided invaluable input. There was no intent to have full-time faculty assigned to the Program; it was believed that joint appointments would provide for more flexibility. Meshing the efforts of the 30 or more individuals who teach fractional loads either steadily or intermittently in the Program is an obvious but productive challenge.

The richest source of ideas has been the student group involved. Most are in their thirties, with ages ranging from 25 through 60. Three-fourths are concurrently employed in area high technology enterprise. A third have backgrounds in engineering, mathematics, or science. A fifth come from business curriculum backgrounds and the remainder from the total remaining spectrum of disciplines. Ideas for course revisions and new courses are proposed each semester and are welcomed and in many instances implemented the next semester.

The Program of 1975 as shown in the figure is somewhat different than that proposed in 1968, but is still based on the original concept of developing among problem solvers a common language based on cybernetics, systems and computers such that better attacks on complexity can be mounted. The Program recognizes that social, biological, and physical systems may be treated analogously. A health-care system, the human nervous system, and a complex natural or man-made environmental system should be able to be treated the same way in terms of objectivity and analytical thought. These are all cybernetic (feedback) systems and involve input, output, sensors and feedback. The same mental skills are essential to the analysis and synthesis of each.

SAN JOSE STATE UNIVERSITY
MASTER'S DEGREE PROGRAM IN CYBERNETIC SYSTEMS
(1975-76)

A.B. or B.S. DEGREE IN ANY DISCIPLINE

From Non-math Backgrounds

Tools Prerequisite* to System Dynamics

- 5-Cptr Sci Fndmtls (3)
- 110-Quantitative Think'g (2)
- 111-Mathematical Analys (2)
- 112-Stat Sys Modeling (2)

1st and/or 2nd Sem: * (or) 200 — 210 — 212

3rd Sem: 214

4th Sem: 220 — 230

CORE COURSES - 15 Units

- 200-Technological Society (2)
- 210-Sys Appr and Team Actn (3)
- 212-System Dynamics (3)
- 214-System Simulation (3)
- 220-Appl of Sys Technqs (2)
- 230-Systems Seminar (2)

ELECTIVES - 12 Units **

- 204-Futures Studies
- 206-Technology Assessment
- 208-Technology Transfer
- 211-General Systs Theory
- 216-Information Mngmnt
- 218-Telecomms as Soc Systs
- 225-Advanced Systs Methods
- 240-Behavioral Cybernetics
- 245-Biocybernetics
- 250-Educnl Cybernetics
- 260-Environl Cybernetics
- 270-Soc-Econ Cybernetics
- 280-Organizational Cybernetics
- 290-Spec Topics in Cybernetics

From Math *** Backgrounds

1st Sem: 200 — 210 — 212

2nd Sem: 214

3rd Sem: 220 — 230

Defense of Thesis (3 units) and Comprehensive Oral Examination

MASTER's DEGREE - 30 Units

* Courses necessary depend upon individual backgrounds.
** May also be totally out of Cyb Sys Program.
*** Full-time student can complete in one year.

THE PROGRAM OF 1975-76

As of the fall of 1975, the 30 semester unit Program will consist of a core of 15 units, 12 units of electives of the student's choice; and a three-unit thesis. The first two core courses, The Technological Society and The Systems Approach and Team Action, are non-quantitative in nature and emphasize the philosophy and methodology of systems thinking. This permits the student lacking a quantitative preparation time to get involved in the program and to take one, two, or all three of the especially designed mathematics courses in preparation for the next core courses. These are of a quantitative nature and are entitled System Dynamics and System Simulation. The special mathematics courses do not earn degree credit for Cybernetic Systems majors and are applications oriented, a feature which is drawing an increasing number of enrollees from other majors, both undergraduate and graduate, who take them as electives. Individuals completing these courses obviously won't have the quantitative skills of the engineering or mathematics major but will know the relevance of the quantitative tools being used and can work comfortably along with a team involved in simulation or decision analysis studies. The fifth and sixth courses of the core, Applications of Systems Techniques and Systems Seminar, continue the practice of team work begun in the first core courses and involve larger and more complex problems.

