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DEVELOPMENT OF UNIVERSITY/INDUSTRY COOPERATIVE RESEARCH CENTERS: HISTORICAL PROFILES

INTRODUCTION

The University/Industry Cooperative Research Centers Program (UICRC) has now been in operation long enough to have acquired a substantial body of experience. Many of the prescriptive lessons learned from this experience have been summarized in a companion volume, the Practice Manual. But it is also helpful to have the details of others' experiences made available so that one can test for possible parallels in behavior. Thus, the purpose of this volume is to summarize in a brief compass the development and current state of the seven active UICRC's (this excludes only the MIT Polymer Processing Center, now operating independently of NSF).

The effort to document the development of the Centers has been of necessity primarily a post hoc exercise. The creation of the Division of Industrial Science and Technological Innovation brought the UICRC program together with the Innovation Processes Research Section to provide a focus for assessment of Center operations. UICRC staff had recognized the need for assessment of each Center and had in all but one case built an assessment component into the final grant awards. IPR staff provided the expertise for developing a framework to make comparisons among Centers. The IPR

these cases rests with the Center evaluators -- personnel associated with (but not part of) the Centers themselves -- and only editorial judgment has been applied by the NSF staff in this compilation.

The experiences in these cases are a sample -- but only a sample -- of what future Centers may expect to encounter. One of the themes which clearly emerges from these pages is the degree to which the peculiar circumstances of both university and industrial bases -- the organizational and cultural context of the research area -- will shape the evolutionary process. Other Centers, in other universities and industries, can expect to encounter their own range of odd and wonderful happenings.

Again and again, we see that the issues most hotly debated at the planning phases of a Center -- patents, publication delays, and the relative priority of basic and applied research -- tend to become non-issues once operations begin. The issues most salient in the operational phases -- pressure for results, reporting procedures, and time allocations -- are hardly thought about at the earlier stages. To the degree that later concerns can be anticipated and coped with earlier, the whole process will be more efficient.

The Practice Manual which parallels this case summary is a sort of road map through these cases, and should help the reader to navigate the twists and turns, and more fully understand the paths these Centers have taken. Seeing what others have been through may offer at least some ways to anticipate how the general issues described in the Practice Manual are played out in the real world.

UNIVERSITY OF MASSACHUSETTS

CENTER FOR U-MASS/INDUSTRY RESEARCH IN POLYMERS

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The Center for U-Mass/Industry Research on Polymers (CUMIRP) is designed to establish a permanent industry-sponsored, self-sustaining Center for University of Massachusetts and industry cooperative research in polymer sciences and technology. At this writing, CUMIRP is approaching the end of the second year of successful operations. Thirteen companies have committed themselves to three-year memberships and fifteen faculty research project have been initiated. More importantly, industrial members have expressed enthusiasm for the potential of the project and continue to support its development.

Current Structure and Organization

The project is jointly funded by the National Science Foundation and the industrial members. For the first three years NSF contributes roughly $250,000 each year, then decreases its contribution to $150,000 in the fourth year, and $125,000 in the fifth year. Thirteen industrial members

Industrial Program Monitors: Monitors are bench-level industrial scientists selected by the CUMIRP industrial representatives. They are responsible for reviewing specific CUMIRP activities of interest, interacting with faculty around these scientific projects, and communicating useful results to interested scientists in their corporation.

Ph.D. Students and Post-Doctoral Scientists: These students and scientists from the UMass PSE department work under the scientific direction of faculty conducting CUMIRP projects.

Principal Investigators: The two principal investigators are totally responsible for maintaining a research program of mutual interest to industry and the PSE faculty, interacting with UMass administration, and handling the apportionment of funds.

Project Director: The project director is principally responsible for the administrative concerns of CUMIRP including the maintenance of coordination with industry and NSF, and working closely with the steering committee to carry out its administrative intentions.

Faculty members reserve the right to publish in scientific journals the results of the research conducted within the CUMIRP Project. The sponsoring companies, however, have the opportunity to review any paper containing results of the research program prior to submission of the paper, and have the right collectively or individually to delay publication for as much as one year. For all inventions conceived or first actually reduced to practice in the course of CUMIRP research, the university will apply for a patent and grant a non-exclusive royalty-free license for the life of any U.S. patent (or patent applications) to each company which is a sponsor at the time of the particular invention covered by the patent. Interested companies must agree, however, to pay a share of patenting

already contributed to the UMass PSE department through the Unrestricted Grants program. Faculty members were concerned that the development of a large cooperative project could lead to declining interest in unrestricted grants. The faculty were also concerned about the possibility of creating another set of administrative responsibilities, not to mention the amount of effort that would be required to develop the grant. With these concerns in mind, there was still a general consensus that the development of such a cooperative relationship could be a useful undertaking.

During the same period, the PI's were in contact with officials of NSF. Abstracts of potential research projects were collected from interested faculty, and all faculty were mobilized to contact their scientific colleagues in industry to float the idea of the project and to receive any suggestions from them.

Early in 1979 a major impediment to the development of CUMIRP was overcome when the PI's discovered that a recently retired research manager from a major corporation would be available to work with them. Because of his background he was able to work with the principal investigators without having to rely entirely on their association with scientists in the industry. Working together, the PI's and the consultant were able to bring together the desires of the faculty and the suggestions they received from industrial contacts to submit a planning grant to NSF in May 1979.

Planning Grant Period

Planning grant funds were received in September 1979 and the consultant joined the UMass PSE department as the CUMIRP program manager. Once again, the contacts of the faculty (and of the recently hired consultant) were used to establish the identity of the highest appropriate corporate

organization. There was very quick agreement favoring a fixed yearly fee schedule as opposed to a sliding schedule based on corporate sales. It also became clear that many industrial representatives preferred that the faculty involve themselves in research concerned with fundamental ideas and concepts in polymer science focused around a single or limited number of scientific themes. It was agreed that the theme of "functional and post-reactive polymers" was of interest to most industries present. However, the discussion did include suggestions for some changes in broad research topics. These suggestions seemed mutually agreeable and advantageous to both industrial and university interests. Industrial representatives were given abstracts of faculty research proposals for examination.

During February 1980 the principal investigators and planning grant program manager met together with UMass/PSE faculty to consider the results of their first meeting with potential industrial members and to reformulate a research plan. It was proposed that research through this cooperative organization should focus on exploring areas of fundamental polymer science judged to have the greatest potential for advancing polymer technology. It was proposed that research projects start in areas of existing strength for the PSE faculty, ultimately leading to new areas of high interest common to both industry and faculty: network polymers, extended lifetime polymers, and techniques for monitoring polymer post-reactions. An organizational structure and a proposal for three-year commitments with a fixed fee for each industrial member were formulated for presentation at the February meeting with potential industrial members.

The February 1980 meeting with industrial representatives, the principal investigators, the program manager, and the NSF representative was held at Hartford Airport. Twenty-one companies were represented (some of those

discussions with corporate managers. Private discussions, especially with those compasanies with which the department enjoyed long and friendly relationships, established an unofficial but firm understanding that CUMIRP would not be considered a substitute for contributions to the unrestricted funds program.

In April 1980 the CUMIRP grant proposal was submitted to NSF. At the same time, Letters of Intent to participate were requested from all companies that had attended the initial meetings. In June 1980 a meeting was held at UMass and attended by 13 industrial representatives whose corporations had returned Letters of Intent. By this time there was essential agreement about the issue of patent rights for CUMIRP participants. There was some discussion of the protection of information and the participants' right to a one-year lead time on all publications. This discusssion was, however, not considered terribly crucial. The research to be conducted would be of a fundamental nature, and the protection of proprietary rights to information seemed unimportant for most cases. The first part of the meeting was, in fact, concerned with more general discussions of the structure of the advisory committee and the industrial monitoring system. A budget for the first year of CUMIRP was presented by the principal investigators. The last half of the meeting was taken up by faculty presentations of first year proposals.

By July 1980 industrial representatives had had another opportunity to look over faculty proposals and to indicate their interest in them. The levels of expressed interest by the corporate representatives varied widely across companies. There were, however, no overtly negative responses to any of the proposed research projects. During this same period, the steering committee reviewing the faculty proposals decided to fund 15 projects

During this October meeting several industrial representatives suggested that time be set aside during the advisory committee meeting for a private caucus of industrial members. Although there was not complete agreement that this was a useful idea, it was finally decided to arrange for this closed caucus at future meetings. In general, it was thought that there could be issues of particular concern to the industrial representatives which they would like to discuss among themselves and about which they would prefer to express opinions with a single voice. In particular, it was suggested that because steering committee members were also members of the UMass/PSE department, they could face difficult problems with internal politics concerning decisions on funding and defunding of research projects proposed by colleagues. Some industrial representatives felt that the political difficulty of this position could be reduced by the presentation of recommendations and criticisms expressed specifically by the industrial members.

By January 1981 members of the CUMIRP steering committee were already involved in intensified recruitment of new industrial members for CUMIRP. The first meeting of the industrial monitors was held at the university in February 1981. Monitors are selected by the industrial members on the advisory committee to be involved in substantive aspects of the research projects. During the first meeting, monitors were introduced to the faculty, given a tour of the facilities, and introduced to graduate and post-doctoral students. After the presentation of a general overview of CUMIRP, each faculty member presented a short research paper.

Following these short presentations, monitors were given a list of the research projects and asked to make priority ratings of those they would

The recommendations put forward by the caucus of industrial sponsors represent a recognition that CUMIRP is rapidly approaching another important step in its development. As the next phase of CUMIRP approaches, it becomes increasingly important for the industrial members to express their interests and priorities in the funding of scientific projects. During the first phase it was important to get the projects started and to involve as many faculty as possible, working in areas of established strength. However, the next phase of the CUMIRP Project is described as one in which there will be a sorting out and testing of potential new major themes identified under Phase I, an evaluation of the progress toward goals of the CUMIRP program, and the re-establishment of directions as needed. During the next phase, research proposals will have to be more focused and almost inevitably some proposals will be rejected.

During April 1981 the steering committee received 17 faculty proposals for CUMIRP research during the second year. Ratings of interest in each project were solicited from each of the industrial members before decisions were made by the steering committee; one of the project proposed was dropped as a result of this process.

Current Issues

Background: A variety of important preconditions helped facilitate the development of CUMIRP. In some cases, from either the academic department's point of view or the industrial participant's point of view, certain preconditions were indispensible. First, the UMass PSE Department is one of the top three, if not the best, department in the world. This fact was mentioned as a major attraction by every industrial representative interviewed. Second, industrial representatives mentioned that they are inter-

the last decade or so, there has been some disappointment about the number of science students applying to polymer science graduate programs. On a national level, many of the best students have gone into other fields or have entered industry at high salaries after the bachelor degree. Polymer science departments across the country have accepted a disproportionate number of foreign students who tend to return to their own countries to work after graduation. Industrial laboratories have had to recruit scientists from other related fields and train them as polymer scientists in their own laboratories. As a consequence, companies have taken a considerable interest in promoting advanced education and especially education which will ready students to enter industrial science careers on graduation.

Potential Benefits: One of the more significant benefits of CUMIRP is the participation of industry in furthering research on ideas and concepts and being exposed to major trends on the cutting edge of polymer science and technology. It seems clear that large corporations such as those involved in CUMIRP are most capable of benefiting from minimal or diffuse influences on research that advances fundamental scientific knowledge. The CUMIRP Project is structured to give the possibility of competitive advantage to participating companies. However, the fact that research is directed toward fundamental ideas and concepts reduces the importance of these particular benefits. Most members of CUMIRP do not expect there to be any patentable ideas to come out of research done within CUMIRP.

In a general sense, more vigorous pursuit of research support from the private sector seemed a prudent strategy to establish a more secure base of funding. In the 1980-81 academic year, with the addition of a number of industrial grants as well as CUMIRP, approximately 24% of the department's

understood to be a uniquely useful organization compared to other available mechanisms.

One unusual feature of CUMIRP is the bringing together of an entire department, as well as scientists from other departments, to work on independent research projects around a common theme. It is expected that this organization of a "critical mass" will facilitate perceptibly better and more creative scientific work than the funding of totally independent projects.

One major intent of CUMIRP is to create an organization that will support fundamental research initiated and directed by university scientists, while at the same time facilitating the industrial advisory committee's participation in the general direction of these research projects. At this point it is not yet clear how well this relationship will work. On the one hand, how much influence or guidance of scientific judgement will, or should, the academic scientists accept? On the other hand, to what extent will the industrial participants attempt, or should they attempt, to inflence the direction of fundamental research?

CUMIRP is organized in such a way that its success depends on the enthusiastic participation of a large number of faculty. The PSE faculty are scientifically vigorous, conducting a large number of research projects, and have been very successful at finding grant monies to support their research. They are not desperate for new sources of money. In this sense, the talent and competence of faculty that is the strength of CUMIRP is also a potential source of organizational problems. During the first round of funding decisions by the steering committee, it was decided to fund 15 projects rather than the intended 12, in part because the committee felt it was important to include as many faculty as possible in the early

tigators) has been a crucial factor in the successful development of the CUMIRP Project. As the project matures it will be necessary for the project director and the principal investigators to reassess the partitioning of their responsibilities continually.

The initial year of CUMIRP included the participation of 13 industrial members. The results of the original recruiting efforts might have led to a considerably larger number of industrial members. However, it is the opinion of the project director and the principal investigators that the participation of a significantly larger number of companies during the first year would have made administration very difficult. As the number of participating companies increases, it will be important to monitor the continuing effectiveness of administrative and reporting procedures. Moreover, it may eventually become necessary to set a limit on the number of particpating companies in order to ensure the effective and satisfactory operation of the project.

A number of factors that will affect industrial members' satisfaction with CUMIRP have to do not so much with the organizational structure as with the collective expectations and needs of the participating companies. While these issues will certainly be discussed or arise within the CUMIRP organization, they are in some respects independent of it. The bottom line for the satisfaction of industrial members is the productivity of the faculty in generating scientific advances that are in areas of interest to the companies.

While this is a continuing and fundamental issue, because of the quality of faculty scientists it is not a particularly concerning issue to most of the companies involved. Given the relatively small contributions required by each particpating company, even a very few substantive advances

that CUMIRP hold a competitive auction to gain exclusive patent rights. The fundamental focus of CUMIRP research also diminishes the advantage of delaying research publications. It appears that most industrial members understand the improbability of gaining competitive advantages in the short term.

The organization and structuring of CUMIRP is more likely to yield benefits to corporations which are large and diversified. Obviously, no single company can influence the choice of scientific projects to be undertaken, but all companies may have some influence. There is already some evidence that less diversified companies can more easily become concerned about the direction of individual research projects and more intense in their demands for meetings and the exchange of information on those projects which do interest them.

In many respects the interests of faculty scientists are compatible with the interests of industrial scientists. There are, however, some special difficulties. Academic freedom is a most jealously regarded responsibility and right. The desire of faculty to pursue research questions of their own devising has made unrestricted government grants so popular, and has in parallel caused some dissatisfaction with individual faculty grants from industry. The smooth operation of the publication delay process will be of the utmost importance in keeping faculty interest and commitment high.

February 1980 — Meeting with companies and NSF (21 companies attend) (Hartford Airport). Presentation: new version of project, agree on goals and structure of relationship, sketch of timeline, research topic areas. Go ahead: industry agreed, no more meetings needed before NSF grant proposal submitted.

March 1980 — Faculty propose topics and general descriptions of research.

Faculty research topics sent to companies.

Industries respond to research topics; no negative responses.

April 1980 — Submission of CUMIRP grant proposal to NSF.

Letters of Intent requested from companies.

June 1980 — Meeting with industry representatives (13 companies and NSF) at UMass.

Agenda: 13 Letters of Intent received from industry; discussion of language in agreement; freedom of information issues; patents; budget for 1st year; structure of industry advisory committee; industry monitors; publication of research.

Research proposals: all faculty present research proposals in more detail.

July 1980 — Industry responds to description of faculty research proposed. Levels of interest varied across projects depending on company, but no negative responses.

PI's decide to accept all faculty proposals to get broadest participation (15 projects).

September 1980 — NSF officially approves grant.

