Achieving a long-term business impact

Improving the energy effectiveness and reliability of electric motors.

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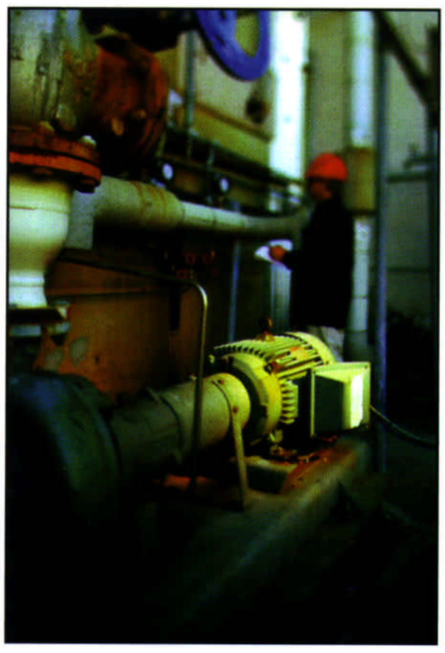
Over 100,000 motors drive production equipment throughout the DuPont Company. The efficiency and reliability of these motors have a decided impact on DuPont's manufacturing costs and production capability.

The DuPont Corporate Motor Technology Team began a program to optimize the cost-effectiveness and reliability of new motors and developed criteria to determine whether to repair or replace failed motors. DuPont's existing motor specification, procurement, maintenance, repair, and replacement practices were improved in the last few years and are now consistent throughout the United States.

One study showed savings greater than $500,000. This was the result of installing more than 2,000 energy efficient NEMA frame motors the prior year. DuPont expects these savings to accrue as well as the savings from lower maintenance cost and reduced downtime.



Every motor is part of the solution.

The challenge

DuPont surveyed 21 plants in 1990 to determine the root cause of a large number of electric motor failures. Survey data highlighted a broad range of mean-time-between-failure of NEMA frame motors. The reported life of repaired motors ranged between nine months and seven years!

In some plants frequency of repair became routine and quality of work by the outside contractors was unaudited. Repair quality and costs varied greatly. **Also, bearing contamination and inadequate lubrication, often the consequence of reduced manpower, caused 60 to 70 percent of motor failures.** Clearly, improved motor management was needed.

Further, many project functions among them, motor specification were shifted to contractors. The diversity of specifications and procurement practices increased the incidence of misapplication, start-up delays, and production losses. The focus on the minimum investment gave inadequate attention to life-cycle cost.

These trends led to the formation of the Corporate Motor Technology Team—Motor Team—in 1992. DuPont believed improved motor designs could prevent such failures and would be justified by increasing equipment up-time. Team members included representatives of USA regions, corporate electrical and mechanical technologists, procurement managers, and vendors.

The effort

The Motor Team focused its effort on DuPont's businesses gaining a competitive advantage by consistently applying the most cost-effective motor technology that **ensures optimum life-cycle cost of the equipment**. The Team identified opportunities, prioritized them according to their business contribution, and went to work on them creating several *products*.

Energy consumption—Members addressed improved energy consumption in keeping with Corporate energy policy. They created guidelines for investment decisions when purchasing electric motors. The guidelines compare motor efficiencies and allow users to make the best economic choice using an internal rate of return for energy savings.

Sole source supplier—Another product established an alliance with a single motor manufacturer. The Motor Team conducted a corporate-wide motor supplier convergence effort for induction motors from 1/2 to 3000 hp. The transition to a single supplier for premium efficiency products was immediate. However, there was a transition in the DuPont motor specifications as improvements, codified by the **new IEEE 841 standard, were incorporated in motors supplied to DuPont. Also, they adopted non-contact labyrinth bearing seals as standard to eliminate contamination and the consequential motor failure.**

Motor repairs—the Motor Team reviewed motor repairs and adopted a Corporate standard engineering specification for induction motor repairs. They recognized the impact of quality repairs on motor energy-efficiency. Many plants audited the repair procedures of their local motor repair shops and changed their practices or switched vendors.

Specifications—The Team worked with the vendor motor group to develop an easy-to-use and comprehensive specification data sheet to help designers and engineers make cost-effective decisions regarding motors.

