5.3 Building an Innovation Ecosystem

5.3.1 Defining the ERC Innovation Ecosystem

The ERC Gen-3 Program rest on the core key features of the historic (Gen-2) program and adds innovation features. However, a primary mission of the Gen-3 ERCs continues to be industrial collaboration and technology transfer to member firms. This is augmented by a focus on innovation and entrepreneurship for students and a reliance on small firms to carry out translational research when member firms fail to license ERC-generated IP. In addition, Gen-3 ERCs are required to build partnerships with innovation facilitators (university and/or state and local government organizations devoted to entrepreneurship and innovation) to help accelerate the transfer of ERC technology to the marketplace when member firms are not involved in that process.

Thus the original mission of the ERC Gen-2 industrial collaboration program is to build a strategic industry alliance to develop and deploy new technology. This is the primary industrial mission of Gen-3 centers as well. The Gen-3 small firm component and the innovation facilitators are additions to that original mission.

The overall strategy for innovation and technology commercialization can best be described by the following narration from Dr. Deborah Jackson, and ERC Program Director in the NSF ERC Program Office.

â€œMoving innovations from discovery through to commercialization involves numerous actors, often including academic researchers, small businesses, the investor community, and commercial industry. At one end of the spectrumâ€”academeâ€”there is a heavy concentration of government investment in fundamental research. At the other end, in the commercial marketplace, there is a much higher level of industry investment in direct product development. In between lies the so-called Valley of Death, where many potential innovations die for lack of the resources needed to develop them to a stage where industry or investors can recognize and exploit their commercial potential. Crossing that valley requires a complex interplay of relationships along the innovation spectrum. Common approaches include creating formal vehicles for collaboration, such as non-disclosure agreements and memoranda of understanding, or creating opportunities for actors to circulate among different entities through visiting-scientist or post-doctoral programs, sabbaticals, or consultant arrangements. Additional vehicles for promoting interactionâ€”topical conferences, cross-disciplinary institutes, or centers of excellenceâ€”create the intangibles of the innovation ecosystem, improving the odds a venture will succeed.

Beyond the intangibles, one-time investments in the innovation infrastructure by the government can make the overall operation more efficient and thus either help lower the threshold cost to industry of launching new ventures or remove obstacles to reduce the time to market. These investments may include physical infrastructure, such as rapid prototyping facilities, or bundled start-up and intellectual property legal services that are accessible to most players in the ecosystem. Lowering the threshold cost and reducing time to market result in more ventures successfully crossing the valley and entering the marketplace.â€•

This philosophy is illustrated in Figure 5-4.

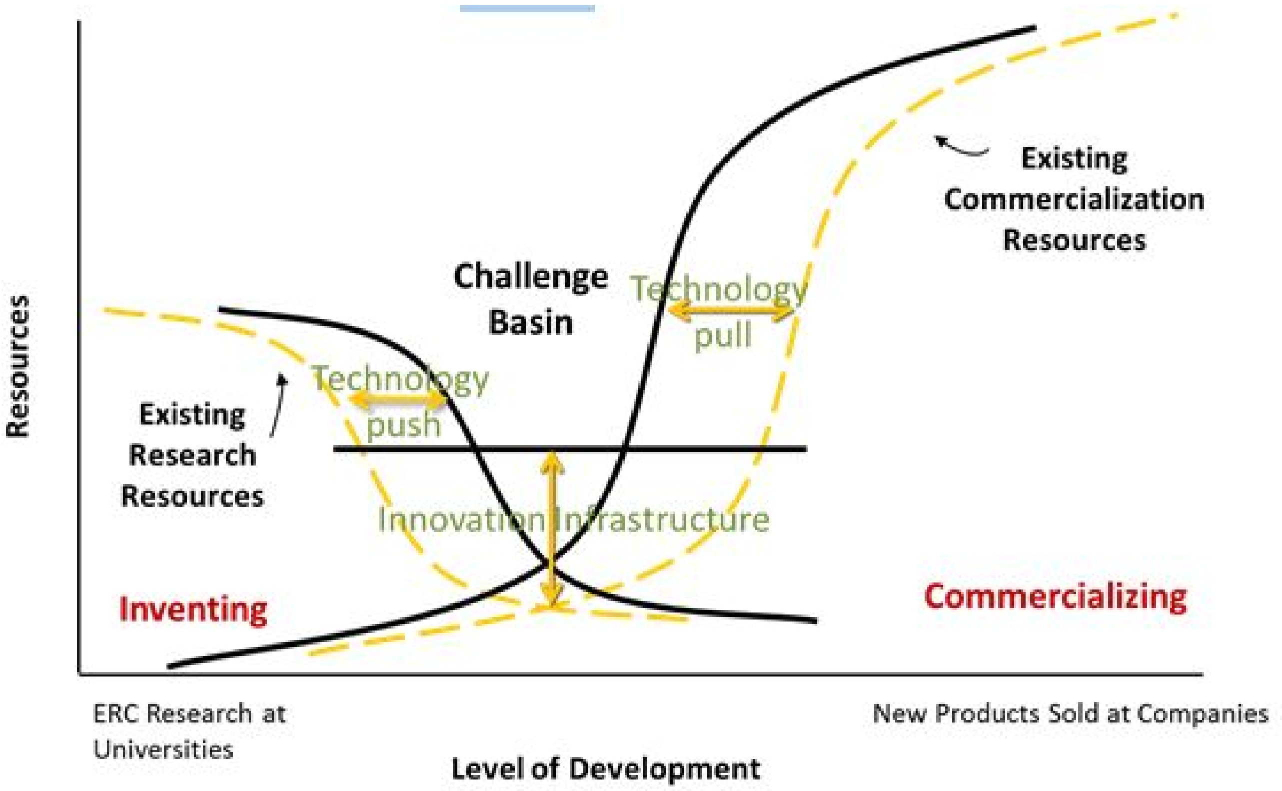

Figure 5-4â€"Innovation Bridge Structures Turns the â€œValley of Deathâ€• into a more approachable â€œChallenge Basinâ€• [1]

The major objectives of the ERC program include both developing and commercializing technologies to bolster the competitiveness of U.S. industry. To successfully bridge the gap between technology development and commercialization, ERCs must take a holistic, integrated approach to technology (creation, experimentation, development, and implementation) that is unique among NSF-funded organizations. The involvement of industry representatives in goal setting, project review, technology evaluation, and technology implementation is vital to the success of this effort. In addition, if they are to be successful at commercialization, they must have ways to ensure the equitable treatment and ownership of intellectual property (IP) resulting from research by individual researchers, the ERC, the university, and industry sponsors.

