EXHIBIT A

AGREEMENT OF PROGRAM PARTICIPANTS

The purpose of the following agreement is to describe the responsibilities of and to enlist the support and cooperation of research participants and to insure compliance with relevant University policies.

Therefore, as a participant in a research project under the Biomedical Research Program sponsored and funded by Monsanto Company, I agree to abide by the following terms and conditions:

1. PATENTABLE INVENTIONS:

   (a) Participants will promptly disclose to the University's Program Director any potentially patentable invention or novel scientific development they produce in any research Project funded by Monsanto. Such disclosure will occur prior to disclosure to any other non-Program participant.

   (b) Participants will, upon request, assign rights to patentable inventions to the University so that it may grant required licenses to the sponsor.

   (c) Participant inventors will cooperate with Monsanto and

University patent attorneys in the filing and prosecution of patent applications. Due to the major expense and specialized professional assistance required to pursue patent rights in a research program of this magnitude, Monsanto has assumed this responsibility. The University will monitor these efforts and at its option may assume such responsibility on a case by case basis.

(d) In consideration of Monsanto's willingness to file and prosecute patent applications at its own expense, participant inventors will be requested to waive any claim of liability by Monsanto in these efforts. Otherwise, the University must assume this responsibility and its expense.

(e) Any royalties from licensed inventions received by the University will be distributed as follows: 40% to the research laboratory(ies) in which the invention was made, 40% to the cognizant department(s), and 20% to the School of Medicine.

2. <u>PRODUCTS OF RESEARCH:</u>

(a) New materials, processes, devices, scientific information, and any other research products isolated or developed in a project, whether patentable or not, will be made available to Monsanto for its evaluation and general use.

(b) Such research products may be made available to other research scientists at non-profit institutions according to normal academic practice. However, recipient scientists should agree not to further distribute such research products and not to use them for the benefit of another commercial firm. Distribution of potentially patentable research products should not be made until Monsanto has evaluated patentability and, if appropriate, filed a patent application.

3. <u>PUBLICATIONS</u>:

(a) Scientific advances made under this research program will be freely reported in the scientific literature.

(b) Two (2) copies of each proposed publication, including abstracts, in the best form then available will be provided to the Program Director at least one (1) month before being submitted for publication.

(c) Based on a review by Monsanto patent attorneys of the proposed article, a brief delay in its submission for publication may be necessary to allow the filing of adequate patent applications. Such brief delay may occasionally be necessary to avoid the loss of patent rights.

(d) Two (2) copies of the final abstract and article as submitted to the publisher shall be simultaneously provided to the Program Director.

(e) Each publication will acknowledge Monsanto Company support of the research being reported.

(f) Prior to the evaluation of research results for potentially patentable inventions, participants will use caution in public or other outside presentations and discussions not to prematurely disclose critical technical information which could result in the loss patent rights.

4. <u>COOPERATION WITH MONSANTO</u>:

(a) It is intended that there be mutually productive and continual interchange between the University and Monsanto scientists. For this purpose a Monsanto Project Scientist will be appointed as the primary company contact with each Project Investigator. Each Project Investigator will be available for consultation with the Monsanto Project Scientist on matters concerning the project.

(b) These University and Monsanto scientists will, as necessary, identify Monsanto special facilities and capabilities which may be used by the Project Investigator to enhance the progress of his/her project.

(c) Project Investigators will, upon request by Monsanto, provide reasonable opportunities for individual Monsanto scientists and technicians to spend time in the research laboratories to learn newly developed techniques, to participate in the research if this is mutually desirable, and to assist in the transfer of newly developed technology to Monsanto.

(d) The cooperative nature of this research program is expected to necessitate the exposure of University participants to Monsanto confidential technical information. For participants who may be so exposed Monsanto will require in advance the signing of a personal agreement indicating the partcipants willingness not to disclose such Monsanto confidential information to others.

5. <u>AVOIDING CONFLICT SITUATIONS:</u>

(a) Participants in research projects under this program must consider all other activities in which they are engaged, or have a personal interest, or in which they may become involved during the term of their project so that they reasonably avoid conflicting obligations. Of special concern are obligations to other companies in the same scientific areas or closely related to their research work supported by Monsanto. This project should not overlap the research they are performing or plan to perform under the sponsorship of any other organization, including government agencies and foundations, unless the situation is known to and approved by the Program Director.

(b) Any potential conflict of obligations or interests faced by a participant involving a proposed or approved project under this program must be promptly disclosed to the Program Director.

(c) The Program Director may request disclosure by project personnel of their past, current or anticipated relationships with other organizations in order to assure the absence of possible conflicts.

