MOVING YOUR WORLD

IDEAS IN MOTION CONTROL FROM MOOG INDUSTRIAL

SEPTEMBER 2009 ISSUE 21

MOOG

WIMBLEDON – MOOG'S DESIGN IS MOVING ON UP

By Ian Bartlett, Engineering Solutions Manager and Simon Furnell, Moog Senior Applications Engineer

Moog recently completed a challenging and high profile project that required great expertise in electric actuation as well as the highest level of project management to design. The project involved creating a control architecture for the actuated elements of a moving roof on the Centre Court at Wimbledon - unarguably one of the most famous tennis events in the world. In 2007 it was viewed in 748.4 million TV homes. This motion control challenge required that Moog's world-class products work securely, quietly, speedily, safely and accurately and that the project was on-time for the 2009 Championships where it would be under the scrutiny of the entire viewing world.

Wimbledon Centre Court view at roof level.

The project involved supplying 148 axes of control with products and software for closed-loop control for the roof movement. Engineers from United Kingdom, Germany, Italy, Ireland and the United States worked together from definition of requirements to final implementation and on-going support to provide a truly collaborative solution for a very special customer.

The Project Definition

Take a world renowned sporting venue, steeped in heritage and tradition, one that is home to a sporting championship seen in 750 million homes, followed by more than 10 million internet users making 46 million visits online and spending an average of 70 minutes each with eyes glued to the hallowed turf. That's Wimbledon.

Even non tennis fans will know that the image of the Wimbledon Championships at the All England Lawn Tennis Club can be spoiled by the realities of the British weather. With the popularity of the game growing and increasing numbers of spectators, including the world media taking an interest, uninterrupted play became a big priority. So it became clear that a new solution was needed, and that solution was to put a roof on the world famous Centre Court at Wimbledon. That's when a world leader in motion control, Moog, was called in to help make the vision a reality - because this project was expected to be challenging.

continued page 2

IN THIS ISSUE

WIMBLEDON'S NEW MOVING CENTRE COURT ROOF

recently completed by Moog was a challenging project that required great expertise in electric actuation and project management so that Moog's world-class products work securely, quietly, safely, accurately and on-time for the 2009 Championships. Electric actuation was the answer, a perfect solution that met both technical and architectural requirements, while being extremely quiet. British weather, growing popularity of the game and increasing numbers of spectators made uninterrupted play a big priority at Wimbledon, the world renowned sporting venue, giving Moog the opportunity to create a collaborative solution.

NEW FASTACT J SERVOMOTORS

have very high angular accelerations, differentiating them from the competition. The fully laminated, weight and inertia optimized rotor provides significant inertia reduction over conventional designs. High-energy rare earth magnets allow it to achieve high overload capacity. The result is an increase in effective torque available to accelerate and decelerate the load enabling higher dynamics and improved cycle times. The use of the Fastact J-Series Servomotor will result in application advantages such as increased part quality, shorter cooling time, reduced parts costs and reduced risk of "over casting".

ADVANCED BLADE PITCH CONTROL TECHNOLOGY

is essential to the overall performance of a wind turbine. Adjusting the blade pitch angle is vital to both enhancing energy production as well as ensuring safety. Moog has recently enhanced application expertise with the acquisition of wind energy business LTi REEnergy, the leader in electric pitch control systems. Being able to offer both electric and hydraulic solutions gives the customer the ability to select which will be the best for their special requirements.

Initial discussions took place in 2004 when Moog and a number of specialists were approached to answer the complex control problem of an actuated moving roof. Initial discussions considered the use of hydraulic actuators but Moog engineers, collaborating with the design teams concluded that these would not be the optimum solution: noise and vibration from many hydraulic power units might be an issue and even the slightest risk of oil seepage onto the grass wasn't worth taking.

It was then that Moog expertise came to the fore. "Electric actuation was the answer and we had a solution that met both technical and architectural requirements. The system would also be extremely quiet and remove the risk of oil seepage – a perfect solution", explained Ian Bartlett, Project Manager.

