Saab Rosemount TankRadar STaR™
INNOVATIONS
2005 TECHNOLOGY AWARDS ISSUE

4
SAAB ROEMOUNT’S TANKRADAR STaR™ provides safety, trust and reliability on the high seas – and changes the game in tank gauging.

12
DISRUPTIVE TECHNOLOGIES
provoke questions, such as: Are you where you want to be on the technology S-curve?

16
DESIGN FOR SOURCING SUCCESS
means involving Procurement early in the design process.
This is an exciting time to be with Emerson. We have positioned ourselves to be in the right places in the world at the right time with the right technologies. Our customers see that and our recent financial performance proves they are counting on us.

It is no small challenge to drive continued innovation and technology leadership—key elements of our long-term business strategy. The competition is fierce. We know that Emerson’s technology leadership would not exist without the day-to-day contributions of Emerson engineers around the world.

New product development is what Emerson engineers do each day. And sales of new products are a priority for Emerson because they increase at a much faster rate than total sales. In short, new products drive new growth. Our goal is for new products to exceed 40 percent of total sales. I am confident that Emerson engineers will make this goal a reality.

To help ensure that our technology leadership remains strong, we invested $469 million in engineering and development and $165 million in customer solutions engineering in fiscal 2005.

I mentioned being in the right place at the right time. Emerson today holds a leadership role in helping the world meet four fundamental challenges. You’ll hear us talk more about these throughout the year.

Business without borders is the clear reality of our global economy. Emerson engineers around the world develop global product platforms and use regional knowledge to customize products for local markets.

Energy efficiency becomes an increasingly urgent need in a world that requires historic levels of energy to enable emerging economies to advance. From motors and drives to compressors and new ways of managing energy, Emerson engineers help our customers conserve energy and reduce operating costs.

Communications revolution continues from the convergence of discrete media to bringing telecommunications to people who have never had a telephone. Emerson engineers provide secure power for communications in remote locations and design power and cooling technologies for the most sophisticated mission-critical communications applications.

Resources for the world means making the most productive use of processes and finite resources to meet growing global demand. Solutions by Emerson engineers are helping mine the earth’s minerals more efficiently and extract increasingly valuable oil from Canada’s vast oil sands, the world’s second-largest known deposit of oil.

Of course, the common denominator in Emerson’s ability to provide solutions that help the world meet these four basic challenges is technology leadership. That is the critical strength we must deliver to our global customers to succeed.

I salute the 2005 Technology Award winner Saab Rosemount and applaud its example of game-changing invention and perseverance. And I thank everyone in the Emerson technical community for your continued commitment to innovation—and for keeping our technology leadership momentum going strong.

David N. Farr
Chief Executive Officer
How the engineering profession has evolved – and what that evolution means for engineers

Engineers are people who make things happen. Engineers use science and technology to solve problems and create economic value. We drive progress. Our inventions and innovations make life easier, more productive, safer and more fun. In the process, engineers’ innovations help make economies and industries grow and create livelihoods for people with all kinds of skills.

In my opinion, engineers are special people with problem-solving skills society critically needs. That’s why I chose this profession, a profession that I always have found endlessly fascinating and endlessly challenging.

Given that background (and, I should say, bias), when I saw The Wall Street Journal headline “Behind ‘Shortage’ of Engineers: Employers Grow More Choosy” last November, naturally, my interest was piqued.

The Journal examined the issue from different perspectives. For example, the article said that many companies believe they face a “severe shortage” of engineers and are encouraging Congress to increase funding for engineering education.

On the other hand, the story also pointed out that the unemployment rate for engineers in 2003 was 4.3 percent, compared with 3.2 percent for all professionals. Also, a study by Northeastern University found that U.S. engineering employment fell 8.7 percent from 2000 to 2003.

So, is there or is there not a shortage of engineers?

The point that I found compelling in the article was that companies seeking engineers have become more demanding than ever before.

From Emerson’s experience, I know this is true. For example, instead of advertising for an electrical engineer, companies now want an EE with extremely specific, often, application-specific skills.

Another point that rings true from the Journal article is that companies want more “soft skills” in engineers – for example, the ability to work in groups and communicate well verbally and in writing.

Bottom line, it is clear that demands on professional engineers have evolved. This evolution has been driven by a number of factors – the reality of a global economy, ever-faster advances in technology and the needs of large organizations like Emerson.

These forces have meant that engineers today must do more than create solutions. Today, engineers must create solutions that take into account an array of requirements from global regulation to sourcing and design for manufacturing to marketing.

This means that today’s “evolved engineer” also must be a global thinker, a marketer and a generalist/diplomat with the ability to relate and work with all parts of complex corporate organizations and, indeed, the world.

The evolved engineer is and will be Emerson’s strength in technology leader-
ship — our ability to stay ahead of fierce competition and rapid change.

The idea of staying ahead of our fast-changing environment threads through articles in this INNOVATIONS.

The 2005 Technology Award winner—Saab Rosemount—created a disruptive technology in the late 1970s that it has consistently improved to become the undisputed global leader in tank gauging. (See story pages 4 to 11.) The company’s commitment to technology leadership has put it “miles ahead” of competitors, according to Frost & Sullivan, which gave Saab Rosemount its 2005 Technology Leadership of the Year award.

How can Emerson companies change the game in their markets as Saab Rosemount did? Also, where does your company’s product stand on the technology S-curve? Given that position, what are your vulnerabilities? And how are you planning for those vulnerabilities? These thought-provoking questions are explored in the article on disruptive technology on pages 12-15.

As always, this issue of INNOVATIONS has been designed to make readers think by raising fundamental questions for our companies and for ourselves as individuals. Note that while we raise these important issues, we do not presume to provide the answers. The answers are up to you.

Randall D. Ledford
Senior Vice President and
Chief Technology Officer

“Today’s “evolved engineer” also must be a global thinker, a marketer and a generalist/diplomat with the ability to relate and work with all parts of complex corporate organizations and, indeed, the world.”
Out here, you need SAFETY, TRUST

Saab Rosemount’s TankRadar STaR™

It is the rule, not the exception, that Emerson Process Management systems work in unusual, generally hostile environments. If anything, Saab Rosemount’s TankRadar STaR™ exceeds this standard. It operates on the largest transportation vehicles ever built by man – seagoing tanker ships that deliver the more than 80 million barrels of oil the world consumes daily, not to mention additional quantities of liquid natural gas (LNG), asphalt and various chemicals.

For perspective on their enormous scale, the largest of these tankers can transport more than 4 million barrels of crude oil, or about five percent of the world’s daily consumption. The world’s biggest tanker is significantly larger even than the Nimitz-class supercarrier USS Ronald Reagan and sits so deep in the water when fully loaded that it can not navigate the English Channel or most world harbors and must be loaded and unloaded on the open sea.

One story demonstrates why Saab Rosemount’s TankRadar STaR monitoring system (capitalized letters represent the system’s Safety, Trust, Reliability) is so highly valued. In the bridge of the tanker Aberdeen, a visitor from Emerson asked the first mate how important the TankRadar® system was to the ship’s operation. The first mate moved to the control console. “That’s easy. Let’s simulate a loading situation. The TankRadar system is important because it supplies critical data to the ship’s load calculator.”

The first mate input some values into the system. “Here, I’m loading the ship’s tanks. When we load, the ship’s hull actually bends with the stress. So, if the ship is loaded in a manner that is unsafe, data from the TankRadar system will warn us.” He punched another key or two and the screen showed steadily increasing stress loads on the hull. Even a novice could see that there was a problem. “See, this tells me that the loading pattern jeopardizes the hull’s integrity. But, let’s say we ignore the warning ...”

