9.6 INDUSTRIAL COLLABORATION AND TECHNOLOGY TRANSFER

During the initial organization and implementation of a multi-institution ERC, extra effort is needed to obtain buy-in for the industrial program from all of the partner institutions. The preexisting industrial relationships among the academic partners need to be recognized, nurtured, and augmented to build a new base of industrial members across the Center. A new membership agreement needs to be created. Intellectual Property (IP), technology transfer, and industrial funding (membership, research funds) need to be discussed, negotiated, and codified into agreements. The Industrial Liaison Officer (ILO), a staff member at the lead university, leads this effort and has the additional task of working with the Principal Investigators (PIs), students, and industrial partners from all of the partner institutions. The structure of a multi-institution ERC is more complex than that of a single-institution Center; the relationships between the partners are more complex; and requirements of the ILO task are more demanding.

As a multi-institution ERC pulls together its dream team of academic and industrial collaborators, it faces several challenges. It must adapt to existing working styles and modes of operation, while accommodating different personalities, campus cultures, and industries. And it must create a viable model to enhance intercampus integration and industrial interactions.

The following paragraphs focus on issues common to multi-institution ERC industrial collaboration. Examples and case studies are provided to illustrate how multi-institution ERCs structure their industrial consortia, secure buy-in, and share resources. Some examples will illustrate how membership agreements and IP policies are established. Other examples will describe what is done to enhance interactions with industry, increase involvement, and motivate all partners. The collective experiences conveyed in these examples should serve as good references for both new and existing multi-institution ERCs.

9.6.1 Getting Started

Before starting the effort to build the Center's industrial program, it is important to recognize the added value of a multi-institutional ERC as it can greatly enrich both industry and university partners. Industry gains multidisciplinary, innovative technologies and resulting IPs; expanded technology transfer opportunities; access to multi-campus graduates as possible employees;, and collaborative possibilities with multi-campus researchers. Participating universities gain additional funding (from industry membership, NSF, multidisciplinary projects) for research and publication, and access to a broader spectrum of industry partners for more R&D and technology transfer opportunities. Recognizing each party's motivation helps in building an infrastructure that will flourish.

9.6.1.1 Securing Buy-in and Commitment

One of the start-up challenges is to secure cooperation and support from university administration on all partner campuses as well as their respective Technology Transfer Offices (TTOs). ERCs that provide industry membership funds to leverage grant-funded research also need to negotiate an overhead rate structure that optimizes both industry membership and research funding.

If a new ERC has pre-existing industry partnership programs at one or more of its partner universities, the Center must establish a membership agreement that incorporates the cultures of all partner institutions, and develop a membership structure that will ensure an easy and transparent transition for existing members. If no such pre-existing industry partnership program is in place, one suggestion for initiating a membership agreement is to request sample agreements from existing multi-university ERCs for reference. Another useful approach for potential partners is to make it clear that three things are expected from/for partners: (1) to contribute to the ERC; (2) to participate actively in the work of the ERC; and (3) to benefit from the ERC. If these goals are articulated early in negotiations, expectations are clear and subsequent unpleasant turns in the relationship can be reduced.

CASE STUDY: *Realizing the importance of securing buy-in and commitment from its five core partner universities, the Center for Power Electronics Systems (CPES) began a series of teleconferences with pertinent university officials and TTOs from team universities during the ERC proposal stage. The outcome of these discussions was a draft of a Memorandum of Agreement (MOA) that was eventually refined, approved, and executed by all partner*

campuses. The MOA helps to clarify the team's agreement regarding membership structure, intellectual property rights, and mechanisms for technology transfer.

