Strategies to Address the Problem of Exiting Expertise in the Electric Power Industry

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Abstract

Retirements, restructuring, and technology changes are producing an accelerating exodus of expertise from the electric power industry. In this paper we review the major approaches to address that challenge: managing available resources, outsourcing, automating, recording, and educating. The approaches may all be used in a comprehensive strategy to overcome exiting expertise. Each approach has different implications for the resources needed to be successful. The responses to date have not been sufficiently comprehensive and of adequate scale to address the looming workforce losses. Our thesis is that the needed leadership by executives, policymakers, and academia to comprehensively address the expertise exodus challenge will be enhanced by a better understanding of the diverse approaches and of where effective intervention with sufficient resources is needed.

1. Introduction

The coming mass exodus of expertise in technicians and engineers in the electric power industry is a well-expected phenomenon [19] [1] [17] [15]. The loss has been the subject of workshops, conferences, and symposia [11] [2]. It has been the focus of work by industry [27] professional societies [10], the National Academy of Engineering, and the National Science Foundation [16]. A better understanding of the scale of workforce needs is being studied; IEEE's Power Engineering Society has begun a detailed study of the workforce environment in the electric power delivery industry in North America [21] as has already occurred in other countries [7]. Manpower issues are increasingly listed among top strategic concerns of industry executives [1].

The principal reason for the expertise exodus is the aging workforce [5]. Figure 1 illustrates the distribution of ages in the utility workforce now, and in five and ten years in the future. The Nuclear Energy Institute estimated that 73.2 percent of direct employment in the nuclear generation is between the ages of 43 and 57, and that 28 percent of those employees will retire within five years, with another 18 percent for non-retirement reasons [164]. The prediction in [13] is that the "tipping point" in accelerating retirements will come at the end of this decade. Some utilities report that as much as 40 percent of their employees will be eligible for retirement in the next five years; however, the average may be more on the order of 20 percent over the next five years and 50 percent over the next ten years [2] [23]. Besides retirements, other reasons for the exodus include industry restructuring and internal reorganizations.

Actions are being taken in response to the rapidly approaching "tipping point." In this paper, we synthesize the responses into four approaches:

1. Human resource management: *identification and evaluation of knowledge and skills at risk and strategies to address the risk.*
2. *Automating: applying technology to complete tasks.*
3. *Recording: putting knowledge into accessible records.*
4. *Educating: transferring knowledge to the next generation of engineers and technicians.*

The responses to date do not seem to be sufficiently comprehensive and of adequate scale to address the looming workforce losses. Technology deployment does not appear fast enough. University power programs face significant short-falls in resources and

