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Collaboration to Facilitate Research and Education in a Transitioning Electric Power Industry

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ABSTRACT

The electric supply industry is in transition from its historical objectives, structure, ownership, operating practices, planning processes, and customer services. Since the transition has no well-defined end-point, it may be thought of as "end-less." From this perspective, decision-makers addressing challenges in the transition should focus on means and processes for finding solutions in addition to identifying and evaluating possible solutions themselves. By putting greater reliance on collaborative research programs involving the "triple helix" of industry, universities, and government, synergies can be captured from multi-institution, multi-discipline collaboration for clarifying research needs, and for developing and implementing research plans to address those needs. But collaboration requires attention to interpersonal dynamics among other principles of effective collaboration. In this paper, we give examples of collaborative research program structures and of principles that can help make collaborative programs successful. A case study illustrates how the collaboration principles can be applied. The paper concludes with comments about issues facing developing countries in using collaborative research. In general, investments in research and education are needed along with investments in physical facilities such as "poles and wires" by all countries in order to transition each one's electric power industry in the most beneficial way possible for their society.

1. INTRODUCTION

The electric supply industry is in transition from its historical objectives, structure, ownership, operating practices, planning processes, and types of customer services. Yet the basic function of the industry – to produce and to deliver affordable energy safely and reliably consistent with public policy – has not changed. Challenges abound for meeting that basic function successfully. In general, those challenges arise from decisions that must be made about new market structures and ways of doing business, new technologies, meeting the evolving needs of customers, strategic choices between centralized and decentralized technologies, institutional changes, preparing well-trained power engineers, new environmental priorities, and country-specific needs (such as for modernization, capital, and social concerns). The scope, complexity, uncertainty, and distributional effects of possible solutions to those challenges call for study, creative thinking, and discussion, in some cases over an extended period of time.

Historically, the electric power system has been vertically integrated with one or more utilities assuming the responsibility for power supply from generation to load. The system has been configured to deliver electric energy, produced by a mix of generation sources, to customers by means of complex interconnected transmission and distribution systems.

Power systems are generally inflexible with respect to accommodating rapid changes in load, generation, and/or delivery conditions, or even rapidly changing economic, environmental, or regulatory policy changes. While present-day systems may have been designed for "least cost supply of electricity" based on the slowly changing environment of the past, they are just beginning to reconfigure to adapt to growing demand and introduction of new technologies (particularly information technologies). Power systems in transition need managed re-designs. The alternative is to accept unmanaged change and to operate the systems in ways that were not anticipated by the original designers.

Thinking about the challenges for an industry in transition should not only focus on "solutions," but also on means and processes for finding the solutions. The power industry may be more reasonably characterized as being in a period of "endless transition" because it does not have a well-defined end-point [1]. In this transition, research and education should be considered as much a part of the electric supply industry infrastructure as poles and wires. New research program structures are needed to facilitate the multi-disciplinary, multi-institution research required in the new power industry. Furthermore, industry, government, and universities each have unique contributions that they can make in finding solutions to challenges facing the electricity sector.

Collaboration is a key in this research environment. It can be used to inform decision-making, broaden perspectives, and create and transfer knowledge. However, collaboration is not easy for institutions (and the people in them) that may not have collaborated before. An understanding of collaboration principles and organizational mechanisms is needed for success.

In this paper we discuss trends in collaborative research, and give examples of structures of collaborative research programs and principles of effective collaboration. A case study of a collaborative research program is used to illustrate ways in which the principles of collaboration can be applied. The paper concludes with comments about possible issues facing developing countries in using collaborative research.

2. COLLABORATION IN RESEARCH

Historically, departmentalization of research has occurred by type (such as basic and applied), by discipline (such as engineering, economics, and public policy), and by research organization (principally university, government, public research laboratories, and industry). A transition is occurring in research. Etzkowitz [1] identifies three "boundary breaking" characteristics of that transition in science and technology research:

- No strict boundaries between basic research, applied research, and product development
- Interdisciplinary collaboration ending the strong boundaries between disciplines
- New institutional configurations comprised of university, industry, and government members.

Increasingly, research programs are turning to collaborative models to achieve their research objectives. For example, in its new roadmap for accelerating medical discovery to improve health, the U.S. National Institute of Health, one of the largest research organizations in the world, is establishing a "Liaison for Public-Private Partnerships" to expand collaboration among researchers in academia, government, and the private sector [2]. In support of the restructuring, Dr. Michael Friedman noted that the "NIH is betting that, in the near future, the focus of the scientific process will move from encouraging individual scientist interests to ensuring the success of more collaborative research enterprises. Think ensemble rather than soloists"[3].