Research projects get underway.

October 1980 — Meeting 13 industries and NSF (UMass); most have signed agreement.

Agenda: Review faculty research projects; budget; UMass/industry communications; update of CUMIRP progress; discuss industrial committee closed meetings; publications approval process.

January 1981 — Intensifying process for recruiting new CUMIRP industrial members by project director.

OHIO STATE UNIVERSITY
CENTER FOR WELDING RESEARCH

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The Center for Welding Research (CWR) at Ohio State University is currently in its second full year of operation. It is organized to conduct basic and applied research on problems associated with welding in all its varieties, for applications from tank cars to computers. Thirteen companies are currently members, and six research projects are underway. Welding is a field currently undergoing some substantial changes resulting from automation and other developments, and CRW represents a significant response by Ohio State and industry to these changes and developments.

Current Structure and Organization

CWR is jointly funded by NSF and industrial participants. For the first year NSF contributed $265,000; this contribution will decrease to $120,000 in the fifth and final year of Federal support. The companies have signed a three-year commitment at $30,000 per year. CWR is expected to increase its number of industrial participants during NSF funding.

this challenge was particularly difficult, since the entire full-time faculty consisted of Chairman Roy McCauley and Professors David Howden and William Green. In fact, the continued existence of this academic department was under serious review by the university.

During 1976-1978, Howden, Green, and McCauley pursued a number of possible sources of cooperative support. However, measureable progress was not apparent until decisive events in the spring of 1978. At that time, Dean Glower announced to the College of Engineering's "Committee of 100" (a group of leading industrial executives who were OSU alumni), the formation of a program called "The Engineering College Alliance with Industry." That alliance was intended to promote mutually beneficial cooperative ventures between the departments of the College of Engineering and the industrial community.

At the same time, Dean Glower pursuaded McCauley to relinquish the Chairmanship, which he had held for some twenty-five years, and to concentrate his efforts on developing a Welding Institute at OSU. Karl Graff, Professor and former Chairman of Engineering Mechanics, was named to head a search committee to recruit new faculty and a new chairperson for Welding Engineering.

Initial contact between Alex Schwarzkopf of NSF and Dean Glower and McCauley was made in January 1979. Professor McCauley followed the NSF funding possibility, while Professor Howden pursued an alternative funding possibility through the then-current Cooperative Generic Technology Centers program of the U.S. Department of Commerce. It soon became clear to OSU that the NSF program was the more viable prospect. Before a proposal was prepared McCauley attended a NSF Principal Investigators Conference and visited other Centers. In May 1979 a proposal for a planning grant was

The department had an ongoing research program which was heavily interdisciplinary, and they would have preferred to fit the Center into the departmental program for ease of administration and control. However, NSF recommended that the Center remain independent of any academic department. Internally, OSU procedures require that interdepartmental centers go through a rather elaborate approval process including approval by the Graduate School, by the Graduate Council and by the Provost. In the interest of expediting the process, Robert Redmond, Associate Dean for Research of the College of Engineering and Director of the Engineering Experiment Station (the research administration arm of the College), arranged for Lauer and Schwarzkopf of NSF to meet directly with Provost W. Ann Reynolds to work out the necessary arrangements. Graduate School approval was obtained concurrently and university approval for establishing the CWR was obtained.

A second potential problem involved the drafting of a patent agreement which satisfied the requirements of prospective industrial sponsors. In this case the College of Engineering had a precedent. In founding the Advanced Design Methods Laboratory (ADML) at OSU, the General Motors Corporation had prepared a prototype patent agreement. The University had to modify its traditional patent posture substantially to accommodate the ADML patent agreement. CWR's draft patent proposal relied heavily on ADML's experience, as well as that of MIT's Polymer Processing Laboratory.

Normally the university retains the right of first refusal to pursue patents and to receive the income from the licensing of those patents. In these cases, the university assumes the cost of the patent application. Under the revised policy, the CWR will act as the University's agent in determining whether or not to pursue a patent, the cost of the patent and any income generated from it would accrue to the Center and the University

fication Under Time Dependent Power Variations," (3) "Improving Weldability of Shielded Metal Arc Welded Pressure Vessel Steels," (4) "Improving Strength Characteristics of Resistance Welded Structures," (5) "Weld Discontinuity Analysis." Some ten different OSU faculty drawn from three academic departments (Welding Engineering, Metallurgical Engineering, and Engineering Mechanics) were identified with the five projects.

The presence of planning grant funds made formal proposal preparation procedure considerably more efficient than such processes usually are. The cost to the university of contacting potential industrial sponsors, preparing the presentation materials, and marketing the Center concept was underwritten by the planning grant. Consequently, the plan was much more professional in its execution than is typical of similar university efforts, and was quite impressive to the potential sponsors. Furthermore, two meetings to structure an initial research plan were held with potential sponsors near the end of the planning grant period.

Early Operation of the Center

In July 1980, the first meeting of the Center's IAB was held at OSU. By that time commitments for participation had been obtained from Bishopric, Caterpillar Tractor, GATX, General Electric, General Motors, and Westinghouse. In addition, Boeing, Columbia Gas, and John Deere & Co. attended the meeting as observers and potential members. The one and one-half day meeting featured presentations by OSU researchers on the proposed projects, rating and selection of projects by IAB members, and discussions of Center organization matters.

The assessment of research projects by the IAB members was conducted by Professor George L. Smith, NSF Project Evaluator, with McCauley and

in royalties. Since each company's corporate legal staff was involved, this meeting just initiated the dialogue.

Membership issues went beyond the matter of participation in royalties. There was concern about companies "buying in late" to get access to research and not paying the bills. Another issue was whether or not equipment grants could be offered in lieu of cash payment of membership fees. Finally, the question of associate membership (non-voting) at a reduced rate was raised. The IAB instructed the CWR Director to prepare a proposal for ratification at the next meeting. That proposal was to define the rights of an associate member, who would qualify, and what fee would be appropriate. Of particular concern was the presence of equipment manufacturers who could have access to technological breakthroughs without full financial participation in support of CWR.

The Board voted to meet tri-annually and established the dates of October and February as research reporting meetings and June as the Annual Meeting. In addition, a CWR-recommended policy for ratifying proposals was discussed. Since ratification by mail was too cumbersome, new research project proposals would be distributed to IAB members through the mail and voting would take place at a meeting of the board (most likely the Annual Meeting). The IAB gave McCauley the responsibility for preparation of bylaws for ratification at a future meeting.

The discussions which accompanied project presentations and the rating and ranking seemed to reflect a concern on the part of some, if not all, of the board members about the sophistication of the researchers and the instrumentation available at OSU. In fact, one member company hesitated to have top management visit the Center because of its physical appearance. Whereas researchers were inclined, for example, to "build up" equipment to

development of the policy was particularly difficult since the parties who ultimately had to approve the policy (industry patent attorneys and university administration) worked through IAB and Center staff as agents. Deliberation in board meetings had an air of futility, since neither the IAB members nor Dean Redmond, who assumed responsibility for managing this matter for the university, had decision making power. The agreement has been signed by all parties and only one relatively minor matter requires further definition.

Concerns about "later joiners" participating in patent income have been resolved by making only companies holding membership at the time of the patent disclosure eligible to participate. Also, the IAB wanted assurance that revenues would flow into the CWR to provide additional support for research programs. As was already mentioned, that concern was accommodated through a major shift in the university's basic philosophy of maintaining control over patent rights to vest such rights with the CWR.

The university's proposal for allowing equipment manufacturers and small industries to have nonvoting membership in the Center for $10,000 per year was rejected by the IAB. Also rejected was a proposal to allow equipment grants in lieu of the membership fee.

One innovation was introduced by an IAB representative. Most of the research topics which were initially proposed by OSU research investigators were based on problems which were central to their research interests. In the case of micro-joining, however, the research topic was introduced at an IAB meeting via a presentation by the interested company's representative. This company was unique among member companies in its interest in the topic. This led to the scheduling of a "generic" workshop on micro-joining open to member and nonmember particpants, which was held in June 1981. That

Continuing Issues

A survey of the IAB representatives from all participating companies reveals four basic reasons for support of the CWR:

1. To develop new and improved welding processes for use in-house and for possible marketing.
2. To provide a source of qualified welding engineers and the active recruiting of them.
3. To assess current in-house welding technology and provide contacts for "problem solving."
4. To provide a means for interaction with industrial peers.

The payoffs to OSU have been somewhat more direct; the presence of the CWR has been crucial to the survival and growth of the Welding Engineering Department. The university's decision to retain the Department in combination with the availability of NSF funding of the CWR was significant. This meant that OSU had much higher stake in this particular operation than normally accompanies university efforts to secure funding. The unique and distinguished history of the Welding Engineering Department was certainly significant in NSF's interest in OSU. Furthermore, the Welding Engineering Department's normal mode of operation was multidisciplinary and the ongoing research program was substantially interdisciplinary, making the Center concept natural.

The fact that the faculty recruited by OSU had established research reputations was also positive. In fact, when Dr. Richardson came from Caterpillar, the firm became charter members of the CWR. Professor McCauley's distinguished career as a researcher and as a consultant was effective in opening many firm's doors. While some OSU alumni participate in the Center, there is no evidence to suggest alumni contacts influence Center participation. In fact, several prime candidate companies who have alumni in positions of responsibility have yet to join the Center. Reasons

A potential problem which did not prove serious was the divergent research interests of some IAB member companies. One company has unique interests in micro-joining, while the interests of the others cluster into two other welding priorities. The CWR has been able to give all of the divergent interests a piece of the action.

Concern was also voiced that the CWR researchers may not be adequately informed about the state of the art in industrial research and practice. There was a strong sentiment among IAB members that the CWR researchers interact with the research and development people in the member companies through visits to companies. The inability of OSU to staff the resistence welding project led to some general concern about whether or not there were sufficient personnel available to carry out the other research porjects. The concerns were not expressed in a context of dissatisfaction with the CWR but as part of an agenda of improvements important to CWR's ultimate success.

The meeting dates of the IAB are not yet coordinated with the academic schedule of the university. Thus, investigators are under pressure to generate progress reports at peak demand times in the academic year. This is a problem which has just been recognized and the dates of the meetings will probably be shifted accordingly.

From the perspective of the research staff, the CWR projects place a heavy demand on available time. In some cases industry representatives have made excessive use of the CWR's invitation to visit and observe progress on the project. The matter is a delicate one and has not yet been resolved. For the most part, however, progress on the research has been consistent with original plans.

tion and feedback from the IAB. This role may become formalized in the CWR structure beyond the period that NSF funding would require it.

June 1981	Euclid Corporation Joins
	Micro-joining Workshop
	3rd Board Meeting
September 1981	TRW Corporation joins
October 1981	John Deere & Company joins
November 1981	Cincinnati Milacron joins
December 1981	Reynolds Metals joins

CASE WESTERN RESERVE UNIVERSITY
CENTER FOR APPLIED POLYMER RESEARCH

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In the Summer of 1981, the Center for Applied Polymer Research (CAPRI) at Case Western Reserve University became a National Science Foundation Cooperative Center. Five companies participate in the Center at present: B. F. Goodrich Chemical, Bethlehem Steel, Celanese, Dow Chemical and Hydron. The formal approval of the grant proposal represented the culmination of nearly two years of work by Case faculty and administrators, in conjunction with industrial scientists, and members of the NSF.

Polymers are the foundation for seven key industries in the U.S. -- plastics, resins, elastomers, fibers, films, adhesives and coatings. Altogether, polymer products account for about $100 billion in annual sales. The chemical industry historically has made a strong commitment to long-term research and development; it was one of the first to support company-owned research laboratories and still spends a considerable percentage of funds on research compared with other industries. Recently,

Industrial Sponsors participate in a variety of research and teaching programs designed to share information. For example, twice yearly faculty, students, and industrial scientists participate in a two-day symposium which allows students the opportunity to give research talks before an audience of industrial scientists, and provides company representatives a chance to keep up with current research and to observe students who may be possible candidates for positions in their company. In addition, the program offers short courses for the sponsors, keeps them abreast of faculty research, and offers industrial sabbaticals in which industrial scientists can study or work with a professor at Case Institute or a faculty member can spend time in an industrial laboratory.

CAPRI constitutes another element of the University's industrial relations strategy. Its organizational components are:

Center Director. The Director of the Center is responsible for coordinating research activities, executing the program's objectives, and communicating the progress and development of the Center. Other administrative responsibilities include fiscal management, chairing the advisory board of the Center, initiating communication with other potential industrial participants in the Center. One of the interesting aspects of the CAPRI organization is that the Center Director is a faculty member actively involved in current CAPRI research projects.

Steering Committee. Each company project is managed by a steering committee, co-chaired by a faculty project leader and a scientist from the sponsoring company. Other faculty members and company researchers also comprise the steering committee. The steering committee is staffed by postdoctoral research associates, industrial scientists in residence at CIT, and advanced graduate students. At least two meetings are scheduled

only one company, and there is relatively little transfer of industrial interest across the research agenda. Center integration is provided by staff interaction and by a so-called "Blue Sky project" which is less focused on direct industrial needs than the rest of the agenda. All companies participate in this project, which is allocated 15% of the research budget, and its emphasis and research directions will be largely defined by all companies acting jointly. Blue Sky will enable companies to explore long range issues related to macromolecular polymers. The emphasis here is decidedly exploratory.

All patentable inventions and discoveries that result from a project's research will be the property of the company. With respect to publications, the Project Leader will inform a company of a desire to publish materials resulting from research on the project. The companies have 30 days to review publications or request delay for up to six months. If the company feels that extra time is needed for completion of a patent application for filing, publication is delayed another six months.

If patents emerge from the Blue Sky project, patent rights are to be assigned by competitive bidding among the companies who participate in the Center at the time the patent is conceived. Any proceeds will be contributed to the Center, administered for the Blue Sky project, and will be subject to university overhead rates.

Growth is expected to occur through the expansion of existing projects and addition of new industrially-sponsored research projects. New companies would participate at the same financial level as existing industrial projects. Two new projects are expected to be added to the original four, one in the first year (Bethlehem) and one in the third year. A maximum of six or seven companies is considered desirable.

general concept, and when industrial representatives were informally contacted over the next year, about half the group indicated more serious interest in further dialogue.

After consulting with NSF officials in February 1980 and making a trip to the Center for Welding Research at Ohio State, Hiltner and Lando submitted a planning grant to the NSF. The purpose of the planning grant was to explore general methods for structuring and organizing the Center, so as to make it maximally attractive to both industry and the university. For example, the grant proposed to study methods to facilitate interaction between industrial and university representatives, patent procedures, and research directions.

In mid-May 1980, the principal investigator attended a special meeting sponsored by NSF in Hot Springs, Arkansas. The meeting gathered together scientists and administrators from existing and prospective Centers, as well as NSF officials. Its purpose was to encourage exchange of information regarding the formation and maintenance of Cooperative Centers, and to acquaint potential Center directors with the structural and organizational factors that related to the formation of an NSF Center. In early Summer 1980, the industrial sponsors heard an NSF representative, Dr. John Kaatz, speak in more detail about the Center concept. They again expressed general interest in the plan.

Planning Grant Period

In early September 1980, NSF officially notified the principal investigators that the planning grant had been approved. The $82,000 grant provided the principal investigators one year's time to explore and study the creation of a Cooperative Center on polymers. Over the next several

equal "non-exclusive" rights to patentable discoveries, there would be little industrial interest. "Where everybody has everything, nobody has anything," remarked one of the participants. Even though much of the research might not produce patents, and even though companies do not always seek patents from fundamental university-sponsored research, industries do like to have the assurance of obtaining patents should the possibility occur. Consequently, it was decided that each company should have separate rights to patent techniques and inventions that might emerge from their projects.

From an academic perspective, this was clearly an interesting idea, since it is common at many universities for the university to own the patent. But for reasons outlined above, this alternative was not pursued. The proposal that industries would be entitled to separate patent rights appeared viable and workable. However, some faculty members commented that this procedure did not allow faculty to gain the benefits they might otherwise receive if they helped to produce a patent while working for industry directly.