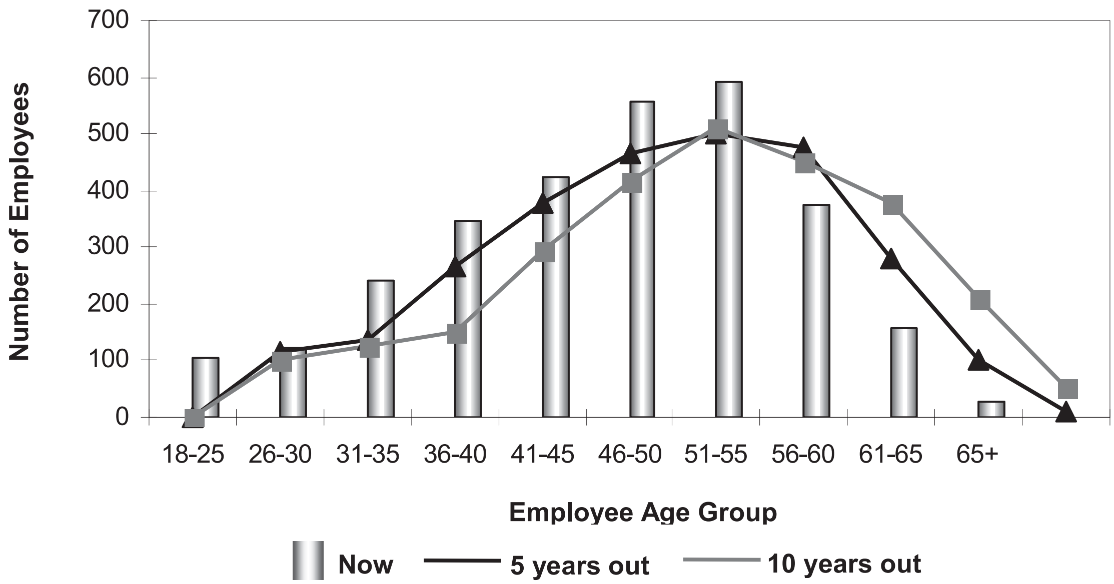

Figure 1. The aging of the utility workforce

Source: KEMA analysis

faculty. Our thesis is that the needed leadership by executives, policymakers, and academia to comprehensively address the expertise exodus will be enhanced by a better understanding of the diverse responses and of where effective intervention with resources can occur to make a difference in addressing the expertise exodus problem.

2. Human resource management

The human resources issues associated with an aging workforce require new practices and policies around recruitment, retention, and other traditional human resource concerns. For operations management, the challenges can require daily juggling of resources and priorities based on workload, emergencies, manpower availability, and many other variables. These are not new challenges for operations and engineering organizations, however, the added variables of shrinking workforce and diminished organizational experience compound current decision and prioritization processes, and increase the probability of important work being done as a lower priority, to a lower standard due to lack of time and expertise, or at higher costs. We know these are not acceptable options, so risk mitigation is critical.

There are strong parallels to be made between the focus of the industry today on asset management strategies and the challenge the industry faces in managing the aging workforce. Both issues are fundamentally rooted in the need to develop operating strategies and practices that optimize the available resources. This could mean scarce financial resources for system expansion, improvement and maintenance. It also could mean scarce human resources (and experience) for daily work management and task completion.

One asset management philosophy identifies three primary areas of competency for a robust asset management structure: management, engineering, and information [3]. Workforce management must consider people, processes, and technology. To optimize the human capability within the organization, that capability must be inventoried and evaluated. In addition, an assessment is needed of the business processes and technologies supporting those processes. This comprehensive evaluation offers both the challenge and opportunity to identify operational strengths and weaknesses and to prioritize the areas requiring immediate action. As with asset management, workforce management requires a comprehensive understanding of the current condition, the areas of greatest risk, and the timing of required actions.

2.1. Management skills

Operations management today faces the challenges of workforce attrition, aging physical infrastructure, rapidly changing technology, increasing customer expectations for reliable service, and continuing cost pressures to maintain acceptable financial performance of the company. Significant workforce attrition due to retirements is an additional factor to be addressed as part of a holistic management approach to business operations. Such a comprehensive approach involves the study and consideration of all tools available to management to meet the company objectives, not solely the human resource component. The business processes and technology currently in place combine with the human element to create a complete business operations and management system. When addressing a specific change in one element of the system, it is necessary to consider all elements of the system. Attrition due to an aging workforce can be a driver for improving overall operational efficiency through a comprehensive review of how people, processes, and technologies are used.

During the 1990s, in their efforts to contain costs and increase efficiencies, utilities endeavored to “reengineer” business processes, and replace or install information technology (IT) systems to support the newly designed processes. The practice of “reengineering” evolved to “business process management”, and then to “operational innovation.” The concepts underlying these practices have a place in the overall strategy for managing the aging workforce challenge. Activities such as codification of information, knowledge management system creation, business process redesign, work process automation, and outsourcing are elements of comprehensive strategy. The issue for management is how to best use these tools and activities.

2.2. Outsourcing

Utility companies have used outsourcing as a tool to supplement the permanent workforce and manage peaks in workload. In this paper, outsourcing refers to temporary employees and contract labor forces. For example, utilities often supplement construction and maintenance forces with line construction contract companies. The contractors can be used as workload dictates, and the company workforce can be used primarily for critical operations activities. Similarly, temporary workers have been used to supplement many operations functions when workload dictates the need.

As a temporary workload management option, outsourcing has been a normal operating process. But what about outsourcing work as a permanent operating practice? Can this be successful? Is it confined to specific functions and what are they? How do we determine when and how to apply outsourcing as a primary tool for workforce management? These are all questions that should be answered for outsourcing to be a more permanent solution to workforce attrition due to aging.

