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ABSTRACT

The final report on a program to encourage industry-university interaction in the materials processing industries presents the findings of various proposed activities, establishes some conclusions, and provides suggestions and recommendations for extending the task to the actual design and conduct of the project. The background in which the program was established is discussed in relationship to the problems in productivity and the need for industry-university interaction to provide new technology in the industry. Based on visits to Germany and Japan, it was found that high industrial productivity was the results of industry-university interaction and government support for research. Some characteristics of graduate and undergraduate engineering programs in the United States are discussed and compared with those of Germany and Japan. The status of industry-university interaction is described and brief reports of several symposia conducted for this purpose are presented. A test case of an industrial internship program is briefly described. Conclusions from the study emphasize the importance of industry-university interaction towards increasing productivity and the need for U.S. Government incentives in industry. Eight recommendations are outlined. A list of references is included and materials related to the test case are appended. (Author/EC)

SUMMARY REPORT
ON TASK "A"
OF AN
EXPERIMENT IN MATERIALS PROCESSING ENGINEERING EDUCATION: THE INDUSTRIAL INTERNSHIP PROGRAM

Submitted to:

THE OFFICE OF EXPERIMENTAL R & D INCENTIVES

of the

NATIONAL SCIENCE FOUNDATION

by

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June 1975

NSF Contract No. DI 40464

INTRODUCTION

The study, which is reported herein, was based on the hypothesis that a carefully designed education plan for engineers will have a beneficial effect on the innovative development and transfer of technology to the manufacturing sector of our economy. Any attack on the problem of manufacturing productivity is simultaneously an attack on the energy problem, the materials problem, and the balance of payments problem. A mechanism which brings about a more synergistic relationship within the man-machine-technology environment will achieve higher productivity. One such mechanism, the subject of this study, is the carefully coordinated formal education and on-the-job learning experience of engineers.

The United States is considered to be the most technologically advanced country in the world; however, the transfer of this technology to the production of goods and services has apparent weaknesses. Graphic evidence of the problem is indicated by (1):

- Manufacturing output per man hour in the U.S. has increased by 34% in the 1960's, as opposed to an average of 87% in 10 other countries.
- Manufacturing productivity increased in the U.S. during the 1960's by an average of 3.2% per year --as opposed to 11% per year in Japan and 5-6% per year in Europe.

(1) Numbers in parentheses represent references in Bibliography.

- The United States fell to fourth place in 1971 in the installation of machine tools -- after having been first in the world in this important area for many years.

- If the United States could improve its productivity by .01%, it could improve its Gross National Product by $1 billion per year.

The Experimental R & D Incentives Program, announced by the National Science Foundation in November 1972, coupled with the Experimental Technology Incentives Program of the Department of Commerce, was established to provide evidence concerning incentives which the Federal Government might use to increase the transfer of new technology to all sectors of the economy.

For several years prior to the announcement of the Experimental R & D Incentives Program, the Mechanical Engineering-Engineering Mechanics Department at Michigan Technological University had been exploring mechanisms for enhancing university-industry interaction in the materials processing industries. The timely introduction of this new program by the National Science Foundation gave encouragement and support to the initiatives already underway.

A preliminary proposal on "An Experiment in Materials Processing Education: The Industrial Internship Program" was submitted to the National Science Foundation under the Experimental R & D Incentives Program on Human Resources for Technology Innovation in December 1972. After several meetings to discuss this rather comprehensive preliminary proposal, a modified version labeled "Task A - Program Definition" was submitted in March 1973. The "Task A" proposal was funded and the program of activities was started in September 1973.

The program of activities for "Task A - Program Definition" included 1) a review of existing interaction programs, domestic and foreign in public, private, and captive institutions; 2) a symposium on campus for potential industrial participants; 3) identification of interested companies and students; 4) establishment of an Advisory Council; 5) symposium for faculty and industrial participants to establish program objectives, procedures and guidelines; and 6) design of the full experiment.

An interim report on the project was submitted in March 1974. This report reviewed the activities associated with obtaining industrial support, the results of various symposia related to productivity, and reports on visits abroad. It established the basis for conference with the program director at the National Science Foundation and this conference gave definition to the work that would be undertaken to complete the study.

This final report will incorporate only that material from the Interim Report that is necessary to make this document complete. For further detail on the work covered during the first half of the study the reader is directed to the Interim Report.

