Real Learning with America's Tax Dollars

Kristoffer S. Findley and Mary C. Emplaincourt
Mississippi State University

Abstract

The Industrial Assessment Center (IAC) at Mississippi State University (MSU) is currently one of 26 Department of Energy (DOE) funded centers providing no-cost energy assessments to small- and medium-sized manufacturers. The work performed by the MSU IAC is done through the efforts of undergraduate and graduate mechanical engineering students throughout the state of Mississippi and surrounding areas. While the students are providing opportunities for savings in industry, they are also gaining valuable knowledge and experience. The benefits, academic and professional, available to students participating in the Industrial Assessment Center program at Mississippi State University are discussed.

Background

The centers are managed for DOE by a field organization located at Rutgers University. The organizational structure is different for each center, but the client eligibility and the assessment process are common to all the centers. A facility (client) categorized in the Standard Industrial Classification Codes 20-39 (Manufacturing) qualifies for an assessment. The facility must have gross sales below $100 million, fewer than 500 employees, annual utility bills more than $100,000 and less than $2 million, and have no in-house professional staff to perform an assessment. The assessment process begins by requesting from the facility their most recent utility billings (January – December). Then a site visit to perform the assessment is scheduled and made. The assessment report for each site visit must be completed and mailed to the facility and to the field management office within 60 days of the visit in the facility. Within six months of the assessment, the IAC contacts the management of the facility to determine which of the recommended measures have been implemented.

The Industrial Assessment Center at Mississippi State University began operations in 1994. The organizational structure of the MSU IAC consists of a mechanical engineering faculty member who serves as the director, mechanical engineering faculty members who serve as assistant directors, and a staff engineer, who is employed full time by the MSU IAC while taking graduate courses toward a master's degree (up to two courses per semester) in mechanical engineering. The MSU IAC employees five to seven undergraduate students at a time. Over 40 undergraduate and graduate students have worked for the MSU IAC over a nine-year period. When a client has agreed to have an assessment conducted, the MSU IAC assigns one student, known as the lead student, with the sole responsibility of directing the site visit, and completing and distributing the report. To date, the IAC has performed 224 site visits throughout Mississippi, Alabama, Tennessee, and Arkansas. The MSU IAC has identified potential savings since 1994 that can be categorized into three areas: $7.2 million of energy saving recommendations , $3.1 million in waste minimization suggestions , and $8.8 million in productivity improvement ideas.

Most of the students hired are undergraduate mechanical engineering majors typically in their junior year of study. By the junior year, students have completed all the engineering science courses; they have learned a math tool software package (MathCAD, for example) for solving engineering problems; and they have taken courses in thermodynamics, heat transfer, business finance, electrical engineering, and technical writing. Qualifications sought when interviewing students to work for the MSU IAC are at least three semesters remaining in school and at least a 3.00 grade point average. Attributes desired in students hired are dependability and good time management skills. The MSU IAC has concluded that junior-year students with at least a B average in their studies are prepared to learn the technical skills required to provide a quality assessment to the client.

Technical Skills

Analyzing Utility Bills - The first step taken by the lead student before the assessment visit is to obtain, analyze, and graph a year's worth of the facility's utility bills. The graphs of the utility bills will show seasonal trends revealing irregularities that can be analyzed and possibly corrected. Students are taught to decipher utility bills and rate schedules that at times can be complex. Once the lead student understands the facility's rate schedule then a billing history can be developed. Any discrepancies observed in the bills (billing history) can be brought to the client's attention. Fees or charges that the facility could easily avoid in the future are pointed out to the client.

Collecting and Analyzing Data –During site visits, students spend a great deal of time collecting a variety of data. The MSU IAC staff engineer trains the students to use instruments to acquire data for developing recommendations. Students learn to measure a wide range of variables, including temperature, air velocity, combustion efficiency, power factor, lighting levels, and fluid velocity through a pipe. Once on site, the students have the instruments at their disposal for data collection. As the students become more experienced, they become more familiar with which instruments are used to collect data for certain recommendations and equipment operating parameters. A sampling of instruments the students use to collect specific data is listed in Table 1.