Since retiring employees often have interests in continuing their professions, outsourcing sometimes takes the form of contracting with former employees. This approach avoids significant loss of institutional knowledge, but it creates a change in the fundamental business relationship between company and employee. While this can be a non-issue it must be addressed to ensure thorough understanding of the expectations of both parties.

Complete outsourcing of selected business processes is an option in addressing exiting expertise. As illustrated in Figure 2, certain administrative functions are already outsourced by many utility companies [14] and because the industry spends an estimated $19.1 billion on selling, general and administrative functions [8], there are many vendors who offer comprehensive outsourcing options. The outsourcing of engineering and operations activities is more complex, however, because those activities involve critical tasks associated with electric system integrity.

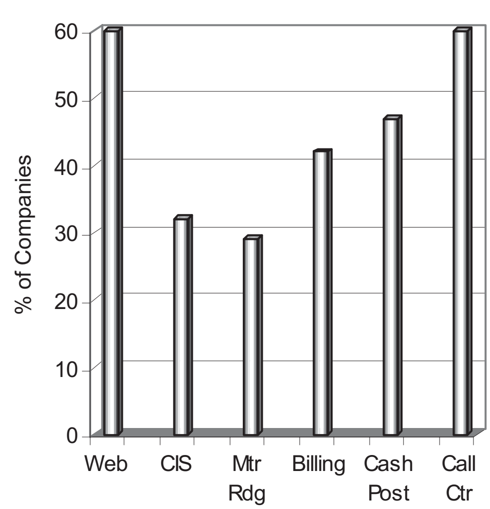

Figure 2. Outsourced utility functions in 2003

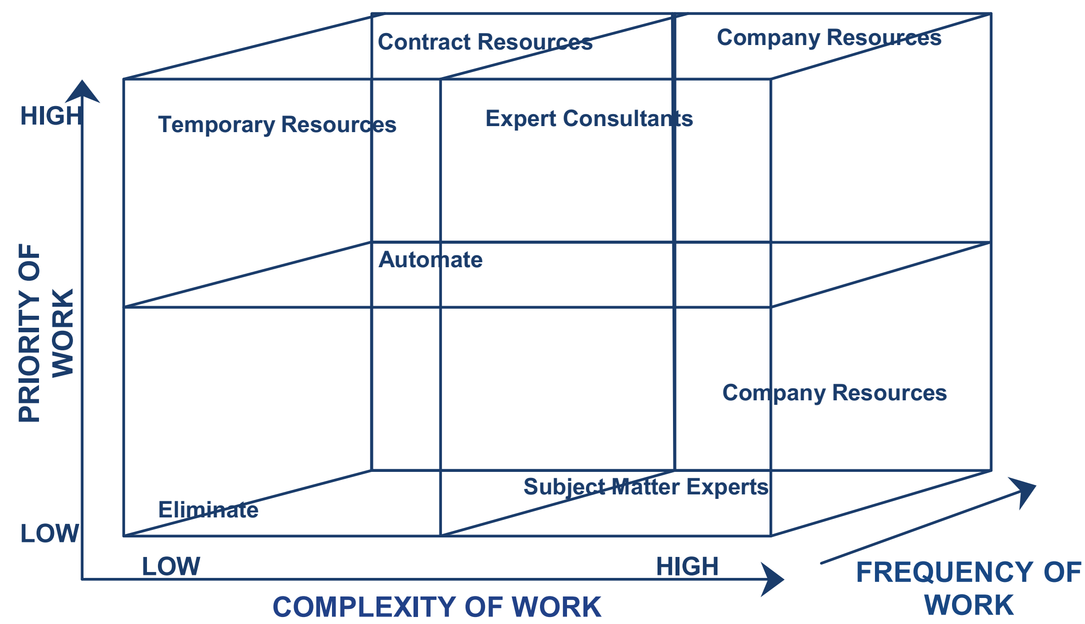

Figure 3. Process evaluation

2.3. Task and skill analysis

As utility companies evaluate their needs, resources and capabilities, they ultimately consider the tasks to be performed within an organization and the skills required to proficiently execute those tasks. This is fundamental job-task analysis. Most often the existing paradigm is to base workforce planning on in-house execution of the expected or average work load, and to manage workload peaks by exception, either through overtime, temporary personnel or contractors. This is a tried and proven approach, but not necessarily the most effective approach when considering limited resources and lack of requisite skills in any given task area. The challenge is to consciously and actively evaluate specific job requirements to determine what workforce management philosophy best suits the needs of the company or offers alternatives that facilitate achievement of multiple operating objectives.