This final report, when coupled with the Interim Report, provides the findings of the various proposed activities, establishes some conclusions where supported by evidence, and provides suggestions and recommendations for extending this task to the actual design and conduct of a project or experiment.

BACKGROUND

There were and a e a number of problems related to the economic wellbeing of the United States that plague the nation. A partial list would include unemployment, inflation, productivity, balance of trade, balance of payments, energy, materials and the environment. It is clear that the innovative application of technology can have a beneficial impact, direct and indirect, on these problems.

The United States must compete with other nations of the world. The problems noted above give evidence that our position as the most advanced technological nation is being eroded. Improved productivity, in its broadest sense means improving our efficiency of converting resources, some scarce, into goods and services. The innovative application of appropriate advanced technology is one of the most powerful tools at our disposal to improve productivity. James M. Utterback, in his article on "Innovation in Industry and the Diffusion of Technology" (2), provides a list of sixty-nine references which show the wide range of interest in this subject. The Arthur D. Little, Inc. study on "The Manufacturing Engineer - Today and Tomorrow" (3) indicates the great resistance on large organizations to innovation and change.

The "National Inquiry into Productivity in the Durable Goods Industry" workshop held at the University of Massachusetts, October 4-6, 1972 (4), focused on the machine-tool manufacturing industry of the United States. The participants agreed that the industry was in severe economic peril, that transfer of new technology was crucial, and that engineering education could play an important role by moving into more practical areas of applied engineering.

The "Manufacturing Productivity Conference" held in Washington, D. C., October 11-13, 1972 (1) was held with the theme that significant improvements in manufacturing productivity can be achieved through the development of new processes, techniques and equipment.

The manufacturing productivity problem was identified in the Proceedings of the Manufacturing Productivity Conferences as:

> "of all areas in which productivity can improve the U.S. position in world trade, none exceeds manufacturing in importance. Virtually hundreds of examples can be cited of outdated manufacturing processes in use today which have not been improved in decades, and failure to develop improved processes is a result of inadequate attention to R & D activities. Governments of other industrialized nations have provided greater incentives and stimulations than has the United States toward research and development in the manufacturing sector."

The proceedings go on to point out that various measures of productivity in the United States have not kept pace with those of other countries. The summary of the conference related to university-industry-government interaction recommended a study of various mechanisms to improve productivity through enhancement of innovation in manufacturing.

From the foregoing conclusions it is apparent that the goals of engineering education must be related to the ability of practicing engineers to generate and apply new technology and to improve productivity. Few educational disciplines have undergone more frequent evaluation studies than engineering. All of these evaluative studies (5,6,7) have been controversial. The scientification of engineering, the evaluation of the engineering technician and technologist, and the accreditation of engineering programs at the basic and advanced levels are all related to the findings and/or recommendations of these evaluations. (Whatever role is played by the Engineers Council for Professional Development, the accrediting agency, and the various professional societies in formulating goals for engineering education, these roles will continue to be sensitive to the needs of the market place.) It can be seen that government decisions on such matters as research support, the aerospace program, and the project to put a man on the moon have all had an effect on the thrust of engineering education. It is certain that government policies and decisions will continue to have an effect on the focus of engineering education.

In spite of what appears to be a very healthy relationship between universities and industry there are some rather obvious signs of strain (7). Most universities believe that a certain amount of on-the-job learning will be necessary to convert a graduating engineer into a practicing engineer. Some industries, in apparent agreement with this point of view, have introduced formal learning programs for new engineers. Other industries, frequently the smaller, fragmented industries, have adopted more of a sink or swim attitude toward the development of a graduate engineer into a productive employee, mainly because they cannot afford training programs. Some industries are technology intensive and others are manpower intensive. It should be clear that the fragmented industries of our nation and their varying needs for technically educated people are too diverse for educational institutions to serve each in the unique role of training manpower for instant productive employment. It would be impossible for graduating engineers to be ideally suited to any specific industrial employment; however, rather than consider this a problem which generates strains, it should be considered as an opportunity to build programs of interaction between universities and industries. The professional development and attitudes of an engineer are the result of formal and informal experiences and education. The more synergistic the education and experience, the more efficient the professional development.

The educational plan can graduate an engineer with a broad formal education who is clearly suited to on-the-job learning for those industries that feel this sequence is best suited to their objectives. The co-op program represents a coupling of education and practical experience, carefully integrated, to achieve practical competence by the time of graduation. The various continuing education programs, advanced degree programs and in-house programs of study are all further elements that are available for use by individuals and industries to achieve educational and experience objectives.