Reasons for the growth of collaboration in research programs are varied. The 'triple helix' thesis is that the relationship among the three institutional spheres of university, industry, and government is central to innovation [1]. Other reasons for increasing collaboration are:

- addressing research questions that are increasingly multidisciplinary in nature
- grounding researchers in research needs of industry and government
- convincing industry of the value of research with long-term benefits
- capturing the synergies among universities, industry and government
- leveraging government research funds with private sources
- reducing the time for commercialization of new ideas
- reducing inequalities facing less research-intensive regions.

The defining characteristics of collaborative programs include:

- mission (research, education, commercialization, etc.)
- lead organization (such as university, private non-profit [14], etc.)
- specificity of research direction (self-directed, targeted to meet governmental priority, etc.)
- role of government (creating and supporting the collaborative, co-managing the collaborative, participant in the research, etc.)
- level and duration of government support
- extent to which industry co-funding is expected.

Fundamentally, the extent to which any particular research program achieves benefits of collaboration depends upon the structure and mission of the effort. Some collaborations are established with the purpose of meeting a specific research need without necessarily any enduring change in the way research is done. Some triple helix programs of the Natural Sciences and Engineering Research Council in Canada [16] are examples. Other collaborative research programs are established with an explicit mission of creating enduring change, such as the European Networks of Excellence program [4] and the U.S. National Science Foundations Industry/University Cooperative Research Center's Program [15].

3. ACHIEVING COLLABORATION

Achieving collaboration is not an easy task because of the changes required in normal research behaviors and processes. True collaboration is not simply separate researchers working in isolation on their portion of a larger research effort, even when multiple researchers and organizations are involved. True collaboration requires engagement among participants through joint decision-making, communications of research needs and questions, problem solving, planning, strategizing, etc. Fundamentally, higher levels of collaboration require relatively more attention to program management and to social interactions of the participants than in less collaborative programs. This section identifies basic principles for effective collaboration.

3.1 Building Trust to Achieve Success in Collaboration

Government can be a catalyst in creating an environment where two institutions (such as industry and academia), that operate on and with very different metrics, can come together and achieve a track record of working together successfully " and thus develop the trust that is foundational to true collaboration. This happens when the collaborative structure makes behavior more predictable across and within institutional boundaries, and minimizes the possibility that the "worst fears" of each institution about the other will be realized. For example, industry may fear that academics will pursue research that does not address its most pressing needs. On the other hand, academics may fear that fundamental research with long-term benefits will not be supported, and that innovation will be stifled by a micro-managed research work plan. Of course, the "worst fears" will depend on situations and involved parties.

Trust within group working relationships is typically observed to develop in a three-phase sequence: DETERRENCE, KNOWLEDGE, and finally IDENTITY [4-5]. When a group is first brought together, DETERRENCE tends to be the basis for trust; that is, people "trust" that their co-workers will act appropriately mainly because there is an authority figure who calls them together, structures interaction, and controls sanctions that will be brought to bear if they do not live up to responsibilities. As people work together under this framework, they begin to learn about each other " their capabilities, track record, responsiveness, etc.

Assuming that the work goes well and that the participants really do bring good information that contributes to group success, the group transitions to KNOWLEDGE-based trust. Obviously this is a more profound level of trust, based on understanding of the others' abilities and actual contributions.

With time and with obvious recorded success that brings value to each of the participants (where each participant begins to truly get important needs satisfied through the working relationship), the group transitions to the most profound level of trust " that based on IDENTITY. At this point, participants in the relationship begin to strongly identify with the group, to internalize and promulgate its values, and to make sacrifices to assure its continued success. As a result, they begin to define themselves in part through their membership in the group.

The structure for a collaboration needs to create the opportunity for this developmental sequence to occur. Indeed, the "success" of the collaboration (probably defined in terms of mutually met needs) will be a function of how far it has transitioned along the trust continuum. The structure must channel behavior of each of the institutional members to make that behavior predictable and understandable to other members.