In the utility industry this may involve determining which operating tasks contractors can perform and which tasks company employees must always perform. The determinants may be issues of safety, security, knowledge, or skills, among other considerations. In an engineering organization, for example, this may involve decisions on whether company employees, contract engineers, or consultants should do design, planning or forecasting tasks. The analysis also forces consideration of what skill level is required of in-house employees for specific processes and job tasks.

A structured approach to process analysis involves evaluation of the business process and tasks from several perspectives. One approach is a formalized job-task evaluation that includes assessment of what tasks are priorities, what skill level is required, and how often a task is performed. Once these parameters are established, an evaluation can be made of what would be the most efficient and effective manner of task completion. Figure 3 represents a model for evaluating tasks and options for completion.

For example, a low complexity, high frequency, high priority process would be an excellent candidate for system automation (as discussed in section 3). Consider remittance processing as an example of a process that meets this description. Every day, companies handle thousands of customer payments that require immediate handling to properly reflect the customer’s payment as well as to optimize revenue collection for the company. This process was automated years ago in most utilities and has evolved to electronic payment capabilities to further accelerate the process. Automated meter reading is an example of a current generation business process that is being evaluated against these criteria with decisions being made on how to best allocate limited resources. In the past, a primary driver for initiating process change was cost of operations and reducing the cost of operations. With the aging workforce, the driver for initiating process change is different, but the manner in which the issues are addressed can be similar, if not the same.

As with all elements of work management and manpower planning, there is no one right solution for all operations. The framework for analysis, however, is useful in forcing discussion and rigorous consideration of all options available to management to meet overall business objectives. At the very least the evaluation provides inputs to a business decision process addressing the optimal utilization of financial resources.

The evaluation of work processes, options for carrying out those processes, and overall effectiveness of the organization provides information for a business case analysis. Again, applying the premise that the objective is optimal resource utilization, the analysis must consider the question of effectiveness of resources consumed, or more directly, what "bang for the buck" is being achieved. Is it more effective to buy an employee's services with all the additional costs of training, benefits, and facilities, or is it more effective to buy services from a vendor? Or a third option may be to buy a technology to do the work. All of these issues carry different weights and priorities in different companies and management must determine what best suits their culture, business model and service delivery objectives.

3. Automating

One of the process management options to be considered, as illustrated in Fig. 3, is automation or the application of technology to complete tasks. A comprehensive evaluation of technology available to support business processes is a fundamental element of process design and in the case of replacing aging workforce, technology can be an important element of a comprehensive strategy. Recent industry events as well as operating policies mandated by legislation demand more sophisticated technological tools and solutions in the industry.

As processes and operations become more dependent upon automated solutions, the importance of human skills to use and support the technology increases significantly. It is not enough to understand the business processes, rules, standards, procedures or science associated with a job function. The employee must also have a working knowledge of the technologies or applications that are used to support or perform the job functions. Each technological innovation requires some new degree of skill by the employee using or depending on the technology. Even without an aging workforce issue, the increasing use of technology for operations and management demand new skills in the workforce.

The aging workforce again may be the catalyst for automation that, until now, has been considered too expensive, too complex, or just too new. As the aging workforce "tipping point" approaches, management should consider what additional business functions or opportunities exist with the application of a particular information technology. With the automated meter reading example, if the intent is simply to perform the meter reading function as a cost reduction initiative, the business case is generally weak; however, the business case is improved when management considers that value of the expanded functionality available through the technology for load control functions, customer data gathering, and a number of other activities that could drive additional business revenue opportunities or reduce other costs in addition to the labor for reading the meter [13].

