ENERGY EFFICIENT MOTOR AND DRIVE SYSTEMS: YOUR PATH TO PROFIT

A MOTOR CHALLENGE VIDEOCONFERENCE PROVIDED A FORUM FOR QUESTIONERS TO TAKE ADVANTAGE OF A U.S. DEPARTMENT OF ENERGY SPONSORED PROGRAM CONCERNING ENERGY EFFICIENCY AND RENEWABLE ENERGY IN INDUSTRIAL TECHNOLOGIES.

EDITORS NOTE: On May 19, 1998, the U.S. Department of Energy's Motor Challenge program broadcast a live, interactive satellite videoconference to over 5,000 people located at 250 sites in the U. S., Canada, Mexico, Puerto Rico and the Virgin Islands. Entitled "Efficient Motor Systems II: Your Path to Profits", the broadcast provided viewers with tips and techniques on improving motor systems efficiency, process control, productivity and profitability. Several "question and answer" sessions scattered throughout the broadcast allowed the audience to ask questions of a panel of 5 motor system experts and hear their replies on the air.

The panelists consisted of: Jerry Aue, Energy Manager for Consolidated Papers, Inc., Wisconsin Rapids, WI; Tom Bishop, Vice President of Engineering at Longo Industries, Wharton, NJ, representing the Electrical Apparatus Service Association headquartered in St. Louis, MO; Roger Lawrence from Jacobs Engineering Group representing Electric Power Research Institute (EPRI) adjustable speed drive (ASD) demonstration office in Cary, NC; Mike Muller, Eastern Regional Manager of U.S. Department of Energy Industrial Assessment Center and Professor of Mechanical Engineering at Rutgers in New Jersey; and Ziba Kellum, Senior Motor Systems Engineer with Advanced Energy of Raleigh, North Carolina.

TAPPI JOURNAL would like to thank the broadcast panelists for their contribution and the Motor Challenge and its Allied Partners for their support. The Motor Challenge Allied Partnership includes more than 170 leading companies in the field of automation, electric power and scientific research in engaged in helping the DOE promote energy-efficient manufacturing strategies. Special thanks to the Reliance Electric Motors and Standard Drives groups of Rockwell Automation — Allied Partners since 1997 — for providing the original broadcast transcript and background materials. For clarity TAPPI JOURNAL has edited both questions and answers. For additional information about Motor Challenge and TAPPI contact Bill Stafford, phone: +1 770 209–7201 or email: bstafford@tappi.org.

Question: What is the specific makeup of an effective corporate motor technology team that can save money and enhance profitability through increased efficiency of electric motor-driven systems?

Aue: Our organization has had energy teams in place since the energy crisis in the 1970s. The teams include people from the production area, the boiler house, maintenance, management and the energy resource providers. You need to involve the entire mill—the whole area—to keep everybody involved. You never know whether they will have a speed up on the paper machine or if you will have production changes. Everybody must remain involved.

Lawrence: It is also important to have a nominated leader of this team—somebody who will actually force the program through. One person's enthusiasm will really carry the project to a very great success. This enthusiasm will bring all the benefits from any project because we are looking for more than energy. We want productivity and profitability from the operation.

Aue: We have about 20 energy coordinators around the corporation. Twice each year we like to bring them to the home office to share ideas. We find that one area may be

doing something that is applicable to another division or another mill that could be overlooked if we did not share among ourselves.

Question: Who is eligible for the free services of the Industrial Assessment Centers where small to medium manufacturing facilities can assess their energy audits?

Muller: This is a program that started in 1976 and consists of sending teams of faculty and students from nearby universities into manufacturing facilities and providing technical and consulting services. It is limited to small and medium sized manufacturers. This means gross sales of your division of your company of U.S.$ 75 million or less, energy bills on that site of U.S.$ 1.7 million per year or less, less than 500 employees, and no on-site energy technologists. Although this seems restrictive, many manufacturers in this country fit that bill. Also remember that the program is free.

Question: I have heard that rewinding a motor will reduce its efficiency. How many times should we repair before replacing?

Kellum: Yes! It is possible to maintain efficiency during the repair process assuming nothing traumatic occurred during failure and the proper procedures and materials are used during the repair. But, let's consider that from a different perspective. If you have a properly applied, properly specified, properly maintained motor, it should not be failing very frequently. By the time you reach two or three repairs, you should be considerably older than you were when the motor was installed. If it is only a few years and you've had two or three repair cycles, the question you should be asking is why is this motor failing so often? You also need to look at the application and what might be influencing the life of that motor to shorten it.

