Career Paths of Senior Industrial Assessment Center Program Alumni

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ABSTRACT

This study assessed the career paths of senior student alumni who participated in the U.S. Department of Energy's (DOE) Industrial Assessment Center (IAC) Program. A survey was conducted by the University of Tennessee, Knoxville, of senior IAC alumni who graduated in 1995 or earlier. Fifty-one senior alumni were contacted; 33 of these participated the survey, representing 14 schools. All respondents reported engineering as their field of study, with most (82%) being mechanical engineers. Approximately 58% of the respondents have had jobs that entailed energy-efficiency responsibilities throughout their careers and 73% currently have such jobs. Only seven alumni have never had a job related to energy-efficiency. On average, alumni have held three positions over their careers. This result holds true for all career paths. Respondents who have spent their careers in positions related to energy-efficiency work for a wide range of employers, have a wide range of job responsibilities, and employ numerous methods to influence energy efficiency. All groups of alumni, regardless of their position in their organizations, continue to conduct energy assessments. However, many senior IAC alumni have assumed responsibilities for research and financial evaluation, as well as construction, operations, maintenance, and repair. All stated that their IAC experiences were very relevant to their career paths. Some alumni have moved up in their organizations, but relatively few have moved beyond first-level supervisory positions.

Introduction

The purpose of this study was to assess the career paths of alumni from the U.S. Department of Energy's Industrial Assessment Center (IAC) program. The study was conducted by the University of Tennessee, Knoxville under a grant from DOE. The IAC program was originally named the Energy Analysis and Diagnostic Center (EADC) program when it began in association with four schools in 1976. The current IAC program provides funding to 26 engineering colleges across the United States to conduct energy, waste, and productivity assessments for small- to medium-sized manufacturing establishments within their respective regions. Through part-time employment with the university, students receive training and in turn conduct assessments for local manufacturers, under the direct supervision of engineering faculty. Annually, IAC participants conduct over 700 assessments, and each assessment generates recommendations for energy savings, energy cost savings, and waste and productivity cost savings customized for individual clients.

An earlier study determined that energy savings could be attributed to alumni of the IAC program who take their IAC experiences with them to the professional workplace (Martin et al. 1999). During their careers, the alumni conduct additional energy assessments as well as influence energy efficiency through design, teaching and training, and other activities. Indeed, a significant level of program benefits can be attributed to the alumni. This

project addressed these specific questions: How many years after graduation are IAC alumni involved in energy-efficiency activities and what different methods do they use to influence energy-efficiency decisions? To answer these questions, this project surveyed IAC senior alumni who graduated in 1995 or earlier. The next section of this paper describes the survey design and our approach to data collection. The third section presents descriptive statistics about the senior alumni who responded to the survey. The fourth presents two frameworks used to help analyze the data about alumni career paths and then presents career path results.

Survey Design and Data Collection

The survey consists of 17 questions, 7 of which are repeated for each job held as reported by the survey respondents. The initial survey questions collect background information on respondent's degree program, graduation year, major degree, and how participation in IAC benefited respondent's professional skills and capabilities. Some questions also pertain to professional memberships and registration or certifications. With regard to what percentage of respondents addressed energy concerns over their careers, we asked alumni to provide information on up to six positions held after their IAC participation. If alumni held more than six career positions since involvement with IAC, they were asked to summarize positions held about every three years. Regarding different methods of influencing energy-efficiency decisions for each position held over the years, we asked them to describe their involvement in energy-efficiency. We also collected information on the employer, job responsibilities, and where the position fit within the organization's hierarchy. Finally, we asked respondents to rank the relevance of their IAC experience to each position held. Even though senior IAC alumni were trained only in energy efficiency, their jobs may entail productivity enhancement and waste reduction. These areas were added to the IAC program only recently.

