
BUILDING AN INTEGRATED NUCLEAR ENGINEERING AND NUCLEAR SCIENCE HUMAN RESOURCES PIPELINE AT THE IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY

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Abstract. In a joint effort with the Argonne National Laboratory – West (ANL-W), the Idaho National Engineering and Environmental Laboratory (INEEL) has assumed the lead role for nuclear energy reactor research for the United States Government. In 2005, these two laboratories will be combined into one entity, the Idaho National Laboratory (INL). There are two objectives for the INL: (1) to act as the lead systems integrator for the Department of Energy's Office of Nuclear Energy Science and Technology and, (2) to establish a Center for Advanced Energy Studies. Focusing on the Center for Advanced Energy Studies, this paper presents a Human Resources Pipeline Model outlining a nuclear educational pathway that leads to university and industry research partnerships. The pathway progresses from education to employment and into retirement. Key to the model is research and mentoring and their impact upon each stage. The Center's success will be the result of effective and advanced communications, faculty/student involvement, industry support, inclusive broad-based involvement, effective long-term partnering, and increased federal and state support.

1. INTRODUCTION

In 2002, the US Government's Department of Energy (DOE) transferred sponsorship of the INEEL and Argonne National Laboratory – West (ANL-W) to the DOE Office of Nuclear Energy, Science and Technology and designated the INEEL and ANL-W as the nation's lead laboratories for nuclear energy reactor research. This transfer acknowledged the laboratories' history, infrastructure, expertise and commitment to collaborate broadly to fulfill their assigned role as the nation's centers for nuclear energy research and development.

In 2005 the INEEL and ANL-W will be combined into the Idaho National Laboratory (INL). One of DOE's objectives for the INL is to act as the lead systems integrator for the DOE Office of Nuclear Energy Science and Technology near- and long-term missions to develop Generation IV (Gen IV) nuclear technologies and advanced fuel cycles, and to sustain research to develop and refine peaceful use of nuclear energy to the benefit of the nation and the world.

Another DOE objective is for INL to lead the US research, development and exploration of Next Generation Nuclear Plant technologies and to carry out this mission in cooperation with other national laboratories, universities, international partners, and the private sector.[1] Knowing that strong university alliances will be critical to accomplishing these goals, DOE has directed that the INL establish a Center for Advanced Energy Studies (Center).[1] The Center is to be an independent entity, in which the INL and Idaho, regional, and other

Universities cooperate to conduct on-site research, classroom instruction, technical conferences, and other events for a world-class academic and research institution. DOE understands that its objectives for the INL will not be accomplished without a ready source of well-educated and trained nuclear engineers, nuclear scientists, and others with advanced degrees in supporting disciplines such as physics, chemistry, and math.

This is not the first time the US Government (Government) has influenced the development of technology through a policy that involves educational institutions and industry. The Government's role in Nuclear Energy Research and Education began in the 1950s with the Atoms for Peace program.

With Government support, Argonne International School was established and operated from 1955 to 1960. By 1959, the School had graduated 325 foreign students and 95 Americans in Nuclear Energy (NE) technology. Many of these graduates became leaders of NE programs in their own countries.

During the period 1960-65, the Argonne International School became the Institute of Nuclear Science and Engineering. Throughout this early period, there was a continuous transfer of coursework and scientific knowledge to the growing number of nuclear engineering departments at universities being organized across the nation, first at North Carolina State University and then at Pennsylvania State University, in 1956.

Around 1960 other Government programs at national labs, notably Oak Ridge National Laboratory, were established. The Government wanted to make these national laboratories user facilities where NE research was conducted. However, NE was a national obsession and nuclear labs and research reactors began to spring up on campuses around the country.

In the 1960s, the US Atomic Energy Commission (AEC) demonstrated its resolve to create the needed nuclear engineering graduate professional by offering three-year graduate fellowships, with tuition and fees paid, and an annual stipend. Moreover, these AEC fellowships could be applied at over 50 US Universities. The AEC fellowship program played a very important role in building a US NE infrastructure.

Concern about the rapid proliferation of nuclear arms in the 1970s caused the Government to reverse its policy of support for NE in order to set an example of nuclear nonproliferation for the rest of the world.[2] Government support of nuclear engineering education was reduced even further in the 1980s, as the public became increasingly more concerned over the environmental risks associated with NE.

