SELECTION AND IMPLEMENTATION OF SIMULATION AND MODELING WITHIN INDUSTRIAL ENVIRONMENTS FOR ENERGY, WASTE AND PRODUCTION IMPROVEMENTS

Howard W. Penrose, Robert Miller, Geoff Al-Chaar, Gail Gueco, Ed Soto, and Aaron Horton
University of Illinois at Chicago Energy Resources Center

Abstract: Through proper application of simulation and modeling within industrial environments, greater impact for energy, waste and production improvements can occur. Modern simulation and modeling systems can help determine impacts of energy and waste reduction concepts on production and vice-versa. Through a 1999 Illinois Department of Commerce and Community Affairs funded project, improvements of over 40% in production, 6% in reduced waste, 3% in employee effectiveness, and a 6% reduction in energy costs were realized through proper use of simulation and modeling in an industrial environment.

Key words: Simulation, modeling, energy, software, waste stream, and production.

I. INTRODUCTION

In January, 1999, a project was initiated by the Illinois Department of Commerce and Community Affairs to review the impact of energy and waste in certain industrial environments. Upon implementation of the project several small manufacturers (less than 50 employees), as well as several large manufacturers (greater than 200 employees) were visited by the industrial improvement team. It was quickly realized that the smaller manufacturers required assistance in process improvements and the larger manufacturers required a reduction in risk for implementing energy and waste stream recommendations.

The industrial improvement team, a group of five industrial engineering students, determined that the best approach may be the implementation of simulation software. In this, process improvements could be tested and proven for small manufacturers and the impact on the production system for energy and waste stream improvements could be investigated, before any changes were made, for larger manufacturers.

A larger group was formed and called the Industrial Engineering Team (IET). Within this group were several professors of industrial engineering, graduate students, and the energy resources team. The purpose of the IET was to select a simulation and modeling software that could be used for multiple projects and to select the criteria for the selection of the best cost product. Following the selection, the software was to be implemented as part of the IL DCCA funded project.

II. DISCUSSION

The first step was to understand that the simulation software was to be used as a tool that would assist in analyzing industrial survey data. Once data was collected, it was to be used to indicate the relative strengths and weaknesses of the study's initial recommendations, as well as assist in the identification of problems and other opportunities that would otherwise be missed. The objective, at this point, was to determine the criteria necessary to select the appropriate simulation and modeling software.

The IET team deliberated and came up with several criteria for the software selection process:

- Accuracy - The simulation and modeling results had to be accurate in a number of different environments. The team concluded that these environments were to include: retail, job shop, and manufacturing process'.
- Intuitiveness - The selected software had to be easily understood by the users. It was to be assumed that some simulation and modeling background would be required.
- Graphics - During a heated discussion, it was accepted that the purpose was not just to use the data output of the software for analysis, but that the output would have to be understood by the client who, most likely, would not have an industrial engineering background. The graphics of the software would have to be such that the client would be able to see the recommendations in action. In this way, there would be a greater chance of "buy in" and implementation of the recommendations. So, it was determined that animation would be prefered with accurate representations of machinery.
- Market-Share - It was important that the software carried a significant market share in the simulation and modeling arena. The main reason was to ensure that references would be available and that the company would not dissappear shortly after the purchase of the software.
- Support - Product support, especially for software, was of paramount importance. If the IET was to run into trouble, either with the software or had simulation questions, would the company be able to assist. This also had a secondary purpose, it was the feeling of the IET that the software designers would have to understand the types of environments that they expected their software to operate in. The

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general belief was that if you don't understand the environment and interactions, how can you design the software.

- Best Cost - It was understood that the software that would be selected was more than likely not going to be the cheapest on the market. This was an important distinction, as the objective of the overall study was to show that initial cost is not what industrial firms should be putting first, but quality, overall return on investment, and improved competitiveness are.

Once the criteria was determined, over 55 companies were identified to be approached through an internet and magazine article search. In this approach, demo versions were requested so that they could be evaluated. Ten companies remained after most companies refused to supply working demos. Through general concensus, IET determined that those companies would provide limited support after the purchase of the software. Additional companies were pared out by reviewing response times, one company even sent the initial information 5 months after the initial request. While most of the IET were strong believers in the power of the internet, the companies that supplied only internet support and communications were eliminated. It was accepted that sometimes a discussion with a human being would be necessary to resolve issues.

Following six weeks of initial review, the remaining three simulation and modeling software packages were ready to be tested and evaluated. One of the three packages was a software that the university was using to teach industrial engineering simulation. A known model from that class was to be used in the test simulations. The model was extremely complicated and required the estimation of use of materials at a health club. The software would be required to determine manning of equipment and capacity based upon random requirements of potential users and customers.

The university's software package was not acceptable for the project as it lacked the graphical and intuitive requirements. The remaining two packages consisted of a local company's software and a nationally renowned software. The local software was available at $1,400 per license while the national software was available at $14,000 per license. Both met most of the criteria we were looking for except that the local software did not maintain a large market share. Upon negotiation, it was determined that the nationally renowned software had an educational cost, and, as the projects to be pursued were educational in nature, 20 licenses, all manuals, and special information and models were made available for $2,100.

As a result, the nationally renowned software was purchased. In the next step, a small combined retail and production facility had to be selected to perform the project. The resulting survey and results were offered to be funded by IL DCCA at no cost to the company as an incentive to take part in the research. Shared cost funding for implementation of the results was also discussed, depending on the results.