Bishop: Any degradation in efficiency is not cumulative. That applies to energy efficient motors and standard efficiency motors. You can experience multiple repairs and not expect to see increases in losses of the machine.

Muller: I want to comment about how you request the rewind and how you accomplish the rewind in terms of trying to maintain the efficiency of a motor. A rapid emergency rewind is very hard to do and maintain efficiency. Good rewind shops will tell you it takes a certain amount of time for them to do the job. This is because of the baking and other technical aspects of rewinding the motor. If you are in a business that rewinds on an emergency basis reasonably often, you might find some efficiency decrease. You may need better planning for emergencies.

Question: What are the current trends in ASDs for medium voltage motors and particularly medium voltage synchronous motors?

Lawrence: That is a good question because technology now enables us to achieve much lower cost equipment on medium voltage units. It was only a few years ago that we would replace the motor and go to a low voltage simply to get less expensive ASD equipment. Now we can use multi level equipment that can give us much lower cost and much more system friendly equipment. We obtain better technical performance at a lower cost. The trends are down in cost and higher in efficiency and reliability.

Question: Please comment on the effects of an ASD on energy efficient motors. Does this affect efficiency?

Kellum: If you look at the motor not in the system context but just the individual motor itself when you apply variable speed drive to it, the wave form that is going to the motor is not the perfect wave form the motor would like to see. So there is some loss in efficiency in the motor itself looking at it isolated that way. When you apply a variable speed drive, you are generally looking at overall system benefits. The loss of efficiency in the motor is not significant to the overall benefit you gain from the system improvements that is if you have applied the ASD correctly to the right kind of application.

Question: Some publications claim that manufacturer's nameplate efficiency ratings are exaggerated. What safeguards are in place—NEMA or EPACT: Energy Policy Act of 1992—to ensure that these ratings are reliable?

Lawrence: I think that the efficiency of a motor depends very much upon the way in which you apply it. One of the most important consideration is to ensure that you provide the motor with its nameplate conditions, voltage, and frequency. If you stray from those conditions, then the efficiencies will be degradated. The important thing is to stick to the nameplate data.

Kellum: As far as assurances about the efficiency on the nameplate especially as it relates to the Energy Policy Act, one effect of the act is going to improve the accuracy of those numbers on nameplates for two reasons. One is that manufacturers' laboratories that perform the testing to establish those numbers all must be accredited

by a nationally-recognized accrediting association. Presumably, this will help laboratories be more consistent in the results they obtain when testing the motors. The other thing is that the Energy Policy Act does allow for a rather significant civil penalty if you are found out of compliance with a motor covered by the act. This means mechanism and motivation both exist for making those numbers accurate.

Question: Are manufacturers able to build and sell standard duty motors, or do they all have to be energy efficient? Do end users have to buy energy efficient motors when purchasing new motors?

Muller: Yes, manufacturers of most standard and common motors built for sale in the United States must have a certain minimum efficiency that we formerly called energy efficient motors. That is in place and exists now. They were allowed to sell whatever they had in stock until now. If you call around, you will find especially for more common grades of motors that most of the old standard efficiency motors are out of stock. So, yes, some changes must be made for your more common motors, but it is a change for the better. It is a change to a more efficient motor that will pay off eventually. There will be some motor changes as you add motors to your system.

Aue: We have always used energy efficient motors since they have been available. We have an agreement with a supplier if they have a motor that is more energy efficient than the one we request, they ship the better one and bill us for the difference. We have made great strides in continuing to upgrade our motors to energy efficient ones.

Kellum: Let me comment on whether users have to buy energy efficient motors. Users are not required to do anything. All the impetus for compliance with the Energy Policy Act is on the manufacturers, distributors who nameplate motors, and importers of motors from overseas.

Question: The corporate team approach in the case study worked well because upper management supported it. This is something that people face in any company situation not just in motor systems. What do you do?

Muller: Walk before you run. Prove yourself with tiny projects. Do not go to management and say I need U.S.$ 1.5 million to put in an entirely new system. There is much of what we call low-hanging fruit. These are simple, low-cost energy efficiency projects that you can do. If you start there, you then develop a track record. I would say to take a long-term view. Those great ideas may have to wait a few years while you develop your running legs.