With NE off the table, the Government invested its research dollars to finance an abundant and efficient source of renewable energy. When renewable energy sources failed to provide a cost effective answer to the nation's growing demand for energy, the Government turned its attention back to NE. In the late 1990s, the Government increased its commitment to NE research.

Currently, money is available for research reactor fuel support and regional university alliances of nuclear departments and nuclear facilities. But the two decades of NE decline has left US universities with a limited range of nuclear research facilities. Nuclear Science and Engineering programs at Universities have to be re-established and University research capabilities are severely limited.

2. INTEGRATED NUCLEAR ENGINEERING AND NUCLEAR SCIENCE HUMAN RESOURCES PIPELINE

At the INEEL, the Human Resources (HR) Director also serves as the Education Director with responsibility for the company's education programs, initiatives, and university outreach. HR's Education Initiatives (HR/EI) department is where these programs and initiatives are housed. HR/EI believes that a highly integrated and aligned cooperative education system, which guides promising young university students through an integrated Nuclear Engineering

and Nuclear Science HR Pipeline (Pipeline) towards becoming NE scientists and engineers at the INL, is essential to meeting its future staffing and research needs. This Pipeline forms the backbone for all the Centers efforts to rejuvenate nuclear science and engineering education and research in the US.

The first step HR/EI and INEEL Senior Management took to establish the Pipeline was to establish the INEEL Education Advisory Council (Council). The purpose of the Council is to review HR/EI programs and initiatives for alignment with the laboratory's strategic research initiatives, identify key universities to be targeted for collaboration development and/or enhancement. Once a university is targeted, the Council establishes resources and funding from within the different research divisions for university collaboration development and HR/EI program support. Additionally, the Council addresses joint appointments of university faculty and technical industrial leaders, Sabbaticals, Affiliate Faculty and Affiliate Research programs, and HR/EI student and intern programs as university collaboration development and strengthening activities.

Most importantly though, the Council members will be high-level champions for HR/EI as the components of the HR pipeline are developed and employed. Council members are representatives from Senior Management, the Assistant Laboratory Director (ALD) for NE and the ALDs for the other research divisions, the Chief Information Officer, the Director of Strategic Planning, the Director of HR who serves as the Director of Education, and the HR/EI Group Lead.

With the Council's help, HR/EI is working to modify existing programs and systems and to develop new programs and systems necessary to create the HR Pipeline Model shown in Figure 1.