A total of 78 alumni graduating from college in 1995 or earlier were identified from a list of all IAC alumni collected by Rutgers University in 1997. Because of the desire for a high response rate, we decided to administer the survey via telephone (see Folz 1996 for expected response rates from different survey methods). We e-mailed the questionnaire to those alumni who, although reached by telephone, opted to complete the questionnaire by e-mail. Between November 2001 and March 2002, we placed at least four calls to each senior alumnus or e-mailed a survey. Because the initial response rate via telephone was low, we decided to contact the non-respondents by mail. After at least four attempts at telephone contact, we mailed cover letters, surveys, and postage-paid return envelopes to the remaining non-respondents in mid-April, even if alumni had missing or incorrect telephone numbers identified through the telephone method. Follow-up post cards were mailed two weeks later. Through the telephone contacts, e-mails, and U.S. Postal Service mailing, 65% of those alumni contacted completed the questionnaire.

Characteristics of Senior Alumni

Nearly three-fourths of the respondents graduated from the IAC program with their first degree between 1990 and 1995. The mean graduation date is 1991, with a 3.97-year standard deviation. The distribution is similar to findings from previous studies (Martin et al.

1999) and parallels the increase in IAC participants over time. It also appears to reflect more accurate contact information. The complete range of graduation dates is 1981 through 1995.

Of our 33 respondents, 4 participated in the IAC program during their undergraduate and graduate careers at the same university. Of these four who received graduate degrees, one graduated in 1983, one in 1990, one in 1995, and one in 2000. The 2000 graduate *is* included in our analysis for energy influence over the course of his career, as he received his undergraduate degree in 1994 and did graduate work part-time while employed in a full-time career position.

Respondents represented 14 schools with IAC programs. The majority participated at Colorado State University, but Bradley, Kansas, Texas A&M, and Oregon State universities are well represented. The overwhelming majority of our respondents earned degrees in mechanical engineering (82%), while the remaining majored in industrial engineering, industrial engineering and management, electrical engineering, or architectural engineering. Most respondents received Bachelor of Science degrees (64%) as their first degree while participating in the IAC program, while 10 received Master of Science degrees, and 2 received Doctor of Philosophy degrees. Four participants in the IAC program received both bachelor and master degrees while participating in the program, as noted above.

Upon graduation, more than 80% of our senior participants have gone on to professional registrations or certifications. Most are professional engineers, while others are engineers in training and certified energy managers. Twelve of our participants hold 2 professional certifications or registrations; 2 hold 3. Likewise, the participants have joined professional organizations. Twenty-eight hold memberships in at least 1 professional organization, while 15 hold memberships in least 2 professional organizations, and 9 have membership in 3 organizations . The majority belongs to the American Society of Heating, Refrigerating and Air-Conditioning Engineers, followed by the American Society of Mechanical Engineers and Association of Energy Engineers. IAC alumni hold membership in a total of 15 professional organizations.

Finally, we asked the alumni an open-ended question: What personal skills and capabilities were enhanced as a result of your participation in the IAC program? We then grouped the results by primary subject matter. Table 1 presents those results. They represent engineering skills as well as personal skills gained. Additionally, most respondents who ended up working in the energy area credited the IAC program with helping them gain employment and the technical ability to pursue energy-efficiency.

Energy Career Results

Data Analysis Frameworks

One task in this survey was to assess what percentage of senior IAC alumni had addressed energy concerns over their careers. One measure of effectiveness of the IAC program is the transfer of energy-efficiency knowledge gained in the educational environment to workplace settings. Through the knowledge gained, former students can speed the incorporation of energy savings opportunities in industry and in other sectors of the economy. This diffusion of technological knowledge can contribute to economic development in the United States, as suggested in Martin et al. (1999). This does not eliminate the importance of other skills that are acquired through the IAC experience (e.g.,

communication skills). It simply suggests that the key component of the IAC experience is to incorporate energy-efficiency measures into an industrial setting.