CASE STUDY: *An existing industry membership organization, the Industry Educational Partners at Georgia Tech, was consulted at the ERC proposal stage for industry input. The industry members, consisting primarily of large medical device companies, strongly suggested the inclusion of EmoryUniversity to gain participation, access, and guidance from clinical groups relevant to the biological systems in the proposal. The industry members thought this partnership would be essential not only to successfully competing for an ERC, but also to the overall, long-term success of the Center. Consequently, the commitment of Emory University was secured and the formation of the Georgia Tech/Emory Center for the Engineering of Living Tissues (GTEC) was proposed for ERC funding, with the Educational Partners Program as a component. The buy-in of the industry members and transfer of the industry program to GTEC was facilitated by including them in the proposal process. They now benefit from the value-added relationships with Emory and Georgia Tech. Because the GTEC industry program was focused on tissue engineering, one member dropped its membership since tissue engineering was not a priority area for the company. With that exception, however, all the other original members have stayed involved and strongly support the Center.*

9.6.1.2 Structuring a Program to Benefit All

A multi-institution ERC is usually comprised of a diverse faculty with specialized expertise in complementary areas. Such a multidisciplinary program inevitably attracts industry members with varying interest levels. To serve the needs of a broad spectrum of industry, some ERCs have found that a tiered membership structure is effective because it offers flexibility in terms of financial commitment and collaborative opportunities with the academic institutions.

Although the NSF ERC program prefers that contributions from industrial and practice partners be in cash, to provide maximum operational flexibility for the ERC, in-kind contributions are possible and are welcomed. Companies in financially difficult periods, including start-up, often find it easier and more beneficial to contribute in-kind than in cash. Examples of in-kind contributions include hardware, software, or even support for students under certain conditions. Terms and extent of in-kind contributions must be administered fairly across companies and academic partners; i.e., no favoritism should be shown to a particular company or to a particular industrial or practice partner.

CASE STUDY: *The Center for Extreme Ultraviolet Science and Technology (EUV ERC) offers a tiered membership structure with three levels of corporate membership: Full, Associate, and Small Business Corporate Member. The Full Corporate Membership is $50,000 annually, Associate is $25,000 annually, and Small Business (less than 100 employees) is $5,000 annually. Credits for separate contracts which add substantially to the Center's needed infrastructure, equipment, or other valuable resources are given. At a minimum, Full Corporate Members must donate $10,000 in cash annually. The $5,000 annual fee for Small Business has made this level particularly attractive and has brought the EUV ERC a significant amount of industrial participation early in its existence. Companies large and small have joined for a seat at the table, to see the emerging technologies firsthand, meet the faculty and students directly, have potential access to the IP, and in some cases, receive help with simple tasks or components which help them get into the business.*

CASE STUDY: *CPES offers a tiered membership structure that includes four levels of participation—Principal Plus, Principal, Associate, and Affiliate. Principal Members pay $25,000 per year, and Principal Plus Members pay an additional $25,000 to gain the option of participating in a mini-consortium for focused research or sponsoring a fellowship for exploratory research within the Center's strategic plan. In addition to basic member benefits, Principal-level members also have early access to CPES-developed intellectual properties. Principal Members guide the Center as Industrial Advisory Board (IAB) members and work closely with Center researchers as research champions. Associate Members pay $10,000 per year and have easy access to the Center's research results, CPES researchers, and the state-of-the-art facilities. Affiliate Members include contributing WEMPEC members, small start-ups, and suppliers that are interested in making in-kind contributions to the Center in exchange for access to Center information as well as networking opportunities with Center personnel and other industry partners.*

CASE STUDY: *At the ERC for Biomimetic MicroElectronic Systems (BMES), Center membership funds are leveraged with sponsored research funds. BMES membership categories include Senior Members and Technology Members. Senior Members commit $50,000 per year for three years, serve on the IAB, and are mentors for technology development. They are in the best position to help define industry needs and influence research direction. They participate in research program reviews, have early access to Center-developed IPs, and are given*

first licensing opportunities. Technology Members commit $10,000 per year for three years. In addition to receiving the Center's research reports, Technology Members are invited to the ERC campus once or twice a year to meet-and-greet students for exploring summer internship and employment opportunities.