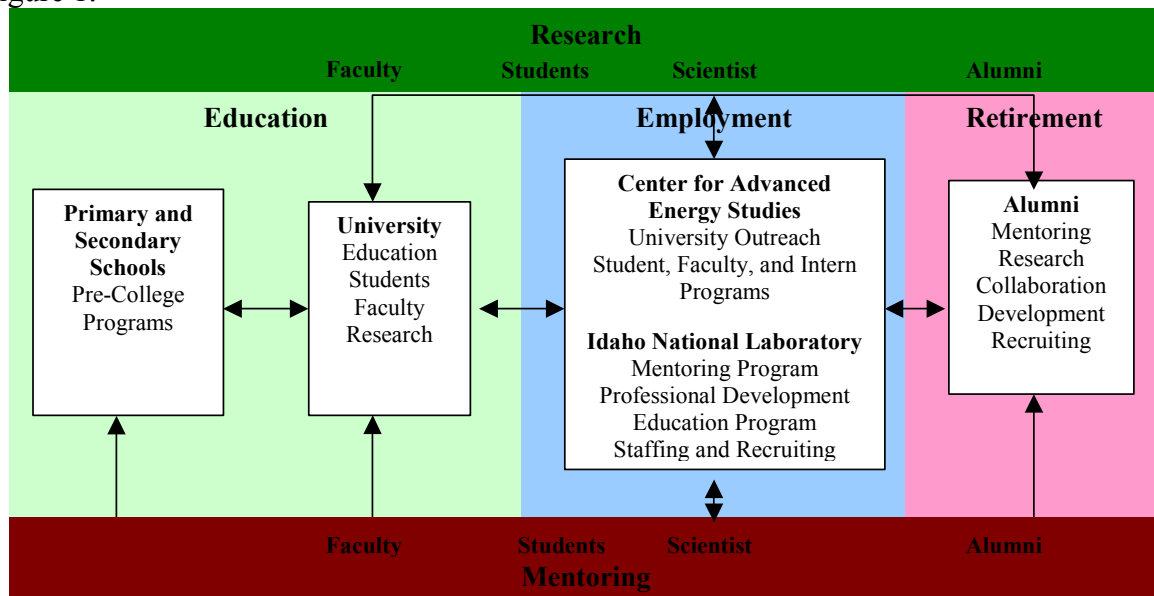


Figure 1: HR Pipeline Model

The model describes the Pipeline or pathway by which primary school students are introduced to math, science, and engineering through the Pre-college programs such as Jason, the Science and Engineering Expo, Science Bowl, Robo challenge, and other DOE Office of Science and INEEL outreach programs. By sparking the interest of primary school children in NE related sciences, we are influencing their decisions to obtain a university degree in a nuclear energy-related discipline. At the university, students are involved in collaborative research between the Center and their university. This involvement may include fellowships, scholarships, and mentoring by scientists and/or alumni preparing the student for employment at the INL.

Retirement will not be the end of a long and successful career for INL scientists who have participated in an Alumni Program. These distinguished Alumni will continue to share their knowledge and skill with the next generation of students and researchers through mentoring and continued research involvement.

The model in Figure 1 shows the Pipeline, but collaborative research and curriculum development between the Center and its partnering universities is the power that guides students through the pipeline. Opportunities for faculty and laboratory scientists include Laboratory Affiliate Scientist designation, joint appointments, Sabbaticals, and professional leave. These programs increase the intensity of the collaborations, keeping them strong and productive.

3. STUDY OF NATIONAL AND INTERNATIONAL BEST PRACTICES

Due to the importance of INL-University collaborations to the success of the pipeline (and the Center) and the expected role of the Center in revitalizing NE education, HR/EI conducted a study of national and international academic and industry literature focusing primarily on articles and cases addressing industry and university partnerships developed to meet industry's staffing needs. These articles were reviewed to identify practices, programs, and strategies that could benefit current HR/EI programs and pipeline development efforts.

3.1 University – Industry Research Partnerships

The literature review showed that university/industry partnerships were an effective source of skilled employees that meet a company's research and staffing needs. Leaders in education, business and government met last fall at the New England Board of Higher Education's "Building Human Capital" conference in Newport, RI. Anthony Carnevale, noted economist of the Educational Testing Service, warned that America could soon find itself short 15 million college-educated workers and that higher education will feel extraordinary pressure to align its offerings with the demands of employers.[3]

Business leaders are looking to universities and see the future as requiring the development of closer partnerships with a smaller number of key university partners. Several authors noted that networks of excellence between universities and industry were the best solution to research and education needs. Current literature presents universities as the best solution for long-term problems or as a source of innovation and new ideas with company researchers addressing short-term problems.[4]

Student and postgraduate programs were a critical part of many firms' staffing plans. More than two thirds of employers that emphasize college hiring use internships or cooperative education programs to "test drive" prospective employees and create a pool of quality candidates. Participants in postgraduate programs (internships) have a relatively high rate of conversion to full time employees. Employer internship programs average 41% percent of interns converted to full-time employees. Additionally, research shows that workers who serve as a company intern are twice as likely to stay with the firm than an employee who did not work as an intern.[5]

3.2 Opportunities and Challenges

As with any successful collaboration or alliance, there must be benefits to the company and its collaborating universities for participation. It is critical that the Center's structure address the needs for return on investment from every member of its alliance. In addition to filling the pipeline, the INL may enjoy the following benefits: lower research and development (R&D) expenses and higher levels of innovative output, more patents, and more technology-based alliances with other companies than firms without such alliances.[6]

Harney and Doan described benefits for both the industry and universities.[3] Industry-university technology relationships encompass four highly related components. It was found that benefits for industry (from collaborative education partnerships) comprised enhanced

industry professionalism and legitimacy; increased professional status; better public image; control of abstract knowledge and improved industry competitiveness. For the university, key benefits from successful alliances have included improved educational offerings; enhanced reputation in the professional discipline; additional student fees and economies of scale; and funds for curriculum development and research.