Wiener called cybernetics the "cement of society" and it is within this context that the Program is intentionally open-ended and flexible. With the concepts of cybernetics and systems as a foundation, the real significance to the individual student lies largely in the design of a

meaningful elective pattern made up of courses either from Cybernetic Systems or elsewhere and a compatible thesis. Students are urged to select real-world problems of a futures-oriented nature for their theses and to apply systems tools in attempted solutions. Encouragement is given students to associate coursework and theses with business, industry, education, and government and, if possible, to write theses on problems present or lying on the horizon of specific organizations. Coordinated theses efforts of two or more students are encouraged.

Program elective courses have been developed in Futures Studies, Technology Transfer, Technology Assessment, Telecommunications as Social Systems, General Systems Theory, Biocybernetics, Behavioral-Cybernetics, and Advanced Systems Methods. There is a special topics course in which cybernetic principles are applied to current problems; typical one-time offerings have been The Low Energy Society, Strategic Futures Planning: Energy, and Technical Invention Processes, all offered live over the Stanford/ACE ITV Network. With the failure of traditional departments to recognize the subject matters as valid areas of inquiry for students and faculty, courses in the areas of parapsychology and Kelso's Two-Factor Theory economics[4] may be offered in 1975-76. In order to cover the full range of student interests, courses are offered in the areas of educational, environmental, socio-economic, and organizational systems, all with the word cybernetics as a suffix.

Full advantage is taken of the varied backgrounds of interest and expertise of the mature students in the development of new courses and the improvement of existing ones. An instructor can never assume that

s/he is "the" expert in any course because within the student group there is always one or more mature students who has experience or is very well read in the area. For most courses, the title "facilitator" is more appropriate than that of instructor. Graduates of the Program have in many cases proven to be the better instructors of courses taken but one or two semesters previously because they have a better awareness of the student mix and the objectives of the program. Further, they recognize that it can never be assumed that the individual from a highly quantitative background is better able to understand and interpret complexity than the person from the humanities and arts — too often the reverse is true with the latter taking the constructive and creative leadership.

To date, approximately 100 master's degrees have been awarded. Theses have been written on problems requiring graduate level mathematics as well as those of a non-quantitative nature having to do with such things as improving communications within a large and complex organization. The important and common requirement is that all theses must use concepts emphasized in the core in an attempted solution of a complex and futures oriented problem.

CRITICISM OF THE PROGRAM

Despite the acceptance of the Program by students, supporting faculty, graduates, high technology enterprise and government, and the success of graduates in changing career directions and getting jobs, institutional administrators and some faculty and committees still maintain a skeptical

attitude. Issues raised by this year's University Graduate Studies Committee, and capsulized in the next paragraph, illustrate the reluctance to accept ideas not wrapped in the respectability of traditional and commonly named disciplines.

Can you name the specific categories of jobs where graduates of this program can be expected to be employed? Entrance requirements should specify expected specific quantitative skill levels! There is no entrance requirement of a bachelor's degree from an accredited institution in the same discipline! Thus, develop a comprehensive means to determine the suitability of a student for the Program! Develop a method for ascertaining an incoming student's interdisciplinary aptitude and capabilities! Change the title to one that is simple, self-explanatory, and easily identifiable with the academic contents of the Program! There is no national or regional accreditation agency for such a program; therefore, hire knowledgable, outside and impartial consultants! What are the societal needs and demand for graduates of the program?

Presumably, the committee would like to have the security of being able to columnize comparisons with identical programs at Berkeley, Ann Arbor, or Cambridge. But there are none. Even for the oldest, most tradition bound, and narrowly specialized curriculum, the committee would find answers to such questions elusive. The complexity of today's uncertain socio-economic-political situation is compounded by rapidly changing technology in a way never before encountered.

Who knows what most graduates are going to be doing five years hence? May not the philosophy of systems thinking be as important as the ability

to quantify a system when looking at societal problems of pressing importance? Just what does accreditation mean anyway, now that all who seek become accredited? Can't people be taught to work together in interdisciplinary teams by means of group dynamics techniques? Considering the breadth of the meaning of cybernetics and of systems, what is a better name for a program addressing itself to managing complexity? In a cybernated society with resource scarcities, population pressures, changes in world power structures, and which lacks job making wars and space exploration efforts, just what are the needs for specific numbers of the products of any traditional curriculum? An overview of higher education would certainly indicate that almost all curricula have problems now or on the horizon.