As the model was finalized, increasing attention was paid to the choice of industrial participants. It appeared desirable to select companies which were familiar to the department and which placed particular importance on fundamental research. After informal contacts with the companies, it appeared that five companies were likely to be most interested: B. F. Goodrich, Celanese, Dow, IBM, and Hydron. The first four were sponsors, and Hydron was suggested through contacts established by the principal investigator.

In March, the companies were contacted either by telephone or in person. In early March, the faculty investigators met with Hydron in New

one case (Dow Chemical) was commensurate with a recent financial commitment the company had made to the macromolecular science department.

Shortly after the meetings and discussions with the companies were concluded, the companies sent letters of commitment to the CIT principal investigator. On May 1, 1981, the proposal was formally submitted to the NSF. In mid-June, the principal investigator was notified that the grant had been approved.

Early Operations

Over the summer months, various administrative matters were resolved. Students and postdoctoral fellows were selected and allocated to various project responsibilities, and students were reassigned to different faculty advisors to enable them to work on particular CAPRI projects.

In July, another important development occurred. The director of CAPRI met with Bethlehem Steel representatives in Bethlehem, Pa., to discuss the possibility of Bethlehem joining the Center. Earlier, in the winter, several scientists from Bethlehem had given a presentation which intrigued the macromolecular science faculty members. Subsequently, the Bethlehem scientists were invited to Case to give a presentation, and in July the meeting between Bethlehem and CAPRI was arranged. CAPRI provided Bethlehem with the opportunity to link up to CIT's technical equipment; Bethlehem saw this benefit in conjunction with the other advantages of CAPRI, as an important reason for participating in the Center. By the fall, Bethlehem became the fifth participant in the Center for Applied Polymer Research.

In mid-September, the first meeting of the CAPRI Board was held. The meeting, held at Case Western Reserve University, was attended by represen-

considerable credibility and respect.

Involvement of the CIT Administration: From the very outset, the Dean of Case Institute of Technology played an active role in planning the applied polymer center. The Dean exerted a creative role in formulating the model for the Center, used his experience as a macromolecular scientist and knowledge of company dynamics to facilitate communication between the university and industry, and lent financial support of the College to the developing Center. This support of the College and external CIT administration appears to have helped gain industrial and Case support. Other administrative support came from the macromolecular science department chairman, who also had long experience with research in the private sector.

Long-Standing Relation with Industry: Like other high-ranking departments in macromolecular science, CIT has long-established relations with industrial scientists. As noted above, the Industrial Sponsors Program provides regular contact with industrial scientists, and many Case faculty members have other involvements with industry -- through either consulting or research grants. Thus, faculty and industrial scientists appear to be part of the same professional network; consequently, when a proposal such as CAPRI is broached, it is considered by industrial scientists in the context of years of fruitful associations and interactions.

Structure of CAPRI: One of the key aspects of the CAPRI model is its provision that industries can patent discoveries, inventions or technologies that emerge from their projects. While many of the projects do not anticipate patents, and although many industrial participants are more interested in knowledge acquisition than patents, it is nevertheless true that industries like to have the assurance that they can, in theory, patent

scientists with enthusiasm. Moreover, the small closely-knit nature of the CAPRI projects allows companies maximum opportunities to meet, observe and interact with students in the program. Since an overwhelming majority of students go on to work for industry, this clearly represents a real benefit to the industrial concerns.

The success of a cooperatively-funded Center depends upon the extent to which key constituents are satisfied with the outcomes and outputs of the program. For the participants, satisfaction ultimately hinges on the quality of the research products that emerge from CAPRI. There is presently considerable enthusiasm about the potential contributions that the Center can make. At the same time, each company is making a three-year financial contribution to CAPRI, and consequently, they expect some returns on their investment. The track record and expertise of both academic and industrial scientists suggest that a number of fundamental scientific benefits will be forthcoming.

For those industrial participants who seek or expect patents, the criteria for success appears to be straightforward and clear. But for most of the companies, patents are less important at this stage than gains in basic knowledge. How are "basic gains in knowledge" to be evaluated or assessed? Some participants mention number of publications as an easily quantifiable criterion, yet number of publications is probably not a satisfactory indicator of qualitative gains in knowledge. According to one industrial participant, the problem of assessing knowledge gain is, at this point, akin to problems in measuring creativity.

Another related problem may concern the yardsticks that different participants use to assess success or gains in basic knowledge. Do industrial and academic scientists employ the same criteria? And if they do -- as

faculty participants, one of the chief advantages of an approach like CAPRI, which relies heavily on industrial funding, is that it allows for creative, innovative research. Government grants all too frequently discourage innovation and encourage conservative research perspectives, according to some faculty. Thus, there is optimism that CAPRI can provide an environment in which innovative science can flourish.

If any dark (as opposed to blue) skies lurk overhead, they rest on the possibility that patents might begin to materialize and place faculty in the uncomfortable position of having to foresake various benefits that they would ordinarily gain from patents. However, other participants in the Center have suggested that faculty clearly have the option of pursuing consulting relationships with industry, should this appear appropriate and desirable.

For many faculty members, the possibilities of forging intellectually stimulating partnerships with industrial scientists is a highly attractive feature of CAPRI. Still, the relative merits offered by this Center, when compared with other funding options, remain an important consideration for the future.

As presently planned, CAPRI will be managed by a faculty member who chairs the Center Advisory Committee, is involved in one company project and also is faced with assorted professional responsibilities as well. Will the Center management tasks prove too unwieldy for one faculty member?

One factor that appears to mitigate strongly against this possibility is the limitation set on the number of companies that can participate in CAPRI. No more than six or seven companies will be part of the Center; this limitation is expected to allow the director to manage the Center effectively.

OUTLINE OF KEY EVENTS

Summer 1979	Case faculty and administrators learn of cooperative centers program.
	Contacts with NSF begin.
November 1979	Industrial Sponsors meeting/Center concept introduced to faculty during this period.
February 1980	Planning grant submitted to NSF.
May 1980	Conference in Hot Springs, Arkansas to exchange information on NSF Centers.
September 1980	Planning grant funded.
Fall 1980	Meetings between principal investigators and CIT Dean to develop model of CAPRI. Talk with industrial representatives to assess their interest in CAPRI.
March 3, 1981	Meeting with Hydron (New Brunswick, N. J.)
March 5, 1981	Meeting with Celanese (Summit, N.J.)
April 1981	Discussions with Dow (by phone) and B. F. Goodrich (in Brecksville, Ohio)
	Letter of commitment from companies incorporated into grant.
	Scientists from Bethlehem Steel invited to CIT to present research ideas.
May 1, 1981	Proposal submitted to NSF.
June 15, 1981	Principal investigator learns that proposal has been accepted for funding.
Summer 1981	Administrative and personnel arrangements made for project.
	CAPRI model presented to Bethlehem.
September 1981	First meeting of Center for Applied Polymer Research at Olin Hall, Case Western Reserve University.
Fall 1981	Bethlehem formally joins CAPRI/Work on projects begins.
Winter 1982	Work continues as industrial and academic scientists begin to meet.

RENSSELAER POLYTECHNIC INSTITUTE
CENTER FOR INTERACTIVE COMPUTER GRAPHICS

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The Center for Interactive Computer Graphics was formed in 1977 with four firms participating. Currently, there are over 27 industrial participants in the Center. The research program of the Center is jointly funded by the National Science Foundation and industry. The initial NSF commitment in 1979 was $270,000; for 1981, it has declined to $210,000. The overall industrial commitment in 1981, on the other hand, was $433,000 for general support and $75,000 for specific contracts.

Current Structure and Organization

The Center for Interactive Computer Graphics is a unit within the School of Engineering. The Director of the Center reports directly to the Dean of Engineering. In developing this structure, the objective was to keep it from becoming a captive of any specific academic department. This has helped in avoiding any duplication of conventional teaching and research conducted by any specific academic department.

departments. Their Center research becomes the basis for theses and dissertations. Moreover, the students have been hired by the industrial sponsors for summers. The Center has hired post doctoral and visiting faculty persons in its program. This helps promote better interaction between RPI and other institutions.

The Center has a program to promote better linkage with industry through cooperative research; this is the component of the Center's activities which most closely resembles the work of the other Centers. The Industrial Associates Program involves companies who contribute an annual fee ($20,000 currently) to the Center. The funds are used primarily to support graduate students and research staff. The Industrial Associates help provide guidelines in terms of selection of research projects. On an informal basis, the Industrial Associates review the progress of the projects. The Associates participate in three formal technical reviews a year where the projects are reviewed and discussed. The Companies share the results of the work done at the Center.

One important aspect of the Associates Program is the direct and personal contacts maintained with the Corporate representatives and the Center personnel. A graduate student working on a specific project often works closely with the Industrial Associate interested in the project with respect to information and evaluation. The student frequently accepts summer employment with the specific company. This fosters a close collaboration with the participating companies.

The scope of the research program at the Center involves several areas including graphics, geometric modelling, analysis, data base management, and manufacturing interfaces.

This area was not unfamiliar to RPI. In 1970, Lester Gerhardt had become Chairman of Electrical Engineering. His background with Bell Labs had familiarized him with a then-current graphics system called IDIIOM (originally developed by an RPI alumnus), and he had secured this system for use by his department on a limited basis. In 1974, another graphics package called ADAGE had been acquired. The Electrical Engineering Department had two graphics-oriented computers, and the Civil Engineering Department had one. In 1975, Larry Feester became Chairman of Civil Engineering; in his previous work at Colorado, he had been closely involved with computing and graphics, and was disposed to support such an initiative at RPI. Thus, there was a sound basis for this commitment to the development of a general graphics Center.

Initial contacts were made with General Motors, which was at that time beginning its major commitment to CAD/CAM, and with General Electric and other companies. GM's Vice President for R&D and GE's Vice President for Technology were at that time both on the RPI Board of Trustees, and were heavily involved in the planning for this graphics initiative.

At about this point, some RPI faculty members contacted NSF regarding possible support for such a Center. No formal proposal was made even for planning purposes at that time, however, since the school was given to understand that the possibilities for such funding were at that time extremely slight. Original funds for Center development came largely from RPI centrally (which had just received a very large gift from the President of Texas Instruments Corp.) and from GM.

Initially, it was thought that a supplier might be found to take over the operation of the entire graphics Center. However, although many suppliers indicated interest in participating in such a Center, none was in a

for the past four years. The total extramural support for the Center has grown from $49,000 in 1977-78 to a projected $874,000 in 1981-82. Since 1979, when NSF funding was first received, the private sector funding has been increasing by a fast rate. This funding level significantly exceeds the original estimates made in the grant proposal to the NSF.

Current Issues

Discussion with the Center personnel showed that the most important feature on the benefits to be generated by the Center are the general expansion of knowledge in the interactive computer graphics and CAD/CAM areas, the expansion and enhancement of both undergraduate and graduate student training in interactive computer graphics and CAD/CAM, and the enhancement of graduate students' understanding of industry and opportunities in industry.

The important feature of the Center's benefits appear to be an exposure to major trends in interactive computer graphics beyond what can be done in industrial laboratories, an opportunity to influence the general trend of university research toward industrial problems, the enhancement of current in-house research projects. The development of patentable products and development of commercialized products are in decreasing order of importance.

The Center has already realized several benefits. An improvement of the general knowledge base, assistance to companies by providing better recruits, an improvement of current research projects, an initiation of new projects, and completed projects which improved industrial productivity have all been substantially realized. In general, satisfaction with the Center program is high. Center personnel report particular satisfation

OUTLINE OF KEY EVENTS

1974 George Ansell became Dean of Engineering School

Reorganization of the School took place under Dean Ansell

Lester Gerhardt became Chairman of Electrical & Systems Engineering Department

Paul Derusso became Associate Dean of the school

Larry Feeser joined from University of Colorado as Chairman of Civil Engineering and strengthened the interest in computer graphics

"BUILD" program for the Engineering School initiated

Computer Graphics was chosen as a target area in the school program

1975 Discussion with the trustees continued

President Gross left RPI

Search for a President began

Herb Freeman joined the Electrical and Systems Engineering Department from NYU

Feeser, Gerhardt, Freeman actively involved in Computer Graphics

Informal discussion with GE and GM continued

Trustees supported Computer Graphics strongly

1976 Feeser, Gerhardt and Derusso responsible for Graphic Center Project

George Low became President

Discussion for equipment selection with vendors

Meetings with ouside advisers from GE, GM, MIT, etc., in terms of equipment needs, activities

RFP for equipment finalized and response from vendors by 12/76

Decision for hiring a director made and search initiated

1977 Responses to RFP evaluated

Orders for two Prime 500 and 36 Imlac terminals placed

GM made a major gift for the Graphic Center

NORTH CAROLINA STATE UNIVERSITY

COOPERATIVE RESEARCH CENTER FOR COMMUNICATIONS AND SIGNAL PROCESSING

Denis Gray

Department of Psychology

North Carolina State University

In August 1981, North Carolina State University (NCSU) was awarded a one year grant by the Division of Industrial Science and Technological Innovation of the National Science Foundation to plan and possibly establish a University/Industry Cooperative Research Center for Communications and Signal Processing (hereafter called Center). Communications here means the science and art of transmitting information from one place to another using electrical means; signal processing is the process of extracting, adding or otherwise altering the information contained in an electrical signal. Since the initial planning process has indicated substantial interest and support, a formal application has been submitted to NSF to establish such a Center. However, since the planning process is still ongoing it should be reemphasized that the Center described in this report along with its organizational structure, procedures and research agenda, is still evolving and is likely to change during the next critical few months.

At biannual meetings the Center Director, after meeting with the University Research Program Committee, submits a research proposal and a fiscal proposal to the board. The research proposal contains a number of research projects. Board members review these research projects. The board may recommend that projects originated by the director be modified or dropped or that new projects be added. Similarly, the board advises on the fiscal proposal which determines how the Center funds are to be used. The recommendations of the board are forwarded to the Dean of Engineering, who has final authority over the research program, allocations of resources, and Center bylaws.

Academic Policy Committee. The Academic Policy Committee consists of the Associate Deans of Research of the School of Engineering and the School of Physical and Mathematical Science, and the department heads of Computer Science and Electrical Engineering. The functions of this committee are (1) to help the Center Director insure that the research proposed to the Industrial Reseach Board is consistent with university goals; (2) to coordinate manpower, space and equipment requirements with the Center; and (3) to provide direct information to the departments regarding the activities of faculty members contributing to the Center.

University Research Program Committee. This is a committee made up of the university faculty who do the research for the Center. This committee helps the Center Director determine research projects to be proposed to the Industrial Research Board.

Industry Program Monitors. There will be industry program monitors selected by the sponsors. Their function is to provide a mechanism for technical interchange between sponsors, technical personnel, and Center

Pre-Center Development

A number of preexisting circumstances within and between NCSU and the communications/signal processing (C/SP) companies in the Research Triangle Park area probably served as major contributors to the eventual development of a proposal to establish a Cooperative Research Center. Taken as a whole, the prevailing atmosphere between NCSU and the C/SP industry during 1980-81 (the time immediately proceeding the submission of the NSF planning grant) can best be described as a informal symbiotic relationship. The mutual dependence of the university and industry was growing and was ripe for an initiative which would formalize and expand extant cooperative efforts.

Nationally, there is a shortage of well-trained engineers in the communications and signal processing industry including telecommunications, and a need to update and retrain currently employed professionals. However, there are only six graduate engineering schools in the nation with formal programs in telecommunications. Because Research Triangle Park has attracted a large number of research-oriented communications/signal processing companies to the Raleigh vicinity (at last count, seven "Fortune 500" communications or signal processing companies were located within a 50 mile radius of NCSU), the need for technical personnel and retraining opportunities in this area is particularly acute.

Coincidentally, approximately 20 faculty and 40 graduate students in electrical engineering (EE) and computer sciences are involved in studies and research related to C/SP. Although a formal program did not exist in 1980, telecommunications was the primary research area for three faculty with complementary backgrounds (transmission, switching, computer telecommunications), providing a critical mass of expertise in this area. All

discussions within the department and the School of Engineering generated addtional support for the idea and resulted in a decision to hold a University/Industry Telecommunications Conference in October 1980.

