Mechatronics has evolved into a broad range of easy handling solutions, allowing customers to select tools from a menu of standard products (courtesy of Bosch Rexroth).

Project Integration

DESIGN ENGINEERS ADAPT TO MODERN DAY MECHATRONICS

Matthew Jaster, Associate Editor

Though the original definition of mechatronics derived from the Yasakawa Electric Company in the late 1960s (the company won trademark rights for the term in 1973), the word has remarkably evolved. It was originally coined as a term for electromechanical systems or control and automation engineering. Today, mechatronics combines mechanical, electrical and computer systems into an integrated solution—and that's still merely scratching the surface.

For the purpose of our *PTE* audience, mechatronics incorporates products like microprocessors, sensors, actuators, circuit boards together with mechanical components to create an integrated machine package. The software provides analysis, simulation and optimization tools. The trick is putting it all together as a single, cohesive unit. This mechatronic "magic" so to speak is developed with the engineer in mind in order to provide a better value to the end customer. The advantages of product integration with mechatronics in today's manufacturing environment are limitless.

"First, there are fewer variants to purchase—one component can perform the function of multiple mechanical variants. A second advantage is the ability for self diagnostics of components—wouldn't it be nice if your Christmas lights could tell you which bulb needed replacing? That's what self diagnostics brings. Finally, there is the inherent potential to use the feedback from the mechatronic component to dynamically improve the quality and consistency of your products," says Mark Hinckley, director mechatronics platform, SKF USA Inc.

"One of the greatest advantages is the opportunity to increase machine performance while simultaneously decreasing energy consumption. In concert with that, if a machine builder

Rockwell Automation's *Motion Analyzer* software helps machine builders evaluate design alternatives (courtesy of Rockwell Automation).

uses digital modeling and simulation to achieve these ends, they are accelerating innovation while decreasing time-to-market and mitigating risk," says John Pritchard, global marketing development manager, Integrated Architecture, Rockwell Automation. "With mechatronics, there may be a greater upfront investment of time in the initial design process but the return on investment is quickly recouped."

Software & Hardware

For Rockwell Automation, the initial mechatronic focus was to create design tools that integrated mechanical information. Today, Rockwell is still investing heavily in mechatronic design tools by integrating its *Motion Analyzer* software with Dassault Systemes *SolidWorks* solutions. Rockwell Automation offers both software and hardware mechatronic products, according to Pritchard. "*Motion Analyzer* software helps machine builders evaluate design alternatives to facilitate a reduction in motor and drive size, help maximize the percentage of power applied toward moving the load and increase the stability of the system. For mechatronic hardware, Rockwell Automation offers linear and rotary direct-drive motors, integrated drive motors, and electric cylinders."

"Over the last few years the design and analysis request from our users has evolved into a multi disciplinary requirement where the multiple impact points on a design have to be simultaneously evaluated," says Stephen Endersby, product manager at Dassault Systemes. "*SolidWorks Motion* and *Event Based Motion* are two features that can analyze mechanical systems, calculating actuator forces, motor torques etc. The motion calculation can be controlled by Rockwell Automation's *Motion Analyzer* and National Instrument's *LabView*, which can act as the motion controller. With this combination you can virtually prototype your machine, ensuring product quality and performance."

Recently, mechanical and control industries have been increasing collaboration through organic growth, partnerships and acquisitions. All evidence indicates that the trend will continue and that machines will be built using evermore highly-integrated mechatronic sub-systems. "Although the lead time for sophisticated systems might be longer, the time required to install, configure and commission a system could potentially be less overall—which is complimentary to a just-in-time environment," Pritchard says.