Table 1. Personal Skills and Capabilities Gained Through IAC Experience

Personal Skills and Capabilities	Number of Observations
Verbal and written communication skills	18
Research and technical analysis skills	16
Understanding of various manufacturing procedures and their effects on energy use	7
Enhancement of engineering knowledge and information gained in class in an industrial setting	6
Teamwork	5
Energy consumption patterns and utility rate structures	4
Time management	4
Assessment of industrial equipment	2
Energy-efficiency opportunities	2
Modeling and computer skills	2
Self-confidence	2
Organizational skills	2
Appreciation of various energy sources (solar, nuclear, electric)	1
Budgeting	1

Particularly since we were assessing career paths, we assumed that energy-efficiency-related activities would vary over the careers of IAC alumni from no energy focus at all to an entire career of energy-efficiency activity. Moreover, for an individual alumnus, we assumed that there would be variation across a career, e.g., one person worked in the energy-efficiency field at some point during a career, but not throughout the entire career. To handle this variation in career paths, we developed a framework to categorize types of career paths. Our framework poses these four categories:

1. No job experience related to energy-efficiency. These alumni did not choose a career path that involved energy-related activities. It is assumed that their knowledge about energy-efficiency was not diffused to others. This does not imply that other skills learned through the IAC experience have not enhanced the alumni's career, e.g., technical writing or communication skills.
2. Initial job responsibilities related to energy-efficiency but have since transitioned to other responsibilities. This category consists of those IAC alumni who entered the

work force in an energy-efficiency position. These alumni were employed in settings that offered opportunities to influence energy efficiency. However, during the course of their careers, there was a shift away from energy-efficiency activity as a primary or secondary job responsibility.

3. Initial job responsibilities were not related to energy-efficiency but have since transitioned to positions involving energy-efficiency. This is the opposite of the previous category. Here the alumnus entered the work force in a non-energy-efficiency-related position, but had opportunities to diffuse knowledge about energy-efficiency through changes in job responsibilities and/or employers.
4. Entire career has involved jobs with energy-efficiency responsibilities. Here we assume that each position held by senior IAC alumni entailed energy-efficiency responsibilities.

We developed a second framework to capture the methods used for influencing energy-efficiency decisions over the years. Here we defined the methods rather broadly. The most obvious method comprises energy assessments and recommendations to clients, as the alumni were trained. However, we felt that there could be other methods that could influence energy efficiency, such as through residential or building construction, teaching undergraduate and graduate classes on energy-efficiency measures, research on energy-efficiency measures, maintenance of equipment for energy-efficiency, and calculating energy savings potential for utility clients. In the end, we devised six groupings of methods used for influencing energy-efficiency:

- Energy assessments — energy evaluations or assessments, recommendations to clients and/or companies, and implementation related to recommendations.
- Teaching and training — at an academic level through course work, consulting firm offering classes, training students on conducting assessments.
- Outreach and technology transfer — development of outreach programs on energy-efficiency, writing manuals, technology transfer of energy-savings opportunities.
- Research and financial evaluation — research on alternative energy systems, calculation of cost savings on investments in industrial energy-efficiency systems.
- Construction, operation, maintenance, or repair — for better efficiency and implementation of energy-efficiency strategies within the respondent's firm.
- Design — energy-efficiency systems for residential, commercial, or industrial buildings.

An individual in one position might be involved in more than one method. Moreover, we would expect changes in methods over a career. For example, an employee may begin providing technical assistance but then move into a training position. We would also expect people to change organizations during their careers.

We measured alumni activity in energy issues and methods of influencing decisions on energy-efficiency by analyzing their responses to: "Please describe your involvement with energy-efficiency during your tenure in position no. __ (e.g., conducted assessments, approved purchases, implemented energy-efficiency strategies, etc.)." We categorized each response into one of the six categories listed above. To confirm our interpretation of their

responses, an engineer who had been involved in energy-efficiency measures throughout his career performed an independent review. His categorizations matched ours.

Results

No job experience related to energyeEfficiency. Of the 33 respondents to our survey, 7 (21%) have not pursued any energy-related activities at all during their careers, although they were complimentary of the IAC program and its ability to assist in career opportunities.