Technology commercialization at ERCs is an ever-expanding art. The process is significantly more complex than it is where technology is developed and commercialized wholly within a single company or at a small business spin-off based on a university invention that is not licensed by ERC members. The challenge lies in melding a commercially promising research agenda with the often disparate goals of individual industrial sponsors, guiding the resulting work to a point at which industry can use the product, and supporting the commercialization effort through continued close contact between ERC researchers and industry representatives. Both university investigators and industry scientists must understand that their roles will change from advisor to project director as a commercialization effort moves forward.

These challenges are significant, but ERCs are well positioned to take advantage of the considerable experience of industry in generating value from new ideas. The ERC model has a built-in mechanism for maintaining industrial relevance, in the form of periodic project reviews and direction by industry representatives. Technology transfer takes the forms of directly commercializable technologies as well as the transfer of ideas, which industry can refine and cultivate into saleable products.

5.3.1.1 The Virtuous Innovation Cycle

NSF provides guidance on some of the critical success factors and infrastructure needed to establish and grow a strong innovation ecosystem, and these factors feed directly into a complete ERC industry communications and marketing program.[2] The ERC structure has a strong focus on industrial collaboration and innovation, bringing together necessary resources and talent to build a â€œvirtuous innovation cycleâ€• that combines the strength of the â€œResearch Economyâ€• and the â€œCommercial Economy.â€• ERCs are uniquely positioned to engage resources from both of these economies to push technologies from the research spectrum as well as pull technologies to market applications from the commercial spectrum. This combined push-pull strategy relies on the coordinated application of resources (funding, talent, innovation champions, educational programs, etc.) from both economies and a well-articulated and delivered industry communications and marketing program will clearly illustrate the value to industry and innovation partners of engaging with the ERC and translating technology and talent from the academic to the private sector. This is illustrated in Figure 5-5.

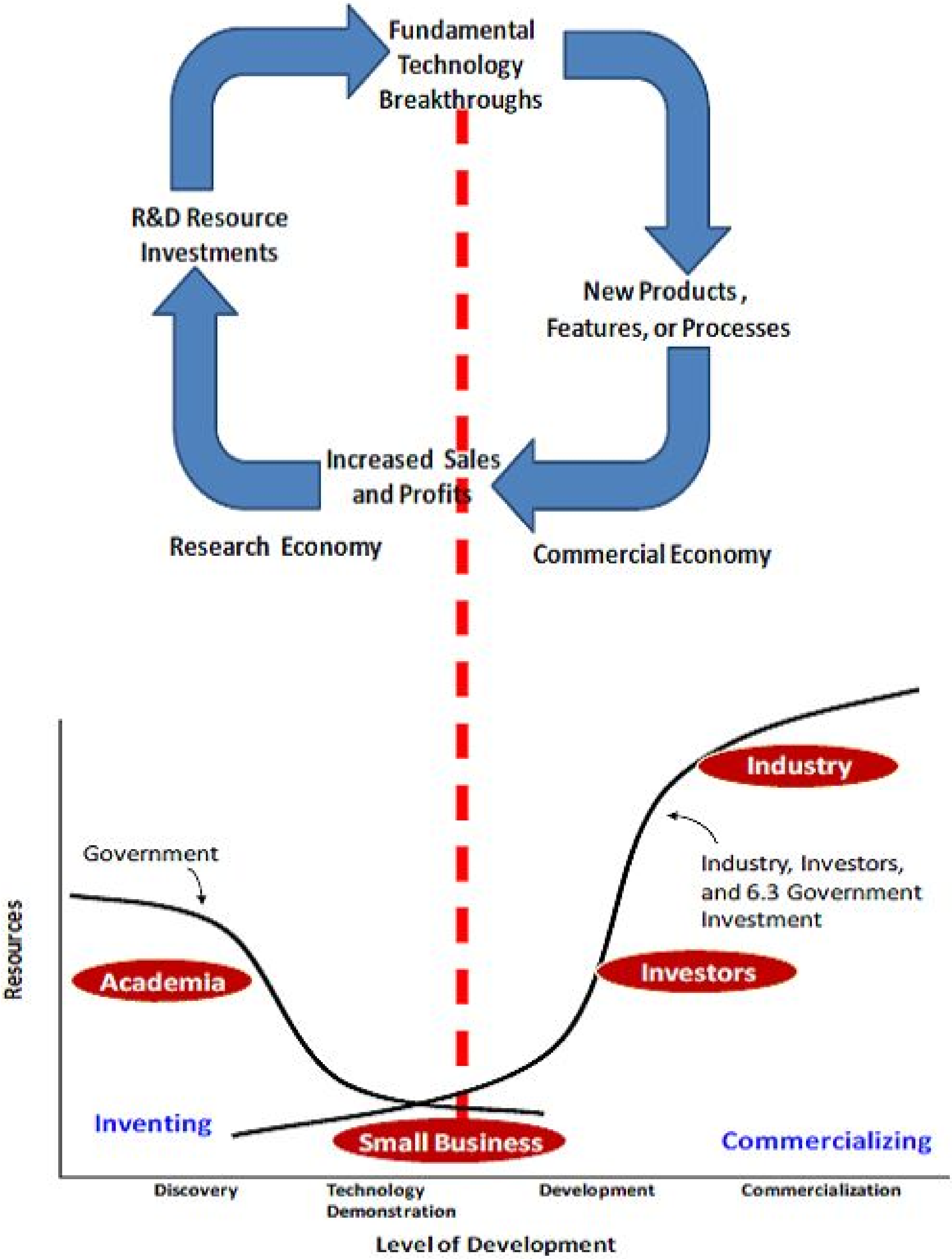

Figure 5-5â€"The â€œVirtuous Innovation Cycleâ€• Relationship to the Valley of Death