A Broad Range of Capabilities

SKF's experience in the mechatronics field dates back to the late 1960s and expanded further in the late 1970s. In 1968, SKF acquired Transrol, a French company that specialized in the manufacture of ball and roller screws. Then in 1976 SKF invested in the startup of another French company named S2M,

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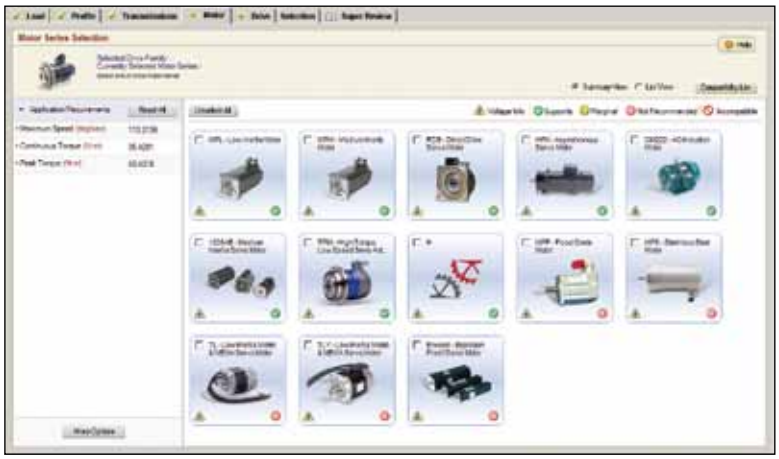
SKF's mechatronic solutions are based on the company's strength in mechanical systems that incorporate smart controls (courtesy of SKF).

focusing on electromagnetic levitation. In 1977 SKF began manufacturing industrial actuators in Gothenburg, Sweden. These early activities have been supplemented over the years with additional developments and acquisitions.

Today, mechatronics is one of five Knowledge Platforms within SKF, together with Bearings & Units, Seals, Lubrication Systems and Services. The range in each category is quite extensive, with customers encompassing a range of industries and applications.



Rockwell's *Motion Analyzer* software can assist engineers in reducing motor and drive size (courtesy of Rockwell).

"Some of our most recent products have proven popular with our customer base, including a newly designed actuator for solar applications, actuators designed for off-highway and outdoor equipment and SKF's new line of profile rail guides, just to name a few," Hinckley says. "SKF's knowledge in mechatronics is firmly based on our strength in mechanical systems while incorporating smart controls to enhance performance for our customers' value. Our portfolio of products includes mecahtronic solutions for actuation systems, linear motion, magnetic systems and sensor bearings."

These products have been well received in part due to the increased awareness among SKF customers for how environmental impact and energy costs affect SKF's decisions. Other factors driving consumer choices include the search for increased productivity and efficiency, and the desire to minimize variance and manage the total cost of ownership.

"Many OEMs who, like SKF, have made a commitment to minimizing their impact on the environment use mechatronics to deliver green solutions, such as the movement of solar panels to track the sun and thus help optimize the power generated by the panel."

There have been some significant changes in the mechatronics area over the past five years, Hinckley adds. "Some of these changes involve customer and end-user acceptance of mechatronic solutions in the equipment they build or purchase. As the acceptance of integrated electronic and mechanical systems has increased, more OEMs are able to take advantage of smart functionality and integrated packaging."

As an example, an OEM in the HVAC industry has applied SKF's high-speed permanent magnet motors which use magnetic bearings. "With this application they are able to significantly reduce the number of mechanical variants typically associated with the traditional gear drive machines. Features that would have required different options in the gearbox can now be managed by changing the programming of the variable speed motor," Hinckley adds.

A potential disadvantage mentioned earlier was the cost associated with mechatronic solutions. "There is a higher per piece price associated with mechatronics, though the total cost of integrating the solution is often equal to or less than the traditional solution's total cost."

Another argument is that in today's just-in time environment combining electronic and mechanical solutions can actually make the job more complex for the design engineer.

"Certainly the systems are different. But whether they are more or less complex depends on your past experience and the way you choose to integrate the mechatronic solution. Many times our engineers, who may have traditionally interacted with the mechanical designer, will find they are working with an electrical engineer at the OEM," Hinckley says. "This highlights the importance of partnering with a company like SKF that has a strong mechanical foundation behind our mechatronic solutions. It allows the OEM to be able to focus on the electrical interface, without needing to be so concerned over the selection of the mechanical components."