Question: Our company insists on centralized purchasing usually to the lowest bidder. What materials can you recommend to educate our purchasing department that lower capital cost does not equate to lower lifetime costs?

Kellum: I cannot cite specific materials, but it takes an appreciation for the operating cost of the motor. A motor that is operating at full load around the clock can easily use ten times its purchase price in electrical energy each year. If it is an application where the motor might run ten years, you have about one-hundred times the purchase price cumulatively in operating cost. From that perspective, the efficiency and operating cost of the motor are far more important than the purchase price.

Question: Jerry, can you provide some first-hand experience with taking the systems approach in your mill in Wisconsin. Tell us a little bit about how it has been working and its success.

Aue: We had installed a 400,000 lb/h gas boiler when we installed the paper machine. It was theoretically supposed to run at 40,000–50,000 lb/h on low fire. We could run it at about 117,000 lb/h. The problem we encountered was that we were burning a lot more gas at 117,000 lb/h and less coal or bark. We could not burn all our bark. Running the unit properly would have saved the company considerable money.

We brought in a combustion expert. I also visited the Energy Center of Wisconsin and went through the Performance Optimization service they had. When I returned, I realized that we needed to look at the fans and the fan system around the boiler in addition to the combustion chamber. Putting variable speed drives on the fan system could allow us to reduce it to about 50,000 lb/h—the target we had looked at. That saved us in the fuel switching in the million dollars per year range. So, it was an excellent savings!

Question: If no enthusiastic leader or advocate is present within a forum, what can be done? Is there a step to inspire such a role, a person, or a particular method, and what role can external organizations or consultants play?

Muller: We think there are several ways. One approach involves energy efficiency awareness. A large automobile manufacturer in this country did a private study, but I am aware of the results. They found that simply having an energy efficient awareness seminar at lunchtime with pizza provided reduced energy costs 10%. Simply talking about it makes people think about it.

A second way is to make it very local. A worker probably does not think about plant-wide issues. He is interested in his immediate workplace. Air leak tags are an example. Workers being told to affix tags when there is an air leak so maintenance people will fix it develops their interest.

Finally, I really like bringing outside people in to give you and your management a sense of what dollars are really available in terms of simple energy efficiency projects. Sometimes just seeing the numbers will generate the interest, and you can start to identify leaders.

Question: Do companies take enough interest in energy efficiency? Because they have so many other things to consider, are energy efficiency and the resulting savings or production increases overlooked?

Aue: Many times you cannot save energy for energy reasons. What happens is that energy savings always influence other areas of the company. It will always affect production and the environment. You must not only sell your energy project but also benefits that go with it. That is how we have had success.

Question: Will harmonics and ASDs harm the motor, and will low voltage harm the motor?

Kellum: The harmonics that are on a wave form that supply a motor in ASD application can harm the motor to some degree by causing additional heating in the motor. The hotter a motor runs, the shorter its life will be. So there is some damaging effect there. The more significant damage that can occur has to do with reflective wave forms that can occur between induction motors and today's IGBT PWM-type drives where the distance between the motor and the drive becomes very important in terms of creating the situation that can damage the motor.

Lawrence: These standing wave issues are not very well understood, and we can protect the motors by adding system components between the drive and the motor and achieve the right levels of reliability from the motor.

Bishop: If the motor is heavily loaded or at full load, the under voltage will increase the heating and will increase the current draw on the motor. This could be even more damaging if there is an unbalanced voltage condition.

Question: How can one determine or prove that a motor bearing failure is caused by excessive motor greasing lubrication and shaft voltages caused by ASD operation and bearing pitting?

Kellum: If a bearing has failed due to over lubrication, it is generally an overheating failure. One dead giveaway for that is when you open the motor and grease is inside. Generally, the grease has been pumped past the shaft seal and gotten inside the motor. If a bearing is damaged by shaft currents, it is usually very obvious if the bearing has gone to a severe condition because of fluting. Those are striations that you can see with the naked eye on the race of the bearing. It looks like a washboard. You do often have to cut the bearing open to see this. That is how you can identify shaft current damage.

Question: Is there a typical payback period recommended for most industrial applications when considering upgrades?