5.3.2 Intellectual Property Management and Delivery

Because the potential for commercial success of ideas is difficult to forecast or control, it is important that ERCs and industry forge a more fluid relationship with university administrations concerning ownership rights to intellectual property. For industry, one of the main attractions of belonging to an ERC is the potential access to breaking technology that could bring competitive advantage. Indeed, this is a central purpose of the ERC.

Intellectual property rights specified in the membership agreement are influenced by the type of industry, by the university's experience, and by common sense. The type of membership structure also should influence IP decisions. If all of the center's core research activity is precompetitive and supported in common, shared rights for all members may be appropriate. If the center has, in addition to core research, special project support by a company, the arrangement should reflect that company's unique contribution and rights. In a typical center, the university owns IP and licenses are available to members. Access to licenses is based upon membership category, varying from royalty-free license to all center-developed IP to no access for any members. Other IP issues that may be included in the agreement or dealt with on a case-by-case basis include restrictions on licenses, who pays for and maintains patents, and royalty amounts. A more extensive discussion of IP rights is presented in Section 5.3.2.

Sections 5.1.1 have already discussed the need for pre-establishing agreements among the ERC, host university, partner universities, industry members, and ERC researchers to assure that systems and protocols are in place to get the ERC successfully launched. As discussed in those sections, Intellectual Property management clauses and terms is a key component of those agreements and so will not be repeated here.

5.3.2.1 The ERC IP Process Flow

However, it is instructive to discuss Intellectual Property Management protocol in a more granular fashionâ€"that is, from invention disclosure to ultimate licensing. It is anticipated that development leading to commercially viable products and processes will be primarily performed by industry members, rather than the ERC; but it is truly a partnership to develop and translate ERC research to market-impacting offerings. This section describes best practices in the steps of that process. Note that further detail can be found through examination of the Sample ERC Industrial Membership Agreement in Attachment 5-C. The basic ERC IP Flow Process is illustrated in Figure 5-6 and is discussed below.

When the figure is read from left to right, it illustrates the hierarchy of potential commercialization pathways, ranked from lowest to highest risk. The available options for innovation commercialization are (a) translation to industrial partners for further development, (b) licensing technology to a non-member firm for further development, and (c) licensing technology to a university-initiated start-up focused on translating the technology. NSF intends that the ERC will place the highest priority in developing industry relationships on cultivating IAB members and other firms that co-invest with NSF in the ERC enterprise. Small businesses in all three options are eligible to apply for funding from the NSF translational Small-Business/ERC Collaborative Opportunity (SECO) fund. Since NSF is not in the business of launching start-ups, nor does it have the resources to shepherd a start-up through to success, the start-up option should be used only as a last resort when no other options avail themselves.