Auditing Energy Practices – The main objective of a site visit is to collect information about the facility's process and process-related equipment. Based on the equipment counts from the site visit and the billing histories provided by the utility companies, students learn to calculate the energy consumed by the equipment. These calculations are referred to as end-point energy estimates. The students' end-point energy estimates are based on equipment operating parameters and equipment counts and inputs. The students are taught which pieces of equipment are important to the energy assessment. They are shown the correct and safe way to count equipment, as well as how to locate nameplate data found on the equipment. The students either speak with facility personnel or take readings to gain an understanding about the operating parameters of each piece of equipment. The students learn to compare their end-point energy estimates with the utility billing history to determine errors or problems.

Table 1. Instruments Used by the MSU IAC to Collect Data

Instrument	Purpose	Variables Measured
Thermocouple	To determine if cooler outside air rather than warmer outside air ducted into an air compressor will reduce energy required to operate an air compressor	Inside and outside air temperatures
Anemometer	To determine the amount of heat rejected by an air compressor that could be ducted back into the facility to be used for supplemental heating thereby reducing the energy required for primary heating	Air velocity and temperature in an air compressor heat exchanger
Infrared thermometer	To calculate convective and radiant heat losses from the surfaces of tanks in order to recommend insulating the surfaces of tanks generating energy savings by reducing heat loss	Surface temperatures
Sonic leak detector	To determine the amount of energy lost by leaks found in the compressed air system thereby showing energy savings in the operation of air compressors	Locates compressed air leaks and helps to determine the size of the leaks
Light meter	To determine if reduced lighting can be recommended thereby saving energy used for lighting	Lighting intensity
Combustion analyzer	To determine energy savings if the air fuel ratio needs adjustment to increase combustion efficiency and if hot flue gases can be used to heat the cooler combustion air	Analyzes the gas content, the combustion efficiency, and flue gas temperature of natural gas equipment

Mastering Computer Software Skills – Most of the work performed by the students at the MSU IAC is done on personal computers. The IAC utilizes a wide range of computer programs to create the technical documents and to perform calculations that go into each assessment report. The Microsoft Suite of software programs is the most commonly used. Microsoft Word is the word processing program used to create the assessment report document. Students become familiar with the many commands and nuances of Word. They learn to format the document, add and manipulate tables, insert charts and graphs, create headings for the different sections of the report, and insert and format other documents into the report document.

Microsoft Excel is another important tool for the IAC students. Excel is the spreadsheet program used for performing the utility bill analysis and calculating the end-point energy estimates. In Excel, students become familiar with the different calculating functions and the spreadsheet arrangement. Many of the charts and graphs presented in the assessment report document are created in Excel.

Students use Microsoft Visio to create the process flow chart presented in the introductory section of the report. Visio is a flow chart program that allows the students to create professional flow charts that present the manufacturing process, step by step.

There are also some non-Microsoft products that aid the students in the office. AutoCAD 2000 is a technical drawing program used by the students. AutoCAD allows them to create the facility layout drawings presented in the introductory section and drawings that are specific to certain recommendations.

Also extensively used is MathCAD 2001, a mathematical analysis program. Students use MathCAD in combination with knowledge learned in engineering courses to create user-friendly worksheets to perform complex mathematical calculations for assessment recommendations. The MSU IAC also utilizes a building simulation program called ACCA-N. Students use ACCA-N to simulate cooling loads required by buildings and other conditioned areas. From the simulation, the students calculate the usage factor of the space conditioning units based on bin weather data.

Experiencing Manufacturing – While working at the IAC, students are exposed to a wide range of manufactured products and manufacturing processes, such as food products from food processing equipment, plastic parts from various molding processes, metal castings from casting operations, electronic component manufacturing and assembly, furniture made from wood assemblies and upholstery operations, paper products from pulp and paper operations, medical products from medical/pharmaceutical production, and products from the defense contract industry . Touring these different types of manufacturing facilities allows the students to observe the industrial work environments and responsibilities of engineers and to make informed career decisions upon graduation.

Extending the Classroom – The IAC presents a situation in which students are able to apply the theories and concepts learned in the classroom to real-life engineering problems. Students use the data obtained from the site visits and draw from a wide range of academic courses to calculate costs and energy, waste, and productivity savings for the assessment recommendations. The financial ramifications are calculated using either a simple payback period, or a more involved method such as rate of return analysis. Topics most commonly referenced include thermal/fluid sciences, material and manufacturing

sciences, electrical systems, engineering economy, and technical writing. Working for the IAC allows students to use the materials learned in their engineering classes and to become more well rounded engineers better prepared for opportunities in the working world.