Most educational plans, even those involving an iterative sequence of educational and practical experiences, have not included the faculty member as a partner in the practicing engineer phase of professional development. Such a partnership is considered useful, if not essential, by both the university and industry. Thus far no practical way has been found to achieve this relationship. The proposed internship program is intended to address this need.

It was against this background of problems and opportunities that the proposal "An Experiment in Materials Processing Engineering Education: The Industrial Internship Program - Task A - Program Definition" was developed and formulated.

OBJECTIVES

Under the Experimental R & D Incentives Program of the National Science Foundation, Michigan Technological University proposed an experiment with the objectives to:

1. Provide professional training in an atmosphere of innovation for students planning to enter manufacturing engineering.
2. Develop and maintain a university-industry relationship conducive to joint activities that will lead to increased transfer of new manufacturing technology to the manufacturing industry and that will provide feedback to the educational system of the university.

It was proposed that these objectives could be achieved through an educational program which brings together a student or students, a university faculty member, and an engineer from industry to form a team. It would be the task of this team to solve an engineering problem provided by industry.

Specifically, the purpose of this phase of the project was to:

- review existing university-industry interaction, domestic and foreign, involving public, private and captive institutions
- conduct symposia for potential industrial participants
- identify interested companies and students
- establish an advisory council
- conduct meetings for faculty and industrial participants
- identify interested companies and students

- establish an advisory council
- conduct meetings for faculty and industrial participants to establish program objectives, procedures and guidelines and to design the full experiment.

DISCUSSION

The following discussion represents a systematic review of this study. Many of the subjects reviewed here were included in a more comprehensive way in the interim report (8). The interim report should be considered as an addendum to this final report. Some of the findings contained herein came to light after the completion of the interim report.

Existing Programs Abroad

During the Manufacturing Productivity Conference of October 1972 in Washington, D. C., a considerable amount of industry-university interaction in research coupled with government subsidy was claimed to be partly responsible for high industrial productivity in some of the industrialized nations. Particular mention was made of Japan and Germany, America's strongest competitors in the world markets.

First-hand information gained during visits to Japan and Germany helped establish a number of important facts and impressions about the education and utilization of engineers in these countries. Because the visits were short, the conclusions are often based on first impressions. A more lengthy study might change some information; however, the following factors emerged for both Japan and Germany:

1. Technology and the profession of engineering are held in high regard by the general public and by young people preparing for careers.

2. The educational route to engineering careers is more restricted and less a matter of personal choice, mainly due to a limited number of openings at universities.

3. The expectations of industry, regarding the required combination of education and practical experience for engineering recruits, are in reasonable harmony with the existing system of education.

4. The ability of the technical community to communicate is enhanced by the relatively small geographical size of Japan and Germany.

5. The research activity appears to be organized around long range goals with less duplication, less direct competition for support, and more stability in support.

6. Research priorities seem less influenced by crises or arbitrary national goals or policies.

In Japan the profession of engineering has considerable prestige. Entrance to engineering study at each university is controlled in number by an established limit, and quality by an entrance exam. Each university has its own examination. The transfer of students between institutions is highly unusual and faculty members usually stay at a given university. The program is very basic with some laboratory experience that has an industrial flavor. Industry hires graduates at relatively low compensation into blue collar apprentice type jobs. The development of engineering recruits is unhurried because of the concept of lifetime employment. Research is carried out on a long range basis by graduate students working for chaired professors. The chaired professors receive research support each year and do not write proposals. Research support is usually part of the budget supplied by the government or by a single industry, or by a consortium of industries. The support is normally to continue ongoing research and usually the chaired professor is known throughout Japan for his specific area of ongoing research.

In Germany there exists strong interaction between universities and industry. Aspiring engineering professors are required to serve in industry for a minimum of five years before becoming eligible for an academic position. As in Japan, the professor is well known throughout industry for his area of specialization, which creates strong bonds between industry and the university, and promotes joint research activities. Also, engineering students are required to gain practical experience in an industry early in their academic careers. Since the professors maintain an extensive working relationship with industry, engineering studies have a strong practical flavor. This permits college graduates to be productive immediately upon entering industrial employment, and eliminates lengthy training periods, a quality finding considerable favor with smaller and fragmented industries. This system of interaction extends over much of Central Europe, and it is not uncommon for a Swiss or Austrian firm to work with a German university, for example.