Pointing to the screen, “Ah, and here we actually have broken the ship. It now is two very large pieces, about to sink. And there’s a lot of oil in the ocean.” The first mate deadpanned, “Our owner wouldn’t like that.”
& RELIABILITY
“Our vision is ‘Shaping the future in tank gauging.’ This means that we must identify promising technology and move it very quickly up the steep side of the technology S-curve to deliver the performance our customers expect. This means you must have very good engineers. It also means that being number one in market share is not enough. We also must be the technology leader or we may miss market opportunities or be stopped by competitors’ patents.

“It is important to create time for people to innovate. A lot of business demand is for short-term projects that do not provide a base for future-generation products. So, time must be created, and goals must be set high so that engineers have to think outside the box. Almost every company (and certainly every growth-oriented company) needs people focused on bringing products to market and people who can and want to think outside the box.

“Our company was created on a disruptive technology. Now, we cannot forget the threat of new technology disruptions to our technology. So, we always have to cover our back by constantly monitoring and looking at new and different technologies.”
How Saab Rosemount changed the game in tank level gauging

More than 30 years ago, young engineer Olle Edvardsson worked on radar devices for Saab’s military unit in Linköping in south central Sweden. The radar determined the altitude over the ocean of anti-ship missiles fired from military jets. Semiconductor technology had just started to be used with microwave radar, and the possibilities intrigued Edvardsson.

What bothered him, though, was that the defense business was so unpredictable. Projects could be dropped quickly, almost overnight. Sweden’s large ship-building industry gave Edvardsson an idea. He wondered if microwave radar devices might have marine applications.

Conversations with shipbuilders sharpened his focus. Builders of oil tankers told Edvardsson that level monitoring systems for tanks were notoriously inaccurate and unreliable. Traditional mechanical float systems were prone to obvious problems such as getting stuck or bent in tanks. He wondered, could radar replace mechanical gauges?

“The idea then looked to be crazy,” Edvardsson says today. But he obtained funding from Saab to look into it.

In 1972, he saw an idea that could work, albeit with enormous caveats. For example, microwave technology in those days was extremely expensive, certainly far more expensive than the mechanical floats traditionally used as tank gauges. Also, there could be no spark from electronics that could explode fuel vapor. These were formidable obstacles, but Edvardsson and his team persevered.

Calling on Saab’s deep expertise in electronics, the team put equipment on a ship for a field test. The results were encouraging, and serious development started in 1974.

In 1976, the first radar gauge was installed on a tanker. But follow-on sales were dismal. Traditional mechanical devices were much easier to install and maintain.

Ross Fitkin  Senior R&D Engineer

“Our software collects data on tank level, temperature and pressure that goes to the ship’s automation system and to the load calculator that continually calculates the load on the hull. A ship’s systems depend on the values we deliver, for example, for inventory management, reports and data sampling, audit log and, of course, alarms when levels pass desired limits.

“Because a ship is always moving, our software constantly compensates. So, when a tank is off-center because of waves, our software will do trim/list computations and report a tank level as though the ship were perfectly calm.

“Each system is pre-configured to minimize installation time. Hundreds of parameters must be set to properly identify echoes. And everything must be right.

“I spent an afternoon at the University of Gothenburg’s tanker simulator, and I learned that it is very easy to break a ship with bad loading. Also, I spent a night on a ship in near hurricane conditions watching levels on our system. The forces on the ship were incredible. It was great to see the TankRadar monitoring system perform perfectly under these conditions.”

The heart of the TankRadar STaR™ system is the tank gauge unit. It has three radars for a three-in-one solution integrating Level gauging, High Level and Overfill alarm systems in one intrinsically safe electronic unit that galvanically separates the three functions.
We had to create a radar with very low power consumption (half a watt, or half the European standard) that was intrinsically safe. The additional challenge was to create three boards—one for each radar—that would fit in the allocated space. Each radar had to work independently and be galvanically separated from the others. The only common element for the three radars would be the waveguide and a single antenna. But we had to be certain that the radars would not interfere with each other.

We performed many tests, both performance and environmental. For example, mechanical tests of vibration ranging from 2 to 100 Hz from three directions to simulate forces on a ship in high seas. And performance tests with temperature ranges from -40˚ to +70˚ Celsius. All electronics above deck must work in this wide temperature range. There are no electronics below deck which is important because, for example, asphalt is heated to up to 250˚ C in a tanker, which is much too hot for electronics.

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“We also had to know how our radar works in field conditions. We field-tested our equipment in the North Sea, and the seas were very heavy. We learned that it can be very turbulent inside the tank, and the TankRadar STaR system still works perfectly. I was happy I had seasickness pills that worked.”

But then the world changed. Several tankers exploded at sea. A few more disappeared without a trace and were believed to have blown up. The cause of the deadly explosions was thought to be static electricity in oil tanks. International maritime authorities mandated that all tankers over a certain size must fill their tanks with exhaust gases from their engines to eliminate oxygen and, therefore, any chance of an electrical spark.

Among other things, this new safety requirement meant that mechanical gauges no longer could be checked by opening a hatch and looking at the device because that would allow oxygen into the tank. So, a time-honored check on mechanical float devices was eliminated, raising doubt that never had existed before. Also, in the late 1970s,
the Alaskan oil fields began production, increasing demand for tankers. Slowly, the TankRadar system built sales.

And so it happened that a small but determined unit of Saab developed a disruptive technology that changed the game in tank gauges, forever.

The TankRadar® monitoring system offers clear advantages

With each sale, the TankRadar system proved that it was more accurate and reliable than previous systems. Greater accuracy allows better control of the cargo and optimal tank usage. No mechanical parts in the tank mean lower maintenance costs for tanker owners. Another benefit is that the TankRadar system’s accuracy allows tankers to speed up the critical processes of loading and unloading and do it more safely than ever before. This time benefit quickly translates into economic advantage because day rates for tankers can range from $15,000 to $250,000, depending on the supply of oil coming to market and the number of tankers available to deliver it. The ability to load and unload without spills avoids another significant cost in fines and loss of public reputation.

“Technically, the TankRadar system sounds like a straight-forward proposition,” says Dr. Mats Nordlund, vice president of engineering at Saab Rosemount. “But it is a very difficult radar application because, unlike the military air-to-ship missile application, microwaves are subject to a lot of interfering echoes in a tank. Also, they can bounce against the side of the tank, twice or more times in certain types of tanks, creating multiple targets for the radar to track and separate. So, tank radar needs very sophisticated microwave and signal processing technology compared to traditional radar applications.

“Also, in some of our applications we must consider that microwave travels at different speeds in air versus liquids. All these factors, which did not matter in the military application, are critical for the TankRadar system application.”

The TankRadar STaR system, the latest generation of the original, pioneering invention, breaks new ground in reliability and functionality and significantly strengthens Saab Rosemount’s global technology and market leadership.

The TankRadar STaR system development team set the following four objectives. It met each objective and, often, significantly exceeded them.

- **Create the best level system in the world** – instrument accuracy improved by 10 times for the system that already was the world’s most accurate. Even in seas roiled by hurricane-force winds, the TankRadar STaR system measures tank levels well within the requirements of any marine applications. The system also has proven to be extremely rugged and problem-free in the harshest of environments.

- **Cover all marine tanker applications** – TankRadar STaR system technology has been implemented in small tankers, Very Large Crude Oil Carriers (VLCCs), and Floating Production, Storage & Offload ships (FPSOs).

Anders Jirskog  Principal R&D Engineer

“We started almost at a transistor level in designing the microwave circuit and built from there in blocks, testing and simulating each block to know how it would behave. This is time-consuming at the front end. However, we made good progress because we invested in new, sophisticated equipment and software tools. As a result, we achieved a device with low cost, a device that we could manufacture more cheaply than outside suppliers and a device that, unlike most analog electronics, requires very little tweaking.

“It was advanced technology, but not too advanced. We did not over-specify. We knew what was needed.