These specifications for NEMA and above NEMA motors ensure that users select minimum adequate motor features using a *zero-based* concept. Also, specifications identify and recommend design features with individual pricing. They also list optional features and pricing with guidance on when it is cost-effective to specify the option.

Energy efficiency—Energy-efficiency plays a key role in many of these decisions. The Team conceived a motor management program that includes a survey of plant motors for efficiency improvements and establishes a database of plant motors. The database holds records of failure rates and causes, mean-time-between-failures, and service and repair history.

Training—The Team emphasized training to renew the knowledge depth in motor technology throughout the corporation. As part of this training, the vendor provides two programs for technical staff. The program emphasizes energy-efficiency and the basis for optimum decisions.

The approach

The Motor Team networked key people in manufacturing, engineering, managerial, financial, and procurement roles at sites and technical centers. Networking identified issues, prioritized them according to business benefits, and created subteams to develop expertise in the products.

Linking experience with specific technical knowledge and a common focus on well-defined business needs led to quick and effective actions. Vendor participation was invaluable in contributing the motor group's perspective on costs of diverse features and potential alternatives.

One member of the Motor Team was an electrical technologist and also a member of the IEEE working group rp841. Another participated in the development of the American Petroleum Institute Standard 541 for large ac motors. Their participation in these activities allowed them to bring valuable external insights to the activities of the Motor Team. **The Motor Team was able to improve the energy consumption within six months of its creation by implementing the revised IEEE 841 based standard motor and its premium efficiency designs on new motor purchases.**

Since it takes time to create and incorporate new ideas, many other accomplishments have taken between 12 and 18 months to become operational. The Team began working on items with the greatest value. It continues to create and introduce additional products and does not feel it has exhausted its potential for improvement.

The significance

The shift in focus from lowest first cost—price—to an understanding of the benefits of lowest life-cycle cost was the most significant aspect of these accomplishments.

Before business leaders subscribed to this concept, they need to understand the financial implications. Communications and understanding address and alter many strongly held beliefs in managerial as well as engineering and operating environments.

The guidelines for purchasing premium efficiency motors have since been computerized and extended. Now, they cover motor repair versus replace decisions, electric power transformers, electrical conductors, motor-driven ANSI pumps, and centrifugal compressors.

The software provides step-by-step instructions that lead to analysis and clear decisions based on energy savings. The broad application of the repair versus replace analysis led to a general rule for DuPont: if a motor's repair cost exceeds 70 percent of the replacement cost, the economics favor replacing it with a more efficient unit. The use of the software, the guidelines, the vendor alliance, and the improved specifications is growing constantly and is now routine in many sites and organizations.

Results

The 1995 results of the team's effort was an average energy reduction of 5.7 percent by more than 2,000 NEMA frame motors replaced or installed in new facilities in 1994. The benefits of this effort are summarized as:

- **reduced failure frequency and more cost-effective repairs that have a direct impact on production capability and cost.**
- increased investment effectiveness due to better capital and life-cost guidelines and vendor alliances.
- avoidance of misapplication and errors through a corporate-wide understanding of motor technology and energy-effi ciency considerations.

Together, these benefits conservatively have saved an estimated $5 million in 1995. The 5.7 percent increase in energy-efficiency obtained by using more than 2,000 energy-efficient motors installed in the prior year translates into savings of more than 16 million kWh.

The investment for this higher efficiency yielded a calculated internal rate of return of more than 100 percent. Further, increased savings continue to accrue and more energy-efficiency motors permeate DuPont's manufacturing facilities.

As a result of conscious efforts to become more energy-efficient, DuPont and its partner joined efforts with the U.S. Department of Energy to promote energy-efficient manufacturing strategies. The Department of Energy invited DuPont to become a "charter" excellence partner in its Motor Challenge Program and help lead the U.S. industry toward significant reduction in energy consumption through effective motor management practices. Sharing of metrics and technology with other industries signals the business value and cost advantage of efficient energy use.

Conclusion

The benefits of each motor will be hard to measure but reflect in the general trend of continuously lowering the consumed energy per unit of production. Trends are consistent since 1991 in all business units and visible in corporate and site metrics. Lowering energy demand in DuPont plants required expanded thinking and reviewing the way they do business. The motor team continues to be a factor in DuPont's effort to conserve energy and increase process availability.