Initial job responsibilities related to energy-efficiency but have since transitioned to other responsibilities. As displayed in Table 2, the two IAC alumni who addressed energy concerns in their first career positions provided energy assessments (leading assessments, soliciting companies for assessments, writing technical reports, approving procedures, and implementing energy strategies). The first alumnus held that position for 1 year; the second, for 5 years. Employers for these energy positions were (1) a university and (2) a small to medium industrial/manufacturing facility. The IAC experience was extremely relevant to the positions where the job responsibility was energy.

With regard to their assessments of the IAC program, one respondent indicated that the teamwork and communications skills garnered through the IAC position were helpful. He noted that these skills have been beneficial in his career beyond positions involving energy. He commented that the lead professor in the IAC program is key to its success. He indicated that his University of Dayton experience was excellent due in great measure to the professor leading the effort. Finally, he was pleased that he participated in the program, although he has not pursued energy efficiency in every position held during his career. Although not all alumni pursued careers in energy efficiency, most claimed to have acquired a great deal of practical information through the IAC program.

Initial job responsibilities were not related to energy-efficiency but have since transitioned to positions involving energy-efficiency. Five survey respondents did not initially pursue an energy-related career in their first position, rather they moved into an energy position further on in their career.(Table 2). On average, these individuals have held slightly less than three positions throughout their careers. The average length of a position has been 3.3 years. However, of those positions that involved energy-efficiency, the average length of tenure has been 4.0 years.

Employers for positions involving energy include consulting firms, universities, large industry and/or manufacturing facilities, or energy service companies. Some of the five alumni have changed employers during their careers, while others remaining with the same firm experienced changes in their job responsibilities. Two have held positions in consulting firms throughout their career, while others have ventured from university settings to consulting firms and/or large industrial facilities. The six main career path categories include: energy assessments; teaching and training; construction, operation, maintenance, or repair; and design. Within four of the six career paths, specific methods of influencing energy efficiency include:

- Working with manufacturing plants and hospitals with regard to the most efficient control system, including energy assessments.
- Conducting energy assessments.

Table 2. Summary of Energy-Efficiency Work

	Initial energy-efficiency responsibilities	Later energy-efficiency responsibilities	Entire career energy-efficiency responsibilities
No. of observations	2	5	19
Avg. no. positions held	3	2.8	3.0
Avg. length of positions in energy	3.0 years	4.0 years	9.8 years
Years since graduation: mean (min–max)	12 (7-16)	9 (8-10)	11 (7-15)
Employers	· Small, medium industrial/manufacturing · University, college, other post-secondary institution	· Consulting · Energy service company · Large industrial/ manufacturing · University, college, other post-secondary institution	· Construction and/or design · Consulting · Electric power/utility · Energy service company · Government (federal, state, or local) · Large commercial business · Large industrial/manufacturing · University, college, other post-secondary institution
Job responsibility categories	· Engineering management · Productivity/process engineering	· Business management · Consultant · Engineering management · Project engineer/project manager · Research and development · Other – product development	· Analyst · Business management · Consultant · Education/training · Engineering management · Facilities management · Project engineer/project manager · Research and development · Sales · Technician · Other – product development
Methods of influencing energy efficiency	Energy assessments	· Construction, operation, maintenance, or repair · Energy assessments · Teaching/training	· Construction, operation, maintenance, or repair · Design · Energy assessments · Outreach and technology transfer · Research and fiscal management · Teaching and training
Relevance of IAC experience to positions involving energy	Extremely Relevant	· Relevant · Extremely Relevant	· Relevant · Very relevant · Extremely relevant
Organizational hierarchy for current position	· Entry level · First-level supervisor	· First-level supervisor · Middle management · Top management	· Entry level · First-level supervisor · Middle management · Top management

- Recommending changes in energy design.
- Supervising construction of new energy systems (construction, operation, maintenance, or repair).
- Training students how to conduct assessments.
- Providing seminar training on energy-efficiency (teaching and training).
- Facility assessments, renovations, and purchasing of energy equipment (energy assessments).
- Implementing energy-efficiency packages (construction, operation, maintenance, or repair).
- Incorporating energy efficient equipment into HVAC design (construction, operation, maintenance, or repair).
- Replacing old equipment with high efficient equipment into HVAC design (construction, operation, maintenance, or repair).