The purpose of the conference was to obtain industry support and input for the proposed telecommunications engineering program. Fourteen industry staff attended the conference representing seven companies. The industrial response to this meeting was quite enthusiastic and stimulated discussion of industry-wide training and research needs and avenues for future university/industry cooperation. A decision was made to offer a formal program in telecommunication engineering within the EE department, and the months following this conference were marked by increasingly frequent contacts between industry and university agents relating to the new training program and a number of other cooperative projects (contracts, consulting, etc.).

In February 1981, the PI learned about the NSF-sponsored UICRC program. Information about this program was relayed to the PI by a colleague in the EE department who was investigating funding possibilities for the newly formed NCMC. This colleague, based on a brief conversation with NSF representatives, urged the PI to obtain additional information about the program. During the next two months the PI, working closely with NSF staff, revised and refined a formal planning grant proposal.

Initially, the PI suggested the establishment of a Center which would focus exclusively on telecommunications research. However, NSF staff felt, and the PI concurred, that a telecommunications label and mission was too narrow and would not attract enough industrial support to sustain a Center, and would only appeal to a small minority of the faculty in the EE and CS departments at NCSU. It was decided that these problems would be remedied by expanding the purview of the proposal to include communications and

During the first months of the project, the PI was the principal, if not sole, actor involved in the project's execution. Various meetings were held with key university officials and faculty in EE and CS to explain the goals of the Center and obtain support and advice. In general, both faculty and administrators were openly supportive of and enthusiastic about the proposed Center and its goals.

At about the same time the PI began to consult with the Dean for Research about various obstacles and solutions to what promised to be a sticky debate over patents and publications. Patent problems had recently resulted in a four-month delay in a small research contract with a prospective Center member. In addition, patent and publication arrangements had been singled out by PIs at other sites as a major obstacle to finalizing an agreement with sponsors. During this period, the PI kept in touch with and sought input on this issue from the six or seven large companies who had supported the telecommunications program and wrote in support of the planning grant project. By early September 1981, the PI indicated to the program manager at NSF that he was optimistic about getting committments from a "critical mass" of six or seven companies. The program manager urged the PI to schedule a participant meeting as soon as possible (although the proposal time line did not call for such a meeting until 8 months into the project year).

At this point the PI and the program manager seemed to envision different scenarios for establishing the Center, and therefore developed different expectations for this meeting. The NSF program manager initially believed this meeting would be a critical decision-making meeting attended by both high committment companies and other companies who were just considering the concept. However, the PI's plans to keep the Center small and

pilot-test a prototype presentation for industry before the same group in one week. A number of specific concerns were also discussed at this meeting.

During the preceding few weeks the PI had become ambivalent about using a one-on-one persuasion strategy and keeping his Center small. After reading documentation on how other universities had successfully worked with a large group of companies and discussions with NSF staff, the PI no longer believed that this approach would create a center which was either unwieldy or unresponsive to academic research goals. Two considerations appear to have fostered a decision to switch strategies: reports from NSF that another university had just had a very successful large-scale planning meeting and the opinion (by the NSF manager) that because of new patent laws the "one research project per company" UICRC model was an anomaly which was not likely to be funded in the future.

On November 23, 1981 a second meeting with the Dean of Engineering and other key university officials took place. The PI told the group that he wanted to alter his action plan and suggested the approach which had just been used at another university. This approach involved developing a rather detailed formal proposal, sending that proposal to a large target group of companies along with an invitation to attend a planning meeting, holding the planning meeting and using the meeting to obtain corporate input and support.

On November 25, the Chancellor, the university attorney, EE and CSC department heads, the Dean and Associate Dean of Engineering, Dean for Research, the PI, the evaluator and several EE and CS faculty members met to brief the Chancellor on the current status of the project and describe the plan to invite a large number of corporations to a planning meeting.

afternoon sessions participants prioritized research interests, gave feedback on and refined the most popular research areas in small group discussions led by individual faculty, reported to the total group on each research area, and listened to sessions on the North Carolina Microelectronics Center and tax implicatons of membership in the Center.

Many concerns expressed by corporate representatives focused on the need for more detail on a host of issues: payment schedules, budgets, management of the Center, role of the Advisory Board, and the modified research projects. More specific concerns related to participation of foreign students in the Center, advantages of being a charter member as opposed to a late member, need for additonal faculty, and negotiability of the membership fee particularly in lieu of donated equipment.

Despite the concern of many corporate representatives about various details, written feedback on possible sponsorship appeared quite favorable. Twelve representatives indicated that they were "definitely interested" in joining the Center, while 22 representatives indicated that they "might be interested" in joining the Center and no "definitely not interested" responses were obtained. In actuality, a number of representaives who only indicated a conditional interest ("might be interested") in joining also indicated that their personal recommmendation to their supervisors would be to join. Thus, somewhere between 15 to 20 companies appeared to be favorably disposed toward membership in the Center.

During the month that elapsed between the second meeting (January 26, 1982) and the completion of the newly revised proposal for potential sponsors, the PI and approximately six EE and CS faculty met frequently to rewrite a proposal which answered previously unresolved questions and incorporated industry feedback. The revised proposal was forwarded to all com-

already agreed to join the Center. At least eight other companies were still actively considering participation. Thus, the prospects for establishing the Center appear quite favorable.

If the Center is established, a potential intra-organizational problem area at NCSU may be the relationship between the electrical engineering department and the computer sciences department. Although individuals from both entitites will be involved in the proposed reseach program, the Center will be bureaucratically located within electrical engineering. The participation of the computer science department in the Center seems important to its success. Because the computer science department does not have a Ph.D. program, participation in the Center may be in its self-interest. However, indications that they would like to establish a Ph.D. program and the possibility of (or perception of) departmental chauvinism are possible sources of friction in the future.

A potential area for university-industry conflict involves the management of individual projects. Industry representatives have been vocal in their expectations about project accountability and the need for setting and fulfilling specific milestones and goals. Such strictures are rarely imposed on academic researchers, and may be a point of contention in the future.

Feb. 25, 1982 Revised Center proposals to be sent to industries attending January meeting.

March 17, 1982 Final meeting with industry. Eleven companies attend half-day meeting. Many interested companies do not attend because they have enough information for internal decision making about the Center.

RUTGERS UNIVERSITY
CERAMICS COOPERATIVE RESEARCH CENTER

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Rutgers University

The Rutgers Ceramics Center is currently in its planning grant phase. This report covers the events leading up to and involved in that stage of its operations.

Pre-Center Development

The importance of Ceramics as a key material and a prime target for further research was identified in 1979 by a U.S. Commerce Department study of the electronics industry. Within the National Science Foundation, the materials group (Ben Wilcox, Louis Toth, and other experts) had at approximately the same time defined ceramics as an important candidate for an NSF UICRC Planning Study, and the Rutgers Ceramics Department as a leading candidate for a Planning Grant.

Dr. George Walters, Rutgers Graduate School of Management, had consulted the Commerce Department in February 1980, regarding their interest in establishing very large cooperative research Centers in robotics and other areas of technology. In responding to questions concerning Rutgers'

view of NSF Industry/University Center programs gave him a great deal of additional background on the policies and operation of such a cooperative Center. The conference proceedings were made available to ceramics faculty.

Between June and November 1980, McLaren made five trips to discuss a planning proposal with Schwarzkopf. On the fourth and fifth trips he was accompanied by Klein and Walters. The principal challenge at this time was to shift away from the preparation of a traditional scientific research proposal toward a Center planning study. The Rutgers team had an opportunity during this series of meetings with Schwarzkopf to review the success and structure of other Centers. This exposure was enormously helpful in preparing the final proposal for the planning study.

Throughout this Pre-Center Development period the University administration was alerted and many staff meetings were held. Almost from the outset Dr. Edward Bloustein, President of Rutgers University, was informed. The finished planning study proposal was delivered to Schwarzkopf on 24 January 1981 for review. The reviews were favorable and provided helpful suggestions. The NSF Program then approved the planning proposal, and it was given an effective date for financing of July 1981.

Planning Grant Period

A Ceramics Department staff meeting was called for 3 July attended by John Blum, Roger Cannon, Greenhut, Klein, Ronald McCauley, McLaren and Walters. The thrust of this first meeting, because of the way the proposal was structured, was to initiate planning and research activities leading to an Industrial Conference; a detailed, qualified industry prospect list; and

important happening were reported to the entire group Tuesday morning.

Several areas prominent in the Tuesday morning discussions were:

1. Industry asked to support basic research rather than product research.
2. There should be a provision for returning excess profits back to the participating members as well as to the University.
3. A royalty-free license for the life of the patent was essential.
4. Appropriate delays in publication for prosecution of patents were necessary.
5. The areas of research received very critical attention as noted above. They generated a list of preferential generic areas as well as individual projects in those areas.

These inputs formed the basis for the prospectus which was subsequently written. As a result of the November meeting it was apparent that University guidelines and methods of operation might have to be modified. Meetings were held with President Bloustein and all administrative personnel who would be affected by procedural changes. This included Nat Pallone (Executive Vice President of the University), Cayer, Rheinhold, Joe Whiteside (the Treasurer), Pramer, and the University Research Administration Board.

On November 19, the New Jersey Research and Development Council discussed the Ceramics Cooperative Research Center in open forum. Several potential Center members were recruited. Because of the general university interest and Bloustein's interest in creating more industrial participation within the University, a presentation on the Center was given before the Board of Trustees on December 19, 1981. There was great interest and support and further expression of interest in this project on the part of the Administration.

that the research portion would be taxed at the existing overhead rate of 58%. Ceramics had proposed that the summer salaries for staff, technicians and evaluator salary be put into the adminstrative function. The University did not agree to this but did agree to return the equivalent amount of money as a line item in the budget, amounting to about $40,000. Effectively, Ceramics accomplished its original purpose.

The Research and Administrative Board of the Unviersity was convened to review patent and royalty policy and delay in publication. They determined the Ceramic proposals to be acceptable variations of existing University policy. They did approve the policy of issuing a royalty-free license for any member of the Center, and approved appropriate delays in publication in order to prosecute the patent. Thus, none of these issues had to be reviewed by the full Board of Governors.

Those members of the proposal team who back in July 1981 may have had some reservations about dealing with the University may have had a change in attitude. In point of fact, the University responded extremely quickly. Definitive answers were received before the end of January. In a one month period all actions were cleared. The general tenor of the University's role was highly cooperative.

As soon as all of the issues were negotiated with the University Administration and the Research Administration Board, the Ceramics Department rewrote the prospectus reflecting the new procedures and structure. That prospectus was mailed to the industry on February 5, 1982. On January 13, 1982, Blum, Cannon and Walters met with Schwarzkopf and Dr. Donald Senich, Director of the Division of Industrial Science and Technological Innovation, to review a draft of the prospectus. The lead authors for this draft were Blum and Cannon. Major issues of Center structure and policies were

Principal Investigator will be Dr. McLaren. All members of the Ceramics Department will participate as project leaders, and graduate students will be assigned to work with them and/or post doctoral scientists and/or technicians.

Current Issues

Perennial issues with respect to the University and the industry have included patent policy; standard University patent policy continues for the Center but had been modified to accomodate the goals of a cooperative venture. Another point of contention is what Dodd Carr of Ilzor termed as the "trigger number" at which level the profits should be split between the industry and the University. The University has accommodated their recommendation. Both these matters were reviewed at the January 20, 1982 meeting of the Research Administration Board.

There was some disagreement on the organizational structure of the Center. Industry would have liked to have more control over the selection of the projects, while the University's position was that the ultimate responsibility for projects and project selection would be within the Univeristy. Industry accepted the University position at the November 1981 conference, realizing that there would be considerable interaction on this matter. Some also noted that the Industrial Advisory Committee and the Industrial Monitors Committee provided for substantially more interaction than they experience with their normal University research relationships.

Such issues as the opportunity to be a partial member of the Center for a lesser fee have also been addressed. There was an opinion that trade organizations might participate, but the issue of how their members would

largely in control of project initiation, selection, allocation of funds and management through a specially created steering committee.

A series of organizational plans developed to secure faculty control were rendered largely unnecessary by the commitment to basic research made by industrial representatives. Once the faculty saw this commitment, the modifications in the organization chart, project protocol, and governance were accepted. The Steering Committee which was to provide this faculty control remained in a later draft prospectus, but was removed during the NSF session of January 13, 1982 with the realization by the faculty that the revised structure with a PI and Advisory Committee together with industry monitors gave the research faculty full participation in the governance process.

The unfilled needs of industry and the research strength of the Department appear to have been matched. This match and the implementation vehicle, the Center, have sufficient support from Industry, the Department and the University to justify taking the next step -- converting the Industry prospectus into a formal proposal for a Cooperative Ceramics Research Center and then peer review of that proposal.

April 1982

Preliminary feedback from industry suggests that the unfilled research needs of industry and research strengths of the department appear to be matched. The match and the implementation vehicle, the Center, have sufficient support from industry, the department and the University to justify taking the next steps - converting of the industry prospectus into a formal proposal for a Cooperative Ceramics Reserch Center and the peer review of that proposal.

IOWA STATE UNIVERSITY
BUILDING ENERGY UTILIZATION LABORATORY

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Although there is at the date of this report no Center at Iowa State University (ISU), this report will document the activities that have taken place as this institution prepares to submit a proposal to the Department of Energy and the National Science Foundation to establish such a Center.

Pre-Center Development

The driving force behind the proposal at Iowa State is Dr. James E. Woods. Dr. Woods wears many hats. He is a professor both in the College of Engineering (Mechanical Engineering Department) and the College of Design (Architecture Department). He is also in charge of the Building Energy Utilization Laboratory.

Dr. Woods' first knowledge about the potential for such a Center came from his attendance in January 1981 at a semi-annual meeting of the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). There he heard Dr. Donald Langenberg, Deputy Director of NSF,

including the interactions of energy, environment, and economics in several different types of environmental zones.

On October 6, Woods informed University officials about his progress thus far, and received encouragement to travel to Washington, D.C. to meet with Schwarzkopf on October 8. Some of the items from that meeting were:

(1) NSF could not fund a research area that was the responsibility

(2) Utilize a program umbrella concept.

(3) Set up preliminary proposal for industry and NSF to shoot at.

(4) NSF would consider funding the evaluation of the Center.

On October 30, Dr. Anton Netusil was nominated as the evaluator and subsequently attended a meeting of Center evaluators in Washington, D.C. on November 5. His expenses were covered by the College of Engineering. He reviewed materials from other Centers, particularly Rutgers, which he then transmitted to Woods.

On November 5, Schwarzkopf informed Woods that NSF could not fund this Center because of this Center's intended commitment to energy conservation, but that he had been in contact with John Milhone from DOE and that department was definitely interested in funding part of the Center. Woods and Milhone are well known to each other through a variety of contacts ranging back to when Milhone lived in Iowa, through Dr. Woods' involvement in establishing a Building Energy Management Conference at Iowa State in 1978, an International Congress on Building Energy Management in Portugal (1980), and subsequent plans for a second Congress to be held at Iowa State in 1983.

On November 10, Dr. Woods formed his team for the first time. Present were several potential Center participants from the University:

Eino Kainlauri, Professor, Architecture, College of Design
Tom Kuehn, Associate Professor, Mechanical Engineering
Ron Nelson, Assistant Professor, Mechanical Engineering
Arvid Osterberg, Associate Professor, Architecture, College of Design
Howard Shapiro, Associate Professor, Mechanical Engineering
Geitel Winakor, Professor, Textiles and Clothing
Edmund Young, Associate Professor, Architecture, College of Design
Geraldine Montag, Professor, Industrial Engineering

Also present were Michael Brooks, Dean, College of Design; Dan Griffen, Executive Director, ISURF; Mary Kihl, Assistant Dean, College of Design; and Anton Netusil, Professor, College of Education.

The target date for the first meeting with the representatives of industry was December 15, 1981. Meetings were held of the principal investigators (with the evaluator present at most) on November 13, November 24, December 1, December 8, and December 10, to prepare for the session. On January 18, Woods discussed potential sponsors. It was then decided who would contact each company and assignments were made on redrafting the prospectus.