3.2 Other Keys to Successful Collaboration

The capacity for true collaboration is tied to the existence of trust between the participants. What else influences collaboration? Insights can be found in the literature on conflict negotiation, particularly win-win/collaborative/mutual gains conflict resolution described by Fisher and Ury [7]. Fisher and Ury define four principles that are essential to collaborative conflict resolution:

- INTERESTS - focus on interests (needs, desires, concerns, fears), not positions
- OPTIONS - invent/generate lots of options for mutual gain to address the problem that divides the conflict participants
- CRITERIA - insist on using objective criteria to evaluate potential solutions (that is, work together first to develop the criteria that will be used to evaluate potential solutions to the problem)
- PEOPLE - separate the people from the problem (recognizing that when negotiating, people issues related to our humanity, such as emotions, perceptual accuracy, and communication tendencies, become intertwined with the substance of the negotiation, and should be dealt with as they become evident so that they do not interfere/distort the capacity to search for a solution tied to interests).

These conflict resolution principles suggest that, for collaboration to occur, there needs to be:

- a mechanism for participants to surface their interests which undergird any "positions" they may have and to search for intersections of interests that may be the basis for working together
- an opportunity for generating lots of options for how they might work together

- explicit standards to judge whether the relationship is working
- a mechanism for addressing the inevitable "people" issues which arise when vastly different folks come together to accomplish something.

Evaluations of collaborative programs also suggest that attention needs to be paid to objectives and to the structure of the relationships among the parties to achieve effective collaboration [8]. Collaboration will be more effective if people understand the merits and incentives for collaboration, and then have the opportunity to structure their relationships in the research organization accordingly. Simply imposing the requirement that multiple institutions be a part of the collaborative program or project does not insure that true collaboration will occur, nor that there will be a fundamental change in the way research is done.

Collaboration among university researchers is not "natural" to the academic world. Generally speaking, there is little reward for working with others in academic research. Indeed, there is almost a disincentive to do so if a faculty member hopes to get tenure. There is no inherent cultural value that reinforces collaboration. Thus, when presented with an opportunity to do collaborative work, most senior academics say they will do so only if they have to collaborate to get the funding support. However, after being funded, being very busy and stretched, they take the easy (and less time consuming) way out – they apportion the work following a division of labor and only really communicate with each other when it is time to prepare the final report. This behavior reflects the lack of profound cultural belief in and commitment to collaboration. Only when there are clearly defined and enforced procedures and structures for collaboration does true collaboration occur.

It is doubtful that many people in academia would present "One of us is not as smart as all of us" as one of the driving principles for how they do their work, despite the fact it is often said that every scientist stands on the shoulders of preceding scientists. Thus, academia seems to be collaborative far more in a cumulative, historical sense than in terms of co-working relationships that add value in a real-time way.

Collaboration among universities, industry, and government also has disincentives. Because of each party's stereotypical beliefs about the others, they often come together rather superficially. Academics want the financial support and possibly access to data. Industry and government want operating problems solved, intelligence that provides competitive advantage, or help resolving policy issues in ways that win public support.

Perhaps the best way to overcome these disincentives to true collaboration is to select problems that really do require the expertise (as in knowledge, skill, and experience) of both parties to solve the problem. This would require taking a larger challenge and breaking it down into smaller problems. Thus, government can facilitate the identification of smaller problems that truly require the intellectual resources of multiple institutional domains, and then create environments where collaborative work can occur to evaluate and overcome those problems.

4. CASE STUDY OF COLLABORATIVE RESEARCH: POWER SYSTEMS ENGINEERING RESEARCH CENTER (PSERC)

The Power Systems Engineering Research Center (PSERC) draws on university capabilities to creatively address challenges facing an electric power industry in transition. In PSERC, twelve U.S. universities are working collaboratively with industry and government to:

- engage in forward-thinking about future scenarios for the electric power industry and the challenges that might arise from them
- conduct research for innovative solutions to these challenges using multidisciplinary research expertise in a unique multi-campus work environment

- facilitate interchange of ideas and collaboration among academia, industry, and government on critical industry issues
- educate the next generation of power industry engineers.

The multidisciplinary expertise of PSERC's researchers includes power systems, applied mathematics, complex systems, computing, control theory, power electronics, operations research, non-linear systems, economics, industrial organization, and public policy. PSERC has about thirty-five researchers and fifty graduate students working on its research projects.