Muller: Again, the small and medium sized manufacturers have a little more variation. We have considerable data so I can speak knowledgeably. Typical one-year payback is acceptable for about 50% of the manufacturers that we serve. Approximately another quarter will tolerate the two-year payback. The final quarter will not even tolerate a one-year payback. They want to see payback in six months. Some larger concerns I work with often have very strict rules. Most are about one year for energy type projects unless it is a building improvement. Then they will tolerate longer payback.

Aue: We have a longer payback period if we can verify the energy savings. If you have a loading on a motor, you know how much energy it is using. You go to the motor curve and you see the savings that you would have by replacing it. This can justify your savings. We stretch out the verifiable savings. If you simply use an engineering estimate, the payback period is quite short. It lengthens if we can verify the savings.

Question: How can a capacitor bank reduce energy costs, and also describe how it reduces those costs?

Lawrence: The ways a capacitor bank can save energy is in the power-factor correction of the load. If you power-factor correctly, you then put lower current magnitudes down the cables and reduce the amount I^2R loss in the cable system. It is very good for cable system losses and it can make sure that the correct voltage level is achieved at the delivery point of a motor. It can improve the system performance and reduce losses in the cables.

Bishop: The power factor correction applies to the motor. The power factor of the motor itself does not change. Another item would be care about using power factor correction capacitors with an ASD.

Question: What is the most efficient solution for systems constantly being loaded and unloaded such as meat and coffee grinders?

Kellum: Devices on the market today actually vary the voltage to the motor in an effort to reduce the core losses in the motor when the motor is lightly loaded. They will not necessarily save enough energy to justify their application because it depends on the specific application. You must have a significant amount of time at reduced load or unloaded to justify that.

Question: We talk about motor systems but fail to evaluate transformers and wiring sizing. How would you recommend integrating the electric power delivery system?

Aue: I think with the electric power delivery system it is difficult to be within the mill's capability of really varying that a lot. You need to work with your utility and offer advice. Let your utility know what problems you are having. They are more than willing to help solve any problem you might have.

Question: Do you see efficiency standards being established by legislation for system components in a manner similar to what has happened with electric motors, i.e., fans, pumps, compressors, package units, etc.?

Kellum: My crystal ball does not focus sufficiently to suggest an answer to that.

Bishop: I have not heard of any energy efficiency potential legislation for devices such as those or potential standards.

Muller: The NEMA group has done such a good job in standardizing motors that they stand out as an example of how to do it. Many industrial associations for compressors and fans are now starting to look at establishing their own standards in hopes of avoiding any type of legislation action.

Question: Please explain the benefits of motor operating at 50% speed with ASD vs. a two-speed motor?

Lawrence: Correctly chosen, the multi speed motor can achieve results. The key is that when you build a system you do not actually know how it will operate. With a multi speed motor, you may miss the critical long-running operating points. The ASD will enable you to operate the system exactly on the point you want to run all the time. It allows you to get between those spots on the multi speed motor.

Question: There is a rule of thumb that it is financially rewarding to replace motors with energy efficient ones only in the 5–50 hp range. How accurate is this statement?

Bishop: The accuracy of the statement will depend on the payback analysis. It concerns the number of hours of operation, the utility cost for energy, and things like that.

Aue: The rule is probably not too true because we have replaced some at our mill based on energy savings alone in the larger range above 50 hp.

Question: What steps are being taken to standardize terminology of motor efficiency such as high, premium, ultra, etc.?

Muller: The definitions are changing with various changes in legislation. What used to be an energy efficient motor is now the standard efficient motor. I feel that in the future what is usually called a premium efficient motor will then be an energy efficient motor. Various standards are changing as NEMA comes out with new standards.

Kellum: The only terminology actually defined is energy efficient motor. That is established by the National Electrical Manufacturers Association in the NEMA MG1 standard. It is the only terminology that has a universal industry standard definition right now. Other terminology varies depending on how the manufacturer uses it.

Question: We just heard about a project whose initial goal was to save energy. But the end result was considerably increased productivity, reduced maintenance, and more reliable operation. Roger, as a member of that team what is your perspective on that project?

Lawrence: It was a good model of a demonstration case. Through the facilitating action of EPRI and the member utility, Allegheny Power, we had already experimented with one energy saving case for Allegheny Power and demonstrated some productivity gains. That case involved an injection molding machine. When this larger opportunity came along, Allegheny grabbed it and suggested to the end user he could not only avoid unreliability of fans and difficulty in cold starting but also save energy and achieve improved productivity. We achieved those goals and in fact we went beyond the expectations of the team in finding that control of the air speed across the electric arc furnace saved energy at the rate of 400 hp. Energy savings are only one part of the gain.