On February 2, the group met to review its progress. At this time it was decided to hold a meeting of all principal investigators and their department heads, as well as the Dean of the Graduate School, to finalize how the internal workings of the project budget would mesh with required University budget procedures. This meeting was held on February 5, 1982 and proved to be very productive; it allowed each department head to understand how the funding of the project would affect his staff member(s).

A second meeting was held on February 17, following letters to representatives of industry. From the feedback provided at that meeting, the staff has been busy writing the final draft of their proposal and Dr. Woods has been making additional industry contacts in an attempt to assure that at least ten industries are committed for the first three years.

speak on a variety of points, including the NSF program of University-Industry Cooperative Research Centers. In discussion with Dr. Langenberg, Dr. Woods felt he should look further into this program. Following his consultation of Proposals for Research Editing Service (PREPS) for a copy of the prospectus from NSF, he held casual conversations on campus with Dr. Dan Zaffarano, Dean of the Graduate College, Dr. David Boylan, Dean of the Engineering College, Dr. Dan Griffen, Executive Director of the Iowa State University Research Foundation, Inc. (ISURF), and Dr. Art Bergles, Chair of the Mechanical Engineering Department. They encouraged him to proceed, though further progress was held in abeyance until Dr. Woods returned from Europe in September.

In Washington, D.C., attending a meeting called by NSF for an Architectural Technical Research Consortium, Dr. Woods talked to William Bucher and Fred Krimgold, both associated with NSF. They both referred him to Robert Lauer and Alex Schwarzkopf. Schwarzkopf provided him with advice on several points:

(1) Plan on $500,000 from industry.

(2) Plan on a multi-year commitment.

(3) It must be called a "Center".

(4) How to handle the question of patents and publications.

(5) How anti-trust rulings affect Centers.

(6) What the objectives for the Center should entail.

(7) That the industries involved must meet to decide the types of research they want.

(8) That NSF (Mr. Schwarzkopf) was willing to attend the first meeting.

After this conversation, Dan Morgenroth of Owens-Corning (October 5, 1981) helped Woods define a narrow list of potential research areas,

OUTLINE OF KEY EVENTS

Early 1979	United States Department of Commerce study established Ceramics as a key material and prime target for field research.
Late 1979	NSF identifies Ceramics as an important candidate for an NSF Planning Study, and the Rutgers Ceramics Department as a leading candidate for the Planning Study Award.
February 1980	Rutgers Interfunctional Management Program contacts Commerce regarding a very large cooperative research Center, mentions Rutgers strength in Ceramics and is referred to NSF.
April 1980	Rutgers/NSF meeting leads to faculty approval to pursue the Planning Study Award.
June-November 1981	Faculty meetings, discussions with University Administrators, NSF, and Industry used to develop key elements of a Planning Study proposal.
January-June 1981	Planning Study submitted to NSF in January. Peer review culminates in Planning Study Award effective July 1.
June 3, 1981	Planning grant period begins with staff meeting which focuses on planning and research activities leading to a prospectus and industrial conference. Interfunctional Management Consulting team collaborates with Ceramics faculty to produce prospectus and prepare industrial conference.
November 1981	President Bloustein opens industrial conference, attended by 33 corporations and representatives from NSF and the University. Research themes, topics, and policies established.
January 13, 1982	Revised prospectus completed and reviewed with NSF prior to a series of University meetings beginning 20 January.
January 20, 1982	A series of University meetings and negotiations with University officers leads to a final prospectus to be sent to industry.
February 5, 1982	Prospectus reflecting new procedures and organization structure mailed to industry on February 5, 1982.

participate relative to patents could not be answered. Industry members could not resolve these issues during the conference.

The most significant and lengthy discussion was the intense debate regarding the areas of research and the specific projects to be undertaken. These issues, while not fully resolved, were greatly clarified during the conference session. Bill Prindle of Corning Glass, who chaired the session, expressed his debt of gratitude to Schwarzkopf for assisting participants in reaching a consensus on areas of research and individual projects.

Another issue concerned the leadership of the Center. Industry wishes to see McLaren as the Principal Investigator; his dynamic leadership was frequently acknowledged by all members of the consortium throughout the Pre-Center Development and Planning Grant Periods.

One major issue has involved the balance between generic, basic, or applied research and the extent to which the research agenda should include product and mission oriented research. Several faculty continue to feel very strongly that only basic research should be performed in the Center. Others maintain that it may be necessary to do some applied research in order to obtain industry's commitment for basic projects. These divergent positions were taken at the very first staff meeting in July 1980. The interest of faculty in taking whatever steps were necessary (changes in organizational structure and protocol) to ensure basic research was heightened by the experience of another Center, reported as being heavily applied. Faculty perceived industry as being largely interested in using the Center for applied work. Though these perceptions were modified by trips to the other Center, it did not slow down efforts to put the faculty

clarified and resolved. The number of committees within the organization structure of the Center were reduced. The steering committee was eliminated. Ultimate control over projects was shifted from industry to University. These and other changes were included in a revised draft prospectus and made available to the University Administration and Research Administration Board before the January 20 series of meeting. Before the meeting, Pallone was briefed by McLaren, Greenhut, Blum, Cannon, Walters, Whiteside, Cayer, and Rheinhold. He indicated that if the Research Administration Board deemed that all of these policy proposals were acceptable and fell within University policy, then Ceramics could make the prospectus public with the university's approval.

The final prospectus, mailed to industry and NSF in February 1981, was a joint effort by the Ceramics Departmment staff with lead authors being Blum and Cannon. The qualified prospect list was divided and assigned to each faculty person within the Ceramics Department. Each faculty member is following up with the contact person within the company. At present, Ceramics is experiencing the delay predicted by the NSF program manager. As Schwartzkopf said, "By the time the prospectus gets through corporate counsel, it will be two to three months." Each prospect had been asked to indicate their decision to participate in the Center by April 1982, but in the view of McLaren, "I don't think that's going to happen that fast."

No letters of intent have yet been received. The Department has heard from Corning and Johnson and Johnson, who will defintely join; Fansteel, Carborundum, Western Electric, Owens-Illinois, and GTE are quite probable. Possibilities include M&T, Westinghouse, U.S. Steel and Celanese. Those firms continue to see this Center as a way of doing basic research at a moderate price with patent protection. According to current plans, the

During January 1982, a revised prospectus was completed and reviewed with NSF on January 13. Another revision was made and presented to the administration prior to a series of University meetings on January 20, 1982. A final revision was made in February and mailed to the industry and NSF in February 1982. These required very extensive discussions with the administration.

On December 24, 1981, letters to Dr. Bloustein indicated the necessity for returning overhead to the Center in order that it realize its full potential, for the royalty-free license for the life of the patent, and the necessary delays in publication. A series of University meetings were held Friday, January 20, 1982. Dr. Bloustein had alerted University Administrators and passed the letters along to Whiteside, Pallone, Louis Letteri (the Controller), and Al Hanna (Assistant Controller for Research Contracts). Bloustein also consulted appropiate committees of the Board of Governors: Budget and Finance and the committee dealing with structure and organizational matters. Since there would not be a Board of Governors meeting prior to early February, and if the Ceramics Department had to meet deadlines, the appropriate committees of the Board of Governors should review the material so that the Department could prepare written policy statements as part of the prospectus mailed in February.

Some of the requests made in these letters were not so great a departure from existing University policy and could be interpreted as special cases under existing policy. McLaren, Cannon, Blum, Greenhut and Walters met with the Treasurer's Office and counter-suggestions were made by that office. The original request was that 80% of all overhead be returned to the Center for research and related expenses. The counter proposal was that all administrative functions of the Center could be overhead-free, but

an initial prospectus which would in effect be an invitation to industrial firms to attend the conference.

Several issues were debated at this meeting: "the overall aim of the Center is basic research"; "in order to obtain generic research arrangements it may be necessary to give a client an opportunity to complete some applied projects"; "are foreign companies and their U.S. subsidiaries eligible for Center membership"; "some aspects of University patent and publications policy may have to be modified."

It was acknowledged that these and other issues must be resolved through the planning study. A need for business and professional advice was cited. McLaren indicated that some of these inputs could be provided by a consultant and by an Interfunctional Management Team from the Rutgers Graduate School of Management. (Interfunctional management focuses on problems which cut across management functions and solutions, integrating concepts and tools of economics, mathematics, and behavioral sciences.)

During late September and early October the prospectus was developed. A letter explaining the potential creation of the Center and the ultimate goals of the program was sent from President Bloustein to the Presidents of the corporations which were to be considered possible members of the Center. Also included was an invitation to attend the Conference. Approximately 120 letters were sent; 33 corporations sent representatives to the meetings.

This was a very active conference and the participants were very much involved. They worked very late Monday night so as to provide Rutgers with recommendations on administrative policy and research areas and projects. Schwarzkopf played a key role in organizing the forum in which company representatives rank-ordered their research needs. The results of this

scientific strengths, the Rutgers Ceramics Department and its chairman, Dr. McLaren (who was out of the country at this point), were among those cited by Dr. Walters. The importance of ceramics to the electronics industry was discussed, and Professor Walters was urged to contact Alex Schwarzkopf at the NSF. After discussing the situation with University administrators, faculty, and Dr. David Pramer, Rutgers' Vice President of Research Administration, to determine whether or not Rutgers had proposals for a research Center in the pipeline, Walters called Schwarzkopf. It was agreed that a next step would be an NSF meeting at the Ceramics Department when McLaren returned from Latin America.

Presentations of the ceramics operation were made in April 1980 to NSF staff (Robert Lauer and Schwarzkopf) by McLaren, Dr. Victor Greenhut and Dr. Lisa Klein of the Ceramics Department. Internal and external documentation established the Department as a highly professional operation on the forward slope of a growth curve regarding students, faculty and industrial research contracts. With a staff of ten faculty, the department has approximately 192 undergraduate and 49 graduate students. Research activities continue to grow and have now reached a level of $600,000, with a major portion of the research awards coming from industry.

Lauer addressed the ceramics faculty and staff and several University adminstrators, outlining various NSF programs and describing some of the cooperative research Centers currently underway. Over lunch, Pramer, David Cayer (Assistant Vice President for Research Administration), and Stephen Rheingold of the Research Contract Office discussed further the implictions of a cooperative reseach Center program.

Following this meeting, NSF invited McLaren to attend the Hot Springs, Ark., Industrial Program Grantees Conference on May 12th. This annual re-

OUTLINE OF KEY EVENTS

September 1980	NCSU Telecommunications course initiated attracting many industrial employees.
Oct. 28, 1980	Telecommunications Workshop for local industries. One-on-one contacts with industries in telecommunications field begin to increase.
Feb. 1981	Director of North Carolina's microelectronics center learns about NSF cooperative research grants and suggests PI look into program.
April 1981	PI submits proposal for Center to NSF for funding.
May 27, 1981	NSF sponsored meeting on Industrial Science and Technological Innovation Program and Cooperative Research Centers in Park City, Utah. PI gains contact with staff at operating centers.
Aug. 1, 1981	NSF planning grant commences.
Sept. 29, 1981	Small scale meeting of industry representatives held at NCSU. (Served as a informal feedback session for PI.)
Nov. 5, 1981	Evaluator attends training session with evaluators of other Centers at NSF and returns with documents on how other sites are implementing Centers.
Nov. 17, 1981	Meeting with Engineering Dean and other administrators takes place to accelerate recruitment of industrial members.
Nov. 23, 1981	Second meeting with Engineering Dean and other administrators takes place. Decision is made to "mass market" the Center to a large audience by sending invitations to a two day meeting in Raleigh.
Nov. 25, 1981	Meeting with NCSU Chancellor, legal counsel and various representatives of Engineering and CS takes place. Committment to author invitations obtained from Chancellor. Date set for meeting with Industries. Decision made to invite President of UNC system to meeting.
Jan. 26, 1982	Industry representatives from 39 companies attend meeting in Raleigh. Industry representatives provide feedback to organization and research proposals; twelve companies indicate definite interest in joining the Center, all other companies indicate they might be interested in joining.

panies attending the second meeting and to eight additional companies who were not there but who requested further information. Companies were also invited to a final meeting to examine unresolved issues.

On March 17, 1982, representatives from 11 companies (including only one of the new companies) met in Raleigh with university personnel and NSF representatives to discuss the revised proposal. This meeting concerned the Center bylaws, start-up plan, research plan, and budget for the first two years. During the meeting, nine of the companies indicated their expectation to join the Center. Telephone conversations with several companies not in attendance indicated that many of thoes felt that they already had enough information and were currently engaged in the internal negotiations required to decide on Center membership.

Current Issues

During the next few weeks critical decisions will be made affecting the Center's future. Specifically, various corporate representatives must decide whether to recommend Center membership to their superiors and must convince their corporate boards that participation in the Center is in the company's best interests. In general, it appears that the quality of the proposed research program and the perception of their ability to influence the on-going research programs will be the critical determinents of a decision pro or con sponsorship. For some of the smaller firms considering sponsorship, the size of the yearly membership fee ($50,000) is an impediment to participation. NCSU staff believe that at least six members would be needed to warrant the establishment of the Center (although the goal is to obtain 11 members). At the time this report was written, a formal proposal for the Center has been submitted to NSF, seven companies have

The Chancellor approved the overall plan, agreed to author the invitations to attend a meeting, and invite the President of the University of North Carolina system to be the keynote speaker. Despite some concern over the slow turn-around expected over the Christmas holidays the planning meeting was tentatively scheduled for the end of January. A target list of 100+ communications, signal processing, and computer firms was developed from published lists and the input of faculty in EE and CS. A detailed proposal was written and mailed to firms on the target list by early December. During this period several additional EE and CS faculty members became actively involved in planning the agenda for the meeting. Just prior to the meeting, 40 companies indicated their intention to send a representative to the meeting.

On January 26, 1982 the second planning meeting for the University/Industry Cooperative Research Center for Communications and Signal Processing took place at the Royal Villa convention center in Raleigh. Many attendees arrived the evening before and attended the hospitality hour. Thirty-nine companies were represented by 55 technical and/or research staff. Twenty university administrators and faculty participated in or attended the meeting. During the breakfast meeting, the NCSU chancellor, the President of th UNC system and the Governor (accompanied by the his science and technology advisor) welcomed the participants and expressed their strong support for the Center. This "welcoming committee" appeared well informed about and interested in the proposed Center.

The morning session was primarily devoted to presentations about the EE department (Dean), the goals and operating procedures for the meeting (PI), NSF's role (program manager), the proposed organization of the Center (PI), and research themes (PI, three EE and one CS faculty). During the

At the same time, the Innovation Processes Research (IPR) Section within the Division of Industrial Science and Technological Innovation, which coordinates UICRC evaluations, had scheduled a training meeting for evaluators for November 5, 1981 and decided to ask pending centers to send their prospective evaluators to this meeting. The PI at NCSU agreed to fund the travel for this trip out of his grant funds and sent the intended evaluator for the NCSU Center to this meeting. This gave the evaluator an opportunity to acquire materials from evaluators at active and pending centers which had used or were about to use the planning grant strategy currently preferred by NSF. In addition, at this meeting the NSF program manager encouraged the evaluator to talk with the PI and reiterated his optimism about the potential for extablishing a center but underlined his concern about a lack of recent progress.

In general, the PI was quite receptive to the messages relayed via the evaluator. He was convinced of the need to accelerate his activities but not to modify his strategy. He asked the evaluator to attend an impending meeting with the Dean of Engineering and other administrators in the Engineering Department. The PI also suggested that the evaluator continue to serve as a channel for information by maintaining contact with the NSF monitor and other Center evaluators and encouraged him to continue to participate in the planning of the Center.

On November 16, 1981, the PI held a meeting with key engineering officials. The evaluator was asked to relay NSF's mixed message of optimism and concern about slow recent progress in widening the Center's contacts. The PI asked the dean to use his office and personal connections to open doors at specific corporations for the PI's one-on-one sales pitch about the Center. The Dean volunteered his assistance and a decision was made to

signal processing reseach and applications. At these preliminary steps only one other colleague (senior level faculty in EE) was a major contributor to the grant application. In April 1981 the PI submitted a planning grant to NSF.