THE PROGRAM AS A CONTINUING EDUCATION VEHICLE

Despite the hesitancy of the university administration and some of the faculty to gain an understanding and render support to the Cybernetic Systems Program, it continues to grow in quality and acceptance by students, area professionals, and high technology enterprise. It has been especially successful as a continuing education vehicle for a broad spectrum of professionals, many of whom are from engineering backgrounds of education and experience.

In recognition of the probable interest of the concurrently employed professional, most coursework from the very beginning has been offered in the late afternoon and evening. The need to bring the Program to the

students at their worksites either by offering courses off campus or by instructional television were also foreseen.

The opportunity to experiment with ITV as a delivery technology presented itself in 1972 when the Association for Continuing Education (ACE) offered broadcast time for live Program courses. ACE is a non-profit corporation which offers a wide variety of live, televised courses to employees of San Francisco Bay Area firms that are members of the Stanford Instructional Television Network. During 1974—75 Stanford televised 150 graduate engineering, mathematics, and science courses and registered over 2400 television enrollments. Using hours when Stanford classes are not scheduled, ACE and it's affiliated institutions televised 80 courses and registered nearly 4000 television enrollments.[5]

The receptivity of the management and many member companies of ACE to the Cybernetic Systems Program has been an important factor in the development of the Program in the area of continuing education. The premises which form the basis for the successful relationship between the Program of San Jose State University, as a programming source, and ACE, as the delivery system are as follows:

1. Many professionals in engineering entitled positions have backgrounds of education in fields other than engineering, e.g., mathematics, chemistry, psychology, and industrial studies, having developed their expertise through long experience.
2. Many engineers at midcareer are in middle management positions in which mathematical tools used in advanced engineering coursework of today are of little importance; these engineers would benefit,

however, from overview courses emphasizing the applications of such tools.

3. Many engineers at midcareer in technical positions are ill prepared to compete with younger more recently educated engineers in course-work requiring mathematical tools which they have either not had or not retained.
4. Many of the professionals in the above categories turn away from highly specialized technical courses but have interests in courses of a general big-picture nature, e.g., Information Management taught with a philosophical orientation to include such matters as minimizing computer abuse but which would still require a prerequisite of a sophisticated understanding of computer architecture and software. In contrast, a course in Information Management taught with a primary emphasis on the technical detail of hardware and software design may be of lesser interest and use.
5. Having become involved during World War II in technical endeavors for which they had native ability but never having had time, initiative, and/or opportunity to attend school, many individuals occupy technical positions of significance even though not holding a degree or certificate.
6. Many midcareer engineers have developed highly specialized talents, so specialized in fact that they find lack of opportunity to move to other jobs when their project is finished, e.g., an engineer in high-vacuum work in environmental test chamber research, development and design. He has sophisticated capabilities in instrumentation and

control that combined with an interest in bio-medical instrumentation and opportunity for study outside his previous discipline can change his career direction to the advantage of both himself and society.

7. Many engineers and their associated professionals lack awareness of the tools of the "systems approach," i.e., how to define the problem, establish objectives and identify constraints, develop and analyze alternatives, and finally, select the optimum solution to include human values.

8. Societal and technical problems of today and tomorrow are of such complexity that they are most amenable to solution if worked on by teams made up of individuals from disciplines pertinent to the problem at hand, all members sharing an understanding of problem solving techniques based on computer based system dynamics.

9. Except in advanced technical discipline-based courses, mid-career professionals bring to courses a mixed bag of expertise which instructors should take advantage of by encouraging student contribution and participation in lieu of but a "sit and listen" type of course.

10. The energy crisis is real and persistent and will not go away, thus making ITV educational technology more important than in the past; the methodology is cost-effective for the individual who saves time and money in fewer commute trips to campus.

11. Modern audio and video educational technology can be used to the cost-effective advantage of institutions in a consortium in which the talents available to each are shared.

The Program is thus considered to be valid as continuing education for today's world and deliverable using modern technology. It is suited to the needs of individuals seeking a degree or to those wishing to take but one or two courses for specific knowledge or tools.