When you save energy, you can also make the steel heat up quicker and achieve faster production rates in the steel melt process.

Question: How can energy savings be verified on small projects without large investments in instrumentation especially when savings are less than 0.1% of total electric use?

Aue: We have done considerable auditing of our energy projects. We borrowed the instrumentation from a utility that is an Allied Partner with Motor Challenge. You need to work closely with your electrical supplier. They will provide the equipment if they have it. It may be at low cost.

Question: Is there any way to determine efficiency of existing motors currently on-line, and what effect does an oversize motor have on system efficiency?

Kellum: There are ways to measure efficiency of motors in the field. The most reliable method uses the IEEE 1121 method E1/F1. It can determine motor efficiency within about 1%–1.5% accuracy. The motor does have to be run coupled to the load and uncoupled to the load. There is some effort required to do the test. That represents as good a number as you can get on a motor while it is still in the field without bringing it back to a laboratory where you can do a more precise measurement.

The second part of the question concerned the efficiency of the motor depending on the size of the load it is operating. Looking at test data for more than 700 tests on energy efficient motors, there is a very small change in efficiency between 50%–100% load. Often the motor has a higher efficiency at 50% or 75% load than it does at rated load. That makes it very easy for motor users to apply the motor. If it is anywhere within the range of 50%–100% of load, you are going to achieve within about one percentage point of the motor's peak operating efficiency.

Question: In preparing to sell a project at a large plant, what is the best approach in analyzing the system if your company has limited resources for such an investigation when you have a great number of motors in use?

Muller: That is very difficult thing especially when we start talking about the system approach. You can have energy efficiencies, but you can have impacts on your waste streams, impacts on productivity, impacts on worker morale, and impacts on things of that nature. The best advice I can give is to use case histories. More and more case histories are being developed by Motor Challenge and other programs. These are very useful in quantifying effects at other places. Then you can adjust them to fit your particular application.

Question: What testing standards are established for rewind shops, and how can the customer be assured that his service shop is complying with those standards?

Bishop: Set standards do not exist as such. EASA has what we call recommended practice for the repair of electrical apparatus. We also provide motor maintenance guidelines in the repair of electric machines to maintain the efficiency. Beyond that, there's also EASAQ. This is a quality management system. You can also look for ISO 9000 quality standards. Beyond that, you can look at things like the verification of efficiency before and after repair.

Question: Would it be worth the cost to replace my motors on my Chinese machines for my machine shop? Are foreign motors held to motor specifications like U.S. motors?

Kellum: There are specifications for foreign-made motors. They do differ from the standards for U.S. motors. Sometimes the performance you get from a motor built to a foreign standard when it is operated on voltages and frequencies that we have in this country is not what you would like. Our experience has been that motors from overseas—we call them metric motors—do not perform as well. They run considerably hotter than NEMA type motors that are sold in this country. It is often worthwhile to try to identify a NEMA replacement motor for your metric motors. This is much easier to do if the motor is foot-mounted and belt-driven. If it is a face-mounted motor and the shaft is direct coupled, you will have more difficulty because of the metric dimensions. In many cases, it is worthwhile. How worthwhile depends on the operating hours of the motor and the load of the motor.

Question: Is there a practical, cost-effective test method to assess the efficiency of the separate individual components of a motor drive system? Your comments have referenced electric motor nameplate efficiency. Is efficiency data available for other typical components?

Muller: Motors happen to be rather repeatable. They are wonderful devices. You plug them in, you turn them on, and they operate the same way almost every time. When we talk about pumping systems and fan systems with dampers and flow, the efficiency can change from season to season. Many people open a window because their heating system is pouring too much hot air into their office and it is cold down the hall. This is simply a matter

that the system was perfectly balanced and very efficient once. Because of changes in temperature and operating conditions, it does not work to standard a year later. This is a continuous, ever-vigilant activity when you get into the system part of the equation.

Lawrence: To calculate the savings, it is very important to understand the system operating characteristics. It is not merely the pump or fan but it's more how that driving equipment operates within the system. That system curve needs to be established. This is fundamental in establishing energy saving systems and systems that can be employed.

Question: Are there currently any software programs available to assist in the analysis of the economic feasibility of retrofitting into energy efficient motors? Also, are there any software programs to assist in presenting these projects to management?