Existing Programs in the United States

There is considerable danger in making comparisons between the education and utilization of engineers in the United States where rather explicit information is available and the impressions left by rather short visits to Japan and Germany. However, some parallel analysis seems in order and may help to focus attention on factors of special concern or promise. The following comparative factors are cited for consideration:

1. Engineering and technology are characterized by a mixed combination of high and low regard by the public

with careers being popularized only when the supply is short.

2. The educational route to engineering careers is open to almost anyone as a matter of personal choice.

3. The expectations of industry for engineering graduates appear to be reasonably well met, but most industry finds some on-the-job practical experience necessary before an engineering recruit becomes a productive professional.

4. The ability of the technical community to communicate is made difficult by the geographic size of the United States, the proliferation of published technical information and the competitive nature of our educational research enterprise.

5. Research activity often centers on short term goals or crises and is usually based on competitive bidding for support.

6. Research activity is heavily influenced by national goals, programs, and policies.

Engineering education in the United States is open to almost any interested student but the attrition is very high. The undergraduate curriculum is similar in most institutions due to accreditation criteria. Co-operative education programs with industry are common. The supply of graduates is not always well matched to the needs of industry. Research is carried out for industry and with Federal grants. Federal grants support the majority of funded projects.

University-industry interaction in the United States was found to be mostly left up to the initiative of individual professors and industries. Since engineering professors are not required to have industrial experience as a prerequisite for their careers, engineering education tends to be theory oriented, much like in Japan. It is not unusual however, for professors to have industrial experience and to establish cooperative ties with industrial firms, which involve consulting and research. While such a background of activities may flavor the classroom and laboratory presentations of the individual professor, the overall thrust of engineering education remains theoretical.

Graduate Programs

A few schools have adopted programs designed to promote university-industry interaction on the graduate level. Since its founding in 1971, the Processing Research Institute of Carnegie-Mellon University has offered a Master of Engineering Program designed to prepare graduate students professionally for engineering careers. Students are given industrial projects, and have a major responsibility for their successful completion. Supervision is provided jointly by faculty members and engineering experts from industry. As of summer 1974, 13 students had graduated from the program and 20 students were currently enrolled (9).

Another program intended to acquaint the student with industrial problems is the Industrial Internship in the Professional Masters Program of Oklahoma State University, which was initiated in 1972 (9). The last two years of undergraduate study and the graduate program are geared towards solving an industrial problem. The student spends about seven months on location in industry as part of the requirements for the Masters degree. About 30 students have completed professional practice under this program so far.

A similar program established in 1967 is the Professional Doctoral Program in Engineering of the University of Detroit (9). The candidate for the degree spends nine months in industry, and the dissertation involves the solution of a practical problem of suitable complexity. About 30 students have participated in this program.

These programs have as common features (a) an industrial internship by a student, (b) the solution of a practical problem, and (c) a graduate degree.

Undergraduate Programs

Although the Co-op Program of alternating educational and practical experiences could be implemented at either the undergraduate or graduate level, it has been adopted at an accelerating rate as a form of undergraduate education in the United States and Canada.

Cooperative education in its standard form has the following features (8): A student is placed in industry for alternating academic terms. The student is thus able to work his/her way through school, but gains practical experience at the same time. The student usually enters the program after completion of the first year in college, and an effort is made to match the student's field of study and the work assignment. The level of these assignments is adjusted to conform to the student's academic progress, i.e., he/she assumes increasing responsibility as he/she nears graduation. The student's work experience becomes part of the formal education package and credit is received for it. In general, academic studies become more relevant as the student is able to relate theoretical learning to job experience.

University-Industry Interaction in the United States

Three different categories of university-industry interaction in the United States can be identified. The following classifications are not to be taken as rigid. A spectrum of combinations and variations of these categories are possible:

1. Industry interacts directly with professors to benefit from consulting or the research experience of the university.

   This may be the result of either direct contact between a professor and industry, or a formal university program to work with industry. Students are not involved on a systematic basis, although graduate students will frequently be active in related research efforts. The flow of technical information tends to be directed from the university to industry. Some feedback from the research work to classroom activities is likely.