Even though the initial appointment in one respondent's career did not involve energy-efficiency, the respondent indicated that the IAC training was extremely relevant to his position because it provided the ability to understand manufacturing processes and energy consumption patterns. He said his IAC experience exposed him to various rate structures in the utility industry and gave him the ability to explain rate structures to clients and the skill to understand the manufacturing process and energy consumption patterns in a plant during his first career position. He commented, as did others who participated in the survey, that the ability to leave the classroom and move into an industrial setting was beneficial. Other respondents indicated that:

- Those involved with IAC programs were upper caliber students.
- An IAC director was influential in the student's career.
- They would recommend the IAC program to other students.
- Working for the IAC was a wonderful opportunity to learn a wide variety of solutions to engineering problems regarding energy saving issues.

Entire career has involved jobs with energy-efficiency responsibilities. Some 58% of our respondents (19) have spent their entire careers devoted to energy-efficiency. The average length of position in energy since their IAC experience is 9.84 years, while on average, three positions were held (Table 2). One alumnus reported being involved with energy-efficiency activities 20 years after graduation. Based on this finding, it can be extrapolated that some IAC alumni could be involved with energy-efficiency their entire careers, until retirement, covering a span of 40 years or more.

Employers included universities, large industrial/manufacturing facilities, consulting companies, government agencies, electric utilities, research and development firms, energy service companies, large commercial businesses, and construction and design firms. Respondents' methods of influencing energy-efficiency over the course of their careers fall into the following methods: (1) energy assessments, (2) teaching/training, (3) outreach or technology transfer, (4) design, (5) construction, operation, maintenance, or repair, and (6) research and financial evaluation. Specific alumni descriptions include:

- Recommended and implemented energy efficient repairs to heating and air conditioning system (construction, operation, maintenance, or repair).
- Calibrated equipment related to energy use (construction, operation, maintenance, or repair).
- Wrote energy modeling software for DOE (outreach and technology transfer).
- Performed assessments for commercial customers (energy assessments).
- Were responsible for efficiency programs for a university with 8 million square feet of buildings (construction, operation, maintenance, or repair).
- Researched and developed energy-efficiency technologies, practices, and strategies for the purpose of technology transfer, deployment, and training (research and financial evaluation and outreach and technology transfer).
- Performed engineering review for energy-efficiency projects for utility rebates for commercial sector (research and financial evaluation).
- Performed engineering review for utility rebates for commercial sector (research and financial evaluation).
- Performed assessments (about 25 plants per year) and write reports (energy assessments).
- Taught energy-related fundamentals of air conditioning design (teaching and training).
- Designed electric power plants (design).
- Advised electric service customers regarding building design including but not limited to energy-efficiency and wise use of electrical energy in particular (design).

Data were collected for all jobs held by the 19 alumni who have spent their entire careers in positions related to energy-efficiency. They followed 11 different career paths up to this point, which are (number of people following each path are in parentheses and average years in work force are in brackets):

- Began in and have stayed in an entry-level position (2) [8].
- Began in and have stayed in a first-level supervisory position (2) [7].
- Began in entry-level position and moved to first-level supervisory position (4) [10].
- Began in entry-level position, moved to first-level supervisory position and then to middle-management position (1) [10].
- Began in entry-level position and moved to middle-management position (3) [10].
- Began in first-level supervisory position and moved to middle-management position (2) (this path includes one individual who started as an assistant professor and moved to associate professor) [10].
- Began in first-level supervisory position, moved to middle-management position, then to first-level supervisory position (1) [17].
- Began in entry-level position, moved to middle-management position, then to top-management position (1) [7].
- Began in entry-level position, moved to top-management position, then to middle-management position (with a change in employer) (1) [10].
- Began in middle-management position, moved to first-level supervisory position (with a change in employer), then moved to entry-level position (1) [9].