Utilities have over the past decade greatly increased the use of new technologies in operating processes. Automation expenditures are projected to approach $700 million in 2005, and will fall into two principal areas: real-time automation and controls, and geospatial and field automation [12]. Expenditure growth rates are on the order of 20 to 30 percent per year. Geographic information systems, substation automation (SCADA), AMR, mobile work management, outage management, load control systems, and CMMS are all widely deployed in the industry.

A common issue, however, is the integration of the various applications both from an IT perspective and a business process perspective. Many automated systems have been implemented to support a narrowly defined process that is confined to one function or organization. The future need to address the exiting human expertise as well as the need to be operationally efficient and effective will drive an integrated approach to technology across all operational functions and organizations. This requires a high-level technology roadmap that identifies the overall strategy and direction for using automation in the organization. Developing the roadmap is another fundamental element of a comprehensive business operations plan.

The financial evaluations of new technology applications also require a slightly different approach compared than traditional methods. Cost-benefit analyses would show that the costs of many automated

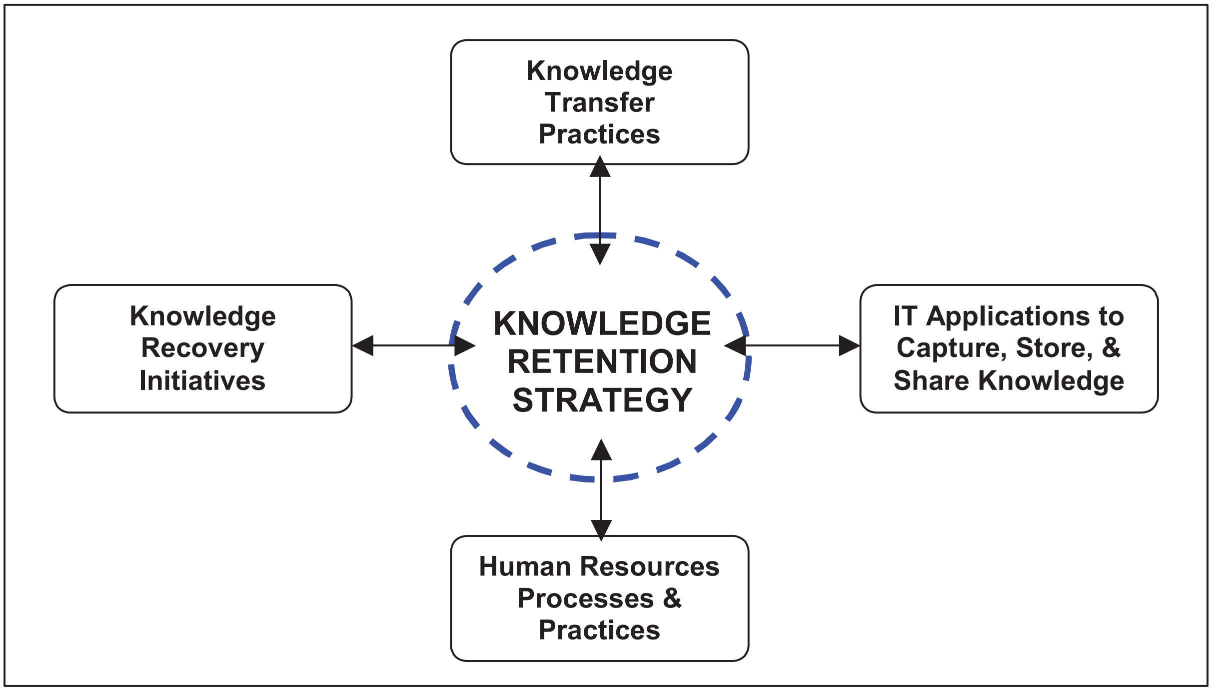

Figure 4. Framework for organizational knowledge retention [6]

tools are still too high to justify their adoption. In using automation to replace aging workers, the analysis must go beyond the immediately identifiable costs and consider the implications of not implementing the technology for the future. The technology business case must quantify and evaluate this risk factor in order to fully address the issue.