6. PROGRESS REPORTS:

In order for Monsanto to be fully informed about research results and to be able to identify potentially patentable inventions as early as possible, occasional brief summary reports of important findings and results will be required of

Project Investigators, as will more detailed annual progress reports which include summaries and conclusions.

The above terms and conditions are understood and agreed to:

P.1. Typed Name	______________________	Other Project Personnel:	
Signature	______________________	Sig.	________________
Date	______________________	Sig.	________________
Phone No.	______________________	Sig.	________________

MAKING COOPERATIVE RESEARCH RELATIONSHIPS WORK

Seven case studies suggest guidelines for negotiating and implementing successful agreements between universities and industry.

David W. McDonald and Scott M. Gieser

N. File w/ University Cooperative Agreements NDS

University-industry cooperative research is being called upon to play an increasingly important role in research and development (*1,2,3*). At the same time, criticisms and controversies have arisen concerning these relationships and the effects they may have on the institutions and individuals involved (*4,5*). In spite of these concerns, the keystone for the promotion of these joint research relationships has been the belief that the benefits received by the participants outweigh the drawbacks. As the academic community and business firms have become more familiar with this form of interaction, much of the controversy which initially surrounded these relationships has subsided (*6*). However, many unanswered questions remain about the implementation and workings of these agreements.

An important question is whether or not there are characteristics of these cooperative relationships that particularly influence their effectiveness. If so, can these characteristics be generalized and transplanted to other agreements? In an effort to answer these questions, an investigation of several university-industry cooperative research relationships was conducted in 1984–85 to determine if there were significant common factors that could be related to their degree of success. The approach used was a study of both current and completed relationships in several unrelated research disciplines and involving both large and small firms. The information was obtained by having key people from both industry and the academic institutions complete a questionnaire in conjunction with personal interviews. After review of the fields data obtained, seven detailed case histories were developed.

The relationships covered a variety of research areas: Composite Materials, Computer Imaging, Fermentation Technology, Fiber Optics, Hybridoma Biotechnology, Magnetic Materials, and Medical Tracers. The universities were respected research institutions in the midwestern United States. The collaborating industry partners ranged from small single-location firms to large, transnational corporations. The agreements were similarly varied, ranging from several months to several years in duration and thousands to millions of dollars in funding. Two of the relationships had some form of government involvement as well. A summary of the relationships is presented in the table on page 39.

Despite the variability in the relationships considered, all had three common stages that were the framework for our evaluation: project formulation, project execution, and project accomplishments. Topics considered under the formulation stage included contract negotiations and project initiation, while project implementation and management were examined in the execution stage. Lastly, both the measurable and qualitative results of the research projects were covered in the accomplishments section.

Project Formulation

Of the seven cases developed, three were initiated by the academic side of the relationship, two began with the corporate sponsor seeking out the university participant, and two resulted from federal government programs designed to bring academic and industrial participants together.

Regardless of how the project began, this study showed that the more thought given in negotiating the contract or agreement, the less the chance of unexpected or unmanageable difficulties occurring once the project begins. Key factors, such as the scope and objectives of the project, the resources to be contributed by each party, patent and publication policies and the project management system to be used, must be thoroughly discussed and clearly dealt with in the contract. If a conflict or disagreement did arise at a later time, the more carefully negotiated agreements were likely to contain provisions for dealing with the situation in a constructive manner.

The value of foresight in these relationships was seen in the Fermentation Technology agreement. In the middle of this collaboration, the principal university investigator (PI) left the institution to take another position. Anticipating this possibility, the participants had inserted a clause into the contract covering situations in which the PI would not be available for two or more months. Because of this foresight, hostilities between the participants were avoided.

Due to the complexity of issues involved in contract negotiations, it was found to be helpful if the

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Radioisotopes.—In the chemical field, specialties are likely to have less elasticity than commodities. This is illustrated here by the case of radioisotopes which require special methods for production, are expensive, and are sold in very small quantities (except for reactor fuels). Data for them, collected by J. Yardley (*4*) are presented in Figure 7. The slope of the regression line is quite close to minus one which corresponds to neutral elasticity. This small elasticity is comparable to the low elasticity for the inorganic chemicals that constitute raw material for electronic ceramics.

Structural Metals.—In this case prices and consumption levels are unusually closely correlated as may be seen in Figures 8 and 9. In the former the units for P and Q are in terms of pounds, while in the latter they are in terms of cubic inches. In both cases the correlation coefficients are -0.99 for the log–log linear regression lines. Thus the exclusionary boundary is very sharply defined, as is the amount of market elasticity.