2. Undergraduate students gain industrial experience through the Co-op Program and thus are the primary beneficiaries of this exposure. No direct involvement by the university exists to benefit industry, and there is very modest feedback from industry to the university which would be helpful to make teaching more relevant to all students. Certainly education is made more relevant for the participating student.

3. Students (usually graduate) gain industrial experience by spending some time (internship) in industry, and by working with faculty members and practicing engineers on an industrial problem. All parties involved in the project can benefit. The student gains valuable experience, the company gets a problem solved with the help of the university, and the faculty member gains an insight into industrial problems. Communication channels between industry and university are open, and the flow of information from industry to the university can make engineering courses more relevant for the benefit of a large number of students.

University-Industry Interaction Symposia

In the recent past a number of symposia were held which dealt with the need to improve university-industry interaction and the transfer of technology.

The Processing Research Institute of Carnegie-Mellon University conducted the NSF-sponsored "Workshop on Research and Educational Needs in the Pressure Vessel Piping and Related Industries" in December of 1973, which is described in Chapter 4 of the Interim Report (9). In May 1974, the PRI held the "First National Conference on Industry University Interaction in Graduate Engineering Education." The chief objective of this meeting was to review the ongoing interactive graduate programs of CMU, Oklahoma State University and the University of Detroit, all of which are described above. Time was set aside for discussions of the problems and experiences educators may have had in the area of industry-university interaction. Panel discussions dealing with evaluating faculty in professional programs, maintaining good relations with industrial sponsors, and the attraction of quality students into professional programs were held. The discussions generally centered around the need to draw closer to industry, the need to balance theoretical and practical skills, and the importance of professionalism in engineering education. The merits of a balanced engineering faculty were discussed.

In December of 1973, the "National Conference on Manufacturing Technology and Productivity" was held at M.I.T. A detailed report on the proceedings of this meeting was presented in Chapter 4 of the Interim Report (8).

Michigan Tech held N.S.F.-sponsored symposia in December of 1973 in Dearborn, Michigan and March of 1974 on the Michigan Tech campus. The purpose of these events was to advertise the university-industry interaction program proposed by Michigan Tech, and to stimulate discussion on it. Industry in particular was to voice its feelings, since its input could be valuable in the final design of the experiment. Additional details of these meetings are contained in Chapter 4 of the Interim Report (8). Some of the significant results of these meetings are as follows: 1) Industrial representatives agree that the program proposed by Michigan Tech is very promising. 2) Although it shares a common feature with the co-op program, namely the practical experience gained by the student, they feel that the direct involvement of university faculty in the proposed program is a most important feature. 3) They feel that channels of communication, which would thus be opened between university and industry benefit all participants. 4) Better than 80 percent recommended that their companies participate in this program.

The Industrial Internship Program - A Test Case

Steps taken in preparing for the possible implementation of Michigan Tech's Industrial Internship Program have already been described in the Interim Report (8). A considerable number of companies with levels of commitment varying from strong interest to desire to participate have been identified.

Although implementation of the Internship Program was not part of Task A, an opportunity presented itself for a test case. A small company, impressed with the philosophy of the program, asked to become involved in a cooperative venture. All pertinent correspondence relating to this project is included in Appendix A. The firm had a major maintenance problem with its production machinery, and hoped to get it solved through interaction with Michigan Tech. The ensuing developments are very valuable evidence for demonstrating the need for industry-university interaction, the difficulties in dealing with smaller companies, and the importance of Federal assistance in getting interaction started, particularly with small industry.

The project was estimated to be of a magnitude such that it would occupy one summer with a student on location, and an additional academic quarter for report preparation. Michigan Tech therefore submitted to the company what was considered to be a "bare bones" budget partially covering faculty time, other direct costs, and university indirect costs. The time for faculty involvement was artifically shortened to hold expenses down. With the student's wages the total expense incurred by the company would have been $8,000. The company did not share Michigan Tech's belief that this sum was small enough an investment to save its machines from further deterioration and eventual ruin. Instead, it imposed a limit of $4,000. on the project, including the student's pay. (See Appendix A). This meant reducing faculty time drastically to the point where little faculty involvement remained. However, since Michigan Tech considered this a valuable test case, it accepted the terms of the company. An undergraduate student spent two months on location, succeeded in isolating the source of the firm's difficulties, and was able to prescribe remedial action. His efforts should save the company tens of thousands of dollars eventually. A copy of the final report to the company is available.