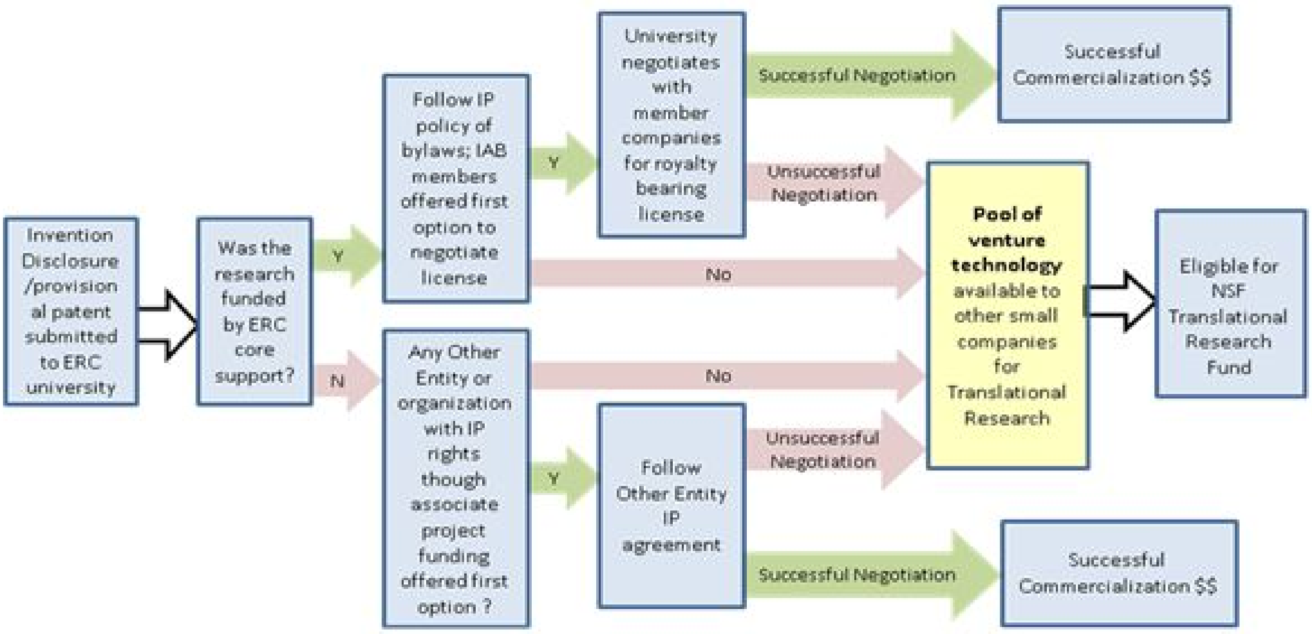

Figure 5-6: ERC Intellectual Property Flow Diagram

5.3.2.2 Membership Levels and IP Rights

Many ERCs have developed â€œtieredâ€• approaches to industrial membership, wherein companies may opt to increase their access to IP or licensing rights on projects they fund in addition to their membership dues in exchange for higher annual duesâ€”see, for example, the discussion of Section 5.1.2 and the Sample ERC Industrial Membership Agreement of Attachment 5-C. The advantages of this system are that the ERC obtains increased annual membership funding based on the expected future value of IP and licensing rights. The details of the tiered membership system must be formulated in concert with the university technology transfer office and existing or prospective members.

The membership system in multi-institutional ERCs presents an added level of complexity. Here, membership rights often reflect the least common denominator. For example, one university may be able to offer companies better access to intellectual property than other universities in the center can. But it is important for the center to present a single criterion of industry benefits, reflecting the consensus of all the partner institutions. Variations can be addressed internally, so as not to confuse the member companies. It is therefore imperative that negotiations between the multiple institutions of the center be started as early as possible, because the development of an agreement suitable for all institutions can be very time-consuming.

5.3.2.3 IP in Relation to Funding Source

Treatment of IP rights varies depending on the source of the funds that generated that research:

- *ERC Core Research* â€“ This is research that is funded through Center unrestricted, discretionary funds. As with most university intellectual property, IP generated from ERC core research is not normally subject to ownership by industry, although ERC industry members enjoy preferential licensing rights to this technology over non-associated companies. Industry members enjoy a first option on licensing, a non-exclusive royalty free (NERF) license or other benefits, compared with non-associated companies, for IP generated from ERC core research, per the ERC Industrial Membership Agreement.
- *ERC Sponsored / Directed Research* â€“ This category of research comprises projects usually funded by a single company through a separate research agreement that outlines terms and conditions specific to that

research project, and is managed through the ERC. IP resulting from research funded by a single company may be subject to IP rights by the sponsoring company, depending on the specific agreement between the university and the company. Some ERCs confer ownership of IP from sponsored research to the sponsoring industry member based on a premium level of membership. This is the first mode for translational research in ERCs.
- *Associated Research* â€“ Associated projects are also sponsored or directed research projects in the scientific/technical field of the ERC, but are funded through the home department of a center researcher rather than through the ERC. Associated projects are only included in the ERCâ€™s research project portfolio if all or part of the project is critical to the ERC achieving its strategic research plan. Many of the characteristics of the ERC sponsored research project apply here as well. It is important for ERCs and the NSF to capture and report the level of ERC Sponsored / Directed and Associated Research, as this captures the breadth of the impact of the ERC and its researchers in the field of focus of the ERC.
- *Research Funded by a Consortium of Companies* âˆ' IP ownership and licensing rights are further complicated by the involvement of several companies (usually a subset of industry members) in funding work as a consortium. An important distinction to note is that these consortia are funding a project in addition to paying normal membership dues to the ERC. In this case, it is typical that all members of the consortium have equal access to the technology and equal rights for IP ownership or use through licensing, although this can be specific to the ERC and specific consortium needs.

5.3.2.4 Invention Disclosure to University and ERC

The ERC has a contractual obligation to its industry members to provide ERC Core Research invention disclosures in a timely manner so that members can get an early look at inventions and decide whether to exercise any IP rights (e.g., first option to negotiate a license or NERF license) provided through the Membership Agreement. The key is to establish a system between the ERC and the university (host and partners) to identify ERC inventions in a timely manner. ERCs have implemented systems such as:

- ERC researchers being instructed to submit ERC supported research inventions to both the university technology transfer office and the ERC ILO simultaneously;
- The ERC ILO communicating regularly (e.g., monthly) with their university technology transfer offices to assure that ERC funded research subject to Industrial Membership Agreement rights are identified timely;
- University technology transfer offices customizing their invention intake systems to flag the NSF ERC agreement number to identify ERC core research inventions; and
- ILOs communicating regularly (e.g., monthly) with ERC funded researchers to query if any invention disclosures have been submitted or are in preparation.

Each ERC will need to determine the system that works best for it with its lead and partner universities. The ERC also has to determine a time period within which the IAB members can review the IP and either exercise the right to license or decline. The time period should be long enough for a reasonable corporate review but short enough to facilitate other avenues for commercialization. If itâ€™s too short, it may imply to the IAB that the faculty are not interested in technology transfer to member firms but would rather spin-off the technology to their own firms. It should be again stressed that ERC-related IP must follow the flow of the IP Flow Diagram of Figure 5-6 assuring ERC members a first opportunity to license and commercialize ERC derived IP.

5.3.2.5 Intellectual Property Vetting

For non-ERC inventions, university technology transfer offices typically vet university researcher invention disclosures for commercial potential through the experience of members of the office, sometimes with guidance from outside subject matter experts or groups. Due to the significant costs involved in applying for patent protection for IP, most universities have full-time staff and/or a committee that decides if an idea, design, or process is worthy of patent prosecution. Committees of this kind may include university administration, legal staff, and researchers. ERCs have the distinct advantage of having a consortium of companies interested in the field of research and so can add substantially to review of inventions for commercial potential.

Some ERCs have established an IP Protection Fund, usually taken from the partial proceeds of industrial membership fees of a higher level tier of membership. This provides the dual advantage of engaging industry members in IP vetting and providing funds for initial protection of IP (e.g., Provisional Patent Applications).