For comparison, the regression line for engineering polymers from Figure 5 is overlaid on Figure 9. The large price differential between the two correlations accounts for the rapid penetration of traditional metals applications by engineering polymers. For applications in which elastic stiffness is important, the price differential may be markedly reduced (or reversed). Nevertheless, the nature of the competition is clearly stated by Figure 9.

Elasticity of Markets

For the various examples that have been presented here, the elasticity parameters are summarized in Figure 10. In addition, an estimate for automobiles is included for comparison. Notice that none of the values lies less than unity, so none of these markets is inelastic. Only highly specialized, or "vanity," markets are likely to be inelastic. This emphasizes the need for caution in approaching markets that are unfamiliar. The objective evidence as presented here is that there is no reason to expect volumes greater than indicated by a demand curve for a given price level. In other words, wishful thinking will not prevail.

The average elasticity is 2.3, while the spread ranges from 1.0 to 6.1. Since the elasticity is a logarithmic derivative, the observed average for this elasticity means that decreasing the price by a factor of 3 corresponds (roughly) to increasing the quantity consumed by a factor of 10. For engineering polymer resins the effect is much larger than this, while for raw ceramics for electronics it is three times smaller.

MARKET	ε
Chemicals	
major organics	1.8
candidates for biotechnology	2.8
engineering polymer resins	6.1
radioisotopes	1.0
Metals	
structural	2.5
soft magnetic	2.0
Ceramics	
overall raw materials	1.9
raw materials for electronics	1.0
refractory bricks	2.2
Devices	
batteries (portable electricity)	1.3
automobiles (approx.)	3.0

Figure 10.—Elasticity coefficients for various markets.

In closing, demand charts are very useful for the guidance of planning as this article has already indicated. However, they are not a panacea. One reason is that they describe the past, or at best the present. Another is that the data available for their construction are not always reliable. Also, in some cases the data show considerable scatter which creates uncertainty about the correlation of the data. Furthermore, it is often not clear as to which market a new, perhaps hypothetical, product belongs.

Acknowledgment

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Collaborative Research Agreements Studied

Field	Time Frame of Agreement	Approximate Amount of Funding ($Millions)	Source of Funding
Composites	1965–72	5.0	Government (ARPA)
Hybridomas	1981–85	4.5	Company
Fermentation Technology	1983–85	0.5	Company
Fiber Optics	1984–86	0.3	Government (SBIR)
Medical Tracers	1984–86	0.3	Company
Computer Imaging	1983–84	0.2	Company
Magnetic Materials	1978–85	0.1	Company

negotiators were knowledgeable both in the technology under consideration and in the intricacies of contractual law. Again, the Fermentation Technology agreement serves as a good example. In this case, the PI from the university and the project manager from the participating company had developed a strong working relationship from the earliest stages of interaction, based on the mutual understanding of the technology involved and the goals which they hoped to accomplish. Translating this cooperation into a formal agreement proved to be difficult, however, because of communication problems encountered when the technologists, attorneys and contract officers met to formulate the actual agreement. As a consequence, initiation of the research was delayed for several months while these difficulties were resolved.

The involvement of representatives of all interested elements of their respective organizations early in the contract negotiations can decrease the chances of unexpected difficulties later. The Computer Imaging project made this point very clear. This agreement was initially part of the involved professor's consulting work, which was permitted by the university by-laws. When the participants decided to enlarge the scope of the relationship, however, the university's research office became the contact with which the company interacted. This required that many more requirements and responsibilities be met. These changes almost jeopardized the relationship because the company was small and not well-equipped to handle the increased requirements. By changing the nature of the relationship, the initially successful interaction nearly collapsed.

The advantages of prior familiarity between the participants were clearly evident in several of the cases studied. The Composite Materials agreement is a good illustration. The parties entered into the relationship with considerable knowledge of each other's capabilities and expectations. This understanding helped during both the negotiating process and the implementation of the agreement. The result of this association was a successful, long-term relationship which integrated basic and applied research in composite materals, and led to the first interdisciplinary education program in composite materials technology in the country.

These instances point out the need to develop a close-working relationship between the parties from the earliest stages of an agreement. The more care that is taken by the participants during the negotiations of an agreement, the more likely an effective, fair contract will result. The negotiators, however, should guard against being too restrictive in formulating the agreement. If their striving for the "perfect" agreement causes undue delay in starting the project, some advantage gained by the joint effort may be lost or enthusiasm for the research may wane on the part of the investigators. Further, if the contract is made too detailed and specific, the flexibility that may be needed later could be jeopardized. Ideally what is sought in an agreement is a contract that clearly defines the project focus and the responsibilities and commitments of the participants, while remaining general enough to permit making adjustments later.