“It was satisfying to personally follow the product from specification through manufacturing to market success. We had a very good work climate and a good degree of freedom to do the designs we wanted and to be fairly bold.

“I did not have to go to my boss and ask if I can do this or that. But we always know we must deliver.”
Mikael Kleman  Principal R&D Engineer

“In an early meeting between customers, marketing people and engineers, I saw that there was a need for something new that would reduce installation cost. I thought about it maybe 30 minutes and realized that, in principle, it would be possible to use the same waveguide for three radars and use the same antenna.

“The problem is how to combine three radars that use the same antenna and do so in an extremely compact way. It would be far too big if we did it in the conventional way. Another problem we encountered is that combining radars creates false signals that look like multiple surfaces in the tank. It took time and work with mathematics to realize what was happening and eliminate false signals by separating the frequencies of the three channels by small amounts.

“We have a very innovation-friendly climate, and we’re encouraged to think of new ways to do things. We also do things together after work. For example, Fridays we play bandy, a sport like ice hockey except played outdoors on a soccer-size field of ice. Activities like these have made us grow together as a team.”

- Develop a microwave platform for all Saab Rosemount applications – The TankRadar STaR microwave and signal processing now are the platform for marine, tank control and process applications, enabling significant cost reductions.

- Produce large volumes very cost effectively – The TankRadar STaR system was planned for global manufacturing and distribution with, for example, the microwave module specifically designed to minimize testing and to accommodate manufacturing variations. About 15 to 20 percent of the total engineering and tooling effort was conducted in low-cost countries; about 85 percent of system electronics is produced in Asia.

The development team faced significant technical challenges. One obvious problem was integrating the system’s three radars (using the same waveguide and antenna for three radars) and then making that package fit in a small space. Integrating the radars means cutting only one hole per system in a ship’s deck. It also minimizes cabling. Both features cut the cost and time for installation.
Three radars operate independently

While integrating three radars and making them fit in a small space, the radars had to operate independently, be galvanically separate and never create interference. Plus, despite increased functionality, power consumption (for displays, communications, radars, signal processing) had to be minimal, below the 1 Watt European standard.

Even the antenna presented unique problems. For example, because the TankRadar STaR system uses very low power, the antenna has to be large to receive a clear signal. It also has to work in environments where the antenna may be submerged in the cargo. Even a very thin layer of condensation or contamination can degrade performance.

The Saab Rosemount team solved this problem by using Teflon and optimizing the antenna’s geometries.

Finally, of course, the TankRadar STaR system had to be cost competitive with mechanical and competing radar systems.

The Saab Rosemount team resolved all these problems, delivering a cost-effective system with no moving parts and no components that wear out. Costs were held down by a compact design, smart use of commercial components and innovative electronic solutions. The radar is designed to work with any type of tank and any kind of liquid or liquefied cargo from crude oil, chemicals and asphalt to liquid natural gas (LNG).

New sensor technology improves performance and was carefully designed to be operator-friendly, allowing for fast response in loading and unloading operations. Up to five different sensors measure temperature, a high-accuracy pressure sensor can be added to the system and a backup battery ensures uninterrupted power.

Temperature and pressure data and Ullage (unfilled space in a tank), High Level and Overfill alarms are transmitted to the ship’s automation center and load calculator that calculates stress on the hull. Data can be accessed at workstations and is integrated with systems controlling, for example, valves and pumps. Data also are used for inventory management and reports.

The TankRadar STaR open-architecture software is specially designed for all tanker specifications. This means that configurations of software, gauging systems and auxiliary equipment are customized before installation with hundreds of parameters for each ship.

“Miles ahead of the competition”

Its wide range of technical solutions and resulting superiority over other systems has put the company “miles ahead of the competition,” according to the Frost & Sullivan report giving its 2005 Technology Leadership of the Year Award to Saab Rosemount.

For their part, members of the Saab Rosemount team prefer to think not in miles but in years. One example gives them particular pride. The world’s first radar level gauging system, precursor to the TankRadar STaR system, was installed in 1976 on the Norwegian tanker M/S Havdrott. It has been in continuous operation since – until the ship was decommissioned in 2004. This is the history of reliability that the TankRadar STaR system has perfected for the future.

Anders Welin  Product Manager

“We sell our equipment to shipyards. It is in their interest to pay as little as possible. However, ship owners have a strong interest in a system that will work for the life of their ship, or about 25 years. This is a major reason why we must be there to support our customers – to make certain our systems work for the life of the ship. In fact, the first system we installed was on a ship built in 1976. Recently, that ship was scrapped, and our system was still working perfectly. That gave us a very good feeling.

“What is unique about Saab Rosemount as a radar manufacturer is that when we develop a new function or product, it almost always starts with the customer. But we do not stop with that. We continually follow up to know how our product works and how it can be improved. We are focused on solving customers’ problems, not only selling products.

“The atmosphere of the company is good. If you think something, you can say it and you will be listened to. Some companies have a rigid hierarchy, so people always do not say what they think. There is not much hierarchy here.”
However, research has identified a general pattern in the life cycle of a particular technology. This pattern has become known as the S-curve of technology, illustrated at right.

It is important to know where your product technology stands on the S-curve. It also is critically important to understand that each phase of the S-curve reflects a different environment. Today’s fiercely competitive global markets show no pity to the business that fails to understand its opportunities and vulnerabilities. Following are points to keep in mind as you plan the survival/growth strategy that best suits your technology and its position on the technology S-curve.

**Infancy.** The dominant technology is challenged by the disruptive technology. Each new cycle of a technology begins at the bottom of the S-curve with an invention or discovery with the potential to disrupt the existing or dominant technology – and, eventually, supplant it.

Examples of disruptive technologies abound – from the steam engine to digital photography. Examples within Emerson include the Copeland Scroll® compressor and Saab Rosemount’s TankRadar STaR system, winner of Emerson’s 2005 Technology Award.

The strength of a new technology is just that – it’s new, a fresh solution to a problem. So, there is great opportunity...
for differentiation and growth. But, paradoxically, the strength of a new technology also is its weakness. For example, do early adopters in the market perceive value in this new solution? Is the new solution well executed? Will it work as well as the dominant technology it seeks to disrupt and replace?

In other words, being first does not guarantee success. The innovator must be ready to be first. In essence, the innovator must carefully – and correctly – think through the technology’s market prospects with particular focus on weaknesses other companies could exploit.

**Rapid growth. The game changes.** Once the disruptive technology begins to take hold in the market, the new technology may experience rapid performance improvement with each new product release up the steep part of the S-curve.

Examples of beneficiaries of this fast market growth include Nokia for its mobile phones and Apple for its iPod music players. An Emerson example is Rosemount’s 3051S Pressure Transmitter, winner of the 2003 Technology Award.

In this phase of rapid growth, the innovator must keep his eyes open for the “fast follower,” the company that quickly develops a similar new product with a critical difference the market perceives as a benefit. Obviously, the fast follower has the advantage of 20-20 hindsight – seeing the innovator’s whole strategy unfold and then taking advantage of any missteps or weaknesses. Such an advantage could have little to do with the actual product. For example, the fast follower could exploit the innovator’s inability to finance a national marketing campaign.

In short, the rapid growth phase creates an often chaotic, competitive turbulence with multiple competitors fighting for market share. There is great opportunity in rapid growth – the opportunity to build market share and a solid reputation in the marketplace. But only the strongest and smartest will survive this phase. So, the innovator must be nimble and must build financial strength through increasing sales to be able to win out over competitors.

**Maturity. Market acceptance of the technology is nearly universal.** The top of the S-curve represents the cycle of dominance for a technology in which a market leader emerges and profits typically are maximized. This is the phase of market leadership for a technology that has been so well executed and delivered such a high degree of perceived value that it has been able to stave off competitors and dominate the market.