"With expertise in both hydraulic and electric technologies, we are able to be unbiased and provide a technology-neutral opinion in such situations, and for this project an all electric approach was proven to be the most appropriate solution," he said. "The architects wanted a roof that would occupy minimal space in the open position, partly to allow maximum sunlight access to the grass and partly to ensure the same level of ventilation was afforded to the space. The Moog solution was one of a number that enabled the architects to achieve their objectives without compromising the functional performance of the system."

Project Implementation

The collaboration along with Moog technical know how and world-class products ensured that the new moving roof at Wimbledon was delivered on time and to great critical acclaim. "Other than the obvious functional performance pressures such as the speed and accuracy of deployment, there was also the small matter of ensuring that the roof was completed and tested in time for this year's Championships," added Bartlett.

In a complex hierarchy of contractors, Galliford Try, who was appointed in 1973 to look after the site and has also been managing the master plan since 1994, instigated the phase to install the retractable roof. At the same time major changes to the Centre Court structure and facilities to accommodate the new roof were implemented. Watsons was appointed to carry out the major steelwork and SCX were contracted to work on the mechanical components.

All of this infrastructure was brought "to life" by Moog's electric products. Moog supplied the high performance electric control system comprising of electric actuators, servomotors, servodrives and closed-loop controllers. Additionally, Moog worked with a partner to deliver the supervisory and data acquisition system. A total of 148 axes of control have been supplied by Moog as well as the 40 control cabinets mounted on the roof trusses and main control desk housed within the Centre Court control room. All these products and software operate together to allow over 1,000 tonnes (1,102 US tonnes) of steel to move safely above 15,000 spectators.

How the Roof Works

Main Control Panel in test

continued page 3

The new roof works on a principle similar to a folding fabric concertina - with metal ribs or "trusses" supporting a translucent industrial fabric. "The trusses are basically inverted triangles, which are supported by the end arms and set into precise motion by electric actuators which form a structural yet moveable part of the roof. The accuracy of movement has to be virtually pin point at both ends of the trusses," explained Ian. With this design, the roof can be folded into the ends of the building, with the translucency giving the court an open feel when closed.

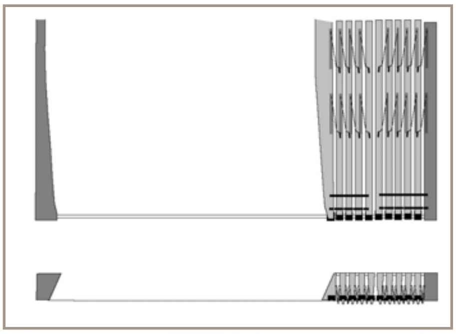
The retractable roof is made up of 9 bays of tensioned fabric divided into two sections (North and South). The northern section has 5 bays, with 4 in the south. Each bay is captivated on either side by a steel truss (10 trusses in total) spanning the 77 m (253 ft) wide court with approximately 5,200 square metres (55,972 square feet) of fabric keeping the rain out and allowing the light in. The ends of each truss are supported by a wheeled carriage or "bogie" which moves along a track positioned on the newly installed 'fixed' roof of the Centre Court. The roof takes eight minutes to close and if that's being done because of rain, court covers will protect the grass in the usual way while the closure is in progress.

Bogie Motor on track

The roof has 5 basic modes of operation, each activated by one button:

1. Move to Park Position

Roof in the Parked Position



The Roof is in two "halves", the North and the South sections.

For most of the year both sections are stored at the North end of the Centre Court.

When not in use for the Championship, the south roof sections are "Moved to their Park Position" at the north end of the stadium for storage. This park position allows the maximum sunlight to reach the court, particularly during the winter months. The south roof unlocks from the fixed roof and begins its travels towards the north section.