Industry-University alliances can be instrumental in facilitating the industrial firm's advancement of both knowledge and new technologies.[3] This is, after all, the primary goal of the Center, to "Lead the US research, development and exploration of Next Generation Nuclear Plant technologies and carry out this mission in cooperation with other national laboratories, universities, international partners, and the private sector.[1]

There are many potential benefits for the INL and the university alliance created by the Center. However, there are significant challenges ahead for the partnering institutions to achieve these benefits. Firms should approach university alliances with their eyes open. Securing external alliances, much less making them work, can be a long, difficult, and expensive process – with plenty of indirect or hidden costs.[6]

However, the ability to create and sustain fruitful relationships will give a company a significant advantage. For this to happen, three fundamental conditions must be present for successful cooperative business alliances: 1) benefits for both partners, 2) genuine collaborations through working together rather than simply exchanging ideas, and 3) building up personal connections rather than strict control (Kanter, 1994). These are the best ways to promote positive relationships.[7,8] Such partnerships represent holistic cooperation rather than fragmented piecemeal attempts at solving organizational problems.[9]

The study revealed a very insightful collaborative model presented by Santoro.[10] Santoro's research focuses on the university research center structure because it's used by many universities to foster alliances with industry. Moreover, the National Science Foundation (NSF) has taken a significant role in helping universities organize research centers. Research parks are limited to operations that are research oriented and have tremendous potential for attracting partners, who can complement and augment a university's research capacity. Also, it appears that the university research center model could meet DOE's expectations of the Center.

Santoro explains that industry-university technology relationships encompass four highly related components: 1) research support, 2) cooperative research, 3) knowledge transfer, and 4) technology transfer.[10] Research support is the contribution of both money and equipment made to universities by members of the corporate community. Support for university research has become much more targeted and tied to specific research projects where a commensurate return on investment is expected.[12] Cooperative research between universities and industrial firms is crucial to ensure that universities develop and deliver an appropriate curriculum for training students in state-of-the-art techniques. In this way, universities supply industry with graduates that meet industry's immediate and long-term needs.[13]

There are many types of formal and informal knowledge transfer arrangements, although the most common is industry's hiring of recent university graduates.[14] Given the critical need for knowledge transfer and knowledge management in the Nuclear Energy industry, any knowledge management program must also encompass a variety of processes emphasizing on-going personal interactions, cooperative education, and personnel exchanges. Knowledge transfer activities are often a necessary foundation for stimulating larger scale cooperative university-industry research programs, such as research consortia or joint ventures.[15]

The results from Santoro's multi-method, cross-sectional research indicates that a positive, two-way linkage exists between the intensity of industry-university relationships and the level

of tangible outcomes generated.[10] His results also show that while the organization's size and length of relationship do not significantly affect these dynamics, the industrial firm's geographic proximity to the university research center does. This is of particular interest because DOE is requiring that the INL develop strong partnerships with Idaho universities.[1] While Idaho universities are rushing to build Nuclear Energy programs and to include Nuclear Energy courses in related discipline curriculums such as physics and materials science, the Center will not be able to become a world class academic and research institution without involving other universities located a considerable distance from the INL. This will be challenging for the INL as geographic proximity plays a consequential role with respect to the intensity of industry-university relationships and the level of tangible outcomes generated. In spite of numerous advances in both telecommunications and electronics technologies, geographic location continues to be a crucial strategic consideration for industry-university alliance partners.[10]

Factors of greatest importance to an industry-university relationship are the university's posture on intellectual property rights (IPR), patent ownership, and licensing. Closely intertwined are two additional items: 1) A firm's willingness to work with a university research center in sharing creative and mutually beneficial incentives for IPR, patent ownership and licensing: 2) The presence of an empowered industry-university champion at the industrial firm who serves as the pivotal player in assessing the complementarity of each organization's skills, knowledge and resources, and in formulating meaningful incentives that satisfy both organizations' needs.[11]

A firm's industry-university champion is uniquely positioned to ensure that industry-university relationships properly leverage each organization's skills, knowledge and resources. Through an appreciation and focus on the complementary nature of industry-university relationships, the champion is often the key player in formulating mutually beneficial IPR, patent ownership, and licensing policies. Effective champions are influential, sensitive to changing market conditions, and serve as the chief liaisons and key communication links between partnering organizations.[11]

Santoro's research indicates that high levels of industry-university relationship intensity tend to produce higher levels of tangible outcomes while higher levels of tangible outcomes generated in the past serve to stimulate higher levels of industry-university relationship intensity in the future.[10] The strong two-way linkage found here between relationship intensity and tangible outcomes suggests that a spiraling interaction exists. This spiraling interaction has implications for the role that each plays in bringing about technical change.