Implementation and operational reliance on technology or automation presents human resource issues in the areas of recruitment, retention and employee skills. As companies work to recruit and retain new workers, they are continually competing for technologically savvy workers who do not think of the electric utility industry as a center of sophisticated technology applications. How much more successful can utilities be in recruiting and retaining workers if the technology used to engineer, operate, and maintain a power grid is leading edge, both for the industry and in development of automated tools in general? We do not know but it is safe to assume that the odds of attracting technical talent will be improved. There is no question that "Generation Y" workers expect to be involved with technology both as a tool for their work and as the subject of their work, so any business that does not have a high component of technology in their work will be less attractive to the best and the brightest employees of the future.

4. Recording

The retention of knowledge held by workers about to retire is an immediate concern and challenge for utility companies. Before a knowledge retention program or activity can begin, the company must have some sense of what is critical knowledge and where it is held. The task to understand these issues is daunting and, in many companies, is without process or precedence. Some early mover companies have explored this issue for a number of years and have developed effective process models for determining what is critical knowledge and who has it. In most cases, the activity to address knowledge retention involves a comprehensive organizational survey activity, coupled with a well-defined process for recording, cataloging, and storing the information acquired through interviews and surveys. How this is done is a function of the culture and practices within the specific company. In all cases, however, there is a strong management commitment to provide the time and resources to make the process successful.

In [6], DeLong presents a four-pronged strategy for dealing with knowledge retention in an organization (as illustrated in Fig. 4). This model calls for a multi-dimensional approach to knowledge

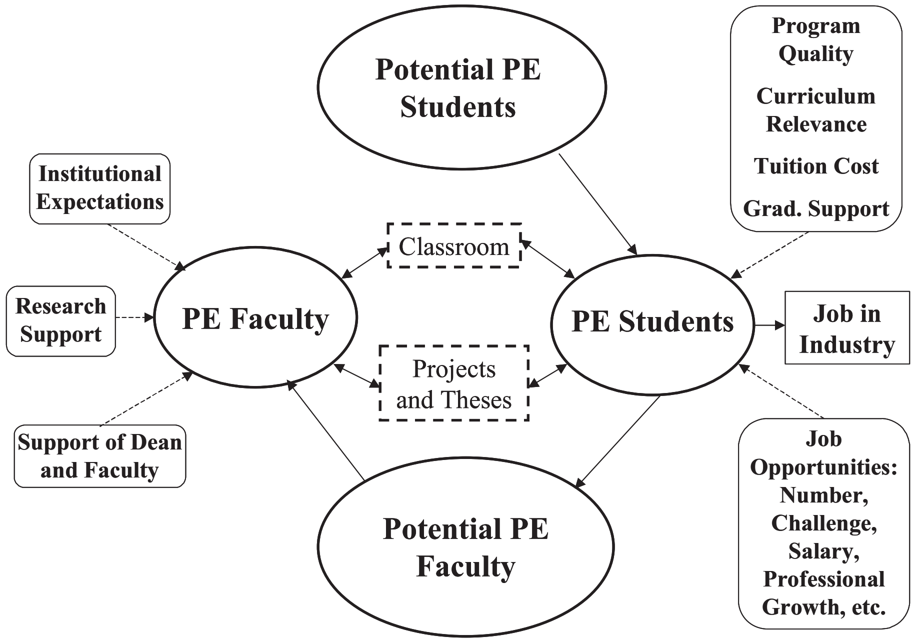

Figure 5. Model of university faculty and students: interactions and decision influences

retention that is customized to the individual company's needs, capabilities, and culture, and has the long-term commitment of management.

Perhaps most significant in DeLong's knowledge retention strategy is the component of knowledge recovery. The need for knowledge recovery initiatives recognizes that, regardless of systems and processes and procedures, some critical institutional knowledge will undoubtedly be lost with exiting workers. It is imperative that companies acknowledge this and have an active strategy to deal with lost knowledge. That strategy may involve hiring retired workers as consultants or contractors, or using expert consultants to address specific issues. In any case, the company must be prepared with a strategy and action plan to mitigate the impact of knowledge loss. Technology can be a key component of an effective knowledge retention strategy. Various knowledge management programs and applications are available "off the shelf" today as well as customized solutions. For operating utility companies, however, the most effective initiatives for knowledge retention will likely be in areas other than a technology for knowledge retention and management. The operating systems used in the business, as well as ongoing mentoring and training of new workers, will be the primary vehicles for retention of information for daily operations.