In late May 1981, NSF's Division of Industrial Science and Technological Innovation held its annual conference for principal investigators in Park City, Utah. NSF suggested that the PI attend this meeting in order to learn more about the operation of currently active UICRC's. Conference sessions and infomal conversations with PIs from planning grants and active UICRCs prompted him to begin a detailed notebook of "do's and don'ts." Further, the personal associations established at this conference opened channels of communication the PI would use during the early planning process.

NCSU was officially notified it had been awarded the planning grant on July 15, 1981. Although the PI had accepted summer support on a research contract, he was able to withdraw to work on the planning grant. Unfortunately the August 1, 1981 starting date meant that two other faculty who were expected to be active in the early planning phase were unable to participate as planned. These individuals would not become very active in the project until much later in the project year.

Planning Grant Period

The proposal suggested the following sequence of activities: meetings with university officials, visits to prospective participants (approximately 10-20), visits to existing U/I centers, and meetings with company officials on the NCSU campus.

three were highly respected in their fields and had extentsive industrial experience.

Both personal and institutional forces appear to have helped to promote expanded university/industry cooperation in C/SP. NCSU's land grant university mandate explicitly includes extension activities with private industry. There appears to be considerable top level administrative support within the university for such activities. In addition, the creation of the Research Triangle Institute and North Carolina Microelectronics Center (NCMC) and subsidiaries of the Triangle Universities (NCSU, UNC-Chapel Hill, Duke) has provided additional mechanisms for university/industry cooperation and is evidence of state government's support for such endeavors. At a personal level, the local industry and NCSU are informally linked by an overlapping network of people (industry employees are part-time students and adjunct faculty at NCSU; NCSU students frequently go to work with local companies and faculty serve as consultants and contractors to local industry).

During the Summer of 1980, the principal investigator and another faculty member responded to a request and developed and taught an on-site telecommunications course at a local company. Subsequent interest in this course by other telecommunications companies prompted the PI to offer a formal graduate telecommunications course in September 1980. This course attracted a large number of students from industry and was eventually videotaped for off-campus presentation at local companies.

The success of this course, convergent interest in this area by several other faculty members, and further prompting by industry representatives resulted in a decision to try to develop a graduate level telecommunications engineering program within the EE department. Preliminary

personnel. Monitors attend research reviews, receive Center reports, and have informal contacts with faculty project managers.

Faculty Project Managers. Each research project will be managed by a project manager who is a faculty member of the Electrical Engineering or Computer Science Departments. The project manager works with other faculty and graduate students to accomplish the research outlined in the projects selected for the Center.

Evaluator. An evaluator is appointed by the NSF to evaluate the quality of the research program and the degree to which it meets industrial needs. The evaluator's reports are made directly to the NSF. It is his reponsibility to give an unbiased view of the success of the Center and to determine its strengths and weaknesses.

Research Program. Five research projects constitute the initial research program:

(1) Speech Processing Research, focusing on voice/noise/data detection, speech compression, and echo cancellation;

(2) Research on data communication over power lines;

(3) Image Processing Research, including image data representations and VLSI architecture for high speed implementations of the above techniques;

(4) VLSI Research, including algorithm/architecture relationships, system interconnection of VLSI components; and, VLSI design automation for communications and signal processing; and

(5) Computing/Communication Architecture Reseach, including local area networks, distributed processing, and multi-access protocols.

Budget. Since the number of sponsors is unknown at this time the budget is tentative. The first year budget has assumed that there are eleven sponsors at $50,000 each and that the NSF contribution is $175,000. Therefore, the operating budget for the first year would total $725,000.

Current Structure and Organization

The organizational, procedural and research details summarized below represent an accurate picture of the current conceptualization of a viable Center, based on input from university faculty and staff and the 39 industrial representatives who attended planning meetings in January and March 1982. Membership in the Center will be open to any company incorporated in the United States. Industrial sponsors must sign a formal agreement committing them to join the Center for three years, contingent on NSF sponsorship and agree to contribute $50,000 annually to the Center's operation. It is also understood that NSF will reduce and eventually terminate its contribution to the Center's operation during a five year period.

The principal officer of the Center will be the director who reports to the Dean of Engineering. The primary responsibilities of the director are to oversee the day-to-day operations of the Center and to implement the research plan determined jointly by himself and the Dean of the School of Engineering, with recommendations by the Industrial Research Board. The functions and responsibilities of committees and individuals involved in the Center are as follows:

Industrial Research Board. This Board will consist of one representative from each sponsoring company. The responsibility of this board is to recommend the research program to be carried out by the Center, and the apportionment of reseach effort and funds into research projects and capital equipment. The board may also recommend modification of the bylaws of the Center, and must approve whether donations of equipment may be used in lieu of money for purposes of Center dues.

1977 (cont.)	RPI endowment fund used for the equpment procurement
	Michael Wozny joined as Director of the Center in September
	Prime and Imlac became the first two members followed by Grumman
	Regular courses in Computer Graphics offerred
1978	Application for a grant made to NSF for supporting a cooperative research program
	Three companies joined as industrial associates
	A full-time manager was appointed for the Center
	Equipment was updated
1979	NSF grant for $1.1 million received
	All terminals working at installed capacity basis
	Four companies joined
1980	Four more companies joined as industrial associates
	Center continued its growth in staff and student enrollment
1981	Eleven companies joined as industrial associates
	Support from the industry in terms of grants continued
	An NSF grant in Computer Graphic Education received
1982	No dropout of the industrial associates
	Book value of equipment quadrupled since 1977
	Major contract research undertaken

with the appropriateness of research projects to the interests of the graphics program, the technical meetings, the technical quality of research projects, and the communication with the industrial committees, while industry is generally pleased with the quality of written reports, the responsiveness of faculty in communicating with the Center's technical people, the support and assistance of the NSF, the amount of contact between non-faculty researchers and industrial participants, and procedures for the control of proprietary research information.

The corporations participating in the Industrial Associates Program are represented through top management personnel. This has helped the Center in obtaining higher visibility and linkage. The participants are rated as well above average of their competitors in terms of technical competencies, innovativeness, and management sophistication. This has enriched the Center-industry cooperation. Several benefits appear have accrued to industry. These include the development of new research projects, changes in the kinds of R&D projects supported, changes in research methods and procedures, improvements in products and services, development of new products due to related efforts, changes in the life cycle costs of products to users, reduction of production costs, and improvement in processes and methods of production. The design and engineering of products were influenced due to the technical information generated at the Center, and the Center has helped improve the capability of firms to cooperate and deal with the government, university and industry.

position to take over the entire operation. The role of industry as a partner in the research program of the Center emerged from the initial consultations with firms regarding hardware discounts, as firms indicated that they would be happy to supply equipment at substantial savings for an opportunity to work with the program. Thus, the Center came into existence as an RPI activity partially supported by but not controlled by industry.

By early 1977, equipment was arriving and the informal troika of the Dean and the two Chairmen who had coordinated the Center thus far was no longer adequate to control the emerging structure. An initial industrial advisory group was formed consisting of representatives from GE, GM, Owens-Illinois and Teledyne, with some participation by an MIT faculty member with graphics experience. This group provided extensive criticism and feedback to the school as the plans for the Center were developed.

A search for a full-time Director for the Center was launched in 1976, with the aim of having the administrative structure in place when the equipment became available that fall. In 1977, Michael Wozny became Director of the Center, and its structure and operations became more formalized. Wozny was a recognized expert in the computer graphics field, and had been most recently at NSF. In 1979, an NSF planning and development grant was secured for the Center to cover major aspects of its management and coordination.

Current Operations

The Center has demonstrated a continued accelerated growth in the Industrial Associates Program in the past five years. There has been no attrition of the membership. In terms of cash funding for the Center, the private sector support has increased at the average rate of 97% per year

Early Center Development

The Center was more advanced than the other Centers described in this report. At the time funding was received, however, the Federal role was much the same as in the other Centers. The Center simultaneously secured planning and operating funding from NSF. Planning and initial operations of the Center were closely coordinated between the PI and the NSF program officer. NSF funding and guidance during the early stages of Center development were critical to its later stages of rapid growth. This Center is particularly hardware-dependent, and has from its earliest stages relied on close ties with the suppliers of that hardware for its major support.

In 1974, the School of Engineering at RPI was reorganized, and George Ansell became Dean. A new initiative for development, known as the "BUILD" program, was undertaken with the aim of expanding the graduate program in particular and enriching the instructional program at all levels. The direction of this effort toward expansion of the computer graphics capability was undertaken as part of an attempt to return a strong design element to the engineering curriculum. With the advent of computing and the consequent emphasis on the mathematical aspects of engineering, design had been languishing for several years.

RPI supported this new expansion/enrichment initiative with substantial resources. Instead of distributing the money in small amounts to all departments, it was decided to invest in a new direction big enough and distinctive enough to give the school's program a unique character and visibility. A steering committee of the Dean and the Chairmen of Civil and Electrical Engineering identified computer graphics as an up-and-coming area for possible development.

This approach has helped maintain the Center more as a resource base than as a competitive unit for the various academic units. Center faculty have joint appointments in various academic departments. Graduate students are supported by the Center to conduct research on problems of interest to industry, but receive degrees in academic departments. Most of the Center's facilities can be made available to other faculty members as well as the staff of other Centers within RPI.

Unlike many of the other Centers, this Center's mission extends significantly beyond research as such. The Center views its activities as comprising three interrelated areas. The Instructional Support Program attempts to enhance learning and stimulate long term technical growth in computer graphics to apply in new types of problems. To achieve this, the Center has developed instructional programs to integrate computer graphics into the entire engineering curriculum. The program cuts across all the engineering disciplines and attempts to develop an applications-oriented philosophy. The Facilities Operations Program maintains systems of multi-million dollar value to support instructional and research programs. The primary objective is to maintain the facilities at the cutting edge of technology and make them available to students, faculty and staff RPI. The University-Industry Cooperative Research Program attempts to nurture the dynamic interaction between the Center and the industrial participants. This interaction helps foster a test bed for innovation, technology transfer and industrial problem solving. An intimate and continued industrial involvement in the Center's programs helps improve importance and relevance of the work.

The Center supports students both at Masters and Ph.D. levels. The students work towards the degrees awarded by their respective academic

As already noted above, there are a variety of potential models to guide a Cooperative Center. According to many participants, the strength of CAPRI lies in the closely-knit nature of the research teams, the opportunities for industrial input and the potential exchange of information between and among companies. If these benefits are developed and nurtured, they would appear to profitably differentiate CAPRI from other models, such as faculty grants from individual companies.

To what extent will this communication occur? How satisfied will participants be with the research output? What types of scientific findings, discoveries and knowledge will emerge by 1986? The answers -- and that term is used cautiously -- should be useful in assessing the viability of industrial-university experirments such as this one.

some participants suggest -- then is their criterion the same as that employed by management?

As the projects begin, both industrial and academic scientists look forward to forming strong synergistic research teams. Given the stature of the scientists and the fact that both groups typically know each other well, there is every reason to expect that such synergism will result. Nevertheless, if the perspectives or interests or research styles of these scientists begin to diverge, the productivity and synergism might suffer. From the industries' point of view, problems might develop if projects got "hot" and faculty became overly zealous in their efforts to publish research findings. However, there is little expectation that this would develop, given the stature and experience of faculty. Most participants look forward to a collaboration, and regard it as a most unique and intriguing strategy with which to pursue scientific knowledge.

Most faculty members prefer to engage in basic research that focuses on one or more specific dimensions of macromolecules. Happily, fundamental research is also the goal of industrial participants; faculty scientists look forward to collaborating with industrial scientists. Several indicated that the projects will hold out considerable appeal for the students who, according to one participant, have "the most exciting experience of all." The success of this "critical mass" approach to scientific research has yet to be tested extensively, and consequently, the results of this experiment will be viewed with considerable interest.

Like their industrial counterparts, faculty members have a variety of mechanisms with which to pursue funding. They can apply for individual grants with industry, seek government grants, seek consulting relationships with industry, or pursue various combinations of these. According to some

discoveries from a project. For those industrial participants who do anticipate patents, the patent provision was essential.

The nature of the projects is also significant. Unlike the Industrial Sponsors program, CAPRI is designed to encourage synergistic research relationships between academic and industrial scientists. An industrial scientist sits on the steering committee of each project, and industrial scientists input is generally regarded as important and critical. Thus, from an industrial perspective, CAPRI allowed for the opportunity for close interactive research relationships, which would be both professionally and intellectually fruitful. Furthermore, industrial participants have considerable respect for CIT students and believe that work produced by these students and postdoctoral fellows would be of an high scientific quality.

In addition, from a faculty perspective, an industrial partnership such as that offered by CAPRI would allow for and encourage innovative research. Faculty commented that research with industry frequently provides more opportunity for creative science to emerge than government-sponsored grants in which more conservative and less innovative sentiments seem to predominate.

The opportunity for learning from other company scientists is important to the firms involved. The Blue Sky Project and semi-annual symposia will allow company scientists to learn about new professional and scientific development. Not only is this personally rewarding, as noted above, but it can be useful from another perspective. Interaction with different company personnel can provide useful information and technical knowledge that individual scientists can bring back to their own companies and apply to their own problems. For example, the possibilities of exchanging information with the Bethlehem Steel Corporation was treated by industrial

tatives from each of the companies, the CIT dean, the macromolecular science department chairman, faculty members working on the project, as well as representatives from the NSF. The principal investigator briefly described the size and resources offered by the department and explained the benefits and structure of the Center. Suggestions for the Blue Sky project were also elicited. During the afternoon, company scientists met with faculty members for the first meetings regarding research projects. Work proceeded on the project into Fall of 1981. By the Spring of 1982, faculty and industrial scientists were actively meeting and engaging in research.

Current Issues

One of the most notable aspects of CAPRI's evolution is the relative absence of stumbling blocks, snags and interpersonal impediments to success. In a relatively short period of time, five companies have committed themselves to spending considerable amounts of money on the CAPRI project. In this section, factors that appear to have facilitated the successful development of the Center will be discussed.

Stature of the CIT Macromolecular Science Department: The macromolecular science department at Case Western is typically ranked among the top five departments in the country. A recent evaluation of materials sciences faculty ranked Case even higher, within the top three in the United States. The department is nationally (and internationally) respected -- both in academia (where Case faculty have trained students who themselves have gone on to form highly respected departments) and in industry (where the CIT Industrial Sponsors program, has spawned a number of successful research partnerships between Case faculty members and industrial concerns). Consequently, when the Case Western faculty approach industry, they do so with

Brunswick, N.J., as well as with Celanese in Summit, N.J. In mid-April they spoke with B.F. Goodrich in Brecksville, Ohio, while Dow Chemical representatives were contacted by phone. All four companies ultimately became participants in the Center. Only one company that was approached decided not to participate, largely for financial reasons.

The meetings were typically attended by a CIT planning grant investigator, the CIT Dean, and industrial scientists and representatives from the company's office. In one case, another faculty member from Case attended the meeting. The response to the patent procedures was typically positive, although the technical and legal ramifications required explanation and further study by the companies. According to several of the participants, once this issue was resolved the rest of the issues fell into place relatively smoothly.

At several meetings, concern was expressed about the question of secrecy agreements. Several companies expressed preference that students and faculty members sign secrecy agreements that would forbid them from discussing background information on key projects. The faculty in attendance objected that it was academically inappropriate for students to sign secrecy agreements, and suggested that if a company wanted faculty members to sign the agreement, it approach the professor individually. This policy was generally agreeable to the industrial participants. In the case of one company, concern was subsequently expressed about publications delays. Management was apparently concerned that information might become public within a relatively short period; however, subsequent conversations within the industry itself served to allay this concern.

In general, the meetings yielded considerable interest and enthusiasm from the company. The model was compatible with industrial needs, and in

months, the model was formulated, developed and refined. Substantial contributions came from the CIT Dean, who is himself a macromolecular scientist and former chairman of the department at CIT. Conversations with faculty and with several industrial scientists also helped to pull the model together.