Preference over the new inexperienced baccalaureate holder is given the mature student in maintaining a steady-state graduate student body of about 125, approximately three-fourths of whom are concurrently employed. In many cases, those from discipline backgrounds such as philosophy are working as systems analysts or in engineering entitled positions.

The mid-career engineer seeking the Cybernetic Systems Master's Degree is generally the farsighted individual wishing to work on more complex problems and recognizing his need for new tools. Such individuals recognize the broad applicability of the Program to solutions of problems immediately at hand in their organizations or those on the horizon in a possible new career path. The core plus a good choice of electives and a good thesis may enable the aerospace engineer to develop a better computer auditing system for the corporation. The engineer having a chemistry baccalaureate may develop an improved quality assurance system. An operations analyst with a mathematics/life sciences baccalaureate may develop a new systems simulation program for a governmental agency.

Some examples of this year of mid-career engineers accomplishing changes of directions are especially interesting. One developed a special interest in hearing and sight problems from courses in behavioral cybernetics and biocybernetics; with electives in the life sciences and an experience background in instrumentation, he was admitted to one of the best medical schools at the age of 36. An electrical engineer at the

age of 50 with some experience in industrial real estate appraisal took electives in business; a paper based on his thesis won national recognition for a new computerized appraisal method based on concepts gained in the Program. A retired navy officer, employed in electronics and aerospace management engineering on the East coast, retired for a second time and moved to the San Jose area; after completing the Program at age 60 and writing a thesis on the cybernetics of organizations, he is now in his third career and applying his thesis concept to the restructuring of a large firm. These are but a few examples of changes that individuals have been able to achieve through the flexible program.

In many cases, achieving another degree is not overly important to the individual or the employer. New knowledge gained in either in-house courses, in short courses, or in one or more courses taken from an educational institution will suffice. In these instances, a certificate attesting to achievement is desirable a personnel performance evaluation times.

ACE presently offers two types of certificates, a State of the Art Certificate which indicates than an employee has taken one or more courses in a certain subject matter area and a Management Development Certificate following completion of four specified courses in the area of business and supervisory management. These are awarded to individuals already having advanced degrees as well as those without baccalaureate degrees. In recognition of this real need, the Cybernetic Systems Program has developed a Continuing Education Certificate for the person not interested in a degree but who takes one or more courses.

CERTIFICATION AND RECERTIFICATION

ACE now performs a unique educational service to San Francisco Bay Area organizations belonging to the Stanford ITV Network. This role could be expanded to provide a more comprehensive service to an enlarged clientele. ACE could become the coordinating organization and the administrative agent for a "regional continuing education center."

Although now primarily concerned with ITV based coursework, ACE could serve as the "credit bank" for courses taken by individuals either by ITV or on various campuses or in short courses offered by industry.

To provide for the continuing education needs of professionals not employed by companies belonging to the current network, ACE would have to negotiate for either rented or donated space in office buildings or community colleges in major employment centers and install ITV receiving capabilities in the established classrooms. Employees of banks, governmental agencies, insurance companies, and other enterprise would be expected to use the facilities.

While serving primarily as a manager and credit bank, ACE could also provide certificates or recertifications. An education institution or a professional society wishing to grant the certificate based on credits evidenced in the ACE office could do so, or any two or all three could collaborate in the offering of the certificate.

Many employees at ITV receiving sites have taken courses offered by more than one of the network participants. In general, the courses

taken by an individual when reviewed as a package would reflect a subject matter direction; the individual, however, is not interested in a formal degree. An example, again based on pervasive advancing computer technology, might be the individual who takes the four courses for the ACE Management Development Certificate (12 quarter units or 8 semester units) and System Dynamics, System Modeling, and Information Management from the Cybernetic Systems Program of SJSU (totals to 9 semester units), and Seminar in Current Economic Problems (3 semester units) from Golden Gate University for a total of 20 semester units. All courses could be taken over ITV but wouldn't necessarily have to be.

The individual taking the above concentration would have enhanced his understanding of financial, operational and organizational aspects of his job responsibilities as interpretable from computer modeling and simulation. A certificate attesting to this enhanced level of knowledge and ability would be justified and sought after. Any number of combinations could be worked out by the employee and his manager who would become a co-partner with ACE and educational institution representatives in the advising and approval of the program and certification of the employees satisfactory completion. This certificate program would be a close parallel to the Recertification Program described later.