CASE STUDY: *GTEC has structured their membership fees according to the size of the companies participating. This was done to make the industry membership program accessible to small ($5,000 per year) and mid-sized ($10,000 per year) companies, as tissue engineering is considered an emerging industry with a limited industrial base. Even within large companies ($15,000 annual membership fee), the number of groups working on tissue engineering is limited, and the company might not have tissue-engineered product revenue streams. The fees are kept low to make the program inclusive, since there are a limited number of companies interested in and capable of investing in this emerging industry. Reduced fees for not-for-profit organizations are also considered.*

CASE STUDY: *The Business and Industry Partnership (BIP) at the Pacific Earthquake Engineering Research Center (PEER) involves industry and government partners that participate in the Center's research and education programs. BIP members are given preferred access to PEER research and products as well as preprinted publications via the PEER website. They have the opportunity to interact with PEER students and faculty and are welcome to attend PEER meetings to provide input on research direction and learn about the latest research findings. Membership contributions vary from $500 to much larger amounts, based on size and participation. Crucial PEER partners, such as the California Department of Transportation, California Energy Commission, and Pacific Gas and Electric Company, are highly involved in defining issues, formulating projects, and funding the specific research.*

CASE STUDY: *The VaNTHEngineeringResearchCenter in bioengineering educational technologies is unique among ERCs in that its research and development focus is on engineering education and associated learning technologies, not engineering* per se. *Several VaNTH partners are leading developers and vendors of engineering education and application software. These companies are encouraged to donate their software for educational purposes; that is, for use in the development of courseware and testing of instructional modules among the student populations of VaNTH research partners. Such contributions have several advantages to both VaNTH and the contributing company: (1) A clientele of users is established among students. If their experience is positive, students who learn to use software during their formal education are more likely to request and continue to use it during their work experience. (2) Instructors who develop educational experiences can provide valuable feedback on product design to software companies. (3) Companies, particularly smaller ones for which cash flow is a problem, can count the value of that software and its maintenance (usually discounted by prior agreement with NSF) toward membership requirements.*

The importance of partnerships with smaller companies cannot be overemphasized. These companies frequently benefit from advertising their relationship with the academic partners of an ERC, are often involved with cutting-edge technology to which more established partners do not have access, and are flexible enough in organizational structure to be more immediately responsive to ERC initiatives. For example, the VaNTH ERC has profited from many hours donated by a small company specializing in multimedia education to help produce bioengineering learning materials. Another small company, as a result of the VaNTH partnership, has helped develop innovative procedures in engineering design that have been emulated in medical as well as engineering curricula. Still another small company has become the second-largest employer in its home county through, among other strategies, taking advantage of VaNTH students and resources in developing learning materials and production strategies. Finally, it should be noted that small companies that are brought in the door at an affordable level have the potential to grow to higher levels in their involvement with the Center.

9.6.1.3 Incorporating Pre-existing Industrial Consortia

To sustain a robust industrial consortium, an ERC must be successful in recruiting new companies and retaining existing members. For multi-institution ERCs with pre-existing industry partnership programs, it is crucial to provide a seamless and transparent transition for existing members.

CASE STUDY: *Two of the five core CPES academic partners have successful pre-existing industrial consortia. The challenge is to develop a strategy to merge these consortia seamlessly into a CPES consortium upon which the Center can build a robust industrial consortium. To achieve this goal, Virginia Tech, the lead institution, folded its pre-existing industrial consortium, VPEC, into CPES, while selected WEMPEC members from the pre-existing UW-Madison consortium who had a relevant interest in the CPES program became CPES Affiliate Members. These members contribute one third of their membership fees to support CPES research activities relevant to the CPES strategic plan.*

9.6.1.4 Membership Agreements

A viable membership structure is one that attracts broad-based participation because it provides appropriate benefits to industries with varying needs and interests. Once the structure is agreed upon, membership agreements are reviewed and approved by university and legal counsel officials. For ERCs established at institutions that have pre-existing Centers, the road to securing buy-in and gaining institutional support can be significantly smoother. Using existing working models, the process for establishing multi-university agreements and IP policies can be highly efficient. For ERCs that have pre-existing industry programs, it is also important to clarify the new plan and transitional process for existing industry partners.