Muller: Excellent, free software packages are available. MotorMaster+ is the first one that comes to mind. It is available by becoming a member of Motor Challenge. It also has a catalogue of most motors available today and provides information on a cost-effective solution to some sort of fix.

Lawrence: We (EPRI and ASDO) have developed some user-friendly software associated with ASDs that will deal with the technology, energy efficiency, specifications, and economic analysis of ASD programs. This allows an objective analysis of various speed control methods.

Question: With the variable flow when a motor is driving a pump, would it be efficient to have a combination of constant speed and variable speed motors given that three or four pumps and motors are being used presently at a waste water plant?

Lawrence: The question relates to the performance you need from the system. Some systems use a combination of fixed speed and adjustable speed pumps to achieve optimum performance. That may not necessarily give the optimum energy performance. Because pumping systems typically have a very high degree of static head, the actual performance of those parallel pumps depends on the performance you want from the system and exactly how they are connected. System performance into which these pumps work is very, very critical in analyzing the results.

Question: The most difficult part of convincing a customer to adopt an energy efficient program is getting a true cost of the energy to plug into a formula. Is there a torque armed with this knowledge or rule of thumb to get a true cost savings?

Aue: The true cost of energy comes from the actual energy being consumed in the last increment you are using. If you are running a steam system and have waste wood you burn, coal, and gas as parts of your fuel mix, what boiler do you back down when reducing steam production? Looking at the entire system, you normally back down your gas boiler. Your incremental cost of that energy is then very high. If your gas boiler is down as low as possible, then your incremental cost may come from coal or from bark. It is really important to examine and determine exactly from where the savings come. When you go to management you must be certain you are looking at total savings. When you audit an energy program and most energy projects should be audited, the audit must verify exactly what you thought you had for savings.

Question: How do you sell a promising energy savings program to a city government when the city council is only interested in the initial cost and is not interested in a payback period longer than the time to the next election?

Aue: The key thing here is you have case studies. You show other areas of success, and you take those successes and you bring them into your council. Even if it does go past their term, ask them to look at it from a voter's standpoint instead of from an elected official's standpoint.

Muller: Leveraging is an important part of selling projects to municipalities. Look for somebody to help you buy into the project. Your state energy office often has municipal programs. Utilities will frequently have municipal programs that are very good publicity for them. I would try to make it a good deal by getting other people to buy off part of the program. Then even a politician only worried about reelection cannot turn it down.

Question: A key piece of information that we need for upgrading to a higher efficiency motor is the motor peak inrush amps. If the motor starter uses a molded case breaker, the breaker may trip the higher inrush currents produced by the higher efficiency motors. How has this problem been handled?

Panel: This is a very common problem. Inrush current is a problem with what is referred to generically as nuisance trips. These are circuit breakers that trip simply because the inrush current is causing a current load beyond what the breaker is set for. Quite often, the solution is to change your starter to what would be called a soft start. There are many ways to do this. In essence, you are using a lower voltage to start ramping up the speed of the motor. That will eliminate your inrush current problems.

Question: Have harmonics from a newly installed ASD affected other electronic control production equipment such as robots or machining?

Kellum: There are certainly cases in the past where harmonics being created by a drive have disturbed other pieces of equipment. Do they always? No, not always. As Roger Lawrence pointed out earlier, there are well-known and well-established mechanisms and processes to avoid these kinds of problems when you are installing drives.

Question: Is it more efficient to operate a pump drive at a continuous lower than 60 Hz frequency other than to simply cycle the motor on or off?

Lawrence: If you can switch the pump on and off and achieve the right output, that is the very best energy efficient way of achieving the results, if the pump can stand the number of cycles. If the process will not permit this on/off process, then go to the added complexity of putting a drive in and maybe suffering some energy penalties.

Question: In order for a drive motor package to be at optimum efficiency, does the motor have to be operated at a certain percent of full load capacity? If so, what is that percent minimum and maximum?

Bishop: This goes back to what Ziba Kellum was talking about before. If you have a motor that is 75%–80% loaded, it will be running at its peak efficiency.

Question: How is a motor affected by a phase voltage unbalance?

Kellum: In real applications, seldom does a motor have exactly rated and balanced voltage. We have tested this to determine these differences. In most cases, a voltage unbalance has a detrimental effect on a motor. In some cases, this is quite significant. I can recall one test that we did where a 3% voltage unbalance actually increased the temperature rise in the motor by 20°C. As you know, a 10°C increase in a motor temperature reduces its life by half. So that is a very significant detrimental effect on a motor.