4.1 Industry/University Cooperative Research Center Program

Since 1996, PSERC has been one of the centers in the National Science Foundation's (NSF) Industry/University Cooperative Research Centers (I/UCRC) Program. NSF's I/UCRC program describes itself as promoting "win-win" partnerships that strengthen the ability of universities to conduct high quality and relevant research, and the ability of industry members to meet their business objectives effectively [9]. The I/UCRC program strives to achieve long-term partnerships among the triple helix of industry, universities, and government. Some fifty other centers in the I/UCRC program focus on a wide array of industries, some of which are already quite competitive. PSERC is the only center in power systems and is the largest multi-university center in the program. Dr. Alex Schwarzkopf, Program Director of the I/UCRC program, states that "Industry-University collaboration is at the heart of the I/UCRC program. PSERC's commitment to collaboration using many universities as the research base is essential to meeting the wide-ranging challenges facing the electric power industry" [10].

4.2 PSERC as a Multi-University Center

PSERC organized itself as a multi-university center for several reasons. First, there is insufficient expertise at any one school to address comprehensively the challenges of the new electric power industry. Restructuring requires the marriage of economics and engineering, thus calling for more multi-disciplinary work than ever before in the industry. And no single school can afford the needed breadth of expertise because of limited resources. Another reason why a multi-university structure was appealing is that industry itself is geographically dispersed, and business and policy issues are increasingly interlinked across the industry, such as in designing regional markets while maintaining system reliability.

4.3 Industrial Members

As an Industry/University Cooperative Research Center, PSERC receives more support from its industry members than from NSF. Members join PSERC by signing a membership agreement and by paying an annual membership fee. PSERC has almost forty members, from the U.S. and the international community, that include energy companies, government agencies, consulting and other services companies, and associations. Members include new organizations to the industry: independent system operators, regional transmission organizations, and for-profit transmission companies.

PSERC provides its industrial members:

- opportunities for collaboration with leading researchers in power engineering and markets
- results of innovative research and early access to research publications
- means for sustaining high quality power engineering programs in a time when the industry and professoriate are graying [10]
- contacts with students about job opportunities

- business opportunities for commercialization of intellectual property
- education and professional development opportunities, such as through workshops, short courses, and on-line seminars.

But PSERC's work is not limited to serving the needs of its industry members. Virtually all of its research eventually becomes public, except when intellectual property rights dictate otherwise. PSERC sponsors a web site for distribution of its research [12]. In addition, its researchers have been involved in public service activities, such as studies of U.S. electric reliability concerns.

4.4 Organizational Structure

There are three central components to PSERC's organizational structure: (1) Center Management comprised of the Director, Executive Director, and Executive Committee; (2) an Industrial Advisory Board of PSERC's industrial members; and (3) Stem Committees. Fig. 1 provides an overview of the organizational structure.

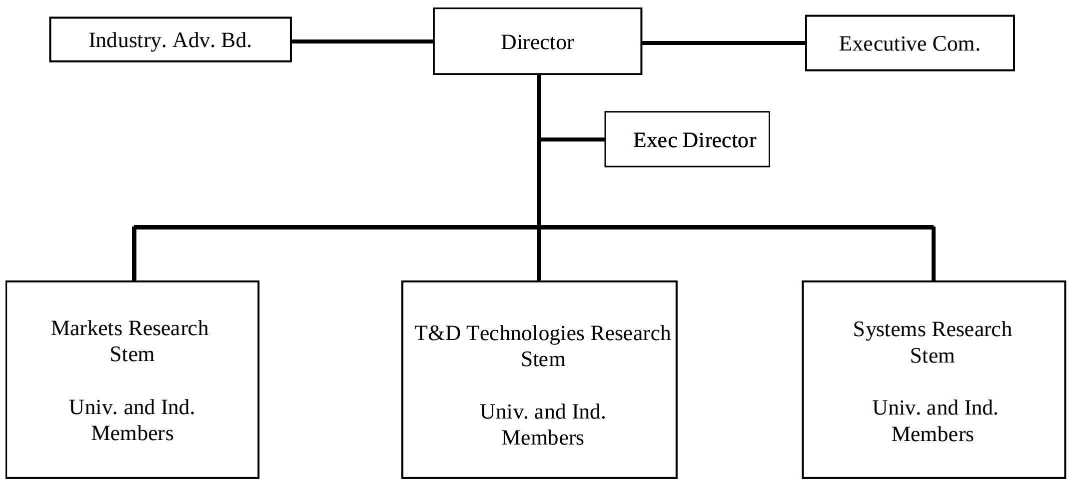

Fig. 1 PSERC's Organizational Structure

4.4.1 Center Management

The Director is responsible for overseeing all affairs of PSERC. A primary function of the Director is to represent the Center before its industrial members and the electric power industry as a whole. The Director is also responsible for the creation of a collaborative infrastructure, recruiting and supervising Center staff at the lead university, and ensuring smooth operation of the Center. The Director coordinates the assessment of the Center's quality through feedback from industry members, working with PSERC's organizational advisors (officially known as "NSF Evaluators"). The advisors are experts on organizational effectiveness, and help the Center develop its management and strategic planning processes. Finally, the Executive Director assists the Director in industry relations and Center management.