3.3 Mentoring and Knowledge Transfer

There was a disappointing lack of research examining knowledge transfer as an outcome of mentoring relationships. Research into the outcomes of mentoring has primarily focused on career advancement, socialization/orientation, training, professional development, and job satisfaction. Apparently, mentoring has not been evaluated as a component of knowledge management.

Research conducted by Jacoby suggested that structured mentoring programs were an excellent vehicle for leadership development, training and *sharing of expertise* (italics added), and rapid development of talent.[16] Levinson et al. defined mentoring as a process consisting of *teaching* (italics added), demonstration, interaction, feedback, and counseling.[17] The dictionary also defines a mentor as a wise and trusted counselor or teacher. Yet, research on the key outcome of training and teaching, knowledge transfer, was not available.

Knowledge management is not just about technology systems, it is about the process your people follow to capture knowledge. Technology is simply an enabler.[18] Yet, technology

may provide a method to overcome some of the limitations of distances between university partners in the Center and the scientists at the INL. Buckingham studied the results of a three-year video and tele-mentoring (use of e-mail or computer conferencing) program, the National Aeronautical and Space Administration (NASA) Virtual Science Mentor.[19] His research supports the extension of traditional face-to-face mentoring to mentoring through new technologies as they become available. As indicated by the mentors, mentoring through technology was satisfying even with some associated technical difficulties.

4. RECOMMENDATIONS

HR/EI's study of best practices leads us to make the following recommendations for the INL and its Center. First, if the INL is to become the preeminent, internationally-recognized laboratory in nuclear energy technologies, the Center should establish a "network of excellence" with universities with recognized education and research capabilities in NE science, engineering, and related disciplines.[1] Currently the INEEL is developing relationships with universities that will provide the bases for integrated research within the US and Internationally.

Issues important to each of the partnering institutions must be identified and addressed in the initial stages of establishing the Center's partnerships. There is an opportunity to settle issues such as IPR in creative ways. Under certain conditions, DOE will consider unique and innovative approaches to information and data transfer, commercialization, and licensing of intellectual property.[1]

Other potential issues are likely to be the roles of the different partners, resource allocation, and funding for and ownership of new research equipment and facilities. It is important that each partner's need to receive an appropriate return from its investment in the Center. Working through these issues and needs up-front is critical to cooperative relationships later on.

Kanter warns that organizations that cooperate and collaborate, must manage the relationships not just as a business deal, but more like a marriage.[7] The INEEL's relationships with Idaho Universities over the last decade reveal that this is more easily said than done. The INEEL's Education Advisory Council should serve as a source of high-level champions of university collaboration. Each partnering university must also identify high-level champions for the collaboration. These champions should nurture the partnering relationship as well as exploit opportunities and resolve issues.

Also, the Center should use utilize advanced communication and conferencing technology such as compressed video conferencing and other distance collaboration tools in order to maximize the relationship intensity of Center partner universities that are not in close proximity to the INL.

It is strongly recommended that the INL establish a Distinguished Alumni Program for retired NE engineers and scientists. This program should also include retired university researchers. The alumni program will facilitate their continued involvement in mentoring, at all levels, and in research.

The following additional recommendations are based on Tener's characteristics of an effective industry-university partnership, which will add value to all parties.[20] These relationships would have positive substantial activity in each of the following areas:

1. Institutional Mission, Philosophy and Commitment. Faculty, administration, and industry leaders need to commit to and publish a clearly expressed mission statement and program charter. The mission and vision of the Center must be well understood and accepted by each partner.[20] The acceptance of a common mission and vision would then become the foundation of planning activities. The INL's NE Division leaders and the partnering university administrators should develop well thought out business and research plans that

coordinate the effective and efficient use of all applied resources. The INL must make a long-term commitment to the Center providing sufficient funding and highly qualified staff members for the development and management of the Center.