Lawrence: It is very interesting to note that if an ASD were introduced between that supply and the motor, the unbalance is eliminated. It can give substantially improved conditions for the motor.

Question: From a combination of repair costs and reduced efficiencies, it does not seem worthwhile to repair small motors. What is a reasonable rating to begin repairs rather than replacements?

Bishop: When you are considering repair vs. replace, it depends on whether the motor is a standard motor and the degree of repair. Not every repair is a rewind. If it is a rewind, you have to do a repair or replace cost analysis. No matter how small the motor, it still may be practical to repair because you cannot replace it with a readily available motor. TJ

OIT promotes energy efficient technologies and processes to reduce pollution and increase competitiveness

The Office of Industrial Technology (OIT) Technology Access programs including Motor Challenge, Steam Challenge, and Compressed Air Challenge help inform industry about the latest energy-efficient technologies to increase competitiveness and reduce waste today. Notably, technical access programs that have proven extremely valuable to thousands of manufacturers are but one area of OIT. Through its unique Industries of the Future (IOF) program, OIT is helping ensure that energy-intensive industries such as the forest products industry maintain global competitiveness in the future.

IOF represents a new approach to public and private partnerships. It is a customer-driven process that features active participation by those most influenced by the outcome—U.S. industry. The IOF process encourages energy-intensive industries to work together for the following:

- Develop broad, industry-wide goals for the future
- Identify specific technology needs and priorities required to achieve this vision of the future
- Develop a path forward by forming cooperative research partnerships to attain established goals.

The forest products industry was the first to join OIT Industries of the Future program. In 1994, the industry published Agenda 2020: A Technology Vision for the Future. As stated in the vision document, "Never before has the industry with such unanimity taken a look at its future, the need for technical development and ways to leverage its own capabilities with partnerships involving institutions, suppliers, and government."

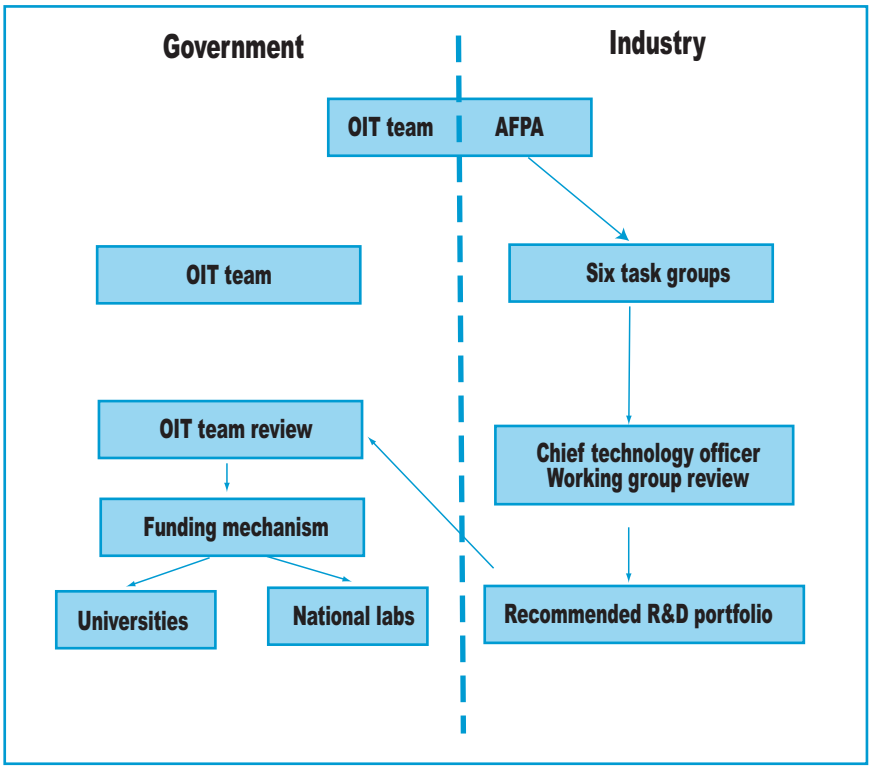
Through industry task groups, the forest products industry works with OIT Forest Products Team— under the leadership of Valri Robinson—to implement goals established in Agenda 2020. As program managers, the Team's primary responsibilities involve matching DOE funding and funding leveraged from other federal agencies with key research and development needs identified by industry committees. The team currently oversees 52 research and development projects that receive approximately U.S.$ 12 million in federal funds annually. Participants cost-share cooperative research and development projects. Typically, OIT provides 50%–70% of the funds, and partners provide the balance.