The Site Directors are PSERC's local campus representatives for the twelve university members of PSERC. They serve as the liaisons to university faculty, staff, and administration. The Director and Site Directors comprise PSERC's Executive Committee (EC). The EC works with the Director and Industrial Advisory Board to provide guidance on strategy, policies and procedures for PSERC, to ensure compliance with established policies and procedures, and to maintain efficient operations at the university level. The EC is chaired by PSERC's Director.

4.4.2 Industrial Advisory Board

An Industrial Advisory Board provides the critical linkage between the industrial members and PSERC. The Board:

- works with the universities to identify research and education needs
- evaluates project proposals and recommends project funding levels
- reviews research results
- addresses policy matters brought to it by PSERC's Director and Executive Committee.

The Industrial Advisory Board meets twice annually. At the meetings, industrial members meet researchers and students from the member universities, hear progress reports on research projects, conduct PSERC business, engage in current issue discussions with researchers and other industrial members, and advance their professional development through tutorials.

4.4.3 Stem Committees

Three research stem committees contribute substantially to collaboration in PSERC. Industrial members join university researchers on the stem committees to:

- solicit and evaluate new project proposals
- update the PSERC research plan
- facilitate research collaboration within PSERC
- conduct technical oversight of on-going research projects
- promote Stem plans, activities and research to entities outside PSERC.

Stem committees have primary responsibility for gathering industry and university perspectives on research needs, and for assisting the Director in developing a portfolio of research projects to take to the Industrial Advisory Board for their review and recommendations. This is a collaborative process involving a summer retreat where industry and university stem committee members meet to discuss needs and update the research plan, and then develop a solicitation for new projects. Subsequently, industry members evaluate and prioritize the proposals for subsequent action by the Director, Executive Committee, and Industrial Advisory Board.

4.5 Education Program

Education is a critical dimension of PSERC. One of the key values of PSERC lies in its power engineering degree programs. As noted above, critical personnel issues are facing the industry and the continuation of strong power engineering programs is essential to addressing future employment needs [10]. By taking innovative research findings to the classroom and involving students in research, PSERC faculty introduce students to the cutting edge of power system technologies, analytical techniques, and industry practices. Not only does PSERC help students become technically prepared for their next job, it also assures that they will be knowledgeable about the challenges and trends transforming the industry. In addition, PSERC facilitates efficient employment searches through industry-student interactions at industry meetings, student involvement in PSERC projects, web site postings, and email announcements.

University and industry members recognize that support of PSERC's research program is intertwined with support of its educational mission. Student education is enhanced through student participation in PSERC projects, through improved awareness of industry issues due PSERC activities, and through the expanded industry knowledge that PSERC faculty bring to their classrooms as a result of the industry-university relationships that PSERC fosters.

PSERC's education program also includes professional development. Through short courses, monthly tele-seminars, and on-site seminars, PSERC meets continuing education needs of engineers from its industrial members. The PSERC website has tutorials, analysis tools, slide and audio productions of the tele-seminars, papers, reports, and presentations [12].

4.6 Research Program

Industry restructuring and technology change is creating new challenges for the operation, security, and reliability of the power system, for the physical and institutional structures, and for delivery of economical and environmentally acceptable electricity services. PSERC's research driven by those challenges is a major reason why industry members join (although as they continue membership, PSERC's ability to facilitate networking, to advance understanding of future industry issues, and to link industry with students become of high value, too).

4.6.1 Markets Research Stem

The electric power industry is in transition toward greater reliance on market-based decision-making. The research under this stem emphasizes the design and analysis of market mechanisms, computational tools and institutions that facilitate efficient coordination, investment, and operations while recognizing the economic and technical characteristics of power systems. Market design research includes verification in advance of design implementation, and validation after implementation to provide feedback for market redesign when needed.