Project Execution

A second area of the study in which useful observations were revealed was the execution of the agreements, including project implementation and management. Two major points were evident here: the need for an effective program management mechanism and the advantage of geographic proximity.

The importance of a suitable project management system was especially evident in the large Composite Materials project. Here the participants recognized early in the program that the committee management approach being used was not producing decisions in a timely manner. Consequently, a switch was made to a single program manager to handle the day-to-day decisions, and an advisory committee representing both parties to deal with major policy issues.

The Fermentation Technology agreement was managed jointly by the PI from the university and the key manager from the company. Because of their ability to work together, this dual management system worked well. A joint advisory committee, which met on a quarterly basis, reviewed the status of the program and dealt effectively with major issues. The close geographic proximity of the two organizations allowed frequent contacts at the "working level," greatly facilitating the project.

The Hybridoma Biotechnology project was executed with a minimum of formal management control and direction. An advisory committee met quarterly and functioned primarily as the solicitor and evaluator of research proposals submitted by university faculty. After a proposal was funded, the project was reviewed each year to determine if it merited continuing support. Day-to-day decisions were handled by the company's liaison scientist and the appropriate PI or administrative officer at the university. The participants felt that this system had an important role in the success of the agreement.

Thus, successful projects had widely differing management systems, with no particular approach being preferable. Rather, the selected management approach should both recognize the participant's capabilities and culture and be effective in furthering the project's execution. Should problems with a project's management system occur, it is advantageous for the contractual agreement to be formulated in such a way that adaptation can take place.

Probably the point most strongly emphasized by the participants in the study was the advisability of geographic proximity of the participants. In the Fermentation Technology, Hybridoma Biotechnology, Composite Materials, and Computer Imaging projects, the participants were located in the same city. This made it easier to schedule meetings, have informal exchanges between researchers, and deal with unexpected developments in the course of the research. Likewise, cooperative efforts are enhanced by the opportunity for the participants to visit one another on short notice, or to work for extended periods in the other's facilities.

For example, in the Computer Imaging project, formal weekly meetings were held and frequent progress reports were written for internal use. In addition, because the firm was only about a mile from the university, there were frequent informal meetings to discuss new ideas and alternate approaches to problems. The Hybridoma Biotechnology project covered approximately 15 individual projects, each having a faculty member as the PI. After the first year, the company assigned a senior scientist to serve as a liaison between the research staffs of the firm and the university. This person visited the university frequently and also arranged for informal visits between the scientists of the two organizations. Being in the same metropolitan area allowed these interchanges to occur much more readily than if the staffs had been far apart.

Negotiators should guard against being too restrictive in formulating the agreement.

The Composites project involved over 30 persons from the company and almost 40 from the university plus two from the sponsoring agency (Office of Naval Research). A project of this magnitude required considerable coordination from a management viewpoint but also frequent contacts between technical personnel at several levels. Visits back and forth to each organization's laboratories and frequent seminars resulted in a degree of communication and cooperation that would be essentially unachieveable if there had not been close geographic proximity.

The Fermentation Technology project also had the advantage of both parties being in the same metropolitan area, but the principals found that a formal communications strategy was needed to ensure that the level and type of communication between various personnel from each laboratory were appropriate. This strategy was implemented to ease scheduling problems and to handle detailed day-to-day problems such as equipment maintenance without involving the project leaders or others not directly affected.

The participants in the Medical Tracers project did not enjoy the advantage of close geographic proximity. The research director of the company visited the university periodically and there was the usual exchange of quarterly and annual reports supplemented with phone calls and informal written communications. However, the spirit of cooperation was not as high as in the projects discussed above; friction developed over the time required to clear papers for publication as well as over what the company expected the university to do in follow-up work on some of the basic findings. While factors such as the personalities of the key personnel involved may, in any project, significantly enhance or reduce communications, we believe that the communication problems would have been minimized if the two organizations had been close to each other geographically.

In summary, close geographic proximity can greatly enhance the productivity of joint university-industry R&D projects, especially when a relatively large number (e.g., over ten) of research personnel are involved. On the other hand, it was clear that proximity to the research partner is not essential, since some projects were successful without it. In such cases, extra effort must be made to ensure good communications between the people actively engaged in the project.