CASE STUDY: *As the second ERC established at the University of Southern California, the Biomimetic MicroElectronic Systems (BMES) ERC enjoys the advantage of the ERC campus culture shaped by the older Integrated Media Systems Center (IMSC). Based on the IMSC model, BMES was able to streamline the process of setting up its industry membership structure and was successful in implementing a cross-campus IP policy that is stronger than a Memorandum of Understanding (MOU).*

CASE STUDY: *CPES includes five core academic partners, two of which have pre-existing industrial consortia. Knowing the importance of ensuring that existing industry members are clear about the transition and happy with the program's features, CPES added a special Q&A session during the Center's first annual seminar and invited industry partners to discuss the new program, raise their concerns, and offer feedback and recommendations.*

CASE STUDY: *At the University of Michigan's Wireless Integrated MicroSystems (WIMS) Center, industry membership agreements are evergreen, allowing automatic membership renewal unless either party opts out. This mechanism has dramatically reduced the burden for corporate champions to obtain executive-level signatures every year.*

9.6.1.5 Unique Aspects of Earthquake Engineering Research Centers

The ultimate mission of Earthquake Engineering Research Centers (EERCs) is to save lives and minimize earthquake-induced economic losses. Due to the broad societal impact of earthquakes, both private corporations and government agencies are integral partners of EERCs. At PEER, industrial corporations such as Pacific Gas and Electric Company and state agencies such as the California Department of Transportation and California Energy Commission have strong and long-term relationships with the Center. Utilizing leveraged funding, these government and industry partners work closely with PEER to develop long-term research programs, aiming to achieve the collective goals of addressing seismic issues and problems, reducing loss to human lives, and minimizing damage to the electrical network, highways, buildings, bridges, etc. These Centers are different from other ERCs due to the direct societal nature of the work and the heavy involvement of government agencies from the regional to the local level.

9.6.2 Building a Strong Industrial Constituency Across Multiple Campuses

The ILO needs to recognize the existing links and potential links between companies, Principal Investigators, and students in the ERC. He or she must build or reinforce bridges between the company and the ERC by communicating the benefits of the relationship to both parties.

9.6.2.1 The Industrial Liaison Officer—A Resource for All University Partners

To maintain strong intra-campus connectivity with industry, the ILO must play a central coordination role and serve as the primary point of contact. The ILO should be both people- and detail-oriented, and be well-regarded by both ERC faculty and industry. In addition to recruiting industry members, the ILO also needs to energize effective interactions between researchers and industry champions and act as the liaison between the TTOs on the partner campuses. To enhance effectiveness, each partner university could also designate a campus liaison to support the ILO, as a resident person would better understand the people and infrastructure on his/her respective campus. The ILO should work closely with the Center's research manager(s) and IP offices, act as industry's advocate, and serve as the primary provider of customer service. In short, the ILO must be the "glue" that holds the academic and industrial communities in working harmony.

CASE STUDY: *Keeping all Center constituents (multiple university faculty, students, and administrations; outreach*

participants, and industry members) informed of activities, special initiatives benefiting industry, and scientific developments is critically important. GTEC publishes an industry newsletter biannually (fall and spring) that highlights faculty/student activities and awards, new publications, patents issued or applications published; introduces new industry members or new faculty; and features short news pieces to keep everyone connected. The newsletter can be distributed to a larger industry community as a PDF file via email or downloaded from GTEC's website to raise the profile of the Center and potentially recruit new member companies. Samples of the Center's Expressions *newsletter can be found at* http://www.gtec.gatech.edu *under "Center Publications."*

CASE STUDY: *At VanderbiltUniversity, the VaNTH industrial liaison group has several additional responsibilities that facilitate industrial contact. Dr. Jerry Collins, VaNTH's ILO, is the recipient of an industrial internship award from the Whitaker Foundation. Internship placement with companies, some of which are VaNTH partners, provides feedback on how VaNTH students perform in conditions of adaptive learning (a development goal for VaNTH), as well as suggestions for improving the instructional milieu. Dr. Collins has also served as chair of the Interface with Industry Committee of the Biomedical Engineering Society, and is current co-chair of the Education Committee of the Tennessee Biotechnology Association and president of the Tennessee Biomedical Engineering Consortium. This visibility and activity among national and local industrial and professional organizations affords numerous opportunities for development of ERC industrial partnerships.*

Additional partnership opportunities can come from follow-up of summer internship and permanent employment opportunities developed through an active university CareerCenter and Alumni Office. Strong relationships with such offices on every campus of a multi-university ERC should be developed by the ILO and her/his associates.