One of the first issues concerned the relationship between CAPRI and the Industrial Sponsors Program. As noted earlier, there had been some faculty concern at the outset that a new Center for applied polymer research might duplicate -- or worse, interfere with -- the work conducted through Industrial Sponsors. If a large number of companies were involved in a fashion similar to Industrial Sponsors, there would be little incentive for industrial scientists or faculty members to participate actively in the NSF program.

On the other hand, there might be considerable benefits to be gained from a model in which a small number of companies worked in close contact, and in considerable depth, with several Case faculty members. This would allow the industries to partake in basic research, a goal that is taking on increasing importance in certain aspects of the polymer industry as a result (in part) of the perception that there may have been too much emphasis upon short-term research in some industries, as well as increased competition from abroad in recent years. At the same time, a more "closely-knit" structure would allow faculty members opportunities for innovative program research, and would provide graduate students with the unique opportunity to work with scientists from both academic and industrial sectors.

Once the model began to take shape, discussions increasingly focused on the patent procedure. It was feared that if all companies were allowed

The research programs will seek to enhance understanding and control of the microstructural state which determines the functional properties of polymer materials. Research on engineering plastics will focus on glass-fiber reinforced thermoplastics, "liquid crystalline" thermoplastics, synthetic microfibrils and the gel state of thermoplastics. One of the areas of unique and special interest concerns the potential electrical conductance properties of polymers.

Pre-Center Development

During the late Summer of 1979, several CIT faculty members and administrators learned of the NSF's Cooperative Centers program. Subsequently, these Case officials -- CIT Dean Eric Baer and macromolecular science department chairman Dr. Jerome Lando -- were in touch with NSF representatives about the possibilities of forming a Cooperative Center at Case Western Reserve University.

In the Fall of 1979, Lando and Dr. Anne Hiltner, an associate professor of macromolecular science, discussed the idea of forming an NSF Center at a departmental faculty meeting. The idea was greeted with interest, although some faculty members were concerned that the program might compete with or duplicate the existing Industrial Sponsors Program. The possibility of overlap between the Sponsors Program and the NSF Cooperative Centers project was an important issue in the evolution of the CAPRI at Case Western and helped to shape the structure of the Center.

In November 1979, Industrial Sponsors were informed of the NSF Cooperative Centers program, and their interest in participating in this type of project was assessed. The Industrial Sponsors expressed interest in the

each year, one at the University and one at the R&D laboratories of the companies.

Advisory Board. The Center Director chairs the Advisory Board which meets twice a year. The Board is also composed of the macromolecular science department chairman, the Dean of Case Institute of Technology and members from each of the participant companies. The Advisory Board is a key link between the university and industry, having responsibility for program goals and effective communication among the various constituents. This Board generally oversees CAPRI's operation and holds semi-annual symposia.

University Policy Committee. This committee is composed of a representative from the CIT Dean's office, the Center Director, the chairman of the macromolecular science department, and faculty representatives from one or two other departments involved in the Center. Its responsibilities are to make certain CAPRI complies with university educational policies, appropriately uses university resources and fulfills faculty and institutional needs.

The project is jointly financed by NSF and the companies. For the first year, the NSF contributes $210,000 and the total industrial contribution is the same. During the second year, NSF contributes the same amount, and the companies increase to $295,000. During the third year, NSF contributes $160,000, while industries give $345,000. During year 4, NSF contributes $110,000 and industries give $480,000, while during the fifth year, NSF contributes $60,000 and the total industrial commitment is $530,000.

CAPRI is unusual in its research agenda. Each of the research projects being pursued by CAPRI researchers is of primary interest to one and

macromolecular materials have been developed for applications in high performance settings. For example, polymers are being used as stiff, lightweight engineering materials, as soft optically clear materials for biomedical uses (contact lenses), and as critical components with unique electrical properties.

Current Structure and Organization

The Department of Macromolecular Science is part of Case Institute of Technology (CIT), which merged in 1967 with Western Reserve University to form Case Western Reserve University. The department is one of the largest and most prestigious programs of its kind in the country, and is the only program which offers concentrated programs in chemical, physical, biological and engineering properties of macromolecules. There are 17 faculty members and associated faculty members from departments including chemistry, metallurgy, chemical engineering, physics and the School of Medicine. In addition, there is one senior research associate, about 25 postdoctoral research associates, some 85 graduate students and about 60 undergraduate majors. In 1977 the undergraduate B.S. in engineering with a polymer science major represented the first program in the U.S. to become accredited by the Engineering Committee for Professional Development. The department is typically ranked within the top three or five in terms of research strength.

Like other major macromolecular science departments, the one at Case Western has long had a strong organized Industrial Sponsors Program. Each Industrial Sponsor contributes to the department's discretionary funds; these are used as matching funds for equipment, seed money for new faculty, and initiating and seeding new research projects. At the same time,

OUTLINE OF KEY EVENTS

April 1976	Henniker Conference on "Welding Research and Development - Problems and Opportunities"
July 1976	Glower is named Acting Dean of Engineering at OSU
October 1976	Glower is named Dean
Spring 1978	Glower announces "Engineering College Alliance with Industry"
	McCauley steps down as Chairman of Welding to Develop a Welding Research Center at OSU
	Graff heads search committee for new chairman and faculty expansion
January 1979	Initial contact between OSU and NSF, regarding CWR funding
April 1979	Planning Grant Proposal sent to NSF
July 1979	Professor Graff named Chairman, Welding Engineering
October 1979	Planning Grant received from NSF
	Professors Albright, Richardson, and Tsai join Welding Engineering Department
Early 1980	Meetings with industry to develop the research agenda
April 1980	Proposal to NSF to fund CWR
July 1980	First meeting, IAB and potential members
	Workshop on Resistance Welding
August 1980	Checks from Bishopric Corporation, Caterpillar Tractor Company, and GATX arrive at OSU
October 1980	General Motors Tech Center joins; IBM Corporation joins
December 1980	Patent disclosure by Professor Richardson (Project 1)
	General Electric joins
January 1981	2nd Board Meeting
May 1981	Standard Oil of Ohio joins

The firms' requirements for concise reporting and substantial lead times for the receipt of written reports prior to IAB meetings and the traditional "last minute" style of operation by academic personnel is a continuing problem. The CWR has not yet acquired a "business-like" approach expected by sponsors. This incongruity of style is also evident in the research investigators' inclination to jury-rig equipment and the IAB representatives' belief that equipment should be bought so that valuable time is not wasted on tinkering. One of the results of this difference in style is the tendency for the facilities to look makeshift and sparse in sharp contrast with the polished look of industrial research facilities. This conflict may continue for some time.

One additional university-CWR issue is beginning to surface. The Department of Welding Engineering does not grant a Ph.D. degree, and welding students are all M.S. candidates. Those seeking Ph.D.'s are mostly enrolled in Engineering Mechanics or Metallurgical Engineering. M.S. students are, typically, two-year residents. When that issue was raised at the first IAB meeting, the representatives did not perceive that it would be a problem. Now that a year of experience has been gained, the value of continuity in graduate research assistants is being recognized. The IAB will probably support the department's efforts to obtain approval for a Ph.D. program from the University Board of Trustees.

Finally, the IAB representatives have voiced a strong endorsement for active participation by the evaluator in IAB meetings. One to one and one-half hours per meeting are reserved for the evaluator alone to meet with the board. These sessions are open and forthright. They serve to mediate the concerns of the IAB, and provide a neutral channel of commmunication. CWR has used the evaluator as an independent source of communica-

for not joining CWR given by some of the originally targeted firms include the state of the economy and the limited availability of money to support membership in the Center.

One source of dissatisfaction among IAB members is the character of the progress reports given by the CWR researchers. The IAB members have consistently asked for reports which are more concise, and which provide information in a form which can be used by IAB representatives to brief corporate officials. The CWR researchers are wedded to a "research paper" style of presentation which, while comfortable to university faculty, is largely inappropriate to the corporate briefing. According to IAB members, this particular problem is common whenever university-industry cooperative research is involved. They indicate that the CWR is, for the most part, better than many similar groups in which many of the IAB members participate. However, they feel universities are generally not meeting industry needs when they communicate research progress.

Another potential problem area involves one company's efforts to accelerate progress on a particular project. The company has independently supplemented the CWR budget appropriation with additional funds. A certain lack of sensitivity to the nature of commitments which the Center must make to support graduate students has been evinced. It is not generally possible for the University to reallocate faculty or student resources quickly. This inflexibility, combined with a decline in the general availability of engineering graduate students and the heavy teaching and research load carried by faculty, may make the university appear to be unresponsive to sponsor needs. In this case, a large number of IAB representatives understand the university's problem and support the University's efforts to respond.

workshop led in turn to the development of a formal proposal for a funded research project, and the IAB approved the budget at its January 1982 meeting.

A significant technical breakthrough has occurred in the "Sensing Variables" project; Professor Richardson filed a patent disclosure in December 1980. As of April 1982, the board had not yet taken any action on that particular matter.

The identification of a faculty member in the Electrical Engineering Department with expertise appropriate to the resistance welding project (Project 6) enabled the CWR to announce at the January 1982 meeting of the IAB that it would move forward on that project as directed by the Board. A request for a slight modification in the direction of Project 4 (Weld Strength Characteristics) based on research findings to date was approved by the IAB.

From a CWR administrative perspective, the initial period of intense recruiting which preceded the first IAB meeting was followed by a period of reduced activity which lasted some six months. This hiatus was folowed by another intensified recruiting period which brought the number of participating companies to twelve by the time of the January 1982 meeting. The dual demand of day-to-day Center administration and recruitment of new companies has exceeded the capacity of one person, and the University Advisory Committee has approved the recruitment of an administrative assistant to the Center Director, to be shared by the Department of Welding Engineering. (This is another example of the benefits which accrue to the university from the presence of the CWR.)

provide particular research capabilities, industry representatives were concerned that this would result in valuable research time being occupied by building equipment which might better be purchased. As the discussions continued, IAB members became participants in exploring the research problems and concepts rather than challenging specific aspects of a particular proposal, and the atmosphere improved substantially.

The IAB subsequently decided to reduce the number of meetings from three to two per year. The June or July meeting would be the Annual Meeting at which decisions about new project funding would be made; the late fall or winter meeting would feature progress reports. Furthermore, they decided not to adopt any by-laws.

IAB concerns about CWR researchers interacting with corporate research and development personnel have continued. At the June 1981 meeting an IAB member recommended that a series of project-related workshops be developed by the CWR. These workshops would be open to representatives from IAB members companies. The CWR responded with a proposed schedule of one-day workshops to report on Center projects which was presented at the January 1982 meeting. The schedule was modified to provide pairs of workshops on consecutive days. The first pair are scheduled for March of 1982, and all projects will conduct workshops in March and April.

For the purposes of this report, the period from after the first meeting of the IAB through the present time (Fall 1980 through the fourth Board Meeting in January 1982) can be combined for discussion. The analysis will focus on three perspectives: IAB activity, Center research and Center administration.

The three meetings of the IAB have evidenced a developing pattern of action. Resolution of the patent policy was one major accomplishment. The

Graff. Seven proposals were presented for evaluation. The projects presented for IAB discussion and selection differed somewhat from the original group described in the NSF proposal; alterations were made primarily to accomodate the availability of faculty due to involvement in other sponsored research projects and teaching duties. (1) "Sensing Variables" and (2) "Weld Solidification" were unchanged, (3) "Improving Weldability" was replaced by "Arc Augmented Laser Welding," (4) "Strength Characteristics" and (5) "Weld Discontinuity" were unchanged. Three new research projects, (6) "Resistance Welding," (7) "Residual Stresses," and (8) "Arc Plasma Research," completed the proposals presented to the IAB at that meeting.

Rating and ranking was conducted after presentations by OSU faculty and discussion of all proposals. At the time, the CWR Director asked that "Resistance Welding" be withdrawn due to the unavailability of personnel, but the IAB insisted that it be retained. Ratings were tabulated with and without the votes of the three noncommitted "observing" companies. Proposals one through five were selected by the official board member company representatives. The addition of the votes of the three observers changed the rank order, but not the content, of the "top five." The "Resistance Welding" project, which came in sixth, was stil highly recommended by the IAB.

Several organizational questions were also taken up: Patent Agreement, Scheduling IAB Meetings, Membership, Bylaws, and Proposal Ratification. The Patent Agreement generated considerable discussion; IAB members were particularly sensitive to limiting participation in the royalties to CWR rather than the University in general. Other topics of discussion were the matter of licensing of patents to corporate subsidiaries, and also the relationship between date of active corporate membership and participation

in partnership. In the event that the IAB does not vote to pursue the patent, individual member companies have the right to assume costs and benefits derived. In both the traditional university policy and the CWR policy, the inventor has final rights to pursue the patent should all other parties waive prior right. Once a patent is obtained by the Center, members have nonexclusive, royalty-free patent rights.

The proposal which went to NSF in April 1980 was written by McCauley and Graff with strong administrative support from Dean Redmond, Dean Glower and Provost Reynolds. The procedure for attracting prospective industrial sponsors which was incorporated in the proposal differed substantially from that originally outlined in the planning proposal. At the recommendation of Professor James E. John, Chairman of Department of Mechanical Engineering, the plan to visit industries with a delegation from OSU was replaced by an alternative plan used successfully by John in recruiting support for ADML. The primary selling effort was to be done on-site at OSU, not at the proposed sponsor's facility as originally proposed. A schedule of visits by industry delegations brought nine prospective sponsors to OSU between the first week of January and mid-March of 1980, when the proposal went to typing. The schedule called for some eighteen more companies to visit by mid-June of that year.

Discussions to formulate specific research proposals were incorporated into the visits of candidate sponsors. While the essential research agenda was faculty-generated and represented their research interests, the inputs of industrial visitors were helpful in structuring the five research projects which ultimately were made part of the proposal which was sent to NSF. They were: (1) "Development of a Means of Sensing Variables for Automation of Arc Welding Processes," (2) "An Investigation of Weld Solidi-

sent to NSF. It was approved and OSU began concerted preparation of the formal proposal to obtain support for a Center under the planning grant effective October 1979.

Meanwhile, the search committee's efforts were effective. Among the names which the search committee recommended to Dean Glower was that of Professor Graff, who chaired the committee. Graff was approved and began his chairmanship in July 1979. As of the fall quarter of that year three additional faculty also joined the department: Dr. Charles Albright, who had thirteen years experience at Sandia Laboratories; Dr. Richard Richardson, who had four years at Caterpillar Tractor Company; and Dr. Chou Tsai, from a post-doctoral year at Massachusetts Institute of Technology.

While the search committee consciously refrained from relating the recruitment of new faculty to the impending formation of the Center at OSU, at least one of the candidates was aware of the possibility of such a development and weighed it heavily in his decision. However, the three report that the reputation of the department and its history of research and teaching was the decisive attraction in their decision to join OSU, rather than the as yet unestablished Center. As a result of the efforts of the search committee, the Welding Engineering Department could boast by 1979 a distinguished faculty of seven highly qualified members to support the planned programs of the CWR.

Planning Grant Period

The formal proposal to NSF for funding of the CWR was submitted in April 1980. In the process of developing that proposal, however, several key issues had to be resolved. One was the question of whether the unit was to be a departmental or a multi-disciplinary interdepartmental center.

CWR's structure provides for a reporting chain-of-command through a the Dean of Engineering to the Provost. A University Advisory Committee continually monitors the operations of the Center. The Advisory Committee is made up of heads of selected departments in the College of Engineering and is chaired by the Associate Dean of Engineering. There is also a Research Committee consisting of all research investigators currently funded by the CWR and the Industrial Advisory Board (IAB) consisting of representatives of companies providing financial support.

Pre-Center Development

CWR had its origin in events both inside and outside OSU beginning in about 1976. A national conference on "Welding Research and Development - Problems and Opportunities" signaled a widespread recognition by industry, government, and professional societies of the need for a welding research Center in the United States, to "compete" with well-established centers in England, France, Germany, Japan, and Russia. The Department of Welding Engineering at the Ohio State University (the only such academic department in the country) seemed singularly qualified to serve the national need for such a Center. However, at that time in its history, the department was struggling to maintain this tradition. The period of development of the Center concept and the efforts to secure funding to locate it at OSU was also a critical one for the academic department.