Examples of product technologies in the mature phase of the S-curve include automobiles with internal combustion engines and personal computers. Many of Emerson’s older products also fit in this category.

If the market leader with a mature technology has its eyes wide open and a solid strategy in place, its strength in the market and incumbency give it great advantages. However, while it may seem paradoxical, it is true that the mature phase – the time of market leadership – also represents the point in a technology’s life cycle in which it is most vulnerable to a new, disruptive technology. So, the mature phase’s inherent strength – market leadership or dominance – also becomes its inherent weakness, because leadership easily can lead to complacency. So, the innovator who has become market leader can not afford to relax. The innovator always must remember that nothing lasts forever – least of all a dominant technology.

Another fact about the technology S-curve often is forgotten but is important to note. While it generally isn’t shown, the S-curve has a downward slope that follows...
the maturity phase. This slope represents the downward spiral of a technology that has been disrupted or supplanted and is falling into obscurity.

From this overview, the strategic implications of different positions on the technology S-curve become clear. It is crucial to understand the opportunities and vulnerabilities of each phase in order to capitalize on the opportunities and avoid the vulnerabilities.

Of course, what every chief technology officer (and every company) wants to know is, what’s coming next? One way of seeing how technology might unfold is to understand the forces that drive technology and study the pattern of innovations they are generating. Importantly, the forces driving new technology may not come from the industry you serve.

As Saab Rosemount’s Mats Nordlund has said, “If you go to traditional trade shows, you only see what you missed two to three years ago. Instead, engineers should watch those areas that drive the future of technology.” Seemingly unrelated fields such as games, health care, aerospace or defense often generate basic breakthrough technologies that can be applied to other fields, including your own.

Here are four ways to monitor emerging customer needs and potentially disruptive technologies.

- **Trade shows** - See what leading, high-innovation industries are doing. How can you adapt their ideas to your markets?
- **Venture network** - What are start-up companies researching? Are they developing disruptive technologies?
- **Customer insight research** - What unmet needs do customers have that current products are not delivering?
- **Consultants** - Conceptual reviews with consultants (via the Advanced Design Center or Software Center of Excellence) who work closely with many businesses can provide overviews of new market developments.

The bottom-line questions for technology planners become obvious. If the strengths of your business are not aligned with your position on the S-curve, what will it take to change? For example, what are your company’s core strengths in developing technology? Do you have the depth of talent in innovation or product development that you need? Do you have resources focused on potentially disruptive competitors?

If not, should you hire additional engineering talent, should you retain consultants – or, perhaps, both? Do you need to create a “skunk works” separate from your existing engineering group to pursue a new direction? Should you buy another company to acquire its technology?

Finally, the two-part question becomes: Do you want to be rich? Or, do you want to be famous?

Fame goes to the inventor of a disruptive technology. But, remember, the typical disruptive technology has lousy earnings performance. Earnings don’t start to roll in until a technology achieves market acceptance and rapid growth up the steep portion of the S-curve.

A well-known example of a wonderfully inventive company that failed to capitalize on its innovations is Xerox. Researchers at Xerox PARC developed and demonstrated many crucial elements of modern computing, including the graphical user interface, the mouse and Ethernet. But Xerox failed to commercialize many of its most important inventions. Other companies became rich from what Xerox invented but failed to bring to market successfully.
Do you want to be rich or famous? (Or both?)  
Fame goes to the inventor.  
Riches don’t flow until a technology’s mature phase.  
But, remember, nothing lasts forever.

If you decide that you would rather forsake fame for riches, then you want to be on the maturity portion of the S-curve. That’s where the money can really roll in for the company that demonstrates superior performance in product development and operations. This is the kind of business that can capitalize on the maturity phase of the S-curve. On the other hand, it’s also where the danger of being picked off by a disruptive technology always lurks offstage, threatening to upset that revenue stream. So, one must be vigilant.

Another choice – have it all. Choose to be both rich and famous. This option means inventing the disruptive technology and then driving its growth as rapidly as possible up the steep part of the S-curve and fending off competitors all the while with superior technology to cash in on the maturity phase. This choice often requires keeping engineers focused on a product set, possibly at the expense of other product development.

Every business must evaluate its core strengths to decide what strategy will be most successful. Rich-and-famous is the choice Saab Rosemount has pursued and achieved with the TankRadar STaR system. By definition, this shoot-the-moon option isn’t easy. But, if it were easy, every company would do it. And what fun would that be?

Questions for Your Business

Where are my products on the technology S-curve?

What are my company’s opportunities and vulnerabilities?

How are we monitoring potentially disruptive competition and the evolving needs of our customers?

Is my company’s current strategy consistent with the answers to the above questions?

If our products are in the mature phase, what is our strategy for the future?

For readers who would like to learn more about the subject, in 1997 Clayton Christensen wrote the book that made disruptive technology a buzzword in business – “The Innovator’s Dilemma: How Great Firms Fail by Doing Everything Right.” In 2004, Christensen wrote the related book “Seeing What’s Next: Using Theories of Innovation to Predict Industry Change.” The editors of INNOVATIONS thank Dr. Mats Nordlund of Saab Rosemount for his help with this article.
For double-digit cost savings:

Design for sourcing success depends on early involvement of Procurement

In our 2001 INNOVATIONS issue we reported that “In the approximately two years Emerson Procurement has used e-Sourcing, divisions have made about $600 million in purchases via Internet auctions.” In 2005, Emerson companies’ use of e-Sourcing exceeded $1 billion, driving savings of 15 percent and more, according to Craig Doiron, vice president of materials and logistics.

Having demonstrated the effectiveness of e-Sourcing, Procurement now has focused on encouraging Emerson companies to involve its specialists early in the process of designing new products.

The reason for involving Procurement early is simple. It works. Or, as Joann Donelon, manager new product sourcing, says, “When you see the results, this is a no-brainer.”

The “Committed Cost vs. Life Cycle” graph (page 17) demonstrates Donelon’s point. The major cost savings opportunities in a product are locked in early on – in initial conceptual work and follow-up design. Cost reduction opportunities decline rapidly once a product reaches production and cost reduction opportunities approach zero in post-production.

Moreover, as the second graph shows, changes that are made up front in design and development stages can be made with little cost impact. But changes made after a product has been released to production become exponentially more expensive.

Why is this true? “Requalification of a product takes far more effort and far more time and, therefore, costs far more,” Donelon said. “Doing it right early becomes critical to product and program cost.”

The lessons for a product design team include:

- **Sourcing issues** should be considered long before a design is locked in. Procurement’s single point of contact with the design team ensures clear communication for coordination of all inputs.
- **Emerson Preferred Suppliers** should be used to maximize cost and quality leverage over the life of a program.
- **Sole-sourced components** should be avoided, to reduce obvious risk in a product’s supply chain.

Following are examples of benefits Emerson companies have achieved by incorporating sourcing issues up front in their design process.

**ClosetMaid** competes in a dynamic consumer market that demands a continuing flow of imaginative and cost-competitive new products. “Early Supplier Involvement (ESI) has meant huge savings for us,” said Gerry Dennis, director of product management. “It has helped ensure that all new ClosetMaid products are accretive to margins.”

Using e-Sourcing, ClosetMaid has managed to realize double-digit savings even on wire components that it has sourced for many years.

Aside from cost, in areas where ClosetMaid lacks core competency, such as plastic parts, early supplier involvement gives the company valuable design support. “Not only do we get lower costs, ESI helps drive innovation and keeps ClosetMaid at the leading edge,” Dennis said.

**Fisher, Francel and Tartarini** have set “very aggressive cost targets” for a global platform of regulators for commercial and industrial customers. Jim Hawkins, senior engineer at Fisher, said. “The broader goal is market growth” in world markets in which price position has cut into the companies’ ability to compete.
The three companies now have 10 regulator product platforms between them. They intend to reduce that number to three while also increasing product functionality. In the process, the number of suppliers will be reduced by a factor of three, and the number of components will be reduced by more than half.