CASE STUDY: The FREEDM Systems ERC established an Intellectual Property Protection Fund (IPPF) as a resource to be used to secure protection associated with the most promising disclosures of Center Intellectual Property, defined as inventions created by Center Core research supported with NSF funds and Membersâ€™ fees. Annual contribution to IPPF is $5,000 per Full member, which comes out of the membership fees paid to NC State. Associate and Affiliate members do not contribute to the IPPF. Contributions to the IPPF are held separately from the membership pool funds. Unused portions of the IPPF may be reassigned periodically to provide support to Center research projects funded out of the membership pool. A teleconference is held where Industry Advisory Board members discuss and review invention disclosures and make recommendations on IPPF protection actions. The Center may reimburse the patenting cost using IPPF funds up to $10,000 per invention.

5.3.2.6 Invention Disclosure to Industry Members

The next step in the process is transmission of the invention to industry members, assuming that right is included in the Industrial Membership Agreement. Tiered membership structures will most often differentiate IP rights between tiers, so not all industry members may have rights to review Invention Disclosures, or abstracts thereof. For those that do, the Membership Agreement typically provides that the ERC will forward invention disclosures to industry members in a timely manner and provides members with a fixed time frame (usually 60-120 days from mailing of the invention disclosure) to indicate whether the company wishes to exercise any IP rights given in their Membership Agreement. The university will typically agree through the Membership Agreement to not engage in license discussions with non-members in the time frame allowed for industry member review.

Transmission of ERC Invention Disclosures to members is usually done through U.S. mail, but sometimes through email, and preferably through posting on the secure portion of the ERC website. Sending emails to industry members indicating that new invention disclosures are available for review through the ERCâ€™s secure website provides the advantages of being able to track members that access the information and also allows multiple groups that are authorized to access the information in a member company to easily review the invention disclosure.

However the invention disclosure is introduced to members, sometimes companies may not want to read the full invention disclosure (or even receive invention disclosures) in order to not compromise company intellectual property that may be under developmentâ€”commonly known as â€œcontaminationâ€• of company internal IP. The ERC can mitigate this concern:

- By providing only a non-enabling abstract of the invention to industry by regular mail or email and inviting them to request the full invention disclosure if they wish;
- If providing the invention disclosure by regular mail, enclose it in a sealed envelope with a non-enabling abstract external to the sealed envelope and a tear-off return slip indicating whether the industry member reviewed the full disclosure and whether it wishes to exercise any IP rights granted in the Membership Agreement; or
- If providing the invention disclosure by access to the ERCâ€™s secure website, assure that the member is directed first to a non-enabling disclosure on the site and then clicks through to the full invention disclosure if they wish, using a password or some other trackable form of access.

CASE STUDY: The BioMimetic Engineered Systems (BMES) ERC, based at the University of Southern California (USC) utilizes a unique approach with respect to its IP portfolio. Specifically, their universityâ€™s tech transfer office assumes all patent prosecution expenses without participation from the Center industry members. Center management takes a very proactive role in developing robust provisional patent applications with strong support from the Stevens Institute. This level of attention is attributed to the tremendous track record of past BMES start-ups, which is well known to USC administration. Director Dr. Mark Humayun estimates that some 80-85% of BMES patents are eventually licensed, which provides great credibility for future Stevens Institute patenting decisions. This level of support provides BMES with much greater freedom than most ERCs have in managing their IP portfolio. For instance, BMES typically only notifies industry partners when a patent is getting ready to issueâ€”much later than other ERCs, which notify industry partners upon invention disclosure. In some cases, BMES lists invention disclosures at the discretion of the faculty members.

5.3.2.7 Industry Member Rights

Typically, ERC inventions conceived or first reduced to practice by ERC researchers in the course of ERC Core Research have ownership (title) vested in the researcherâ€™s home university. If there are joint researchers from multiple universities, or researchers from one or more partner universities along with industry researchers (a less common case), IP ownership is typically jointly shared among all of the inventing partiesâ€”typically the universities or companies as designee of ownership through the researcher employee agreements.

Ownership rights are usually not transferred through the ERC Industrial Membership Agreement. Rather, license (commercialization) rights are usually provided to at least the top tier of industrial membership through the Membership Agreement as discussed below.

IP rights granted by each ERC to its industrial membership are specific to that ERC / university and the needs and standards of the target industry. The Sample Industrial Membership Agreement of Attachment 5-C provides a typical scenario, but this should be tailored to each ERCâ€™s specific situation.

Many ERCs grant industry members a right to a non-exclusive, royalty-free license for in-house (research only) use of inventions that come from ERC Core Research. This specifically excludes any commercial application of the technology and any companies that wish to exercise this right will typically share in patent application, processing, and maintenance costs. This scheme allows the industry member to explore development of products and services that might come from the core research, while providing the university with financial (license royalty) returns should the company wish to fully commercialize the technology. This strategy shares the risks and returns of development and commercialization of ERC Core Research.

If such NERFs are granted, or if other IP non-exclusive rights such as field-of-use license rights are granted through the Membership Agreement, the ERC / university must decide if exclusive license rights that may be granted to and exercised by industry members should take precedence. This is a decision for the ERC and university based on their vision for maximizing IP returns overall. In any case, industry members should be notified of any exercise of rights that may infringe on their rights (e.g,. exclusive IP rights over NERF rights), so that each company can make the best business decision for moving forward with exercise of their rights.

These licenses may provide for sublicense rights to industry member affiliates or subsidiaries, or even to third parties at the discretion of the ERC universities and may also include rights to derivative works (future developments) based on the subject IP. The agreement among the partnering university on these terms is captured in their Inter-institutional Agreement, discussed in Section 5.1.1.3.

Finally, the Industry Membership Agreement should always include a grant-back right for university researchers to continue development of the research for academic purposes.