Communication Skills

The IAC presents an opportunity for students to practice their communication skills, written and oral. Students spend time on the telephone and time writing electronic mail to contacts of interest. During the process of conducting a site visit and subsequent assessment report writing, students must interact with numerous facility personnel, which include laborers, supervisors, engineers, managers, and owners, in order to obtain relevant data required for the calculations and information presented in the assessment report. The students also converse with people other than facility personnel. During the pre-assessment phase of the site visit, students must work with utility company employees in order to obtain utility billing histories and utility rate schedules. During the report-writing phase, students contact vendors to obtain prices for equipment and industrial products to use in the assessment recommendations.

At times, the lead student may be asked to make a return visit to a company and present the findings in the assessment report. The student then prepares a PowerPoint presentation containing the savings and implementation costs for each of the assessment recommendations contained in the report. This meeting gives the facility personnel involved with the assessment the opportunity to interact with the lead student. Many times these meetings include personnel from management, engineering, and maintenance.

Writing an IAC assessment report offers the students the opportunity to apply the knowledge they learn in their junior year technical writing course, but also they become acquainted with the technical style expected from the Department of Energy. Once a student submits an assessment report for review, the report goes through a rigorous review process. The Director, Associate Director, and Staff Engineer meticulously examine each report for correctness and presentation. As the students progress through the program, they become more attuned to the vocabulary and formats that make up each assessment report. They are made aware of the audiences to which they are writing. Not only do the facility personnel read the assessment reports, but also the field office reviews and edits the reports for the Department of Energy.

Time Management Skills

Organizing Work Activities at the IAC – Students working at the IAC are required to work between ten and twenty hours per week. The staff engineer works with the students to create a work schedule tailored around their class schedules. The students are expected to be present in the office two to three hours each day working on assessment reports or preparing for upcoming site visits.

The MSU IAC schedule dictates that two site visits be performed each month to reach the mandatory 25 site visits per contract year. The majority of visits last one day, but occasionally the physical assessment can last two or more days. Usually, two-day visits required an overnight stay. The students are informed upon employment that they will be required to miss up to two days of classes per month making IAC site visits. The

students are also responsible for informing their instructors-of-record of their school-related absences and for obtaining any course materials and assignments missed during these absences.

The lead student has two months to complete the research, to write, to edit and to mail the final assessment report to the facility and to the field managers for the Department of Energy. Therefore, the students must efficiently use their 10 to 20 hours per week of office time to achieve completion of assessment reports during the allotted time period. One of the performance measures in the contract is the number of late reports generated annually by an IAC. So promptness to complete the reports on time is continually stressed to the students.

Managing Academics and Other Activities - The students who work for the IAC must learn to manage studies and other activities besides their IAC obligations. These students take part in other campus organizations such as religious groups, Greek organizations, intramural sports, and professional and honorary societies. The IAC does not want the work at the IAC to interfere with academics. Students hired by the MSU IAC with a minimum grade point average of 3.00 typically can manage school, work, and other activities effectively. Another time consuming activity the students participate in is the job interviewing process. Most of the students working at the IAC are in their junior and senior years. The students must schedule interviews and plant visits into their already full schedules.

An Added Benefit

During the last semester of school while working for the MSU IAC, students are eligible to register for a Directed Individual Study (DIS) course under the supervision of the IAC director, who is a faculty member. The DIS course can replace one of the two technical electives required in the mechanical engineering undergraduate program. The student is the lead person responsible for a visit and report. The grade in the directed study course is based on the student's performance as the lead person at the site visit, the quality of the assessment report, and the ability to finish the report on time.

Conclusion

This paper presents the broad range of benefits to mechanical engineering undergraduate students working for the Department of Energy funded Industrial Assessment Center at Mississippi State University. The students obtain a comprehensive overview in formal report writing, data collection and analysis, and energy audit practices. IAC students, while working in an office setting, are required to meet deadlines, master computer software packages, learn to plan and organize efficiently, and to clearly communicate technical information. Through IAC involvement, students become familiar with numerous manufacturing processes and are given the opportunity to interact with industrial facility personnel. Working for the MSU IAC helps students, during the energy auditing process and subsequent report writing phase, to reinforce academic subjects such as thermodynamics, heat transfer, fluid mechanics, electrical engineering systems, experimental instrumentation, material sciences, manufacturing processes, business finance, and technical writing.