Some of the conclusions that can be drawn from this experience are:

1. There is a need for increased university-industry interaction.

2. As a result of the limited amount of money provided by the company, faculty efforts towards completion of this project outstripped the allocated pay by a sizeable margin. The university simply cannot afford to set aside faculty time for so little renumeration since no additional faculty could be hired to fulfill the school's teaching obligations. It is expected however, that initially most smaller firms and possibly even larger ones would offer funds for interactive efforts which would be insufficient to cover such expenses. This would serve as a major deterrent to industry-university interaction.

3. These difficulties confirm the conclusion drawn by educators and the Federal Government that government incentives are needed to get industry-university interaction started.

Evaluation of Interactive Programs

The emergence of educational programs that deviate from conventional engineering education poses the question as to their effectiveness in providing industry with engineers who are better qualified than their conventionally-trained peers.

As a result of the short period in which the various interactive programs described above have been in existence, and the comparatively small number of students involved in each, only limited efforts at evaluating their impact upon both the employer and the employee have been made, and appear to be restricted to starting salary levels only. However, as each year passes by, additional graduates of the programs enter the engineering profession, and the earlier participants will have seen a sufficient number of years of service to provide a sound basis for a meaningful evaluation.

The longest program in existence, the Co-op program, has not been a subject of evaluation until comparatively recently. However, an evaluation is currently under way at Northeastern University. Another evaluation has been completed on the Langley Research Center Cooperative Education Program in 1970 (10), in which former Langley co-ops, now employed at the Center, are compared with employees recruited from other sources. In summary, the results of this investigation show that former co-op students were promoted sooner, changed jobs less frequently, received more awards, and obtained graduate degrees more often than employees from other sources. Although the employees sampled in this study came from many different schools, and thus had different backgrounds due to this fact alone, it appears that cooperative education with its "hands-on" experience tends to produce engineers with higher levels of motivation and achievement.

CONCLUSIONS

The background study carried out under Task A has revealed a number of significant findings.

The evidence obtained from abroad, notably from Germany, indicates significant advantages to industry-university interaction, both for engineering education and industry.

U. S. industry shows increasing interest in industry-university interaction as exemplified by the ongoing programs at Carnegie-Mellon University, Oklahoma State University, and University of Detroit, as well as the reaction to Michigan Tech's proposed program. U. S. industry is interested in cooperating with universities primarily for the purpose of getting its problems solved. Faculty involvement in projects, preferably on location, is seen as valuable, since it is expected to create an awareness of industrial problems at the university.

There appears to be a need for U. S. Government incentives, since smaller companies in particular find it difficult to meet some of the expenses incurred in interactive efforts.

The emergence of interactive programs at different universities raises the question of their performance with respect to each other as well as conventional education. It is important that evaluations of these programs are carried out. It is also important to identify and evaluate programs which have so far gone undetected. Additional evaluation of the impact of the Co-op Program on industry as well as the individual appears to be in order.

Since the interactive programs, which have been identified, are graduate level programs, the introduction of undergraduate programs with similar objectives as proposed by MTU appears to be desirable. Such programs could complement and interface with the Co-op Program.

RECOMMENDATIONS

A proposal (11) was submitted to NSF in September 1974, which has not been funded as yet because of lack of funds. However implementation of this proposal is still recommended. Details on the following recommendations are given in (11), but are summarized here. These recommendations are as follows:

1. Co-op and other special programs of interaction need to be identified, characterized, categorized, and documented for future reference and further analysis.
2. Criteria and Measure Concepts for program evaluation need to be established.
3. All identifiable programs need to be analyzed using the established criteria.
4. Data on the established measure concepts should be recorded on all future programs as a matter of course. NSF should provide support as an incentive to assure that a compatible and consistent data base is developed.
5. Michigan Tech's proposed internship program should be implemented on a large enough scale to evaluate its effectiveness. Recommendations (2) and (4) should be incorporated into the program.
6. The established criteria and measure concepts (2) should be applied to continuing education as a separate study.
7. The established criteria and measure concepts (2)

should be applied to the case of German system of industry-university interaction as a separate study.

8. An industrial problem must be the focal point in interaction programs if they are to be successful in involving full industrial support and accomplishing the ultimate goals of innovation and increased manufacturing productivity.