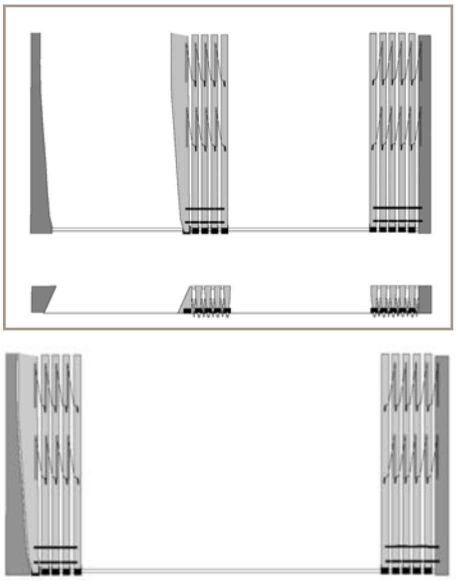
The PLC gives a target position to the Moog Servo Controllers (MSC) responsible for the movement of the "leading" truss. Each truss is controlled by an MSC controller on each end. The master MSC generates a position command profile and this is used by both sides to control the movement of the bogies in closed-loop position control. The feedback position of all the trusses is measured to within 0.1 mm (0.004 in) over the entire length of the roof.

The master continuously monitors the following and skew errors and adjusts the command position to maintain the position accuracy across the roof. The lead truss also sends an assisting torque to the following truss bogies so that all the trusses move as one at 100 mm/s (3.94 in/s) towards the north sections. When the south roof nears the north roof it slows and creeps gently into the final position. The two sections then lock together and remain in position until they are needed again.

continued page 4

2. Move to Championship Mode

Championship Position



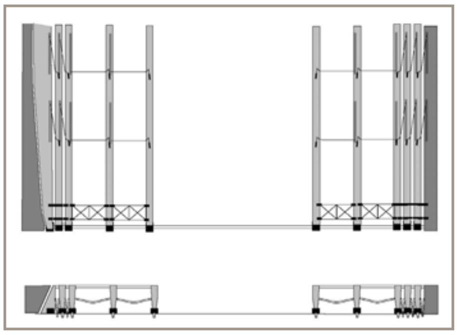
Before the Championship fortnight the south roof is moved into the championship position.

The South section is locked together and moved as one "unit" by the MSC cotrollers(s) under the supervisory control of the PLC(s).

During Championship mode, the reverse process happens and the south roof sections move down to the south and attach once more to the fixed roof. At the end of the movement after the south section is locked into place the trusses are within 0.5 mm (0.02 in) of their desired positions.

3. Deploy/Close the Roof

Roof Part Deployed



Each Half Truss is controlled by its own Control Panel.

Each MSC controls 4 off End Arms, 2 off Restraint Arms and 2 off Bogie motors in synchronization control.

The End Ams and Restraint Arms are controlled in Position control, the bogie motors are controlled in torque mode.

The MSC's controlling each half truss communicate with each other and thus the whole truss is synchronized.

When the decision is made to close the roof, the roof begins to deploy one truss at a time on both the north and south sections. The truss is deployed by the bogies and the end arm assemblies. The end arm assemblies look like giant inverted hinges which open up from a very deep narrow "V" into a wide shallow "V". During the movement the point of the V moves up and the ends move out thus pushing the top of the deploying truss away from its neighbor. This movement is controlled using four end arm actuators on each side. Each actuator is capable of pushing and pulling with a force equivalent to 35 tonnes (38 US tonnes) at its rod end. The actuators are connected to the end arm assembly so that there is a large mechanical advantage.

The position of all the end arm actuators are controlled in closed-loop position control using its own inbuilt absolute encoder. All 8 actuators are synchronized by the MSC controllers. However, as the end arm assembly deploys the mechanical advantage and lever ratio changes, the MSC compensates for this change by using a look up table to check the current actuator position against a linear deployment position. This check is important because not only does the MSC have to keep the end arm actuators synchronized, it also has to

continued page 5

position the bogie directly below the top of the truss to keep the truss in a vertical position. Across the centre of each roof section are 4 restraint arm assemblies, each with its own actuator. These help maintain the shape of the truss across the length and ensure that the trusses meet square when the north and south sections are fully deployed. These actuators also work through a non-linear linkage and they too have to be synchronized with the end arms and bogies.