A Focus on Cost Savings

Mechatronics first came onto the scene in Bosch Rexroth under Rexroth Automation Systems (RAS). The charter of RAS was to combine the technologies of the different divisions of Bosch Rexroth to provide customers with integrated multi-discipline solutions. Mechatronics at Bosch Rexroth today has evolved into a broad range of easy handling solutions, allowing

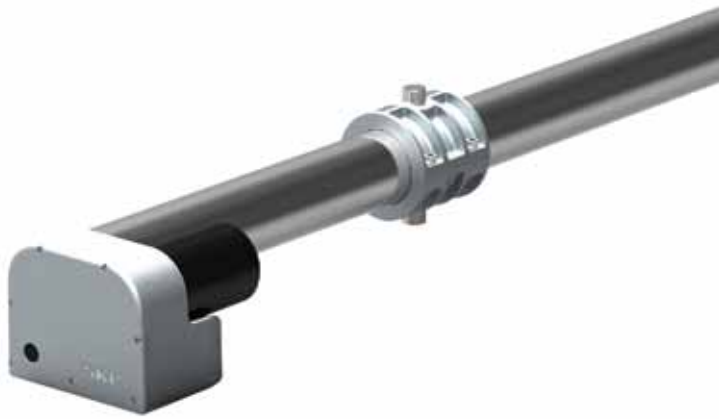
customers to specify custom mechatronic solutions from a menu of standard products utilizing online selection tools like Easy Select.

"Our newest offering in mechatronics solutions is our Easy Handling product line," says Joel Galliher, director—mechatronic systems at Bosch Rexroth. "Customer response on our Easy Handling offering has been very positive as it gives them the tools to be able to specify, order, install and commission mechatronic solutions to meet their application needs with cost savings of up to 80 percent."

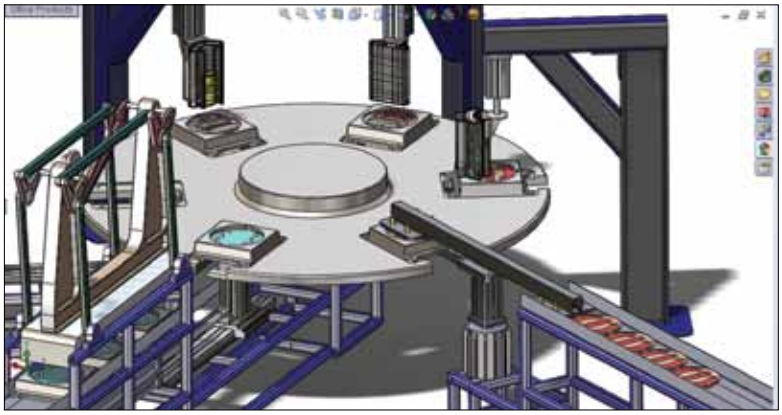
Galliher points to recent economic conditions, saying that many companies have downsized their engineering resources in recent years. "Trends are to utilize the limited resources on core competencies that are market differentiators for the OEM. The integration of electronic and mechanical products for part handling has been outsourced to the motion industry experts."

He feels that leaders in the motion industry will need to respond to provide this competency to the market. Additional trends toward more online engineering tools, "apps" and E-commerce will force the mechatronics suppliers to develop more "easy to use" interactive tools. Additionally, the customer base wants one company to be responsible for the complete system performance. "One part number—one person to call," Galliher adds.

"One of the biggest advantages in exploring a mechatronics solution on the manufacturing floor is the increase in productivity. Properly selected mechatronics solutions can increase capacity and throughput without increasing fixed cost. Today, energy efficiency is a key decision factor when adding equipment in the production environment. The cost of energy continues to rise and environmental concerns all are considerations in the total cost of ownership. Mechatronic systems that utilize regenerative power drives are examples of energy efficient solutions."



One of SKF's recent mechatronic solutions included this newly designed actuator for solar applications (courtesy of SKF).



***Solidworks* can analyze mechanical systems by calculating actuator forces, motor torques, etc. (courtesy of Dassault).**

And the best way to get these mechatronic solutions into the hands of the engineers?

"More traditional organizations have a clear separation between the electronic and mechanical engineering disciplines. Highly integrated mechatronic solutions may make it difficult to decide who does what," Galliher says. "My counter argument is a properly selected highly integrated mechatronic solution will far outperform a segregated solution."