To achieve these ambitious objectives, “early involvement of procurement is integral. We absolutely must have strategic global sourcing,” Hawkins said.

“For years, we’ve looked back and wished we had had earlier involvement by Procurement. Now we do,” Hawkins said. Emerson Motor Company is the world’s largest manufacturer of motors. So, if anyone knows how to buy laminations for motors, it’s Emerson Motor Company. But even with its unique expertise, Emerson Motor realized significant cost reduction from e-Sourcing.

Dave Duebner, advanced purchasing manager and an engineer for 25 years before joining Procurement about three years ago, said the company specified ISO, QS and other quality certifications from a list of global suppliers known to Procurement. The resulting e-Sourcing auction realized a savings of 22 percent, a level that surprised even the experts.

“As an engineer myself, it’s exciting and fun to be able to help a design team achieve a result that will maximize operating profit on a new product,” Duebner said. “It’s the ultimate win-win.”

Copeland relied on one supplier for a Discus valve plate. The supplier raised prices and generally failed to give Copeland the attention it wanted. When Copeland redesigned the valve plate — saving significant cost — it saw an opportunity to bid the new part competitively.

Copeland senior management participated in a Material Review with Procurement and a Design Review with Corporate Technology’s Advanced Design Center (ADC). After the reviews, the decision was made that it was strategically important to eliminate the former supplier because of the risk it posed as a sole source supplier.

In February of 2006, an e-Source auction was conducted for the management of the supply chain, including required inventory, freight and other costs. Copeland realized a 19 percent savings over the historic cost estimate. Perhaps more important, Copeland no longer was subject to the risks of a sole-source supplier. (The ADC offers a risk tool analysis available on the Web that allows a design team to answer a series of questions about its product that will develop an objective risk measurement.)

Doiron emphasizes that Emerson Procurement “has invested in Asia, Eastern Europe and Latin America so that we have people with product knowledge and a deep understanding of regional capabilities.”

The Asian Pacific Procurement Organization (APPO) is fully staffed. The Central European and Latin American organizations are being expanded and are in development, respectively, Doiron said.

“We have the feet on the street to implement a global supply chain strategy that can identify and qualify best-cost country sources,” Donelon said. “This capability will be a real differentiator for Emerson.”
Demonstrating the highly competitive nature of Emerson’s Operational Excellence Awards, Emerson Hermetic Motors, the world’s largest hermetic motor manufacturer, entered in 2002 but did not make it.

After missing out in 2002, the company conducted strategic gap analysis to see where it most needed improvement. Then, Hermetic Motors engaged in intense Performance Excellence (Perf(x)) training, beginning with top management and extending through the rest of the organization, to gain employee involvement and align plant and personal objectives.

Training is critical. For example, an operator receives 120 hours (80 on-the-job/40 classroom) training “before even touching the product,” Lars Gacad, vice president quality, said.

Training also has been critical because the company introduced 126 new models of hermetic motors from 2004 to 2006 to support Copeland. In the process, Hermetic Motors developed new technologies for polygon rotors and Scott T stators and launched a new rotor cell that eliminates boring and grinding, cutting cycle time about 80 percent.

“The employee focus and intense training paid off in a more than 50 percent reduction in lost time accidents and more than 70 percent decrease in lost work days from 2002 to 2005. Worker compensation costs also were reduced by more than 25 percent,” Gacad said.

Top management championed the cause. Quarterly, members of an executive quality council would hold a web and telephone conference with the company’s four plants located in China, Mexico, Thailand and the United States. After four years of this, “Communications between plants has opened up, and the interchange is beautiful. The operations guy in China calls his counterpart in Russellville, Kentucky, and they talk through problems and share best practices,” Gacad said.

Hermetic Motors improved its processes by implementing Six Sigma in all its plants. It completed more than 120 Black and Green Belt Six Sigma projects with an ROI that exceeded $5 million.

The Policy Deployment PDCA process – Plan, Do, Check, Act – was institutionalized to focus resources on high-return projects and align plant and company objectives. The “catchball” process of exchanging ideas on objectives and focusing attention on problems also provided alignment and interaction.

Here are examples of critical business results that Hermetic Motors achieved in fiscal years 2001 to 2005.

• Improved ROTC by a factor of three times.
• Reduced cost of quality as a percentage of sales from 2.9 to 1.6 percent.
• Improved customer acceptance by a factor of more than two times.
• Reduced scrap by more than 60 percent.
• Increased plant productivity by an average of 4.7 percent per year.
• Established a certified high school program that graduated 25 employees in the program’s first year.

(Graduates throw their hats in the air above.)
Liebert Global Services provides preventive maintenance, repair and monitoring services for an installed base of more than 30,000 UPS (Uninterruptible Power Supply) and 20,000 power distribution systems, mostly in the continental United States.

A network of more than 340 customer engineers in 80 locations supported by an additional 200 people serve customers such as Wal-Mart, Northwest Airlines, JP Morgan Chase and Time-Warner Cable.

“Communications is the key in our service business,” said Jim Benson, vice president field operations. “We have to be certain that each customer engineer understands his or her role in achieving our customer satisfaction goals.”

Liebert has aligned individual and group goals through a focus on key performance indicators. Each of the company’s 16 district managers conduct quarterly communications meetings for their 18-24 customer engineers in which they review each individual’s performance on customer satisfaction ratings and group performance. Then the group establishes goals for the following year. (The company prefers not to exceed 24 customer engineers per district because it believes that a larger number could reduce communication effectiveness.)

“This process ensures that everyone has a crystal clear, measurable role in customer satisfaction,” Benson said.

“The process also ensures consistency. We’re not talking about new programs or a change in direction. Our messages and our focus stay the same, quarter after quarter and year after year.”

Like its Emerson counterparts in manufacturing, Liebert Global Services uses tools such as Six Sigma and has a full-time Black Belt trainer on staff. In 2005, the company had three black belts, eight green belts and 15 yellow belts in training.

For FY 2006, Liebert has 11 projects under way with anticipated cost savings of more than $370,000.

Following are examples of the performance results that Liebert Global Services has achieved.

- 98 percent of customers said they were “satisfied” or “very satisfied” with Liebert service, the fourth consecutive annual improvement in this ranking.
- More than 70 percent of customers said they “definitely” would recommend Liebert, also the fourth consecutive year of improvement for this ranking.
- Achieved their goal for sales growth, up 9 percent to $170 million, and an outstanding ROTC.
- Generated $260,000 in savings in 2005 by eliminating errors in subcontracted work assignments and invoicing.
- Reduced direct labor turnover by a factor of almost three times from 2001 to 2005.
- Improved employee opinion survey scores from 2002 to 2004.
- Implemented the Enterprise Project Management system to support project planning, collaboration and portfolio management.
*Beijing Rosemount Far East Instrument Co., Ltd. (BMMC), established in 1996, and Emerson Beijing Instrument Co., Ltd. (EBIC), formed in 2002, share a common location in a world-class manufacturing facility and employ more than 300 people. BMMC manufactures and distributes pressure, temperature, level and flow transmitters to trade customers in China. EBIC manufactures pressure subassemblies for Rosemount pressure transmitters for worldwide distribution.*

The companies began implementation of Lean Manufacturing techniques in 2001. In 2005, the facility provided 38 hours of training per employee, completed eight Kaizen events and a number of 5S projects. (5S is a process for organizing, cleaning, developing and sustaining a productive work environment.) Both companies are certified to ISO9001 Quality Management System and ISO14001 Environmental Management System.