5.3.2.8 License Negotiation

License negotiations are typically handled by the university as non-ERC university IP. One ERC-specific consideration is that with multi-university ERCs, the Inter-institutional Agreement discussed in Section 5.1.1.3 should include a clause assuring that one university takes responsibility for license negotiations so that the company is dealing with one entity, even where the inventors are from multiple universities.

5.3.2.9 Sponsored Projects with Member and Non-Member Large Firms

Industry recognizes that the value to be gained from ERC membership can take many forms, including early exposure to results from the ERC core research and the ability to engage with leading faculty and students in the field of interest to industry members. This can provide industry members with an advantageous position to engage in sponsored research projects with ERC faculty to further advance ERC research of specific interest to the industry member. While all industry members share in the ERC core research results per the ERC membership agreement, industry members also have an opportunity to gain a proprietary IP position in further research that is sponsored by an individual company. In this way, the industry member can take advantage of the knowledge provided by the ERC core research base, which is shared among all industry members, as well as developments from directed research, for which the company sponsor will have commercialization rights as determined by the specific sponsored research agreementâ€”usually a first option to negotiate a license for IP that is developed in the sponsored research project.

Companies that are not members have the opportunity to sponsor research with the university faculty, but will not have the advantage of having the early view of the advancements from the ERC core research provided by ERC membership.

In either case, sponsored projects provide an excellent opportunity to engage more deeply with industry members, engage with companies that are not yet members, and move ERC technology to industry for further development and commercialization. However, the ERC must assure that ERC core research is clearly delineated from sponsored research in application of industry member and sponsored project IP rights.

5.3.2.10 NSF Translational Research Fund

NSF recognizes that ERC research can result in technology that has commercial potential but is at an earlier stage than industry is ready to adopt through licensing. In some cases, ERC research results in inventions that have gone through the standard IP management process of Figure 5-6, do not result in licenses, and could be moved further in commercial potential through incremental funding. ERC-developed IP is qualified to compete for NSF Translational Research Funds only if it has been evaluated and reviewed following the centerâ€™s membership bylaws per the Center IP Flow Chart of Figure 5-6. A proposal is submitted by a small member or non-member firm to the SECO solicitation with a sub-award to the ERC faculty associated with the initial technology. In this way, because the research is separately supported by the ERC program and not by the ERC itself, any secondary IP emerging from the translational research project stays with the small firm awardee and does not revert to the IAB or the source university.

5.3.3 Engagement of Innovation Partners

Discussion of Innovation Partners here includes internal organizations such as university technology transfer groups and centers for entrepreneurship and innovation, as this is essentially an issue of leveraging complementary resources, whether internal or external to the university.

The ERC ILO should fully utilize university and appropriate external resources to meet the centerâ€™s industrial collaboration and innovation goals, but must remain mindful of each organizationâ€™s drivers or this activity can result in a force fit that produces little of meaningful value, as will be discussed here.

There is a strong need for ERCs to engage all of the university and external innovation partner resources in recruiting industrial partners and transitioning technology to the marketplace. Engaging with economic development groups, alumni affairs and development offices, etc., can be a foreign concept to most university-based research centers that are very much focused on basic research and that rely on the universityâ€™s standard intellectual property management protocol (e.g., invention disclosure submission, vetting for patenting, marketing for licensing or spinoff, technology licensing). ERCs are unique in a university with regard to their industrial interaction requirements to go a step beyond in their focus on innovation, and so require a special focus on leveraging resources from within and outside the university that can support their mission.

ERCs should regularly review whether they are engaging all the potential innovation and administrative partners in the process of identifying and recruiting new members to the IAB. This list would include:

- All technology transfer offices of the ERC Partner Universities;
- IAB Members;
- University Partner Business Schools, and especially centers focused on entrepreneurship and innovation;
- University and department development, alumni and corporate relations personnel;
- Innovation organizations in the region;
- Angel investors and venture funds; and
- Regional and State Economic Development Organizations.

These groups can be engaged to utilize their existing infrastructure and processes to vet university technology, and networks to broader segments. These groups will benefit by increasing their opportunity pipeline with high quality technological innovations that they can promote to their contacts, and therefore increase their value to their constituents. The ERC is a unique structure in a university that engages industry in basic to systems-level developments with an innovation focus, and this can be attractive to these partners.

For instance, economic development groups are usually looking for opportunities for industry to leverage university research to benefit company directions, and recruitment to the state or areaâ€”an opportunity specifically suited to ERCs with their focus on industry and innovation. University-based centers for entrepreneurship can increase their influence on campus by providing workshops and courses in entrepreneurship to faculty and students that can support the ERCâ€™s innovation program. Technology transfer offices many times produce technology showcases for entrepreneurs, investors, and companies that can be well served by inclusion of ERC research and advances. University Development Offices are always looking for great case studies of university research programs that can significantly impact quality of life for development of philanthropy targets, whether individuals or companies.

There many mutually beneficial opportunities to work with these groups and these should be leveraged, but only to the direct benefit of the ERC and partnering organization. Force fits in order to count Innovation Partners usually donâ€™t result in any significant benefit to either party and the ILO should constantly be on watch to assure that these groups are best utilized for front-end industry/entrepreneur recruitment to the industrial or innovation partners programs or on the back-end as technology commercialization outlets.

This feature is required of Gen-3 ERCs but is a means of strengthening the technology impact of Gen-2 ERCs as well.