The Mechatronic Message

So, what does the industry itself need to do to get more engineers onboard and create a more unified mechatronic approach on the shop floor? "Certainly there is a need for more education in this field starting with the basic definition of mechatronics today," Galliher says. "As mentioned before, the education and the tools need to be provided in the environment young engineers operate in today…via the internet and apps."

Dassault Systemes have found that the investment into the educational space (universities and school) is time well spent in creating a generation of 3-D aware engineers, according to Endersby at Dassault Systemes. He believes a similar effort is required for mechatronics.

"While some universities offer mechatronics courses, it is still not common across campuses. The modern world is mechatronics, and young engineers need to be exposed to it. The possibilities of a mechatronic design approach are exciting, and it's important that the next generation of engineers has exposure to how it can be used and the resources and opportunities available," Pritchard at Rockwell adds.

SKF is actively involved in many programs that encourage and help develop the next generation of engineers. SKF is a main sponsor of the Shell Eco-marathon. This is a global competition that encourages technical high schools and universities to design and create vehicles that achieve the highest miles per gallon in one of three engine categories: standard combustion, hydrogen or solar. As part of this program, SKF also supports university Society of Automotive Engineer teams (Hybrid, Solar, Baja and Formula) with technical advice as well as products.

"More recently we have been approached by students who

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are working on new engineering robotic projects such as the RoboSub competition that will incorporate more mechatronic products as well as traditional bearings," says Hinckley at SKF. "RoboSub is a competition sponsored by the Association for Unmanned Vehicle Systems International (AUVSI) and the U.S. Navy Department to provide opportunities for students to experience the challenges of system engineering, to develop skill in accomplishing realistic missions with autonomous vehicles and to foster relationships between young engineers and the organizations developing and producing autonomous vehicle technologies."

While the technology is available and young engineers have the proper skills to further enhance the mechatronics platform, today it falls on the design engineers to adapt, react and integrate—full speed ahead.

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A Mechatronics Solution

One of Rockwell Automation's machine builder customers recently created a high-speed, cutting edge rotary saw for their machines using mechatronic products. The OEM was seeking a step forward in its saw cutting technology to significantly increase the speed and throughput of its converting machine. The company decided to take a mechatronic design approach early in order to validate the performance of new concepts and save testing time going forward. "This was the first time that the customer had applied some of the latest mechatronic design tools, so again it was faced with the challenge of applying new technology in order to provide greater value to their end users," says John Pritchard, global marketing development manager, Integrated Architecture, Rockwell Automation. "The company turned to Rockwell Automation to help deliver the advanced design software and automation technology needed to achieve its aggressive goals."

Early in the machine design process, they modeled the new application by virtually linking models created using *SolidWorks* design software from Dassault Systemes with control designs in *Rockwell Software RSLogix 5000* software using *Allen-Bradley Motion Analyzer* software. Engineers leveraged *Motion Analyzer* to evaluate a variety of gear ratios, inertias and mechanical alternatives that would further enhance the system. The integration between *SolidWorks* and *Motion Analyzer* helped designers quickly simulate a variety of mechanical alternatives, motor-drive combinations and more profiles in order to help the customer choose a solution optimized for the saw application.

They used Allen-Bradley RDD-Series Direct Drive Rotary servo motors to help eliminate the need for power transmission devices such as timing belts and pulleys required in its previous saw cutting technology. This reduced the number of items on the bill of materials and simplified installation and maintenance support. Kinetix servo motors were combined with the Kinetix servo drives to help meet the demanding requirements of their high performance motion control system. "The new rotary saw is the highest speed saw cutting application on the market today. Cutting at speeds in excess of 500 cuts per minute, compared with 300 cuts per minute previously, the new saw has significantly increased the throughput of the customer's machine," Pritchard adds.

"We feel mechatronics can help us in the future, saving test time in assembly because it will help eliminate rework of replacing drive and motor combinations. We'll also save time by fully testing our applications in a simulation environment before we get to the plant floor," said the Rockwell customer.