

## **The Iowa State University Industrial Assessment Center- A Winning Combination for Students, Faculty and Industry**

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### Abstract

This paper describes the Industrial Assessment Center at Iowa State University. The center's mission is to provide a service to small and medium-sized manufacturers to help reduce energy usage, waste generation and increase plant productivity while at the same time providing an educational opportunity for engineering students. The center utilizes teams comprised of undergraduate and graduate students from a variety of engineering disciplines that are lead by engineering faculty. Teams visit 25 manufacturing facilities per year to study the plant operations, collect data and write reports which detail the findings. Since the center's beginning in 1991, nearly 100 students have participated and 239 manufacturing facilities have been studied.

### I. Introduction

Engineering education is always enhanced when students have an opportunity to be involved with engineering practice, and with the present demand for engineering graduates, there are many ways students can gain engineering experience prior to graduation. In today's economy future employers routinely seek out students for co-op programs, internships and summer employment. In addition, faculty often employ undergraduate students to work on research projects. While these experiences are all beneficial to the student's learning, they tend to focus on a single project or process within the context of the work assignment.

The Department of Energy's Industrial Assessment Center program (IAC program) provides students and faculty with a broad-based approach to engineering education while at the same time providing a service to industry. The IAC program exposes students to a wide range of manufacturing processes. The clients served by the program include small and medium-sized manufacturers in standard industrial codes (SIC) 20-39. Manufacturing processes in these areas can range from full automation to those oriented around intense manual labor. Industries served by the program are:

- food processing
- tobacco
- textile mill products
- apparel
- lumber
- furniture

- paper
- printing
- chemicals
- petroleum
- rubber
- leather
- stone, clay, glass and concrete
- primary metal manufacturing
- fabricated metal products
- machinery
- electrical products
- transportation equipment
- measuring instrumentation
- miscellaneous manufacturing

The IAC program is a no-cost service for manufacturers that qualify. A company qualifies if it meets three of the following four criteria:

- The total annual sales for the plant must not exceed \$75 million.
- The total annual energy bills (usually gas and electric) are between \$75,000 and \$1.75 million.
- The number of employees is less than 500.
- There are no “energy experts” located at the facility.

The IAC program first began in 1976 with four centers located at Georgia Tech, the University of Tennessee, the University of Pittsburgh, and Case Western University. The original name of the program was the Energy Analysis and Diagnostic Center program (EADC program) and it had two main goals: to assist manufacturers in finding ways to reduce energy consumption in their facilities and to provide student training in the area of energy conservation. Today the program exists at 30 universities across the U.S. and has expanded its scope to include the areas of productivity improvement, pollution prevention and waste minimization. There are no centers outside the U.S.; however, the Republic of Ghana and two universities in Mexico have operated similar programs following training they received through the IAC program.

Iowa State University joined the IAC program in 1991. To date our center has served over 239 industries, employed over 100 students and involved four faculty and one professional staff person. The remainder of this paper describes the IAC program at Iowa State University (ISU) and the benefits the program provides to students, faculty and Iowa’s industry. While the discussion of these benefits is based on the ISU IAC program, IACs located across the country share in the same mission, and therefore, yield similar benefits.

## II. Good For Students

Students at ISU do not receive academic credit for participating in the IAC program; they are compensated financially for their time. For undergraduate students the work is hourly-based employment while a half-time research assistantship is often used to support graduate students. Historically we have had a mix of 20% graduate students and 80% undergraduates. In a typical year we have two graduate students and around ten undergraduate students involved with the program. Most of the students are mechanical engineering majors in their junior or senior year. Any engineering major is welcome to apply for work with the center; however, we find the work to be of most interest to mechanical, chemical and industrial engineering students.

Beyond the financial aspects, the program provides a rich environment for students to develop skills that are essential in today's engineering workplace. A partial list includes:

- verbal communication
- listening
- presenting
- writing
- teamwork
- problem solving
- creative thinking
- efficiency/time management
- leadership
- responsibility/accountability

Perhaps the best way to illustrate how these skills are put into practice is to describe the process involved with a "typical" assessment.