In July 1976, Donald Glower, Chairman of the Department of Mechanical Engineering, was named Acting Dean of the College of Engineering and became Dean the following fall. One of Dean Glower's initial actions was to challenge the academic department heads to initiate cooperative research and development programs with industry. For Welding Engineering, responding to

February 1981 — First industrial monitors meeting (UMass). Introduction to faculty, facilities, review of CUMIRP Project, short research reports, longer research seminars by all faculty.

March 1981 — Advisory committee meeting (UMass). Includes closed industrial members' meeting.

April 1981 — Steering committee received faculty proposals for CUMIRP funding in second year. Steering committee solicits project ratings from industrial members.

OUTLINE OF KEY EVENTS

Late 1978	Principal investigators become aware of NSF interest in supporting the development of cooperative industry/ university research Centers.
Late 1978	Discussion with faculty; faculty approves pursuing project in principle, but with some concerns.
	Faculty meetings on proposal, research interest; faculty development abstracts of research projects.
	Faculty informally contact colleagues in industry to float cooperative project ideas.
Early 1979	PI's too busy to plan grant; hire director on consultant basis (retired industry researcher in polymers).
May 1979	Submit planning grant to NSF.
September 1979	Receive planning grant funding. Project director on salary for development of CUMIRP Project.
	Faculty contacts in industry used to establish highest company contact person to receive formal letter of interest.
November 1979	45 letters to corporate VP's for Research (from UMass Chancellor) expressing interest in cooperative research grant from NSF.
	Director and PI's visit corporations to discuss ideas (12 companies), usually top research directors.
	Faculty meetings on response of companies and discussion of faculty research interests and concerns.
January 1980	Meeting with companies and NSF (Logan Airport); 26 of 45 companies attended (UMass Chancellor, Dean, attorney, PI's, and director). Discuss: focus on single research area, preference of research area, industry straw polls, anti-trust issues, patents, freedom of information, industry membership fees).
February 1980	PI's and project director meet to digest January meeting; reformulate proposal of topic area.
	Faculty meeting to discuss January meeting, industry interests, and faculty interests.
	PI's prepare new presentation for industry.

will correspond to a substantial return on investment. It is still unclear just how much influence the faculty will wish to exercise over the direction of research projects. It is also unclear how receptive the faculty will be to attempts by the advisory commitee to influence the direction of their work. There is, however, an obvious potential for this to become a significant issue.

The meetings between the faculty and student scientists and the industrial monitors is a particularly important aspect of CUMIRP. It is very likely that research results useful for internal industrial projects will be communicated through these interactions. While faculty members are open to engaging in these periodic and special meetings, they are also concerned with protecting their time to engage in scientific research. At this point in the project no explicit limiting rules for special meetings have been set. The negotiation of mutually acceptable limits is an ongoing activity which is likely to affect the levels of satisfaction for both industrial members and faculty participants.

The most tangible benefits from CUMIRP participation will probably come in the form of substantive findings that can be used in ongoing corporate research or can lead to new internal industrial research programs. Because the corporations participate in the consideration of the overall research theme and in the discussion of selecting particular projects, it can reasonably be expected that some portion of the scientific findings will be useful to each and every company. It is very unlikely, however, that participating industrial members will benefit from CUMIRP through the development of new patents and the use of royalty free licenses because of the fundamental focus of the research and equal access to the royalty free licensing. In fact, it has been suggested by several industrial members

stages of the project. It is clear that in the second round of funding more selectivity will have to be exercised in order to satisfy the advisory committee's desire to focus research around agreed scientific themes.

The criteria for selection and rejection of proposals will include a complex set of considerations around appropriateness of the research for the agreed scientific theme, availability of a finite pool of funds, the response of industrial participants to the proposed research projects, a desire to maintain some commitment to innovation and risk taking, etc. The perceptions of faculty members whose research is rejected for CUMIRP funding is likely to affect their enthusiasm for submitting proposals in the future. If a significant minority of faculty become alienated from CUMIRP as a source of research funding, the entire project could be seriously jeopardized.

The organizational structure of CUMIRP places the steering committee (voting members are the principal investigators and the department head) in a potentially difficult position. They are responsible for making funding decisions and distributing research monies based on their scientific judgment and their understanding of the intent of CUMIRP. They are, at the same time, peers with those scientists whose projects they are evaluating. In recognition of these conflicting pressures, the advisory committee has already decided to establish a separate subcommittee of industrial members only. One of the intents of this subcommittee is to segregate more clearly the suggestions and desires of the industrial members from those of the steering committee. It is hoped that this will minimize the potential for intra-departmental political problems around decision-making.

It is widely agreed that the separation of administrative management (the CUMIRP project director) and technical direction (the principal inves-

funding comes from the private sector. Many in the department feel that a reasonably secure balance would be perhaps 35-40% funding from industry and 60-65% funding from federal agencies. The faculty have a continuing interest in the expansion of their scientific activities. The CUMIRP grant alone has allowed 15 new research projects to be undertaken supporting 22 post-doctorate and Ph.D. student researchers.

One of the strengths of CUMIRP, from the faculty's perspective, is the establishment of a three-year membership commitment by all the industrial members. This commitment allows for a relatively stable research base which is not typical on one-to-one grants from individual companies to single faculty members. CUMIRP also has the advantage of allowing more autonomy and independence of scientific judgement while at the same time preserving a broad relationship with the interests of industrial participants.

The organization of industrial support within CUMIRP may serve to help minimize the amount of time each faculty member spends in administrative work such as writing reports, grant renewal applications, and coordinating conferences with grant-giving corporations. Because CUMIRP is an organization which can support a half-time project director to implement administration, it has the potential for being much more efficient than a large number of small independent grants administered by individual faculty members.

Continuing Organizational Issues: CUMIRP is both an ongoing Center and an organizational experiment. A number of continuing issues relate directly to the efficacy of this particular organizational arrangement for funding scientific research. The pertinent question here is whether or not CUMIRP will be perceived as an effective mechanism to expand understanding and stimulate industrial innovation, and especially whether CUMIRP will be

ested in furthering the growth of knowledge in polymer science and technology, in understanding new phenomena, and the development of new techniques. Moreover, with the possible exception of one company, every industrial member of the CUMIRP Project already enjoyed well-established, friendly working relationships with individual faculty members and the PSE department prior to being approached about involvement in this new undertaking.

The particular historic development of the polymer science discipline and the individual experience of most polymer scientists allows a certain ease of interaction between academic and industrial scientists that may not be shared by other scientific disciplines. Polymer science is a young field which largely grew out of industrial laboratories. Most polymer scientists still work within industrial settings, and most academic departments are populated with scientists with considerable industrial experience. Within the faculty of the UMass/PSE department, for example, the average length of industrial research experience is seven years.

By contrast, the polymer science industry is well established and commercially diverse, including some of the largest corporations in the country. Several of these companies have sales in the neighborhood of three billion dollars per year. Most of the corporations involved in CUMIRP maintain their own internal laboratories with hundreds of scientists. To industrial concerns of this size, $20-30,000 a year represents a relatively small investment. Because they are large corporations with a diversity of ongoing research programs, any significant finding from CUMIRP can be used by one of the internal industrial research groups.

There is a shared concern, both in academia and industry, about the relative short supply of Ph.D. scientists trained in polymer science. For

most like to discuss in depth. Ratings were made by both monitors representing each industrial member. While these ratings were originally taken by CUMIRP program manager as a way of conveniently scheduling seminars, the project ratings can also be taken as a rough estimate of interest in the various research projects being conducted. For 13 of the 15 faculty projects, there was at least one monitor (and in several cases between 3 and 6 monitors) who considered that project to be of the highest priority for discussion in greater detail. Every research project was rated as potentially interesting by at least some of the industrial monitors.

The next Advisory Committee meeting was held in March 1981. A general progress report was presented by the two PI's and the director, including ongoing contacts directed toward recruiting new industrial members. However, the most important development of the meeting was the establishment of a private industrial caucus. The first of these caucuses was held, and from that discussion five recommendations were forwarded to the steering committee:

1. Industrial sponsors and NSF request time on future agendas for private meetings.

2. Industrial sponsors do not think it appropriate to try a detailed critique at this early stage.

3. The agreement provides for quarterly reports and the advisory committee recommends formal response. We request that a current quarterly report be in the hands of the program monitors at least one week before their meeting.

4. We request that program monitors meet at least 6 weeks before the advisory committee meetings.

5. The industrial sponsors request a status report in April and they will report their interest on both existing and proposed projects as high, medium and low to the NSF representative. The NSF representative will collect comments, tally and return to sponsors for comments. He will then forward comments to the steering committee for discussion at the August 20th advisory committee meeting.

instead of the originally anticipated 12. This decision to fund all proposals was clearly consistent with the intent of CUMIRP to begin the first phase of research in those areas of existing strength for faculty. It is also clear that funding all faculty proposals helped to establish the broad base of faculty involvement that was believed to be crucial for continuing success.

Early Operations

The CUMIRP Project received official NSF approval in September 1980. Shortly thereafter, faculty research projects got under way. The project manager joined the PSE department as visiting professor, and for convenience is now called the project director.

In October 1980 the 13 industrial members of CUMIRP met at UMass. Most had signed official agreements with the university although some were outstanding, held up by processing in corporate legal departments. Faculty research projects were reviewed once again; the budget was presented to the advisory committee; and there were further discussions of the procedure for approving papers for publication. A procedure for communicating scientific work to industrial monitors was established. The major concerns in establishing this procedure were to ensure that all CUMIRP industrial members had equal access to scientific progress on projects and that meetings and other communications between industrial monitors and faculty were done in the most efficient and least time consuming way possible. It was agreed that regular monitor meetings would be arranged for presentations by the faculty. Any industry desiring a special meeting with a particular faculty member might do so through CUMIRP director's office and a meeting would be held to which all industries would be invited to send a representative.

absent eventually joined CUMIRP; some simply had no further interest). The revised research plan incorporating goals and organizational structure, fee structures, and so on, was presented along with a potential timeline for submission to NSF. Despite the fact that some issues were not entirely resolved, the industrial representatives agreed that the PI's should proceed with submitting the proposal.

During this entire period, and even earlier, the office of Grants and Contracts of UMass was closely involved in the negotiations. The office was especially important in concerns involving various levels of administration at UMass and issues of internal politics within the University.

During March 1980 the faculty re-submitted proposed research topics and general descriptions of research around the agreed themes developed at the February meeting. Abstracts were sent to all interested companies soliciting their response to these research topics. Not all industries responded specifically. However, of those that did respond, there were no negative reactions to the proposals. By this point it was beginning to become clear which corporations were most interested in participating. The small (and more product and production oriented) corporations began to lose interest. Moreover, it was those companies with whom the UMass PSE department had had the longest relationships (such as those companies involved in the PSE Unrestricted Grants program or in individual research grants to faculty, the members of the board of directors of the Polymer Research Institute, and those involved in consulting relationships with individual faculty) who were most enthusiastic about participating in the proposed cooperative research project.

Initial faculty concerns that CUMIRP might act to diminish corporate enthusiasm for the Unrestricted Grant fund were addressed through informal

officials to receive a formal letter of interest from UMass. In November 1979, 45 letters to corporate vice-presidents for research were sent out under the signature of the Chancellor of the University of Massachusetts expressing the interest of the university in developing a cooperative research Center. These letters were followed with visits by the CUMIRP PI's and project manager to 12 corporations. In almost all cases, they were directed to top research managers for substantive discussions. These discussions included exchanges of ideas around research themes and possible organizations for the university-industry cooperative project. The results of these discussions were brought back to faculty meetings for further discussions of the companies' responses and the interest of faculty in continuing with the development of the project.

The first meeting of interested parties took place in January 1980 at Logan Airport and included high officials of UMass, the principal investigators and the manager of the CUMIRP planning grant, a representative from NSF, and representatives from 26 companies. Antitrust issues and the opinion of a consulting law firm concerning the avoidance of antitrust problems was a major initial agenda item for the meeting. The issue of royalty payments by participating industries became a serious point of contention between university officials and potential members of the collaboration. An agreement was reached somewhat later that participants would pay no royalties.

An open discussion between industrial representatives and UMass PSE representatives concerning possible fee structures for membership, topics for scientific research and the major objectives and themes for the proposed collaboration formed the most important part of the meeting. A consensus was reached concerning several aspects of the eventual CUMIRP

costs. The university will apply for foreign patents and will grant non-exclusive royalty-free licenses to such patents under the same terms and conditions as established for U.S. patents. Corporations interested in patents who do not share in the patent costs or who join the CUMIRP Project at a later date may gain the same rights through payment of a pro-rated share of costs and a one-time fee. Any royalties and fees received by the university will be paid into a CUMIRP trust fund to be administered by the CUMIRP Steering Committee. If royalties exceed $100,000 for any year, these royalties will be shared by the university and the industrial members of CUMIRP according to a pre-arranged formula.

Pre-Center Development

Late in 1978 the principal investigators became aware that the NSF was interested in supporting the development of cooperative relationships between universities and industry. Shortly after becoming aware of this interest, the PI's began discussing the idea with colleagues in the UMass PSE department.

The faculty discussions ranged over a variety of issues and interests regarding developing such a cooperative relationship with industry. Some faculty were concerned that the availability of research funds from the government might be on the decline and that it would be important to intensify efforts to increase the proportion of grants received from the private sector. Moreover, many faculty were less than satisfied with some aspects of one-to-one grants from industry.

During these initial meetings, however, there were some serious concerns about the feasibility and potential problems of developing a center of cooperative research with a large number of industries. Many industries

have signed a three-year commitment to participate. Corporations have agreed to pay membership fees of $20,000 each in the first year, $25,000 in the second year, and $30,000 in the third year. The CUMIRP Program is expected to increase the number of industrial members, on the average, by two new members per year.

Steering Committee: The two principal investigators, the head of the Polymer Science and Engineering Department (PSE), the CUMIRP project director (ex officio), and the director of the Polymer Research Institute (ex officio) comprise the membership of this committee. This committee carries full decision making responsibility for the apportionment of research effort and research funds from CUMIRP and supervision of research efforts in the administration of the CUMIRP Project. The Polymer Research Institute (PRI) is the financial administration unit for grants in polymer science at UMass. Participating faculty come from several UMASS departments, with most having at least partial appointments in the Polymer Sciences and Engineering Department.

Advisory Committee: One representative from each participating industry, two representatives from the UMass administration, and a representative from NSF (non-voting member) work in an advisory capacity to review and recommend policy on research programs, communication of results, publications, patents, and budget and to provide feedback on specific scientific projects within CUMIRP.

Faculty: All members of the UMass PSE department and PRI are potential participants in the CUMIRP Project. Faculty are responsible for initiating project proposals within the research areas identified by the Advisory Committee, carrying out research and participating in the communication of CUMIRP results to the industrial members.

staff together with UICRC management have assisted Center evaluators to develop systematic protocols for ongoing internal assessment activities. Currently all new Centers have these protocols incorporated into their grant proposals.

The Center evaluation program has several components. In addition to periodic sample surveys of Center outputs, organization, and communication networks, a protocol for ongoing documentation and description of Center evolution has been developed. Documenting the Centers serves several purposes. First, it is intended to be of help to the Centers themselves by providing them with a view of where they (and other Centers) have been. Careful documentation can help improve their ability to plan future actions and anticipate regular cycles and changes. Second, it is of value to UICRC management; it can help identify common themes in the evolution of Centers and lead to improved program guidance, such as is provided in the Practice Manual. Third, it is of value in the development of innovation process research generally. The Centers form an evolving population of innovative organizations the observation of which is ideally suited to the refinement of methods for conducting field research in this area and improving our understanding of relationships between structure, process, and outcomes in such organizations.

This volume represents the first systematic compilation of Center life histories. Much of the data reported here had to be assembled by the researchers long after the fact, and thus represent less than the optimal currency and clarity of explanation. The versions of the histories summarized here represent edited versions of sometimes much longer and richer analyses; the tradeoff between comprehensiveness and parallel explication has been largely resolved in favor of the latter. Primary authorship of