CASE STUDY: ERCs can act as a venue for commercial vetting of a broader university research base, such as is done by the QoLT Foundry. Although the QoLT ERC is actually a Gen-2 ERC, it has implemented a vibrant innovation-to-commercialization program that is a front-runner among ERCs and could serve well as a Best Practice for Gen-3 ERCs. The QoLT Foundry is focused on identification, evaluation and commercial advancement of technologies from core ERC and associated research within Carnegie Mellon University (CMU) and the University of Pittsburgh. Established in 2008 with support from CMU, a local foundation, and an ERC Program Innovation grant, the Foundry has demonstrated remarkable success: 12 companies created since its inception and more on the way. Rather than waiting for researchers to form start-up companies, QoLT has taken the innovative approach to reduce the time-to-market for QoLT technologies by being proactive about identifying and cultivating opportunities to form start-ups. The Founder is led by experienced Entrepreneurs-in-Residence (EIRs) who serve as consultants on time-limited (6-9 months) contracts and are chartered to find their â€œnext new thingâ€• in the form of a spin-off company. Foundry internsâ€”CMU and Pitt students in business, law, and management programsâ€”work with the EIRs to conduct market analyses, assess intellectual property strength, scan competitors and develop business models. Those are presented to potential investors, industry advisors, and innovation partners (regional technology-based economic development organizations) in â€œOpportunity Meetingsâ€• organized twice a year. Because they are a proven success, Foundry elements have been adopted by new campus-wide CMU programs that have broader reach within the university.

5.3.4 Real and Perceived Conflict of Interest

NSF policy limits the involvement of ERC faculty and staff members in positions of responsibility in member companies or, conversely, involvement of ERC member company personnel in decision-making roles in ERCs. The following is the National Science Foundationâ€™s â€œEngineering Research Centers Program Statement on Conflict of Interest in Technology Transfer on the Dual Role of Center Faculty in an Industrial Capacityâ€•:

It is generally recognized that technology transfer may be enhanced when ERC faculty or students spin off start-up companies. A conflict-of-interest situation may occur when ERC personnel, including those from the lead university and any core partner universities, have outside interests in companiesâ€”financial or otherwiseâ€”that may be affected by ERC activities. This applies whether the company is a member of the ERC or not, as long as the company's interests fall within the field of the ERC's technical focus. ERC personnel should exercise the greatest care and sensitivity so as not to give the impression that public funds are being used to enhance the private income of faculty and students supported by the ERC, or to deter participation by other industrial partners in the ERC.

In accordance with Article 33, â€œInvestigator Financial Disclosure Policy,â€• of the General Conditions, which incorporates by reference Section 510 of NSFâ€™s Grant Policy Manual (GPM 510), Principal Investigators (Center Directors), Co-PIs and any other Key Personnel who are responsible for the design, conduct or reporting of NSF-funded research are required to disclose to their universities any significant financial interest (exceeding $10,000 in salary, other payments for services, intellectual property rights, or equity interests) that would reasonably appear to be affected by NSF-funded research. In addition to the Center Director, this would also apply to the Deputy or Associate Director(s), Thrust Leaders, and individual PIs working in the Center who carry out the above functions. GPM 510 also requires Awardees to have a written and enforced conflict-of-interest policy and to submit the required certifications as a condition of future funding increments.

NSF policy with regard to ERC spin-off companies, if they are members of the ERC, is the same. For nonmember spin-offs, the conflict-of-interest concern applies only to principals of the ERC (Director or Deputy Director, member of the center's Leadership Team, or Thrust Area Leaders). Essentially, anyone in decision-making authority over resource allocation within the ERC cannot be a principal of a spin-off company. Again, it is vital to guard against even the appearance of a conflict of interest.

Conflict of interest (COI) and particularly financial conflict of interest (FCOI) can be a looming challenge in ERCs, and especially so as ERCs drive toward an increased focus on innovation. (See the material on COI at http://erc-assoc.org/ilo-forum). The NSF encourages ERCs to work closely with start-up firms to carry out translational research, promote entrepreneurship, and impact economic development. As such and appropriately so, several ERC faculty members, including in some cases the director, have been tightly coupled with start-up companies, either as founders, officers, advisors, or consultants. Large companies can be reluctant to join or heavily contribute to an ERC that has a focus on innovation if they see this as a pipelining of technology to small companies, or even potential ERC spin-off companies. There can be an inherent COI challenge for faculty or ERC leadership that start up companies or are involved in spin-offs if those companies compete for ERC technologies with industry members. Project funding decisions that are being driven to a great degree by, or at least heavily influenced by, ERC leadership who have a personal stake in the outcomes of those decisions through start-ups, might be perceived as compromised, and this could be extended to the ERC. The university COI policy is typically not set up to address this situation (companies being reluctant to join if they see innovation programs as stymieing their ability to access technology), as the university COI policies are typically focused on managing the back endâ€”post invention and into licensing. While each partner university typically has a conflict of interest policy and management plan, a process to identify and manage COI at the ERC level (across all institutions and partners) has sometimes not existed, but should be established early.

5.3.5 Education Programs with Industry

Industrialists are involved in center education programs as both receivers and contributors. Several centers have industrially focused short courses, workshops, and seminars and industrial degree programs that are offered on campus, at professional meetings, or at company sites. As contributors to center education programs, industrialists lecture, teach entire courses (sometimes as team teachers with faculty), serve on thesis committees, work with students on project teams, act as mentors, and support students financially and with internships. (See Chapter 4 of the Best Practices Manual for a more extensive discussion of industrial involvement in ERC education programs.)

The Gen-3 ERC innovation strategy has a large component of student (and faculty) training in innovation and entrepreneurship as well as a focus on bringing in industrial and innovation partners to provide workshops, experiential education opportunities, technology assessments, internships, etc. As such, the ERCs have a three-fold education mission:

- Develop ERC graduates who will be more effective in industry and more creative and innovative leaders in a global economy;
- Integrate the ERCâ€™s research into the undergraduate and graduate curricula; and
- Develop partnerships with pre-college institutions, engaging teachers in engineering research to bring engineering concepts to the pre-college classrooms in order to attract students to careers in engineering.

For this education mission to be effective, the ERC ILOs and Directors for Education need to partner to nurture the culture of the innovation ecosystem. The Center Director should insure that there is seamless coordination between the ILO and the Education Director to avoid the development of conflicting education and innovation ecosystem agendas.