*Marketing.* Just because the IAC program is free to the qualified client, doesn't mean it's easy to find companies willing to participate. While we have had some success in finding clients by referrals and through advertising, the majority of our clients come as a result of "telemarketing." Here is where the students have an opportunity to practice verbal communication skills. Making a "cold" call to a plant manager to explain the benefits of the program and trying to get him/her interested takes a lot of courage and skill. Not every student in the program gets involved with this activity, but any that wish to are given the opportunity.

Once a plant has agreed to accept our service, we request that a considerable amount of background information be sent to us before we make a plant visit. The information includes one year's worth of billing information for utilities (gas, electric, water, sewer) and waste disposal fees (landfill, hazardous waste). In addition any equipment lists, plant layout drawings and process flow information we can gather is requested. A pre-audit interview is also conducted between a graduate student and the plant contact. During this telephone conversation, detailed information about the plant's various manufacturing processes and process equipment is gathered. The students process all of these data so that we can have an idea of the potential savings we might find once we visit the plant.

*The Audit.* An audit team is formed prior to the plant visit. This team consists of the IAC director or assistant director, a graduate student and three to four undergraduate students. On the day of the audit, the team meets early in the morning to load the van with instruments, equipment and supplies routinely used as part of the auditing process.

Once we arrive at the plant we meet our primary contact person, set up our "base camp" (usually in a conference room), introduce the audit team and meet other key plant personnel. What follows is a round table discussion of our objectives for the day, a brief overview of plant operations and safety issues and then a tour of the plant. The focus on the tour is to follow product flow through the plant so everyone can understand the process and to identify potential areas where we can make recommendations regarding energy, waste and productivity. There are two invaluable tools we use during the tour. One is a transmitter/receiver audio system that allows everyone on the audit team to hear the tour guide no matter how loud the background noise is in the plant. The other is a clipboard for note taking. The plant tour gives both the students and faculty member an opportunity to exercise their listening and interpretive skills.

After the tour, the audit team meets for a brainstorming session. The objective of this session is to list as many ideas as we can that have potential for becoming recommendations to the client. Utilizing a white board, flip chart or even large pieces of paper, we list everyone's ideas and categorize them according to the areas of energy, waste or productivity. Once the list is generated, tasks are assigned to each team member and the work begins on gathering the data required to quantify the potential savings and implementation cost of the proposed ideas. This process forces the student to critically evaluate each potential recommendation in order to determine what information is required for a full and accurate analysis of the problem.

The type of data collected depends on the specific recommendation. We have several instruments that we bring with us for making field measurements, these include: instruments for measuring temperature, air velocity, electrical power, flue gas analysis, light levels, airborne ultrasound (used for compressed gas leak detection), and data loggers used for continuous trending of the operation of electrical equipment (such as air compressors). Some recommendations require more of a "paper chase" in order to obtain the necessary data. These data might include the amount and cost of a particular material used in the plant. Sometimes we gather data by talking with people on the production floor. Often it is the worker in a specific area who provides us with ideas that lead to improved productivity.

After a few hours of data collection, discussions with numerous people in the plant (maintenance, purchasing, supervisors, machine operators, etc.) and some time for lunch, the audit team reviews the list of ideas generated during the brainstorming session. Team members report on their findings for the ideas they were assigned. Usually the practicality of certain ideas comes into question at this time, and the list begins to shrink. Some of the ideas proposed may not be feasible or there may be insufficient information for analysis.

At the end of the day, the audit team and plant personnel conduct a wrap-up meeting. This is the time when the final list of recommendations are presented and discussed. Usually this meeting is lead by the director with students presenting the specific ideas and recommendations they worked on during the day. Often plant personnel ask the students specific questions regarding their analysis or assumptions. It is a great opportunity for students to have to defend their ideas. Following the meeting it's time to pack up and head back to campus.