4.6.2 Transmission and Distribution Technologies Research Stem

The power delivery infrastructure is critical to achieving efficiency, safety, security and reliability in electricity supply. Potential improvements in this infrastructure could be achieved through innovations in software, hardware, materials, sensors, communications and operating strategies. Therefore, a central goal of this research stem is the improvement of transmission and distribution systems through the application of technological advances.

4.6.3 Systems

Restructuring is leading to large and complex operational entities (such as regional transmission organizations), while small-scale, dispersed generation technologies are increasing their penetration in the marketplace. The challenge is to develop new operations frameworks and approaches that effectively cope with the growing complexity of a restructured industry. Systems research concentrates on all aspects of operation of complex, dynamic systems.

4.6.4 Leveraged Research Projects

In PSERC, support from industrial members and NSF is leveraged into other research initiatives. PSERC has provided a one-stop shop for organizations outside of universities to quickly access university resources and has made it easier for PSERC researchers to form teams to respond to research opportunities. For example, PSERC played a key role in helping form the Consortium for Electric Reliability Technology Solutions (CERTS) in 1998, to research, develop, and commercialize new methods, tools and technologies to protect and enhance the reliability of the U.S. electric power system [13]. The leveraged projects in PSERC have added some 30 percent to its overall funding.

4.7 Successes in PSERC

Besides its success in forming a collaborative organizational, PSERC has identified the following as particular successes:

- Power System Visualization Tools. This technology advance integrated new visualization techniques with power system modeling methods to create for the user visual insights into the condition of power systems. A small business spin-off is commercializing the tools.
- Market Design Testing. PSERC has successfully introduced the institutional concept of testing power market designs and policies to verify and validate that anticipated market outcomes would be consistent with policy objectives. Results are informing public and business policy-making.
- Power System Reliability Expertise. Through involvement in national studies and investigations on power system reliability concerns, PSERC has brought university expertise to addressing significant problems in the U.S. power grid.

5. EMBODYING COLLABORATION PRINCIPLES IN PSERC'S STRUCTURE AND PRACTICES

In this section, we discuss elements of PSERC's structure and practices that illustrate how the collaboration principles identified in section 2 can be put into practice.

5.1 Movement along the Trust Continuum

As discussed in section 2, DETERRENCE tends to be the initial basis for trust in multi-party working environment. In PSERC, the authority figure who called the organization together, structured interaction, and controlled sanctions (through control of annual grants to the PSERC member universities) was the National Science Foundation (NSF). PSERC's organizational structure was made formal through university and industry memorandums of agreement (that included intellectual property provisions) following NSF guidelines. Many practices were governed by NSF requirements, such as the requirement to give industry the opportunity to provide project feedback to the university researchers using specified feedback forms.

A structural requirement that also advanced KNOWLEDGE-based trust was the requirement that PSERC (along with other I/UCRC's) have "NSF Evaluators." Evaluators survey industry sponsors to ascertain how well their expectations are being met, listen to concerns of industry and university members, and assess a center's successfulness in meeting its mission while complying with NSF requirements. However, in PSERC, these individuals also serve as organizational advisors, bringing the organizational and collaboration expertise that the researchers who provide the center management do not have. The Evaluators provide a mechanism for surfacing delicate interests among and university members, for the "translation" of values across institutional boundaries, for mutual understanding of the separate "languages" of industry and universities, and for the "people" issues to be raised and addressed (both within institutional groups and across boundaries between the groups).

Movement along the trust continuum to KNOWLEDGE-based trust is also facilitated by regular orientation programs for industry members. This orientation allows the efficient transmission of the Center's values and operating practices to new members, and helps them to better understand how those values and practices protect institutional interests. Trust is not just among "institutions." More basically, trust is among people. Therefore, the orientation sessions provide a way to communicate the culture as well as the policies and procedures of the Center.

To put it simply, institutions do not collaborate. People who represent those institutions collaborate. Thus, the model for institutional collaboration must address fundamental human interpersonal dynamics. The I/UCRC protocol and PSERC's implementation of that protocol consider those dynamics in addition to the process mechanics of a research institution.

Movement along the trust continuum is also facilitated by an organizational structure in which industry and university share decision-making roles. The stem committees require regular interactions among industry and university by having them jointly participate in discussions of research plans, technical issues associated with on-going research, and dissemination of research. At its annual retreat, industry, government, and university participants in PSERC meet to communicate research needs and to plan ways to meet those needs.