By lending its name to the certificate, the educational institution would in effect be accepting coursework developed and taught with industry/government sponsorship. Whether the non-institutional coursework could later be used for formal degree credit would pose problems. It has been observed, however, that instructors of ACE courses are well

prepared both in terms of expertise and teaching ability and that the amount of work and level of performance demanded of enrollees is high. It would seem that methods of evaluating the knowledge of an individual seeking credit for industry offered coursework could be developed; the existing "credit by examination" route would provide to some extent but a greater degree of flexibility would be desirable.

Recertification is an expansion of the certification process with teeth in it. Within California, the medical doctor must certify to the California Medical Association each year the completion of so many hours of continuing education – his nurse will begin to do the same in 1975. The Certified Professional Accountant must have on record with the State of California CPA licensing board a record of 40 hours of continuing education per year in order to maintain his license. The attorney claiming a specialty must have on file with his licensing agency a record of at least 20 hours of work. The continuing education can be taken in many forms – short courses, lectures, conferences, audio and video tapes, and reading substantiated by the completion of a work book.

In contrast to the above professionals, the engineer not only in many cases disdains registration but those registered resist attempts to implement required continuing education programs by either the Board of Professional Engineers or their technical or professional societies. But it does seem that the trend among occupational groups is towards continuing education.

The proposed expanded program of continuing education for a high technology area could provide the basis for the possible acceptance of

a certification or recertification program by engineers. Much of the resistance to required continuing education has arisen because of the practicing engineer's conviction that the academic community was trying to build but another beaurocracy. The proposed "regional center" would deemphasize the traditional academicians role.

ITV, either live or by video-tape, would be an important component of the delivery of the continuing education by the engineer as well as other professionals. Desirably, representatives of industry and professional societies would work with the professionals concerned and the intended instructors either from universities or industry/government in the development of both the sequences of courses, the individual courses, and the content of lectures. This could effectively be accomplished through the proposed program.

The development of suitable instructional packages for the mid-career professional would provide a challenge somewhat different than that encountered in developing a typical undergraduate course. The spectrum of backgrounds, experiences, interests based on current jobs and those anticipated, and abilities to recall knowledge fundamental to the course would be tremendously broad.

Instructors of coursework in the interdisciplinary Cybernetic Systems Program have encountered this problem even more because of the diversity of disciplines; offering the course over ITV having a live talk-back is even more challenging. But once having given the day's lecture and being able to note deficiencies, a good instructor could offer the same content a few hours or days later under controlled conditions. With improved

visuals, a video-tape of high quality could be produced that could be used elsewhere. The live talk-back aspect and the logistic and administrative details usually included on a tape of an "as given" lecture would advantageously be missing.

The marketability of tapes produced under preplanned control is evidenced by the purchase by a participating company of the total instructional package of a supervisory course offered by ACE. In this case, the practised instructor had a warm-up session of ten minutes to establish rapport with his class "out there," then offered a tightly packaged 40--minute lecture with some "planted" questions from students to emphasize the liveness of the situation, placed his course identification card on the lecturn for pick-up by the overhead camera, and then engaged in a ten-minute wind-down session with class members having questions. The meat of the lecture, which is effectively usable elsewhere, however, was in the taped 40-minute portion.

Considering the magnitude of the continuing education problem for the mid-career professionals in the many high technology areas throughout the country, video-tapes of the type mentioned above would provide the most cost-effective method of meeting the need. "Applications of Materials Science" as offered by ACE and video-taped with the advanced technology of the Stanford/ACE ITV system would be usable in Dallas as well as in Boston, Denver, or Oklahoma. "System Modeling" or "Information Management," courses to be offered by SJSU this fall over the network, would with proper preparation be exportable. Courses developed at other institutions with similar facilities could be used in the expanded program of the Bay Area.