9.6.2.2 Industry-student Connectivity

To build and maintain a strong industrial collaboration program, ILOs must cultivate connectivity between students and industry. Initially the level of industry connectivity will probably differ from campus to campus, based on prior industry-faculty relationships. As the ERC evolves, it is important to initiate and maintain efforts that will maximize industry-student connections on all campuses.

The natural way to increase connectivity between students and industry are to use the events that bring the industry and academic communities together, such as IAB/SLC meetings, annual symposia and site visit, technical exchange meetings, and hiring opportunities. In planning an ERC symposium or site visit, the ILO and Education Director can arrange for student and industry interactions; for example, a poster session would bring industry representatives and multi-campus students together to meet and discuss research of mutual interest. Industry representatives can be called upon to review and vote on student posters or presentations, leading to an award. The Education Director can compile a student resume booklet to be distributed at the Industrial Advisory Board (IAB) meeting or at the poster session. Graduating students can be invited and introduced at the IAB meetings. Receptions or dinners can be used to encourage networking by pairing students with industry representatives.

When a student's work reaches the intellectual property stage, the ILO can coordinate an effort to bring the student (with mentor and guidance) and appropriate industry partner together to explore commercialization possibilities. Conversely, an industry partner can help a student recognize the commercial potential of some of his or her work and, through the ILO or Education Director, help the student obtain the proper protection (patent, copyright, etc.).

In general, multi-institution ERCs involve students from all partner campuses in annual meetings, workshops, and symposia so they can present their work and interact with industry participants. In addition, some ERCs also engage industry research champions in intra-campus research meetings for technical updates, providing more opportunities for industry-student connectivity. These interactions sometimes lead to students being invited to present their work at the company site, resulting in higher visibility and possibly leading to summer internships and employment opportunities.

CASE STUDY: *In the VaNTH ERC, Vanderbilt has a strong undergraduate internship program and NorthwesternUniversity has a strong undergraduate co-op program (undergraduate programs at the University of Texas, a VaNTH research partner, and the University of Memphis, a VaNTH academic partner, are still under development). Placement of bioengineering students in both internship and co-op positions is sought and encouraged by VaNTH. After the training period, co-op students, interns, and industrial mentors are asked to respond to questionnaires patterned after ABET-desired outcomes for accredited educational programs. Assessment of responses provides benchmarks of student performance and VaNTH effectiveness.*

CASE STUDY: *The GTEC Student Council has developed a short course pertaining to research and development in industry called **L**earn about **I**ndustry **f**rom the **E**xperts (LIFE). The LIFE short course assists in preparing students for future industry positions or collaboration. This program draws from the GTEC industrial partners' expertise and enhances student-industry relations. The course introduces students to the events that occur within industry to bring a product through research and development to the market—taking a research idea from the bench and delivering it to a patient in the form of a product. Topics include research and product development in industry, FDA regulatory issues, market-driven research and development, and other topics designed to expose students to the processes involved in commercializing a research idea. Students are provided with notebooks for the course, and those attending 75% or more of the talks are given a certificate of achievement.*

CASE STUDY: *To improve industry-student connectivity, the CPES IAB's Working Group on Communications invites the Center's Student Leadership Council to join their monthly teleconferences so they can better understand student needs and exchange ideas. As an outcome of these discussions, a dedicated meet-and-greet function became an annual activity for students and industry participants to mingle in an informal setting. In recent years, these interactions evolved into the highly successful face-to-face IAB/SLC joint meeting held during the annual conference. In these meetings, industry and students openly share issues and concerns and discuss possible means to further improve industry-student connectivity. Another activity that has proven to be of great value to enhancing student experience is that students are given the chance to organize the Center's annual conference by joining the Student Conference Organizing Committee.*

The CPES IPPF plan provides an additional mechanism for direct transfer of knowledge from researchers to industry, as IPPF members are invited to join quarterly telecons to discuss with student researchers the value of their innovative concepts for possible patent protection.