5.2 Implementation of Other Principles

An institution needs to integrate collaboration throughout its organizational practices. In a research organization, collaboration in research projects is fundamental. If researchers can avoid collaborating in their most valued activity, collaboration will not blossom in the organization. In PSERC, every project strives for at least two university and two industry collaborators, and at each industry-university meeting, each project leader dialogues with industry members on the progress of the project. In addition, many project advisors also serve on stem committees, thus enabling participants to see the "bigger picture" of PSERC's research program and participate in research planning affecting multiple projects.

Other actions in PSERC to advance collaboration principles discussed in section 3.2 include:

- mechanism for surfacing interests: annual research retreat and regular stem committee meetings
- opportunity for idea generation: annual research retreat, semi-annual industry-university meetings, stem committee meetings, project team collaboration
- standards to judge whether the relationship is working: industry surveys, stem committee discussions, protocols described in an operations manual for all to use
- mechanism for addressing people issues: Evaluator/facilitator interactions with industry, management structure that incorporates representatives from every industry and university member to make the Center a representative institution through which people issues can be addressed.

5.3 Role of Government

The governmental role in the triple helix affects the quality and sustainability of collaboration. In the I/UCRC program, the National Science Foundation (as the governmental body) does not come to a center as an institution focused on the research products. Instead, it comes as a catalyst for making the other two institutions (industry and university) interact effectively. For example, the fact that the I/UCRC program is located in the National Science Foundation (NSF) is an important factor in enticing the best universities to participate. NSF is seen by most U.S. scientists and engineers as the elite funding organization for U.S. research. There is great prestige in being funded by NSF and to have the imprimatur of NSF clearly advances a faculty member's career. Thus, even eminent researchers are attracted to work on more applied problems and to take on the burden of collaborative working relationships largely because they see value in NSF sponsorship.

On the other hand, industry may be attracted to these NSF-sponsored collaborations because NSF dollars largely fund the infrastructure to create the collaboration. Industry participants can have confidence that their scarce membership dollars go directly to the research efforts of the center, and are not asked to pay for what they would see as non-value-adding activity. This is a quite comforting for industry when there is the scarcity of resources typically found in an industry environment dominated by powerful competitive pressures forcing costs lower.

NSF requires that the universities contribute financially by reducing (or eliminating) the normal university overhead on industry member fees. This, too, is a structural requirement that facilitates collaboration. Universities can correctly go to industry and say that they also have a financial stake in the collaborative organization; they are not merely recipients of industry support. This further makes the relationship between industry and universities one of cooperation rather than one of a consultant and client.

6. POTENTIAL CHALLENGES IN EXTENDING COLLABORATIVE MODELS TO DEVELOPING COUNTRIES

There are numerous country-specific issues that may need to be addressed to achieve success in a collaborative research program that follows the triple helix thesis. One issue results when a developing country has a vertically-integrated, publicly-owned electricity sector. In this case, the role of government as a facilitator of a collaborative enterprise can overlap with the need for government to be a recipient of the research products. Consequently, government may have difficulty in simply being a catalyst for building collaboration. Also, the potential number of collaborating organizations is reduced, thus limiting the value from diversity of membership in a collaborative enterprise.

Forming a new collaborative research program typically requires institutions to alter their historical relationship. Historically, government and industry interactions with universities often may appear as "client-consultant" relationships, wrapped in the administrative process of requests for proposals, etc., that focus on providing particular deliverables. A collaborative relationship based on trust (rather than contracts) will cause new forms of interaction that will be "process-oriented" rather than "product-oriented." This change may be more challenging in some developing countries where the relationship between government and universities has a particularly long history.

Finally, there is the resource challenge. Financial resources for research and education naturally compete with financial resources for infrastructure investment. Developing countries have to respond to rising electricity demands on their infrastructure for their economies to grow. Viewing research and education improvements (achieved through collaboration) as critical infrastructure may advance the incentive for collaboration. Ways of achieving an appropriate balance between meeting physical infrastructure needs with research and education needs will have to be addressed. The "triple helix" collaborative model may provide a way to generate new funds for the research and education needed for the long-term health of the country's electricity sector.

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[15] U.S. National Science Foundation. Industry/University Cooperative Research Centers Program Information at http://www.eng.nsf.gov/iucrc/Program/program.htm.

[16] Canadian Natural Sciences and Engineering Research Council. Programs for industry described at http://www.nserc.ca/programs/indus2_e.htm.