No institution by itself, offering courses on a term-by-term basis, would be able to invest the time and money necessary for the development of an instructional package usable elsewhere. A video-tape of a course "as is" hasn't proven successful when viewed by an individual or class at another time and place — much of the time on the tape is taken up with detail no longer pertinent. Thus, there is need for support by NSF or other funding sources for the development of instructional packages peculiar to the needs of the mid-career professional, such packages to be designed by teams of potential students, employers, professional societies, and instructors. Money is needed to pay the instructor, support the extra expenses of his co-developers, media production, studio-time, overhead expenses, etc.

With such help, the problem of maintaining the "technical vitality" of the professional and his organization would be alleviated in a cost-effective manner.

THE NEXT DECADE — A PROJECTION

The Cybernetic Systems Program concept was proposed in 1965, a decade ago, at a time when the country was engaged in an unpopular war while at the same time reaching for the moon. Unemployment and inflation were modest and unnoticed. Today's situation as portrayed by a politician is that "nobody knows where the hell the country is going. There are no absolutely right answers, but you've got to be going somewhere."

Just as the political figure portrays complexity at the national level, it faces all individuals and organizations constantly. Using

outmoded problem solving techniques, right answers to anything but the simplest problems are elusive.

Those involved in the Cybernetic Systems Program believe that the concepts and methodologies offered in the Program will enhance understandings of social and material reality. Economic crises, inflation, unemployment, international conflict, urban deterioration, and stresses between the individual and the organization will be more interpretable and alternative solutions will be better synthesized. The concepts apply equally well to societal and to technological problems.

With the conviction above and the experience of almost a decade, it is believed that programs of the Cybernetic Systems type will develop elsewhere. The methodologies will be applied successfully to problems of increasing complexity.

The concepts of the Program are transferable to educational levels both below and above the master's degree. Judging by experiences of some associated with the Program, systems concepts are understandable by sixth graders, possibly more so than by those with doctorates in specialized areas. Thus, courses, sequences, and degree programs will be developed at the baccalaureate level in four year institutions, at the junior college level, and in junior and senior high schools. Communities facing up to complex problems will draw upon teams made up of individuals of all ages and education levels who have been exposed to cybernetic and systems concepts.

For San Jose State University the extension of the concepts of the Cybernetic Systems Program to the doctoral level is logical and timely.

This could be done with a senior institution in an area to be called "systems studies." The association with a campus of the University of California or a private university is required by the State of California for members of the California State University and College System. This can be accomplished within the two to five years or assuredly the next decade.

As portrayed earlier one of the major roles to be played by the Program will be in the area of continuing education for a broad spectrum of professionals. Delivery of much of the coursework of the Program will be either at off-campus sites or by ITV in order to economize on the time and the energy expended by participants.

As all of the above occurs, boundaries will become more diffuse. Educational programs will become oriented to issues and problems and will emphasize methodologies of analysis and synthesis leading to solutions.

SUMMARY

The Master's Degree Program in Cybernetic Systems was proposed a decade age as an interdisciplinary problem-solving oriented educational effort. It was implemented seven years ago, and has developed into a successful continuing education vehicle for mid-career professionals.

A tradition oriented academic environment does not provide the best climate for establishment and rapid development of new interdisciplinary concepts. The support and persistence of understanding students, faculty, and off-campus professionals is essential to survival of programs such as Cybernetic Systems.

In the development of new program concepts such as Cybernetic Systems where there are no guidelines to follow, the input and feedback of faculty, students, and professionals from diverse backgrounds is essential and must be nurtured. Ready-to-use texts are scarce and instructors must be innovative in drawing resource materials from a broad spectrum of disciplines.

As presently offered, the Program is flexible and open ended in terms of electives and theses topics. Graduates have developed emphases in a wide range of subject matter and have applied their newly learned tools to improve their current situations or to redirect their careers. Out of the one-hundred graduates, about thirty have engineering backgrounds.

The opportunity to deliver some of the coursework over ITV via ACE and the Stanford ITV Network has enhanced the value of the Program as a

continuing education vehicle. It is anticipated that an increased emphasis will be placed on ITV, with ACE assuming a regional leadership role in the areas of certification and recertification of professionals.

Finally, it is believed that the concepts of the Cybernetic Systems will be extended to levels of education both below and above that of the current master's level. Major social problems will be solved only when individuals of all ages and levels of education can understand the roots of complexity and thus learn to better manage it.

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