9.6.3 Interacting with Industry Partners in a Multi-University Environment

A multi-university ERC must recognize the research needs of the ERC's industrial partners and, to the extent possible within its strategic plan, guide its research to satisfy its partners' needs. The IAB plays an important role as the voice of the industrial partners by communicating clearly their technological and research needs.

9.6.3.1 Modes of Communication for Intra-campus Collaboration

ERC research direction should be aligned with industry trends and long-term needs, so that the research is relevant for eventual commercialization. To accomplish this objective, ERCs must collaborate closely with industry in technology development and transfer. ILOs are responsible for facilitating this process across the campuses.

CASE STUDY: *As the CPES research program matures, the number of cross-campus joint projects increases, allowing more opportunities for multi-campus integration and collaboration. CPES thrust leaders jointly decide on how to group the projects into clusters for team discussions. Student leaders organize the biweekly team*

teleconferences and invite research champions to join them on a monthly basis for progress updates and industry feedback. In preparation for these meetings, agenda and reference materials are disseminated in advance to industry participants. Those who are unable to participate can retrieve student presentations posted on the Center's password-protected website.

CASE STUDY: *VaNTH has held at least three and as many as four meetings each year at VaNTH research partner sites. IAB meetings are held at two of these (the Austin spring meeting and the Nashville site visit), and Industrial and Practice Partners (IPP) and potential partners are invited to the others as well. When appropriate, IPP members give presentations at these meetings. One advantage of distributing the sites of these meetings is that IPP partners can attend meetings in their geographical vicinities with minimal disruption and expense. Regional meetings are also an excellent method for inviting and recruiting potential new partners.*

CASE STUDY: *To optimize cross-campus collaboration, all partner campuses of the WIMSCenter use the Polycom system as their common mode of communication. This audio/video capability has enabled more effective communication with regard to research collaboration as well as Center administration.*

9.6.3.2 Industry Advisory Board

The IAB represents the industrial partners. It meets to review the research of the multi-university ERC, to discuss needs of the industrial partners, to communicate their needs to their university partners, and to carry out the annual industry SWOT (Strengths, Weaknesses, Opportunities, and Threats) analyses for the ERC's and NSF site visit team's reference. Some ERCs open IAB participation to all industry members. However, for multi-institution ERCs with large industry membership, it may be more effective to keep the IAB to a manageable size. Following are examples of how some of the ERCs organize their IAB and related activities.

CASE STUDY: *At PEER, selected representatives of the Business and Industry Partnership, plus representatives of key government agencies providing funding for PEER, are members of an Implementation Advisory Board which advises PEER on its strategic plan, research projects, implementation of research results, and new opportunities for funding.*

CASE STUDY: *CPES Principal-level Members have a stronger interest in closer collaboratin with the Center and demonstrate their commitment by making higher financial contributions. These companies have a guaranteed seat on the IAB. Associate members are mostly interested in basic membership benefits and are offered possible IAB representation by election. In general, the CPES IAB consists of 30 industry representatives.*

To enhance its effectiveness, the IAB forms an Executive Committee (ExCom) to filter and identify issues for broader IAB discussion. The IAB ExCom holds monthly teleconferences, while the full IAB meets three times a year—two via telecons and one face-to-face meeting held in conjunction with the Annual Meeting. To provide a forum for all industry partners to interact with each other, the face-to-face IAB meeting is open to all members. Throughout the year, industry partners are given access to program updates posted on the Center's password-protected website, and are kept abreast of IAB activities via the distribution of IAB telecon meeting minutes.

In addition to the IAB ExCom, there is also the IAB "huddle group" that includes the IAB Chair, Co-Chair, Secretary, Center Director/Co-Director, Technical Director, and ILO. IAB Huddle meets on the phone every week for informal updates and dialogue. This tiered model has proven to work very well in ensuring effective communication between CPES and its IAB.