2. Organization and administration. A separately administered department with control of its resources and direct collaboration with industry is desirable. Close cooperation between faculty and that of the other departments that teach courses in the program is essential.[20] The Center must enhance and/or establish programs designed to keep the Center's partners conducting research, teaching, and mentoring together. Agreements with all partnering universities should be established to jointly fund university chairs and joint appointments. Affiliate faculty status should be provided to INL scientist who teach and/or sit on student dissertation or thesis committees. Additional methods that stimulate close cooperation are university faculty fellowships, sabbaticals, and Affiliate Scientist appointments.

3. Industry advisory committee. An effective, committed group of executives who share accountability for program outcomes is essential.[20] The Council membership should be expanded to include high-level representatives from each Center Partner. Identified collaboration champions would be the ideal partner members of the Council.

4. Curriculum: In consultation with industry representatives, faculty must design and continually update courses to meet the stated needs of industry.[20] The Center should develop knowledge transfer and technology processes and systems throughout its mutual involvement with universities and industry. The knowledge captured from INL Alumni and senior scientists should be shared through mentoring and by other mechanisms. This collective knowledge from the Center partners must be invested into curriculum and course development.

5. Internship program. Industry, university, and graduates all benefit exceptionally if students are required to complete internships as part of the degree.[20]

6. Faculty. In addition to their academic credentials, faculty should have significant industry experience to be fully qualified to deliver the graduate curriculum.[20]

7. Practitioners in classroom. Curriculum planning and development should include a significant amount of classroom teaching by practitioners.[20]

NE division, HR/EI, and INL resources should be combined to support undergraduate and graduate student fellowships, faculty fellowship, sabbaticals, affiliate scientists, sponsored lectures, and sponsored research projects. The Council provides the coordinating mechanism that will make this possible.

8. Indicators of success. University leadership should evaluate the program's effectiveness by using outcome-based measures of success. The best measures of success are those that reflect that the industry that hires the graduate is the university's customer as well as those that are interpreted by the industry advisory committee.[20]

It is important that the Center is able to show that the investment in money and resources made by all the partners is producing a benefit to the advancement of Nuclear Energy (NE) Research, NE knowledge management, NE education, and to each of the partnering institutions. Therefore it is recommended that the Center establish measures, information collection systems, and qualified staff to evaluate its success. Measures of success could include: 1) Rate of hire of graduates, 2) Number of other firms recruiting [at partnering universities], and feedback from graduates and their [INL] employers. 3) Advancement of graduates in [NE] industry, 4) Level of executive talent attracted to industry-advisory committee, 4) Student employee pass rates on [certification] exams.[20]

9. Attention to the stature of the degree. Leaders in education and industry must resolve misconceptions about the degree and establish its deserved stature as an esteemed degree field.[20] This, of course, speaks to the national and internationally recognized stature of the

INL, the Center, and its partnering Universities. When the Center achieves this stature, so too will the stature of the NE related degree programs offered by its partnering universities.

The INEEL's recent university and education programs integration and alignment with NE initiatives has laid some of the foundation stones for the envisioned Center. When the authors' recommendation are fully in place, the Center will have a strong foundation with all the critical success factors for university-industry partnerships identified by Kotnour et al.[21] They are: 1) Increased communication leading to understanding each other's needs, expectations, and capabilities; 2) Increased faculty and student involvement; 3) Industry support of students through mentors, internships, scholarships, and fellowships. 4) Inclusive, broad-based involvement; 5) Increased federal and state support; 6) Focused capability to execute a long-term partnership. The success of the Center is critical to keep the Integrated HR Pipeline flowing smoothly providing, new engineers and scientists for Gen IV reactor development at the INL.

The history of commercial nuclear power demonstrates that, over time, a national technology policy can successfully promote a technology. The development of nuclear power under a favorable policy required more than 20 years of serious effort (1953 – 1974), while its decline under a policy of curtailment encompassed 15 years (1975 – 1990). If the history of commercial nuclear power is any indicator, achieving results with a national technology policy may take decades. Reversing the effects of this policy will be challenging and could also take decades.[2] The establishment of the Center for Advanced Energy Research at the INL will provide a significant step toward reversing the decline of US NE research and education. The success of the Center is very important for the INL and for the revitalizing effect it will have on US NE research and education.