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**PRESIDENT’S Operational Excellence Award**

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Astec Power is a worldwide leading supplier of AC-DC and DC-DC power conversion products from 1 watt to 6 kilowatts. Its customers include all major telecom, computing and mobile phone manufacturers.

The Luoding facility is aggressive when it comes to cost savings. “We track and pursue savings as little as 0.1 cents per piece,” says George Foo, vice president of Astec’s Asia operations.

The Luoding’s facility’s operational excellence “has led to Astec being the dominant player in the cell phone charger business, where we are taking major share from our competitors,” Foo said.

Foo credits Lean Manufacturing and the creation of an environment in which change and fast execution are embraced by everyone for the facility’s superior results. Lean Manufacturing training includes an average of 20 hours of training for operators per year and 40 hours for staff.

Some of Luoding’s performance results include:

- Improved ROTC by a factor of three times.
- Improved inventory turnover by 170 percent in three years.
- Manufacturing cycle time has been cut by 45 percent in three years.
- Scrap has been reduced 50 percent in three years.
- World-class quality has resulted in virtually no rework.

The bottom line of Luoding’s performance in quality and cost to George Foo is his projection that Astec can grow the business for mobile phone chargers by at least 50 percent in 2006.

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“Rosemount Beijing operates a world-class manufacturing facility with great growth and excellent operational performance,” said Scott Olson, general manager. “We focus on continuous improvement through Lean and employee involvement.”

Selected results from the two companies include:

- BMMC reduced average work order process lead time from 11 days in FY 2004 to eight days in 2005.
- Inter-company delivery performance improved to 96 percent for EBIC, with an average lead time of 2.5 days.
- Cost reductions, material containment and direct buys added $2.6 million to net earnings in 2005.

The companies’ combined sales totaled $83 million in FY 2005. Sales increased more than 20 percent for BMMC and more than 100 percent from the previous year for EBIC.

Established in 1999, the White-Rodgers Chihuahua plant manufactures appliance and RV gas valves, electronic boards for furnace ignition controls, commercial water heaters and European oven temperature controls and ignitors for major OEMs.

Every new facility needs a significant period of time to reach standard hour estimates for production. The Chihuahua facility has compressed that time by adopting the Lean philosophy.

A Chihuahua innovation that fits the Lean philosophy of involvement has changed operators’ traditional end-of-shift tidying-up period. Chihuahua moved the 10-minute period to mid-shift and has turned it into an employee involvement and communication session.

“Operators know when their machines and equipment are working properly. The mid-shift meeting provides an opportunity for problems or concerns to be made known,” Eugene Moore, senior vice president of operations, said. “If we waited until the end of the shift, human nature is to clean up and go home without critical information being communicated.”

In the first half of the period, operators inspect their machines and take their findings to coordinators who record them so that corrective action may be taken.

In the second five minutes of the period, employees and supervisors discuss a rotating schedule of maintenance topics and other subjects such as safety, health or personnel services.

“It’s been a very positive experience that builds involvement, understanding and support,” Moore said.

The Chihuahua facility’s results reflect strong employee involvement.

- On-time delivery to request exceeds 95 percent.
- Equipment and machinery down time reduced by 50 percent.
- Productivity improved by a factor of more than three times since opening.
- Cost reductions averaged $800,000 per year for four years.
“Emerson engineers earned a record number of patents in 2005. I salute your achievement and challenge all Emerson engineers to keep our patent trend line moving up.”

Randall D. Ledford
INNOVATIONS PATENTS FOR 2005

ROUN T ELECTRIC MACHINE HAVING A FLUX-COMMUTATING ROTOR AND A STATOR WITH WINDBINGS ON TEETH
Philippe Augier
Eric Coupart
Pascal Gauchere
Jacques Saint-Michel
Christophe Gilles
Andre Eydelle
Laurent Judeau
Atel Abou Akar

ROBOT ELECTRIC MACHINE WITH FORCED VENTILATION
H. Duong

ROVATING ELECTRIC MACHINE
H. Duong

ROVATING ELECTRIC MACHINE HAVING 1 STATOR AND 2 ROTORS
Atel Abou Akar
Jacques Saint-Michel

STATOR FOR ROTARY ELECTRIC MACHINE
Dominique Condamin
Jean Gaste

LIEBERT
AN EQUIPMENT OF CABLE CONNECTION
Qiu Hongjie
Lan Qiong
Yang Yaping

APPARATUS AND METHOD FOR A RAPID FAULT DETECTION AND TRANSFER IN A ULTILITY-INTERAC TIVE UNINTERRUPTIBLE POWER SUPPLY
Robert W. Baker
Jeff M. Powell

DEVICE PARTICULARLY FOR REDUCING THE NOISE EMITTED BY AIR CONDITIONERS
Alberto Doria
Paolo Tarquinini
Stefano Strapparava

INTERACTIVE SENSORS FOR ENVIRONMENTAL CONTROL
Lenoart Stah
Christian Belady

METHOD AND APPARATUS FOR TRANSFER CONTROL AND UNDERVOLTAGE DETECTION IN AN AUTOMATIC TRANSFER SWITCH
Elliot Hohn

REMOTE DISTRIBUTION CABINET
Robert E. Baker
Michael R. Harper
James K. Martin
Randall F. Mathis

SURGE ARRESTOR
Dan Buchanan
Bryan Cole
Andrew L. Gardiner
Mark Matson
Tanya Varjason
Glen E. Wilson

UNINTERRUPTIBLE POWER SUPPLY K.J. Bell
T. Bush
K.K. Eschofen
J.R. Funk
B.P. Heber
F. Kafapo
A. Margraf
M.N. Marshall
N.J. Norris
R.R. Rautenstrauch
R.L. Shetter Jr.
R. Shenoy
R. Subramanian

MICRO MOTION
ADJUSTABLE VOLTAGE CONVERTER UTILIZING A CHARGE PUMP
Bill Mansfield

APPARATUS FOR AND A METHOD OF FABRICATING A CORIOLIS FLOWMETER FORMED PRIMARILY OF PLASTIC
Greg Lanham
Tony Pankratz

CORIOLIS FLOWMETERS USING FIBERS AND ANISOTROPIC MATERIALS IN A BALANCE SELECTED VIBRATIONAL FLOWMETER CHARACTERISTICS (COMPONENTS)
Craig VanCleave

CORIOLIS VISCOMETER USING PARALLEL CONNECTED CORIOLIS MASS FLOWMETERS
Roger Loving
Craig VanCleave

CORRECTION OF CORIOLIS FLOWMETER MEASUREMENTS DUE TO MULTIPHASE FLOWS
Robin Dutton

DETERMINISTIC SERIAL BUS COMMUNICATION SYSTEM
Tom Cheng
Paul Hays
Al Samson
Jeff Wood
Mike Zolock

DRIVE CIRCUIT MODAL FILTER FOR A VIBRATING TUBE FLOWMETER
Tim Cunningham

DRIVER FOR OSCILLATING A VIBRATING TUBE FLOWMETER
Bill Mansfield

FLOWMETER CALIBRATION SYSTEM WITH STATISTICAL OPTIMIZATION TECHNIQUE
Marc Butler
Bob DeBoom
Julie Coffie
Joe Longo

GENERALIZED MODAL SPACE DRIVE CONTROL SYSTEM FOR A VIBRATING TUBE PROCESS PARAMETER SENSOR
Tim Cunningham
Stu Shelly

GYROSCOPIC MASS FLOWMETER
Roger Loving
Craig VanCleave

HIGH TEMPERATURE DRIVE SYSTEM FOR A CORIOLIS MASS FLOWMETER
Dave Campenwell
John McCarthy
Kurt McCormick
Dan McNulty

I/O SIGNALING CIRCUIT
Bill Mansfield

IMPROVED VIBRATING CONDUIT PROCESS PARAMETER SENSORS, OPERATING METHODS AND COMPUTER PROGRAM PRODUCTS UTILIZING COMPLEX MODAL ESTIMATION
Tim Cunningham