- Began in entry-level position, moved to middle-management position, moved to entry-level position, then moved to first-level supervisory position (1) [19].

These data indicate that 53% of these alumni are currently working at either an entry-level position or first-level supervisory position with the balance holding positions in middle and top management. Three alumni have actually moved down the organizational hierarchy. Figure 1 indicates, interestingly enough, that there is no relationship between years in the workforce and current positions in the career hierarchy. Most alumni have moved up the hierarchy but did so in about the same time as many who have not advanced quite as far. Also, the two most senior alumni in the sample have moved up and down the career ladder over the years. Literature in other fields, such as human resource management, would need to be consulted to ascertain whether the career paths indicated above are generally similar or dissimilar to career paths experienced by people in other industries.

It is also interesting to examine how methods of influencing energy efficiency have changed over alumni's careers. As expected, the first jobs of the majority of these alumni encompassed energy assessments. Only seven alumni have experienced careers in which the methods used to influence energy efficiency have not changed. These careers included: conducting energy assessments, teaching and research (academic position), operation and maintenance (primarily of HVAC equipment) or design. Five of the seven have *not* changed employers, where as two alumni who did in fact change employers maintained the same method of influencing energy decisions (conducting assessments). Most of the employers are universities (4). One senior alumnus obtained initial employment at a consulting firm, moved to an electric power/utility, then a large industrial/manufacturing firm, and finally to a consulting firm. The sixth person has been with one employer: a construction/design firm. The seventh person has worked for two consulting firms, then a university, and currently an electric power utility. Graduation dates for receipt of an initial degree while participating in the IAC program are 1985 (1), 1990 (1), 1991 (1), and 1994 (4). The remaining twelve graduated between 1990 and 1995. The various methods of influencing energy efficiency during their careers include the following:

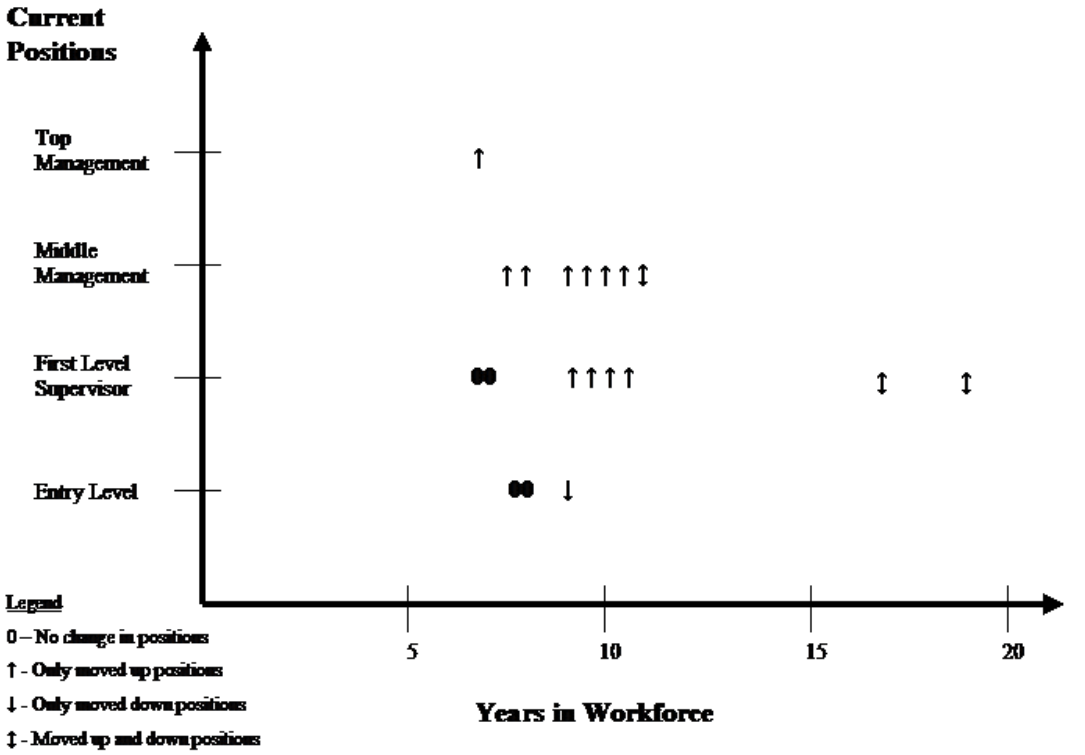
- energy assessments **to** construction, operation, maintenance, or repair.
- energy assessments **to** research and financial evaluation.
- energy assessments **to** design.