9.6.3.3 IAB Working Groups

When the IAB has identified certain issues and needs industry attention and support, IAB may decide to form a focused working group and charge it with a specific objective. As the working groups carry out their mission, contributing members may go within their own companies to seek help and consult experts, thus allowing the Center to gain expanded support from additional industry advocates and mentors. This model has proven to be quite effective for ERCs that employ it.

9.6.3.4 Industry Champions

Industry champions are advocates of specific research areas and serve as mentors to the Center's researchers. As an added benefit, cross-campus interactive opportunities on technical matters are offered to representatives of Principal-level member

firms, as champions who interact closely with ERC researchers can ensure direct technology transfer. Keeping industry champions actively engaged is the collaborative endeavor of ILOs and research thrust leaders. Oftentimes, faculty researchers make the initial connection with industry, and the ILO continues the effort by making follow-up calls, defining champions' role, clarifying expectations, and facilitating communications. ILOs of multi-institution ERCs must make the extra effort to work closely with the various cross-campus research leaders to ensure consistent and active industry involvement.

9.6.4 Intellectual Property and Technology Transfer

Technology transfer is important to all ERCs and can take many forms. However, IP issues vary in importance in different fields. For example, while early IP access is crucial for medical device companies due to the competitive edge it provides, IP is less important to Earthquake ERCs because their business and industry partners are equally interested in minimizing losses and reducing damage resulting from earthquakes.

9.6.4.1 Technology Transfer: Strategies and Mechanisms

The transfer of ideas and technologies from university partners to industrial partners is at the heart of the ERC/partner relationship. Technology can be transferred in many ways (presentations, publications, courses, joint research, student internships, contract and grant support, etc.). The more directly associated the technology is to the compnay's products, the more exclusive and valuable the technology transfer is to the customer. Ideas or technologies derived from sponsored projects and technology jointly developed under joint contracts or grants are generally the most valuable.

- *Joint projects and technology development—*

Working together, industry and universities can be more successful at obtaining government funding for joint research programs. Together they can obtain resources to develop technology needed by both. The transfer of technology then becomes automatic and provides a valuable justification for the ERC partnership and membership dues.

CASE STUDY: *The CenSSIS ASHERD Portal Program is a joint development of a nuclear detector for U.S. ports of entry by NortheasternUniversity and Bubble Technology Industries. Initially, it was a program to develop a spectroscopic portal for detection of nuclear materials in vehicles (trucks, cargo containers, cars, and trains). The successful completion of this development effort resulted in the procurement of a third contract between Raytheon, Bubble Technology Industries, and NortheasternUniversity to build portals for U.S. ports of entry.*

- *Finding effective models suitable for the diverse university cultures—*

Within a multidisciplinary, multi-university ERC where there may be multiple intra-campus joint projects, ILOs must make sure that industry has an easy way to interact with the various intra-campus project teams, and must also ensure that interactions with industry champions are consistent, efficient, and effective. For industry, the best mechanism for gaining the extra edge on technology transfer is to have company engineers serve as research champions, join IAB working groups, or participate in the Center's industrial residence program and work on-site with the Center's researchers.

- *Educating multi-campus researchers on IP-related issues—*

ERC faculty and student researchers often interact directly with industry. It is thus important to make sure that investigators and their students are fully aware of the Center's IP and non-disclosure agreements. Because jointly conducted research could lead to joint inventions, it is crucial that ERC researchers develop the important habit of documenting innovative concepts in IP lab notebooks as new ideas are conceived so as to support any inventions that may be disclosed under the team effort.

9.6.4.2 Developing an IP Agreement for Multi-university Centers

Multi-institution ERCs face the difficult challenge of developing an all-encompassing IP policy that is fully compatible with existing policies at partner institutions. Meeting with pertinent university officials and technology transfer officers from partner

campuses to clarify the parameters, IP rights, and terms and conditions is therefore very important and should occur at the outset. Throughout this process, the ILO must act as the primary facilitator to ensure that the IP agreement serves industry well, while at the same time satisfying the requirements of the university partners. Participating universities should establish an inter-institutional agreement that outlines basic operating policies for the management of IP generated by each university and for collaborative efforts. A lead university may be identified to manage collaborative IP because of its expertise in specific IP categories. These agreements should be put in place early, kept simplified, and used as a guide when managing the Center's IP.