Robinson notes that "OIT forest products portfolio consists of a majority of higher-risk, pre-competitive technologies. These technologies are critical to the industry's future competitiveness, but because of the increasing cost of environmental and capital requirements the industry has limited resources available for R&D. The IOF program demonstrates how public and private partnerships can complement private entrepreneurial development."

IOF projects are selected for funding through an industry-driven solicitation process. The fiscal year 1999 forest products industry solicitation was initiated during summer, 1997, when AF&PA—whose members produce more than 84% of the domestic and recycled paper and account for 50% of the solid wood manufacturing capacity— issued a request for proposals (RFP) to prospective bidders. The RFP solicited collaborative, pre-competitive research and development that addresses research pathways identified in Agenda 2020. Industry task groups initially reviewed 396 preproposals in six technology areas: sustainable forestry, environmental performance, energy performance, improved capital effectiveness, recycling, and sensors and controls. Task groups narrowed the selection and made recommendations to OIT Forest Products Team. After evaluating the recommended proposals, the team selected 18 projects for awards. The team will make awards in October 1998. Additionally, an RFP for the fiscal year 2000 forest products solicitation was issued in May 1998. Two-page preproposals for that solicitation were due August 1998.

Significantly, the forest products portfolio contains several projects with multi industry applications. These "crosscutting" technologies include a project titled "Development of Materials for Service in Kraft Recovery Boilers" co-managed by OIT Advanced Industrial Materials program. Project participants try to identify the cause and determine a solution for cracking in coextruded tubing in black liquor recovery boilers. A second crosscutting project titled "Biomass Gasification Combined Cycle" is co-managed by the Advanced Turbine System program. Project participants are conducting the groundwork for a commercial demonstration of the biomass gasification combined cycle technology at an operational pulp mill.

In addition to Motor Challenge, Steam Challenge, and Compressed Air Challenge, other OIT programs also support the Forest Products Team and its research and development programs. These include the National Industrial Competitiveness through Energy Environment and Economics (NICE^3), Inventions and Innovation, and Industrial Assessment Center programs. NICE^3—a strategic partnership among state government, industry and DOE—provides funding support for technology demonstrations. The NICE^3 program is currently funding five forest products-related projects. Two projects that look promising include an attempt to validate that dehydration of wood waste can succeed successfully and economically using long wave catalytic infrared heat waves and a process that enables the pulp and paper industry to improve the yield generated from virgin wood chips by enhancing penetration of chemicals more uniformly into a chip.



Inventions and Innovation (I&I) provides financial assistance for small, independent inventors for development of innovative ideas and inventions that save energy and have commercial market potential. I&I is currently funding several technologies in the forest products area. These projects include the Cradle Debarker, Christian Veneer Dryer, and Molten Film High-Intensity Paper Dryer. The Cradle Debarker's open design enables the operator to view the debarking process. Stems that have been satisfactorily debarked can be ejected earlier preventing further surface and end damage while retaining logs that require more processing. The Christian Veneer and Molten Film High-Intensity Paper dryers' innovative approaches to the drying process enhance operating efficiency.

Finally, the Industrial Assessment Center program provides no-charge energy, waste, and productivity assessments to help small- and medium-sized manufacturers maximize energy efficiency, reduce waste, and improve productivity. Analyses are performed by local teams of engineering faculty and students from 30 participating universities across the country. In the forest products industry alone, 768 assessments have been conducted since 1982. The analyses have resulted in implementation of more than 2500 recommendations for a cost savings of approximately U.S.$ 4.5 million.

According to OIT Deputy Assistant Secretary Denise Swink, "We are pleased with the forest products industry's consistent support for the IOF program." She continued, "As the processes emerging from this collaborative effort are implemented by the U.S. forest products industry, the industry and ultimately the nation will reap the benefits of increased efficiency and competitiveness and reduced waste."

For more information on OIT's forest products program or current solicitation, please visit OIT Forest Products web site at www.oit.doe.gov/IOF/forest, or contact Valri Robinson at +1 202 586-0937.