Project Accomplishments

Four key conclusions resulted from a study of the accomplishments of the cooperative research projects:

- All of the projects gave excellent technical results which met the expectations of the project leaders;
- Factors external to the research effort can have dramatic effects on the utilization of the information developed;
- Cooperative projects are an effective means for enhancing student education, training and employment opportunities;
- Involvement in cooperative research can lead to increased academic-private sector cooperation for the participants.

The first two points are related to the overall success of cooperative research agreements. Combining the expertise and resources of the participants facilitates the undertaking of challenging projects neither partner would tackle separately because of economic or technological constraints. Of course, not all cooperative projects are successful in achieving the technical goals of an investigation. This limited examination suggests, however, that the findings from, or discoveries made, in a cooperative research project have a good probability of meeting or exceeding the expectations of the participants. In none of the seven cases studied was there any reservation by the key participants about the quality of the results.

This study also found that when cooperative research efforts encounter difficulties, factors external to the research stand a good chance of being at fault; two cases in particular pointed this out. The Hybridoma Biotechnology agreement was enormously successful from a technical standpoint, producing over 60 antibodies with commercialization possibilities; but midway through the agreement the company was acquired by a larger firm. A subsequent reorganization of the company's business activities resulted in severely reduced hybridoma research. Despite the encouraging results of the cooperative project, little significant follow-up of the discoveries occurred.

In the second instance, the Medical Tracers project, again good results were produced from the basic research. But, because of problems in communication and differing expectations of the participants over the amount of product development research provided by the agreement, this project faltered. In this case, the success achieved in the basic research stage was not continued in the development aspects of the agreement.

Several of the participants stated that because of involvement in these cooperative research programs, they either have started or are more likely to enter into subsequent collaborations. These statements suggest that once the initial barriers or reservations are overcome, a joint relationship can be both stimulating and productive. Participants from academia cited alternative source of research funds, an additional

Close geographic proximity can greatly enhance the productivity of joint university-industry R&D projects.

opportunity to work on relevant, challenging research, and the possibility of the university and/or themselves receiving royalties from their discoveries as reasons for continuing and expanding cooperative relationships. For the business participants, access to high-quality "state-of-the-art" research, the opportunity to upgrade the technical skills of their staffs, and the contributions to student education were the most important factors in reaching a similar conclusion on the value of close corporate-academic interactions.

The benefits to students in the seven cases studied were substantial. Some of the projects provided financial support for numerous students; e.g., over the seven-year lifetime of the Composites project, 50 participating students earned advanced degrees. In addition to receiving financial assistance, the students were able to work on projects having practical relevance, and they often had access to corporate facilities and equipment not available on the university campus. Additionally, such contacts with industry apparently were very beneficial for the students when they sought employment. Several of the graduate students were hired by the firms with which they were associated and some now hold positions of high responsibility.

Finally, these cases showed that governmental involvement in cooperative research does not appear to be detrimental and can even be beneficial. Programs funded by agencies such as the Advanced Research Projects Agency (ARPA, now DARPA), or the Small Business Innovation Research (SBIR) Program can be effective in bringing potential partners together and allowing them to collaborate with a minimum of red tape or oversight.

Future Research Arrangements

The significant conclusions from this study have been formulated into the following guidelines for future university-industry cooperative research:

1. Include key administrators, managers and investigators from the participating organizations in the contract negotiations from the earliest stages to final agreement.

2. Attempt to negotiate an agreement that is comprehensive, yet not overly restrictive or detailed. For those situations and conditions which are impossible to predict accurately, include mechanisms that can effectively deal with them if they occur.

3. Previous contacts between the research participants increase the likelihood of success for a particular agreement when it is undertaken.

4. Although close geographic proximity between project participants, is not essential, it can greatly enhance the productivity and effectiveness of an agreement.

5. Factors other than an agreement's measurable results may strongly affect the overall success of a project.

6. University-industry relationships are excellent for training students as well as providing attractive employment opportunities.

While the limited number of agreements studied is not a statistically valid sample, these conclusions are in general agreement with those developed individually in other studies (*7,8,9,10*). The participants in these seven projects believed that the benefits outweighed the risks entailed in entering into a cooperative arrangement (e.g., loss of proprietary information or a diminution of academic freedom, neither of which was considered as a significant problem by any of the participants interviewed). Even in the projects that encountered major difficulties, the participants concluded that benefits outweighed the drawbacks.

For cooperative university-industry research to succeed, then, the parties involved should seek a combination of open communications, mutual dedication and interdependence, respect and trust, an effective program management system, and a willingness on the part of all participants to compromise. The attainment of these conditions holds the greatest potential for promoting successful interactions. ⓐ

Previous contacts between the research participants increase the likelihood of success.

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