*The Report.* The report is the final product delivered to the client. It consists of facility background information, a thorough utility bills analysis, and detailed explanation and cost-benefit analyses for each recommendation. As with the audit, the report writing is a team effort. Usually, a graduate student oversees the process by assigning specific parts of the report to the undergraduates. Often a student will write up the specific recommendations he or she worked on during the audit. Not only does this process involve performing the necessary engineering calculations, but also it often requires doing further research on the topic. Recommendations have to include projected cost savings as well as implementation cost estimates. Students must use multiple resources to find the answers to questions such as the type of equipment required for the recommendation as well as the equipment cost. Various product catalogues, the web, cost estimating books and company sales representatives are often consulted. In searching for

implementation costs, experience proves valuable; knowing which questions to ask makes for very efficient information gathering. Students often find there is more than one answer to their problem. They are then faced with the process of deciding which answer is the best.

Once the pieces of a report are complete, the graduate student assembles the report. Student work is reviewed for accuracy and feedback is provided to assist the students in learning from their mistakes. A faculty member makes final review and approval of the report before the report is copied and mailed to the client. Follow up phone calls are then made to ensure that the client has received the report as well as to answer any questions they might have.

### III. Good for Faculty

The IAC program offers a learning environment for faculty as well as students. Every facility visited offers something new to see and understand. This experience allows the faculty member to broaden his or her own knowledge and to bring some of that knowledge back into the classroom. It also provides a base that is drawn upon when teaching students how to perform an industrial assessment.

Often ideas for design projects or independent study projects come from something the faculty member has seen while on an assessment audit. In some cases faculty can obtain special project funding from DOE to investigate topics of interest to the overall IAC program objectives. Program funding also provides opportunities to purchase equipment used for field data collection.

Once a year directors and assistant directors from IACs across the U.S. gather for the annual IAC Directors' meeting. This three-day meeting provides a time for round table discussion on issues related to the program. In addition seminars are presented that provide new information related to advances in manufacturing technology as well as new programs from DOE and EPA that offer assistance to manufacturers.

### IV. Good for Industry

The majority of plant personnel we've worked with are extremely proud of their facilities, and they work very hard at their jobs. Many times plant personnel are caught up in the day-to-day operations of the plant and they tend to either overlook opportunities for improvement or they don't have the time or resources to address them. The IAC team is five or six pairs of "fresh eyes" that see the facility in an unbiased way, and the team can provide assistance in addressing these opportunities.

On average, clients served by the IAC program implement a little more than 50% of the recommendations presented in the reports. For the 25 facilities the ISU IAC visited in 1998, implemented recommendations amounted to about \$100,000/yr in cost savings per plant. Sometimes recommendations are not implemented but the idea presented by the recommendation causes plant management to re-think the way they are performing a particular operation. We have seen many cases where this reevaluation results in changes that lead to

overall process improvement. Feedback from plant personnel is always positive with regards to the program and its benefits.

The specific recommendations made to a client depend on the process and equipment present in the plant. A complete list of all the recommendations that can be made is beyond the scope of this paper, but a few of the more commonly found recommendations are presented below.

#### *Energy Recommendations*

- High efficiency lighting retrofits
- Compressed air systems modifications
- Improved boiler efficiency measures
- Premium efficiency motors
- HVAC system modifications

#### *Waste Recommendations*

- Baling and selling cardboard
- Recycling various plastic and metal wastes
- Solvent waste recovery
- High efficient painting systems
- Non-hazardous cleaning solvents
- Closed-loop cooling water systems

#### *Productivity Recommendations*

- Direct purchase of natural gas
- Tax credits on energy bills
- Automation / labor reduction
- Bar coding for inventory control
- Bottle neck mitigation
- Scrap rate reduction
- Bulk purchase of raw materials

## V. Conclusions

For over 20 years the Department of Energy's Industrial Assessment Center Program has provided opportunities to enhance engineering education while at the same time providing a service to U.S. manufacturers. It would be impossible to determine the total impact this program has had on the education process for students involved with the program due to the diversity of career paths students have taken upon graduation as well as the total number of students (1000+) who have participated in the program nation wide. However, from the feedback we receive from some of our own students, the IAC program provided them with career opportunities they feel they would not have otherwise had. Overall, the IAC proves to be a winning combination for students, faculty and industry.

For further information regarding the IAC program, visit the Department of Energy's Office of Industrial Technology web site at <http://www.oit.doe.gov/iac/>.

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