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APPENDIX A

RECEIVED

CONCORD MANUFACTURING COMPANY

405 SOUTH MICHIGAN STREET • CONCORD, MICHIGAN 49237 • (517) 524-8970

April 8, 1974 ... DEPT.

Dr. Gordon Scofield
Head ME-EM Department
Michigan Technical University
Houghton, Michigan 49931

Dear Dr. Schofield:

I understand that the N.S.F. informed you at your meeting last week that they could not fund your industry-university interaction program this year, but they will fund continued study. Professor Gerdeen also told me that they thought it would be all right to go ahead with a few experiments with any interested firms who were willing to bear the cost of the program without using N.S.F. funds. As you remember, I told you that I was definitely interested in this program and that I wanted to get a project going by this summer and you told me to see Professor Koski.

I got the project conditionally okayed by the president of our company (subject to cost control) and called Professor Koski last Wednesday, April 3, 1974, and he referred me to you, but you were out of town, so he was going to have you call me.

Today, I called and talked to Professor Gerdeen and he asked me to get a description of the project to him and he'd start the student selection process.

The point I'm getting to is, the only way that you and I are going to get anything out of this project is to have it totally coordinated and organized from the outset. I know, that because my firm is the first to try this, there will be problems and I will have to help by offering suggestions. The first one that occurs to me is that a corrdinator has to be appointed.

The coordinator is the key to the success of the whole project. If he can help my firm select the best available professor and then help us select the best student, the project can't help but be successful. This will also allow a man, the coordinator, to observe and report on the total success of the program.

I would like to hear from you at your earliest possible convenience about my suggestions, so I can get this project started this summer. Please feel free to call me collect.

Enclosed please find a description of our company and the project.

Sincerely,

Camiel E. Thorrez, Plant Manager

CONCORD MANUFACTURING COMPANY

405 SOUTH MICHIGAN STREET • CONCORD, MICHIGAN 49237 • (517) 524-8970

Concord Manufacturing Company is an automatic screw machine (or automatic bar machine) job shop. It was formed in 1946 by three brothers, Henry, Albert, and Morris Thorrez and their brother-in-law Walt Michner. It has grown slowly to a work force of 55 people.

It is an off-shoot of a large company, Thorrez and Maes, which sold out in 1948. This led to the formation of C. Thorrez Industries by the father of the three brothers. Because of his experience in the large firm of Thorrez and Maes, in the area of sales and purchasing, this led naturally to centralizing of purchasing and selling under the name of C. Thorrez Industries. Concord Manufacturing Company and another firm, (also formed in 1946), Stockbridge Manufacturing Company, receive all their work orders and bar stock material from the central office.

The Thorrez name has been associated with the screw machine products industry for over sixty years and with the emergence of at least four interested third generation Thorrez's, this company has the core of interest that will guarantee its survival for many years to come.

At present, combining the sales of all the firms, C. Thorrez Industries is the largest shop of its kind in Michigan and it will continue to expand. A new induction heat treating company has been formed to better serve C. Thorrez Industries' customers and a central engineering office is in the process of being formed.

We hope, being involved in this innovative program at Michigan Tech, we finally will be able to take time to study our operation scientifically, which we're certain will lead to many improvements. In the process, we will expose some engineers to the real and exciting world of manufacturing which will eventually lead to better qualified engineers entering industry.

Camiel E. Thorrez, Plant Manager
MTU 1970 BSME

CONCORD MANUFACTURING COMPANY

405 South Michigan Street • Concord, Michigan 49237 • (517) 524-8970

April 8, 1974

RESEARCH PROJECT

Purpose: To come up with an economically sound machine maintanence program for our automatic screw machines, which will increase their productivity and accuracy.

This project should involve getting expert information from many sources including: bearing companies; screw machine manufacturers; and lubricating products firms. It would also involve developing data from what is happening now in the operation to help determine what changes should be made.

The approach taken and the way things are handled in this project will be the responsibility of the student. He will make the final decisions. I will be there, along with my staff, to assist him in any way we can.

For further information, please call me collect.

Camiel E. Thorrez, Plant Manager
MTU 1970 BSME

michigan technological university
houghton, michigan 49931

college of engineering
department of mechanical engineering and
engineering mechanics 906/487-2551, 2561

Copy

May 17, 1974

Mr. Camiel E. Thorrez
Plant Manager
Concord Manufacturing Company
405 South Michigan Street
Concord, Michigan 49237

Dear Mr. Thorrez:

We are pleased that the Concord Manufacturing Company has chosen to participate in Michigan Tech's University-Industry Interaction Program. I was informed by Bob Szczesny that you have agreed to accept him as the student member of the project team. The faculty member who will work with Bob and you is Dr. Raymond W. Kauppila. Ray's areas of specialization are machine design and manufacturing. He is also knowledgeable in engineering economics.