REFERENCES

- [1] DOE Solicitation No. DE-RP07-03ID14517 Section C, Final Request for Proposal – Idaho National Laboratory, May 2004, pp. C1-C16.
- [2] PARSONS, R. M., "History of Technology Policy – Commercial Nuclear Power," *Journal of Professional Issues in Engineering Education and Practice*, Apr 1995, Vol. 121 Issue 2, pp. 85-97.
- [3] HARNEY, John O., and Doan, Lynn, "Higher Education Gets Down to Business," *Connections*, Winter 2003, pp. 11-12.
- [4] GILL, Laurie, "Industry-university partnerships in materials engineering," *Iron making and Steelmaking*, Conference Report: Institute of materials, Minerals, and Mining; International conference, July 11, 2003, Feb 2003, Vol. 30 Issue 1, p5, 6p.
- [5] ASSOCIATION MANAGEMENT, "Test Driving Job Candidates," May 1997, Vol. 49 Issue 5, P 21.
- [6] BRENNAN, LINDA L., "The View from the Ivory Tower: What Do University Alliances Offer Technology Firms?" *Academy of Management Executive*, Feb 2003, Vol. 17 Issue 1, pp. 125-127.
- [7] KANTER, R. M., (1994), "Collaborative advantage: The art of Alliances," *Harvard Business Review*, July-August, pp. 96-108.
- [8] OLINER, P.M. and Oliner, S.P. (1995), "Toward a caring society: Ideas into action," Westport CT: Praeger Publishers.
- [9] BREEN, Helen and Hing, Nerilee, "Improving Competitiveness through Cooperation: Assessing the Benefits of Cooperative Education Partnerships in Gaming Management," *UNLV Gaming Research and Review Journal*, Vol. Issue 1.
- [10] SANTORO, Michael D., "Success Breeds Success: The linkage between relationship intensity and tangible outcomes in Industry – University Collaborative

- Ventures,” *Journal of High Technology Management Research*, Autumn 2000, Vol. 11 Issue 2, p 255, 19p.
- [11] SANTORO, Michael D. and Betts, Stephen C., “Making Industry – University Partnerships Work,” *Research-Technology Management*, June 2002, pp. 42-46.
 - [12] FORTUNE (1996, Jan. 15), “Will outsourcing save corporate R&D?” 80f-80j.
 - [13] DEUTCH, 1991. Getting university-industry relations right. *Technology Review*, May–June 65.
 - [14] NATIONAL SCIENCE FOUNDATION (NSF) (1982a), University-industry research relationships: Myth, realities, and potentials, Fourteenth Annual Report. Washington, DC: US Government Printing Office.
 - [15] REAMS, B. (1986). University-Industry research partnerships. Westport, CT: Quorum Books.
 - [16] JACOBY, D. (1998), “Rewards make the mentor,” *Personnel*, vol. 66, pp. 10-14.
 - [17] LEVINSON, D. J., Darrow, C. M., Klein, E. G., Levinson, M. H, and McKee, B. (1978). *The seasons of a man’s life*. New York: A. A. Knopf.
 - [18] BOOMER, JAMES, “Finding out what knowledge management is – and isn’t,” *Accounting Today*, Aug 9-22, 2004 www.webcpa.com, p22.
 - [19] BUCKINGHAM, Gregg (2001), “Distance Mentoring in the NASA/Kennedy Space Center Virtual Science Mentor Program, Paper presented at the Annual Meeting of the Southwest Educational Research Association.
 - [20] TENER, Robert K., Fellow ASCE, “Industry-University Partnerships for Construction Engineering Education,” *Journal of Professional Issues in Engineering Education and Practice*, October 1996, pp. 156–162.
 - [21] KOTNOUR, Tim, Buckingham, Greg, and Wolff , M. F., “University Partnerships Help Aerospace Firms,” *Research Technology Management*, May/June 2001, Vol. 44 Issue 3, p5, 3p.