Table 3 below provides information on methods used by the four organizational levels addressed in this analysis: entry-level position, first-level supervisory, middle management, and top management. As expected, most entry-level and first-level supervisory positions held by senior IAC alumni involve energy assessments. Somewhat surprisingly, job descriptions for middle and top management include energy assessments. This is a sign that energy-efficiency activities are receiving attention at higher organizational levels. It may also indicate that there is an opportunity for the IAC program to craft a continuing education program aimed at management issues associated with conducting energy assessments.

Another interesting observation concerns changing job responsibilities as individuals move up in their organizations. Table 3 shows that research and financial evaluation responsibilities become more prominent as people move from entry-level to supervisory

positions. Research and financial evaluation could be other foci for a continuing education program aimed at IAC alumni.

Figure 1. Senior Alumni Career Paths Over Time



Conclusions

The IAC program appears to be successful in diffusing energy-efficiency knowledge to its alumni. The fact that almost 80% of the responding alumni are pursuing energy-efficiency at this point in their careers evidences this diffusion. 58% of the respondents have spent their entire careers in energy-efficiency-related work. This supports the diffusion and represents a remarkable accomplishment for the IAC program. Most respondents who have spent their careers in energy-related functions credit the IAC program with providing the experience and knowledge necessary to gain and maintain employment in energy-efficiency positions. Moreover, the fact that alumni have changed employers and have moved about within organizations has further diffused the energy-efficiency knowledge and expertise. Although in this task we did not specifically ask participants to quantify energy savings, those with energy backgrounds indicated that energy savings have indeed occurred. One can conclude that the IAC experience appears to have offered a breadth of methods for the alumni to use in influencing decisions, as observed through the numerous methods employed during the alumni's careers.

Table 3. Methods of Influencing Energy Efficiency by Positions in Organizations

Hierarchical Position	Method of Influencing Energy Efficiency (# Obs.)
Entry-level position	·Energy assessments (13) ·Outreach and technology transfer (1) ·Construction, operation, maintenance, or repair (2) ·Research and financial evaluation (4) ·Design (1)
First-level supervisor	·Research and financial evaluation (8) ·Outreach and technology transfer (3) ·Energy assessments (12) ·Teaching and training (2) ·Construction, operation, maintenance, or repair (1) ·Design (3)
Middle management	·Energy assessments (8) ·Construction, operation, maintenance, or repair (2) ·Research and financial evaluation (3) ·Teaching and training (1) ·Outreach and technology transfer (1) ·Design (3)
Top management	·Energy assessments (2) ·Teaching and training (1) ·Research and financial evaluation (1)

The IAC program could consider expanding its curriculum to include management classes and offering some form of continuing education/professional training for IAC alumni. Topics for continuing education could include: a review of new energy-efficiency technologies, techniques, and processes; management of energy assessment activities; and management of research and financial activities. Several changes in the operation of the IAC program are currently being implemented to improve the prospects for students to obtain and maintain jobs in energy efficiency. For example, efforts are underway to attract corporate recruiters to the IAC program, by working through university career offices. Another effort is outreach to the professional community to allow student IAC-based school work to contribute towards professional certifications. DOE now issues certificates of accomplishment to students who have participated in the program, to support recognition of IAC experience by state licensure boards.

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