5. Educating

Education is making a critical contribution to addressing the exiting expertise problem. Industry is enhancing in-house education capabilities, and working with education organizations to develop new approaches to life-long learning and to educating the next generation of technicians and engineers [2] [11] [9]. Universities are altering their curriculum to respond to the new skill and knowledge requirements of today's engineering workforce.

Yet major concerns remain about the sustainability of university power programs [24] [27]. The good news is that the number of undergraduate and graduate students has probably bottomed out or even started to grow after reaching a high in the early 1980s [9] (although the recent growth in the number of graduate students at U.S. institutions may be offset by declines in international student applications due to U.S. visa barriers and preferences by international governments for their students to get graduate degrees in their home countries to avoid "brain drain"). The bad news is that the growth in students is probably insufficient to meet the coming demand.

Worse yet, the university infrastructure for supporting that growth is weakening. The major U.S. power programs are not adding new young faculty members at a rate sufficient to make up for the anticipated loss of retiring faculty just at the time that major losses will be occurring in the workforce. This section addresses the problem of sustaining university power engineering (PE) programs

5.1. Basis for sustaining university power programs

To understand what is required to sustain university power programs, it is useful to understand the core decision influences affecting decisions to become a PE student or faculty member, and interactions between faculty and students. A simple model of the interactions may be useful, as illustrated in Figure 5. What this model will show is that universities, industry, and government can, or indeed must, contribute to sustaining university power programs.

Assuming for the moment that the objective is to fill *Jobs in Industry* (as shown in Figure 5) to address the exodus of expertise, it is necessary that potential PE students consider PE as a career. Since the decision to enter into a power program, whether as an undergraduate or graduate student, has to be made in advance of actually going on the job market, perhaps by as much as four years, student perceptions of future *Job Opportunities* are important. They will consider the number of potential job openings, the challenge and career progression opportunities, salary, job security, among other factors. In [25] a comprehensive "professional core values model" can be found that describes factors that someone might consider in choosing PE as a career.

Potential PE students will also consider the quality and cost of the education that they will get. Will the tuition be worth it? Three basic considerations will be the perceived *Program Quality, Curriculum Relevance*, and *Tuition Cost*. For a potential graduate student, the availability of *Graduate Support* will be a prime consideration.

Students taking a *Job in Industry* will help with the expertise exodus problem directly. However, sustaining power programs requires new faculty. Graduate students at the doctoral level may also consider the possibility of becoming PE faculty members and enter the pool of *Potential PE Faculty*. This pool is also composed of people in industry with doctorates who want to go back to academia.

A graduate student's decision to actually pursue a *PE Faculty* position will be influenced by a number of factors. Foremost, there have to PE faculty positions available. There are few such positions opening up for entry by young faculty. The *Support of Dean and Faculty* engineering programs has been difficult to obtain in recent years; they are cutting back on power programs because of greater research funding opportunities in other fields, reduced stature of PE as an engineering field due to the misperception that significant new innovations are not needed or anticipated, and perceptions about low student interest in the field.

Even if a position is available, a *Potential PE Faculty* member must consider the likelihood of getting tenure. That likelihood is based on the understanding of the *Support of Dean and Faculty*, anticipated opportunities for *Research Support*, and *Institutional Expectations* regarding teaching load, tenure requirements, among other considerations. Without *Research Support*, the young faculty member will not be able to establish the research and publishing record necessary for tenure. And that research support needs to be sufficient to carry graduate students through their own program: the young faculty member – graduate student relationship is synergistic, with each relying on the other for reaching their separate objectives: tenure and graduation. Faculty need to be able to attract quality students for the graduate programs, and the ability to provide *Graduate Support* is a critical decision-factor for the potential graduate student, as noted above.