The faculty advisor was to perform the selection of the site based upon potential improvement in energy, waste stream, and production. A company was found and initial estimates suggested that with relatively minor changes over 30% process, 10% waste, and 10% energy could be achieved. The IET began first with a site visit and tour, then the team was split into three groups:

- IET - Field process and simulation development including inventory.
- Energy / Waste Stream - Review cost effective energy and waste stream improvements.
- Maintenance and Reliability - Review the implementation of maintenance and reliability programs on site.

The IET group was to develop a model of the existing system and test it against the real results. They were to then make modifications based upon a field study of the processes and recommendations from the other two groups.

Based upon standard energy and waste stream recommendations, including variable frequency drives; process heat recovery; insulated windows, doors, and process equipment; lighting improvements; and other changes, there appeared to be a large energy improvement opportunity. However, once simulated, several suggestions were found to create negative impacts on the level of production. As a result, those recommendations were discarded but would have otherwise been implemented based on standard practice.

The maintenance and reliability group made recommendations on insulated steam piping, steam traps, lubrication, and other equipment upkeep. These were found to have a positive impact on availability of equipment. In one case, a bottleneck was found at a product cutter that had a tendency of breaking down and repaired on a reactive basis. The end result was a 30 minute bottleneck occuring each operating day. Another maintenance and reliability issue had to do with a broken oven that reduced it capacity by 20%. Through simulation, the actual impacts on production by these issues were measured.

The IET group started by performing time studies on all major processes within the plant. Process maps were developed and drawings rendered of various equipment and the floor plan. The company being reviewed handled a large number of processes, including retail sales, so the IET first had to determine the scope of the simulation and the impact on production by retail sales.

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It was determined that the impact by retail on production was insignificant, but that a separate simulation study was justified based upon manpower and queing problems with the retail business.

Upon the initial simulation study, the following opportunities were found:

- Production schedules were not based upon demand. Demand for the company's product was such that the morning supervisor would inspect the storage area and determine the days schedule based upon storage levels of product and what supplies were available.
- Material levels were not tracked. Materials would be ordered once it was discovered that there was not enough, or when they ran out.
- Work stations were not set up in an ergonomic manner and tools were located in inconvenient locations.
- There was no set work flow. Production was extremely disorganized. There was no clear leadership amongst the 33 employees.
- Equipment was maintained on a reactive basis. If employees could work around a break-down, they would. This resulted in equipment not operating at full capacity and repairs not occuring for weeks, and in a few cases, months at a time. In one case, critical equipment was literally held together with duct tape.

It was determined on optimization simulation studies, that with an $800 investment and a day's downtime, the impact would be significant. The initial recommendations were as follow:

- Based upon simulation recommendations, and basic industrial engineering principles, a new floor plan was developed to allow for a smoother and more natural work flow.
- A production scheduling system was developed that could be easily implemented and changed based upon customer demand. This had a secondary result of determining what inventory levels were required for customer demand. This left more room for high demand product storage.
- Raw material inventory minimum and maximum levels were set.
- Area supervisors were identified to assign responsibility for major processes.
- Preventive and corrective maintenance programs were developed.
- Work stations were re-organized ergonomically and with the tools necessary for all work performed at each station.
- Effective energy and waste stream measures could be implemented with reduced risk. In addition, many of the resulting recommendations effectively improved production while improving energy and waste.

The project resulted in three separate scenarios. Each scenario was an implementation step for the IET recommendations. This was determined to be very important, as the recommendation results were found to be extremely dramatic and the team was concerned about alienating the client.

Each of the three scenarios led up to an overall improvement of 41% production; 66% waste stream; while reducing energy costs over 6%. The scenarios were presented as follows:

- Equipment repairs and maintenance to be implemented over four to six weeks.
- Disposal of unused equipment, freeing up storage and work areas; redistribution of work stations and equipment; Ergonomic work station layouts; and, production scheduling with raw material max/min requirements. To be implemented over three months.
- Design, layout, and development of a new production site to handle additional capacity. To be implemented over six months.

The simple payback for the implementation of these plans was under three years from inception.

It was determined by the IET that the main reason for the dramatic impacts on production, waste, and efficiency was the fact that a group of industrial, energy, and waste specialists using simulation software recognized the overall opportunities. Should the individual opportunities found for energy, waste stream, or energy, have been identified and recommended, the impact of the study would not have been as dramatic.

Following the conclusion of the first study, additional studies in a variety of industrial sites of a variety of sizes have been initiated. In each case dramatic optimization opportunities have been realized.

II. CONCLUSIONS

Through this study, the impact of the use of simulation software to measure the impacts and opportunities for optimized energy, waste stream, production, and reliability can be realized. The necessary steps to implementing such a program will require an investment in time and energy. However, the results will far outweigh the initial investment.

The basic steps to implement a project for energy, waste stream, production, and reliability utilizing simulation software as a tool are as follows:

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- Select a team to include production, maintenance, and energy managers, as appropriate.

- Select a simulation software that meets your agreed to requirements.

- Model the existing production systems including support equipment. Apply the necessary simulation rules to end with an accurate simulation of your existing system.

- Perform an energy and waste stream analysis on your plant. Both this step and the previous step may also be performed by outside consultants familiar with a cross section of industries so that opportunities not known by company employees can be identified.

- Implement the recommendations into the simulation package. The pro's and con's in addition to the standard energy, waste stream, production and reliability paybacks, will become readily apparent.

- Develop an implementation plan for the findings.

- Determine if additional studies are warranted as part of a continuous improvement program.

The results of this type of study will improve profitability, effectiveness, and competitiveness

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