INITIALIZATION ALGORITHM FOR DRIVE CONTROL IN A CORIOLIS FLOWMETER
Rick Maginnis

INTEGRATED CURRENT SOURCE FEEDBACK AND CURRENT LIMITING ELEMENT
Bill Mansfield

LATERAL MODE STABILIZER FOR CORIOLIS FLOWMETER
Curt Ollila

LINEAR ACTUATOR
Roger Loving
Tony Pankratz

LOW TEMPERATURE STRESS CASE CONNECTED TO A STRAIGHT TUBE CORIOLIS FLOWMETER
Curt Ollila

MASS FRACTION METERING DEVICE
Tom O'Banion
Tim Patterson
Julie Valentine

MEMORY PROTECTION SYSTEM FOR A MULTI-TASKING SYSTEM
Tom O'Banion
Paul W. Gress
James E. Hamm

METHOD AND APPARATUS FOR BONDING A CONNECTING RING TO A TORIC AND A BALANCE BAR HAVING DIFFERENT THERMAL COEFFICIENTS OF EXPANSION IN A CORIOLIS FLOWMETER
Craig VanCleave

METHOD AND APPARATUS FOR MEASURING PRESSURE IN A CORIOLIS MASS FLOWMETER
Tanal Bose
Howard Derby
Andy Levin
Tony Pankratz

MULTIFLUX FLOW MEASUREMENT SYSTEM
Robin Dutton
Chad Steele

MULTI-RATE DIGITAL SIGNAL PROCESSOR FOR SIGNALS FROM PICK-OFFS ON A VIBRATING CONDUCT
Denis Henrot

PROCESS PARAMETER SENSOR APPARATUS, METHODS AND COMPUTER PROGRAM PRODUCTS USING FORCE FILTERING
Dave Normen

PROGRAMMABLE CORIOLIS FLOW ELECTRONICS FOR OUTPUT-ING INFORMATION OVER A SINGLE OUTPUT PORT
Paul Hays
Bill Mansfield

SELF-CHARACTERIZING VIBRATING CONDUT PARAMETER SENSORS AND METHODS OF OPERATION THEREOF
Tim Cunningham
Stu Shelly

SENSITIVITY ENHANCING BALANCE BAR
Greg Lanham
Chuck Stack
Craig VanCleave

STRAIGHT TUBE CORIOLIS FLOWMETER
Greg Lanham

SYSTEM FOR PREVENTING TAMPERING WITH SIGNAL CONDITIONER REMOTE FROM A HOST SYSTEM
Mike Keilty
Al Samson

SYSTEM FOR SETTING FRAME AND PROTOCOL FOR TRANSMISSION IN A UART DEVICE
Paul Hays
Bill Mansfield

SYSTEM FOR VALIDATING CALIBRATION OF A CORIOLIS FLOWMETER
Tim Pattn

TYPE IDENTIFICATION AND PARAMETER SELECTION FOR DRIVE CONTROL A Coriolis FlowMeter
Rick Maginnis

INTEGRATED FUNCTIONAL ELEMENTS AND MINIMIZATION OF IMPERFECT ELEMENTS
Bill Mansfield

UNIVERSAL INPUT TO DC OUTPUT CONVERSION CIRCUIT
Bill Mansfield

VIBRATING CONDUT PARAMETER SENSORS, OPERATING METHODS AND COMPUTER PROGRAM PRODUCTS UTILIZING REAL NORMAL MODAL DECOMPOSITION
Tim Cunningham
Dale Normen
Gary Pawlas
Stu Shelly

DRAIN TUBE ASSEMBLY FOR ARTICULATING CIRCUIT AND ACTUATOR
Richard R. Bowles
Paul W. Gress
James E. Hamm

DRAIN CLEANER
Michael J. Rutkowski
Jon R. Dunkin

DRAIN CLEANING APPARATUS
Michael J. Rutkowski

FEED CONTROL DEVICE FOR PLUMBING TOOLS
Jon R. Dunkin
Michael J. Rutkowski

OIL DISPENSER CONTAINER
Jonathan M. Iwamasa
Steven K. Morris

POWERED DRAIN CLEANER
Michael J. Rutkowski
Jon R. Dunkin

ROLL GROOVING APPARATUS
James E. Hann
Randy S. Y. Sim

SUPPORT FOR MOUNTING A PIPE ON A TOOL
Robert M. Barcaski
Richard R. Bowles

TUBE CUTTER
Larry Babb

ROSEMOUNT
AUTO CORRECTING TEMPERATURE TRANSMITTER WITH RESISTANCE BASED SENSOR
Evren Eryurek
Jogesh Warrior

BI-DIRECTIONAL DIFFERENTIAL PRESSURE TRANSMITTER
David A. Broden
David E. Wicklund
Terrance F. Krouth
David A. Broden
Mark S. Schumacher

CAPACITIVE PRESSURE TRANSMITTER
David A. Broden
David A. Horky

CHARACTERIZATION OF PROCESS PRESSURE SENSOR
David A. Broden
Timothy P. Fogarty
David E. Wicklund
Terry X. Beachey
Mark S. Schumacher

COMPACT TEMPERATURE TRANSMITTER WITH IMPROVED LEAD CONNECTIONS
Dirk Bauchache
Heep Nguyen

DATA BUS COMMUNICATION TECHNIQUE FOR FIELD DEVICE
David Tetzlaff

DEVICE IN A PROCESS SYSTEM FOR DETECTING EVENTS
Evren Eryurek
Jogesh Warrior

DIAGNOSTICS FOR INDUSTRIAL PROCESS CONTROL AND MEASUREMENT SYSTEMS
Marcos Peloza
Dale Borgeson
Greg Rome
Evren Eryurek
Lester Roper

DIFFERENTIAL PRESSURE FLOW METER WITH INTEGRATED PRESSURE TAPS
Lowell Kleven

ELECTRO-OPTIC INTERFACE FOR FIELD INSTRUMENT
Michael Smith
George Easler

FIELD BASED PROCESS CONTROL SYSTEM WITH AUTO-TUNING
Henhong Zou
Kale Henderson
Jogesh Warrior
Coy Hays

FIELD INSTRUMENT WITH DATA BUS COMMUNICATIONS PROTOCOL
David Tetzlaff
Jogesh Warrior
Gabriel Malouf
2005 External Awards and Recognition

**EMERSON CLIMATE TECHNOLOGIES**
- Intelligent Store Monitoring Software
- AHR Expo Innovation Award
- UltraTech Home Series
- Copeland Scroll Digital for Commercial A/C
- Intelligent Store Discus Compressor
- AHR Expo Innovation Award Honorable Mentions
- Intelligent Store Discus
- Honorable Mention
- 2005 ACHR News Dealer Design Awards
- Copeland Integrated Products Division
- 2005 Nor-Lake Supplier Award
- Comfort Alert™ Diagnostics
- 2005 Comfortech Product Showcase Award
- Jean-Luc Caillat
- 2005 Richard C. Schulze Award
- Air-Conditioning and Refrigeration Institute

**EMERSON MOTOR TECHNOLOGIES**
- Emerson Ventilation Products
- Excellence in Sales & Marketing 2005
- Johnstone Supplier Award
- Gold Award for Environmental Compliance
- Johnson County, Kansas