CASE STUDY: *The BMES ERC develops innovative medical devices with application horizons that may take up to 10 years for FDA approval. To justify long-term investments in academic research, most BMES industry supporters are interested in gaining the IP competitive edge. Recognizing that licensing opportunities for Center-developed IP is one of its core appeals, BMES was keen on establishing an IP access mechanism that is streamlined and efficient. With strong institutional support from its partner institutions, BMES was successful in establishing a multi-university IP agreement that allows central management and administration of Center-developed IP at the lead institution, providing the convenience of one-stop shopping for its Senior Members.*

CASE STUDY: *The CPES IP policy allows for a certain degree of flexibility within the framework. It states that if an invention is developed under NSF-funded core research, it will be managed in accordance with the IP policies of the university where the invention is disclosed. In the case of joint inventorship, which would be defined by U.S. patent law and the policies of the respective institutions and/or industry member(s), the home institutions of the joint inventors would decide who would be responsible for the prosecution of the patent and commercialization. In addition, partner institutions have agreed that Principal-level Members will be granted early access to CPES-developed technologies, the option to negotiate a reasonable license fee plus royalties, and the added opportunity for Principal Plus Members to credit annual membership fees towards license fees and royalties. To further streamline the IP protection process, CPES-Virginia Tech offers a novel option called the Intellectual Property Protection Fund (IPPF), a plan that allows Principal-level Members to pool funds for IP protection. IPPF members contribute $5,000 per year, jointly decide which IPs they wish to protect, and are granted a non-exclusive, royalty-free license to use these technologies. Not only has this mechanism greatly enhanced the IP advantage for Principal-level Members, it also allows researchers to publish their technical innovations without delay.*

9.6.5 Sharing Industrial Funding Resources

Distribution of resources within a multi-institution ERC is a complex process. Each ERC conducts its distribution differently. Some funds are obtained with restrictions and others are not. Some funds are given to support specific activities at one institution or specific activities at a set of institutions. The distribution of funds and resources is as varied as the variety of sponsors. No matter what scheme for distribution is used, it must strongly support the ERC infrastructure and its technical efforts.

9.6.5.1 Planning and Allocations to Partner Universities

Industrial consortium funds generally are used to directly support industrial collaboration activities coordinated and managed at the lead institution. At times, however, ERCs may find it necessary to earmark a portion of the industry funds to support research or other program enhancement initiatives. In these cases, it is important to make sure that industry and university partners all agree with the purpose of the initiative and understand the funding allocation process.

CASE STUDY: *Under certain circumstances, faculty involved with GTEC may prefer to receive a major equipment allocation rather than receive research project support. For instance, faculty receiving most of their funding from the NIH cannot designate major equipment purchases to these grants. Faculty who are securing funding from outside the Center, but whose research clearly falls within GTEC's strategic research plan, may request the purchase of a major piece of equipment directly involved with that research. GTEC has purchased equipment (or provided matching funds) that would be impossible to buy with NIH grants in order to provide key enhancements and added capabilities that directly impact the Center through scientific advancements and collaborative research with other GTEC faculty.*

CASE STUDY: *To enhance domestic Ph.D. student recruitment and further emphasize basic research, CPES proposed to allocate some industry funds to create special graduate fellowships and fellowship supplements to*

support these initiatives. After receiving the IAB's endorsement, industry fellowships were established at the lead institution and allocated to specific campuses to fill their needs.

CASE STUDY: *In addition to funds, another ERC resource is its students. Some of VaNTH's industrial partners request that they be allowed to hire interns or co-op students as part of their VaNTH commitment. The NSF allows the ERC to do that, partly because VaNTH is an educational ERC and student performance in an internship is an important testbed for the Center. Often, companies request interns from nearby VaNTH partners or from nearby home towns, because they feel their chances of retaining such interns as permanent employees are greater. VaNTH always tries to comply with those requests and coordinates its student searches accordingly.*