One challenge to ERCs is to capture the excitement and interaction of the industrial partner meetings/retreats at other times. Students and industry can come out of semi-annual meetings energized from their one-on-one interactions, but this excitement quickly fades as each party goes back to their everyday activities. The key is to find ways to increase the frequency of interactions, which can occur in everything from ERC-wide events to individual project industry guidance. ERCs should explore creating avenues for students to meet with industry, such as by sponsoring a reception at appropriate society meetings or other natural gatherings. ERCs might also explore unique means for students to present their research projects and industry to provide feedback in an exciting environment such as a reception with â€œ2 Minuteâ€“2 Slideâ€• presentations (essentially student Elevator Pitches of their research projects), with industry providing real-time feedback.

CASE STUDY: Beginning in 2011, the ERC Program has sponsored a Program-wide â€œPerfect Pitchâ€• competition that begins at the center level and culminates in a competition among center winners at the ERC Program Meeting. This competition focuses on the ability of ERC students to explain their research and its importance clearly and succinctly to a broad audience. The competition is judged at the meeting by a panel of industrialists, entrepreneurial faculty, and venture capitalists. The winning student is awarded a substantial cash prize and the studentâ€™s home institution takes custody of the Lynn Preston Perfect Pitch trophy until the next competition. Cash prizes are also awarded to second- and third-place students.

CASE STUDY: Student Leadership Councils can design creative ways to engage industry. For example, the Center for Integrated Access Networks (CIAN) hosts a speed-introduction event with one-page project summary slides in a quad-chart format (summary, schedule, deliverables/impact, and graphic). Additionally, the Student Leadership Councilâ€™s Student ILO coordinates monthly Industry web presentations. However, SLCs need ERC leadership support in terms of direction and guidance, funding, contacts, and organization in order to gain maximum benefit from such activities.

CASE STUDY: C-SOPS organizes â€œLunch and Learnâ€• seminars to bring in industry speakers and expose faculty and students to industrial practice. They have also hosted lectures and workshops that have industry speakers or panelists. There is strong participation in an industry mentorship program and great involvement of industry mentors on center projects providing exposure to industry practices through research teams. C-SOPS has designed a well-integrated set of programs that connected undergraduate and graduate education, curriculum development, continuous education for industry members, and programs to enhance public awareness. Of particular interest is the PharmaHub web site (http://pharmahub.org/) that is being used as a â€œknowledge repositoryâ€• to make presentations and modules openly available. Presentations and teaching materials can be downloaded, along with numerous tools and resources listed.

CASE STUDY: Recognizing the challenge of getting from discovery to proof-of-concept (the "Valley of Death"), the ERC for Biorenewable Chemicals (CBiRC) is meeting that challenge (which it terms the â€œDitch of Despairâ€•) with a technology-led entrepreneurship program that builds awareness of faculty and students regarding the various issues. At the core of CBiRC's approach is a course covering the steps in creating a startup. This Entrepreneurship Course builds understanding of what it takes to develop a technology-led idea into an early-stage entrepreneurial business proposition. Topics include (i) discovery research and how technology relates to innovation and the potential for entrepreneurship; (ii) critical techno-commercial analysis, intellectual property, and how to evaluate risk and reward; (iii) how to define key assets in the context of generating a Business Model Canvas; (iv) working through the elements of a business proposition; and (v) the process of founding a company and securing early-stage funding. In addition, Entrepreneurship Mentoring helps startups by providing a process for evaluating the business opportunity within the context of the Business Model Canvas, which formulates good understanding of a future customerâ€™s needs in relation to the technology being developed and what it takes to meet these needs. This Entrepreneurship Program is broadly managed within CBiRCâ€™s â€œBiobased Foundry.â€• The program was started and is led by CBiRC's Innovation and Industry Collaboration Director, Dr. Peter Keeling.

5.3.6 Role of Venture Capitalists and Other Investors

Going back to the early days of the ERC program, some ERCs (e.g., University of Florida ERC for Particle Science and Technology, Georgia Tech/Emory Center for the Engineering of Living Tissues) were approached by venture capitalists to join the Industrial Membership Program. The venture capital interest was to gain an early look at the commercialization potential of ERC technology and engage with researchers who could help to locate new advances in a field and serve as subject matter experts to help in due diligence of company technologies under consideration by the venture capital firms. ERCs have traditionally avoided formal engagements with investors, primarily due to concerns that individual investors will come in, add little value to the research and education missions of the ERC, and simply abscond with the technologies. However, inclusion of the investment community can be a strong positive for an ERC if managed properly. The MIRTHE Investment Focus Group is an example.

CASE STUDY: MIRTHE established an Investment Focus Group (IFG) with full IAB endorsement. Venture capitalists, corporate, and angel investors have joined the IFG. The IFG objectives are to: a) educate the investment community on the promise and potential of mid-infrared technologies; b) provide mentorship for students and important networking opportunities for faculty, students, industry/practitioners to interact and leverage the knowledge and expertise of seasoned technology investors; c) establish pathways to speed innovation and accelerate commercialization opportunities; and d) assess technology readiness and determine potential approaches to commercialization. In summary, the IFG is configured to add value to MIRTHEâ€™s research, education, industry/practitioner, and innovation programs.

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[1] Jackson, Deborah J. (2012). What Is an Innovation Ecosystem? National Science Foundation, Arlington, VA. (http://erc-assoc.org/sites/default/files/download-files/DJackson_What-is-an-Innovation-Ecosystem.pdf)

[2] Jackson, Deborah J. (2012). What Is an Innovation Ecosystem? National Science Foundation, Arlington, VA. (http://erc-assoc.org/sites/default/files/download-files/DJackson_What-is-an-Innovation-Ecosystem.pdf)