**EMERSON NETWORK POWER**
- ASCO Power Technologies
- North American Automatic Transfer Switch
- 2005 Market Leadership through Competitive Growth Strategy Award
- Frost and Sullivan
- Astec Power
- iMP Digital Switching Power Supply
- DTX Digital DC Converter
- Products of the Week
- EE Times
- DS657 AC/DC Power Supply
- AIF-300Vin Series DC/DC Converter
- LP550 Series AC/DC Switching Power Supply
- DS Series (450W and 550W)
- Products of the Week
- EE Product News
- DS657 AC/DC Power Supply
- Eleventh Annual Engineering Awards 2005 – Finalist
- Product Design & Development
- LPS173 Switching Power Supply
- Best Products of the Year Design News
- Cavite Plant
- Best Employer
- Philippine Export Zones Authority
- Fu Yong Plant
- Shenzhen Top 100 Enterprise
- Shenzhen Enterprise Association
- China Plants
- Green Partner Award
- Sony
- Gold Supplier Award
- Hewlett-Packard
- **Emerson Network Power-China**
- Emerson High Power UPS
- 2005 Best Channel Policies Continuity Award
- Computer Partner World
- Emerson High Power UPS
- Best Brand Recognition Award
- Computer Partner World
- Emerson Network Power UPS Products
- Excellence in 20 Years
- China Computer Users of CCID Group
- Emerson Hiplant UPS
- 2004 Products Award
- China Computer World
- 2005 China Computer Business 500 – Top 100 Suppliers
- Computer Partner World
- Excellence in 20 Years
- China Computer Users of CCID Group
- 2005 China Telecom Best 100 Suppliers
- China Internet Weekly
- Emerson Total Power Solution for E-government IDC
- Emerson Total Power Solution for Telecom
- Emerson Total Power Solution for Financial IDC
- Emerson HiPulse 7000 UPS
- 2004 Editors’ Choice Awards
- China Computer World
- Emerson Total Solution
- 2004 China Telecom Solution User Satisfaction Award
- China Information Industry Electronic Development Research Institute
- Emerson Telecomm Products
- Midwest Microwave
- Raytheon Integrated Defense Systems
- Strategic Supplier
- Liebert
- iCOM Control System
- Gold Award for Commercial Controls
- ACHR
- iCOM Control System
- Gold Award in Controls Category
- Consulting-Specifying Engineering (CSE) Magazine
- DS Precision Cooling System
- Honorable Mention in Commercial Category
- ACHR
- STS2/PDU Static Transfer Switch
- Bronze Award in Power Generation/Emergency Power Category
- Consulting-Specifying Engineering (CSE) Magazine

**EMERSON TOOLS AND STORAGE**
- ClosetMaid
- Golden Hammer Award
- Home Center News
- Emerson Tool Company
- Stinger 2 Gallon Wet/Dry Vacuum Cleaner
- “Best Buy” Rating
- Consumer Digest
- Sears 16 Gallon Detachable Blower Wet/Dry Vacuum Cleaner
- #1 Wet/Dry Vacuum Cleaner Performance Rating
- Ridgid 16 Gallon Professional Wet/Dry Vacuum Cleaner
- #2 Wet/Dry Vacuum Cleaner Performance Rating
- American Woodworker Magazine
- In-Sink-Erator
- Fashion Plumbing Supplier of the Year
- Lowes Companies, Inc.
- Ridge Tool
- NavITrack Float Sonde
- Editor’s Choice Award
- HPAC Magazine
- Quick-Acting Tubing Cutter
- 2005 Top Products
- PHC News
- Stack-A-Shelf
- Target Partner Award of Excellence

**EMERSON INDUSTRIAL AUTOMATION**
- Asco Controls
- PowerPulse Valves
- IF Product Design Award 2006
- Branson Ultrasonics
- Green Circle Environmental Award
- State of Connecticut
- Nuevo Laredo Plant
- Nuevo Laredo Industrial Development Award
- NL Maquiladoras Safety Award
- Emerson Power Transmission
- PN Gold Bearings
- Product of the Year Finalist
- Plant Engineering Magazine
- Valparaiso Facility
- Highly Protected Risk Award 2005
- Factory Mutual Global
- McGill Manufacturing
- Governors Century Award
- Indiana Historical Society

**EMERSON PROCESS MANAGEMENT**
- Emerson Process Management
- Best Supplier of Process Management Technologies
- for the 12th Consecutive Year
- Twenty-eight #1 Reader’s Choice Awards
- Nine #2 Reader’s Choice Awards
- Control Magazine
- #1 Service Supplier in the Process Industry
- More than three times the reader votes over the nearest competitors
- Control Magazine
- Top 50 Award
- #1 Emerson Process Management
- Control Magazine
- Hottest Companies of 2005 (8th consecutive year)
- Start Magazine
- 2005 Process Control & Industrial Automation Company of the Year
- Frost & Sullivan
“Best Technologies Provider” in seven product categories
2005 Readers’ Choice Awards
Chemical Processing Magazine

Best Supplier of Process Management Products
2005 Readers’ Choice Awards
Plant Services Magazine

Asset Optimization
AMS Optimizer
Eastman Chemical Tennessee Facility
American Chemical Council Energy Award
Best Balancing Instrumentation and Vibration Analysis
2005 Readers’ Choice Awards
Plant Services Magazine

CSI 9210 Machinery Health Transmitter
2005 Product of the Year Finalist
Plant Engineering Magazine

CSI 9210 Machinery Health Transmitter
2005 Editors’ Choice Award Finalist
Control Engineering Magazine

Instrument & Valve Services, Gonzales, Louisiana
OSHA Star Site Award

Fisher Valve Division
2005 Vertical Market Penetration Leadership Award
Valves and Actuators
Frost & Sullivan

Best Valves and Actuators
2005 Readers’ Choice Awards
Plant Services Magazine

Best Enterprise Content Management System
Extranet Implementation of the Year
Stellent Inc.

Best Implementation of Enterprise Content Management System
Integrated Solutions Magazine

Enterprise All Star Award
Network World Magazine

Micro Motion
Best Flow Meters
2005 Readers’ Choice Awards
Plant Services Magazine

2005 Flow Meter Vendor of Choice Award
Food Processing Magazine

Mass & Volume Flow Sensor
2005 Innovations Award
Flow Control Magazine

2005 Product of the Year Finalist
Plant Engineering Magazine

Process Systems & Solutions
2005 Market Leadership Award
DCS Market for Pharmaceutical Applications
Frost & Sullivan

2005 Technology Leadership Award
Food & Beverage Industry
Frost & Sullivan

DeltaV
2004 Product of the Year Award
Control Engineering China Magazine

DeltaV SIS
Palmares 2005 Award
Measures Magazine

DeltaV SIS
2005 Breakthrough Product of the Year
Processing Magazine

DeltaV SIS
Editor’s Choice Award and Engineers Award
Control Engineering Magazine

Excellent Supplier Award
Lanzhou Petrochemical

Excellent Supplier Award
BP-SECCO

2005 T&B Enabler Awards
Shell Deer Park
Norske Canada
Start Magazine

2005 Safety Award—Contractor Merit
NPRA

Regulator Division
Supplier of the Year
ComGas (Brazil)

Rosemount
Best Flow Meters
2005 Readers’ Choice Awards
Plant Services Magazine

Flow Transmitter
2005 Innovation Award
Flow Control Magazine

Flow Measurement
Level Measurement
Pressure Measurement
Temperature Measurement
2005 Readers’ Choice Awards
Control Design Magazine

Pressure Transmitter
2005 Product of the Year
Control Engineering China Magazine

#1 Flow Meters
2005 Readers’ Choice Awards
Plant Services Magazine

Supplier Excellence Award
Eastman Chemical

Saab-Rosemount Radar
2005 Technology of the Year
Frost & Sullivan

Saab-Rosemount
2005 Samsung Quality Gold Medal Award

Rosemount Flow Group
Flow Meters
2005 Readers’ Choice Awards
Food Processing Magazine

Rosemount Analytical
ISA, GFT Award

Best Paper Presented
ISA Analysis Division 2005 Spring Session

Strategy Leadership Award
Process Analytical Instrumentation Market
Frost & Sullivan

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