The fundamental interactions among faculty, and undergraduate and graduate students occurs either in the *Classroom* or on *Projects and Theses*. It is those interactions that determine the quality of the education experience. And the higher the quality of the education experience, the greater will be the contribution that student will be able to make in restoring expertise in the industry, and the greater the likelihood of success of a graduate student as a *PE Faculty* member. There is an idiom that says "What goes around, comes around." In this case, a quality education breeds quality teachers that in turn produces quality education. In this circle, research provides support of faculty and graduate students, but also enhances the education experience.

What then is the fundamental basis of a sustainable power program? It is the stature of the program in the eyes of the Dean, fellow faculty members, industry, and students. Major drivers of that stature are:

- Ample R&D funding, particularly of a nature that gives graduate students support through their program and produces new knowledge that both solves industry challenges, but also advances the quality of education.

- Ample attractive positions in industry that motivate students to take PE courses and enter into PE graduate programs.
- Quality and cost of the education.

5.2. Objectives and strategies to produce the next generation of power engineers

Using the model given in Figure 5, it is possible to see where focus needs to be given to increase the number of PE graduates to address the exodus of expertise.

Based on the model, a comprehensive strategy to get attract more students to the PE field would:

- Increase the number of *Potential PE Students*
- Improve power *Program Quality* and *Curriculum Relevance*
- Control *Tuition Costs*, perhaps providing targeted tuition assistance when needed to advance diversity
- Increase *Graduate Support*
- Improve *Job Opportunities*
- Improve the quality of interactions among faculty and students in the *Classroom*, and in *Projects and Theses*

To get more *PE Faculty* to sustain power programs, the model suggests such objectives as:

- Increase *Research Support*
- Increase support by engineering *Deans and Faculty*
- Equitable and reasonable *Institutional Expectations*, particularly of new faculty.

Importantly, the model reveals that industry, government, and universities all have a role to play. For each objective, strategies can be identified for each of the three vested interests. For instance, more *Research Support* is needed from industry and government to support faculty, and to enhance classroom and project learning experiences; universities also need to look at new models of industry-government-university interactions to make that support attractive beyond simply supporting power programs [22] [4].

To get more *PE Students* requires that industry make *Job Opportunities* more attractive relative to other fields, that industry and government help support *Tuition Cost* and *Graduate Support*, and that universities insure that they are offering the best possible education at an affordable *Tuition Cost*.

Thus, there exists a need for greater attention to the problem of sustaining power programs while increasing interest in PE education. A comprehensive strategy is needed with collaboration among industry, government, and universities to develop a plan for educating the next generation of power engineers. As noted in [25], such collaboration needs to articulate a "compelling mission," but with realization that industry, government, and university all have something to bring to (and take from) the table.

6. Conclusions

The exodus of technical expertise is accelerating in the electric power industry. Of the four approaches to addressing this exodus described in this paper, utilities are probably most frequently relying on short payback, low cost solutions, such as operations management improvements, outsourcing with previous employees, and in-house training programs. It is necessary to view the exodus not as a short-term problem, but as a long-term opportunity to rebuild the companies around the next generation of engineers and technicians. Decisions on investments in people are just as important as the decisions on investments in the aging infrastructure.

A priority investment in people should be in the current and potential organization leaders who demonstrate the skills, capability, and forward thinking to envision and create an organizational capability for self renewal through knowledge retention and transfer. This capability may occur through direct human interaction and training, various technological solutions, or most likely a combination that supports the organization knowledge base.

The urgency for the investments in people is felt in professional engineering meetings and in the workplace. But the public discourse among executives and policy-makers does not reveal the same sense of urgency. This is also seen in the declining level of research funding of universities even though research is the life-blood of the research and education mission of universities.

The exiting workforce, the limited labor pool for experienced workers, and the diminished pipeline of newly educated engineers to fill vacant positions challenge all electric power interests to evaluate new educational methods and practices, new work processes, new technology and new methods for knowledge retention. At all levels of the issue there is a need for comprehensive strategies to address attracting and retaining more power engineering students, to evaluate and integrate new technologies into daily utility operations, and to develop innovative operating models that incorporate the best of people and technology to optimize the effectiveness of scarce human and financial resources.

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