As you stated in your letter of April 8, 1974, the purpose of the project is to develop an economically sound machine maintenance program for the automatic screw machines of your plant to increase their productivity and accuracy.

The student investigator, Robert Szczesny, with the cooperation of his advisors, Raymond W. Kauppila and Camiel E. Thorrez, shall

a) familiarize himself with the plant operations of the Concord Manufacturing Company, review present practices regarding screw machine maintenance, and develop data on present operations;

b) seek pertinent information from bearing, - lubricant, -, and screw machine manufacturers;

c) suggest changes in present screw machine maintenance practices based upon his analysis of the data and information collected by him. A final report on the results of his study shall be prepared by the student investigator and submitted to Concord Manufacturing Company.

The duration of the project is estimated to be about six months, starting at the end of May, 1974, and ending at the end of

November, 1974. The student investigator shall spend the first three months on location at the Concord Manufacturing Company and the remaining three months at Michigan Tech. The time spent at Michigan Tech shall be dedicated to preparation of the final report to the Concord Manufacturing Company.

The academic advisor shall spend an estimated two weeks on the project during the summer months, on company location. He shall also spend several weeks on report preparation with the student investigator after his return to Michigan Tech from the summer assignment. Time spent by the faculty advisor on campus in excess of one week shall be considered as contribution towards the project by Michigan Tech.

The coordinator of the MTU University-Industry Interaction Program, Dr. K. J. Weinmann, shall be involved in the project for the purpose of assessing progress, establishing data for comparison with future projects of the program and serving as liaison between the Company and the University. Time spent by him in excess of one week shall be considered as contribution by the University.

Attached is an estimated budget to cover the costs of this project. We hope this budget is acceptable to you.

Please feel free to contact Dr. Scofield (Phone: (906) 487-2551) or me (Phone: (906) 487-2154) for any questions you may have. We are looking forward to this project and hope that it will establish a tradition of meaningful and mutually rewarding cooperation between industry and Michigan Tech.

In case this proposal meets with your approval, please let us know so that it can be formalized by contract.

Sincerely yours,

K.J.W.

Klaus J. Weinmann
Assistant Professor

KJW/clj

Enclosure

cc: G. L. Scofield
J. C. Gerdeen
R. W. Kauppila

BUDGET

1. Salaries		$3,460
a) Faculty Investigator		
R. Kauppila	1 week on campus 2 weeks off campus	
b) Coordinator		
K. Weinmann	1 week on campus	
c) Student - Fall Quarter Stipend		
2. Travel (Faculty Investigator and Coordinator)		500
3. Report Costs		200
4. Total Direct Costs		4,160
5. Indirect Costs		1,560
TOTAL BUDGET		$5,720

CONCORD MANUFACTURING COMPANY

405 SOUTH MICHIGAN STREET • CONCORD, MICHIGAN 49237 • (517) 524-8970

June 24, 1974

Dr. Klaus Weinmann
Michigan Technological University
ME-EM Department
Houghton, Michigan 49931

Dear Dr. Weinmann

I have been authorized to offer $4,000 for the total cost of this project. My thoughts on how this money should be allocated is as follows:

Students portion	$2,500.00
University's portion	$1,500.00

It is my hope that the University will supply a professor on site for at least one day and some lab facilities will be available. Professor involvement is of utmost importance to me so that the goal of the total program, of making college more relevant by exposing instructors to real industrial problems, is to be reached.

If I can get away, I am tentatively planning to visit the Tech campus from the evening of July 3, 1974, to July 7, 1974. If it can be arranged, I would like to visit with you and Dr. Scoffield during my stay. Please let me know.

Sincerely yours,

Camiel E. Thorrez
Plant Manager

CET/skh

BUDGET FOR CONCORD MANUFACTURING CO.

Kauppila (3 days off-campus, 2 days on)	$ 550
Weinmann (2 days on-campus)	170
Fringe Benefits	130
Travel	250
	$1,100
Overhead	410
TOTAL	$1,510

7/2/74