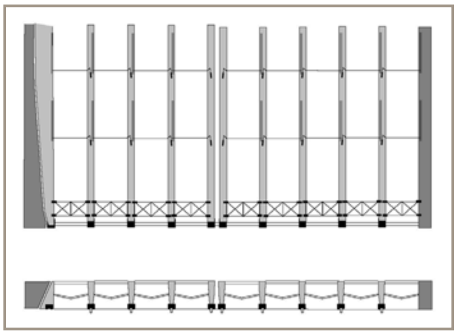
End Arm Actuator

Restraint Arm Actuator Full Deployed

Once a truss is deployed the restraint arms and end arms are locked and the next truss deploys. While the next truss deploys a torque is sent to the bogie motors on the already deployed truss so that it moves in unison. In this way when the last truss is deploying the actuators and motors on that truss uses roughly the same forces as the first truss deploying on its own.

4. Roof Deployed

Roof Deployed



From Championship position to fully deployed takes around 8 minutes.

View from below (without roof cloth)

The roof retracts in a similar fashion to the deployment.

5. Sunshade Mode

The leading truss on the southern roof is deployed to provide shade over the Royal Box. When the roof is in this position it can be either deployed or retracted, depending on the whims of the British weather.

continued page 6

The Benefits of the Moog Solution

The roof has been designed to work securely, quietly, speedily, safely and accurately. In a sense, the less it's noticed the more it is achieving its technical objective. The translucent nature of the roof makes it easy to forget it's there when it's fully deployed.

This project involved collaboration with engineers from our facilities in the United Kingdom, Germany, Italy, Ireland and the United States to design and build a motion control solution that met all of the stringent requirements of this high profile project. Everyone at Moog has felt a huge sense of pride at working on this prestigious project, not just those who have been involved in bringing it to fruition. It demonstrates the partnership approach we bring to complex situations where many contractors are involved. A key objective was to ensure that while the finest technology was employed, the heritage of the venue was preserved. But one tradition that even die-hard Wimbledon fans won't miss this year is the phrase: 'Rain stopped play'.

Authors

Ian Bartlett worked as a Senior Project Engineer working on a number of Electro-Hydraulic applications, becoming Engineering Solutions Manager for the Industrial Engineering Group at Moog in Tewkesbury, England (MCL) with responsibilities for the engineering team. Since 2009, as part of the European Control Solutions Organisation, Ian now has responsibility as the European Programme Manager for Power Generation as well as the MCL Local Engineering Coordinator role. Ian has a background in both electrical and mechanical/hydraulic systems having studied for his Degree in Electrical Engineering.

Simon Furnell, Moog Senior Applications Engineer has been with the company since 2001. Simon has been involved in the project since the first telephone enquiry until the final sign off and has played a key role in the early design stages, development of software and testing of the roof, often working in the difficult conditions the British weather can throw at you. Simon has a B.Eng in Mechanical Engineering and a MSc in Fluid Power Systems, both from the University of Bath.

ACCELERATE FAST WITH THE NEW FASTACT J SERVOMOTORS

By Andrew Barrett, Product Line manager for Moog's Industrial Servomotors and Manuel Niedermann, Project Manager for Application Engineering of Electromechanical Systems

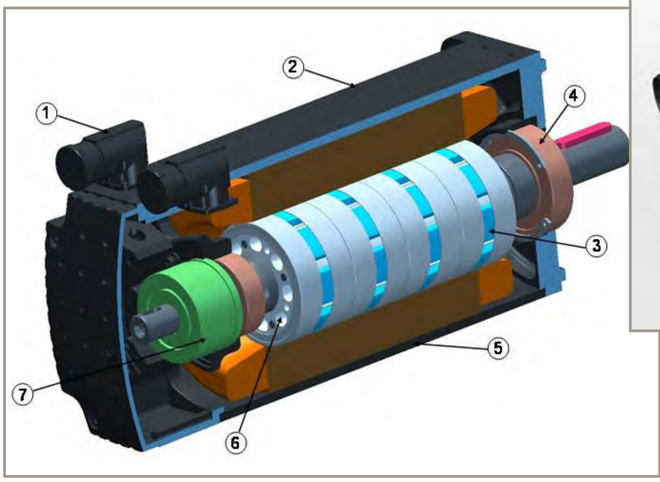
Moog is pleased to announce the introduction of a new series of servomotors called Fastact J Series Servomotors. These are electronically commutated synchronous AC motors with permanent magnets that are for highly dynamic servo applications where positioning times of 15 msec or less are the norm. This complete family of servomotors has very high angular accelerations which differentiates it from the competition.

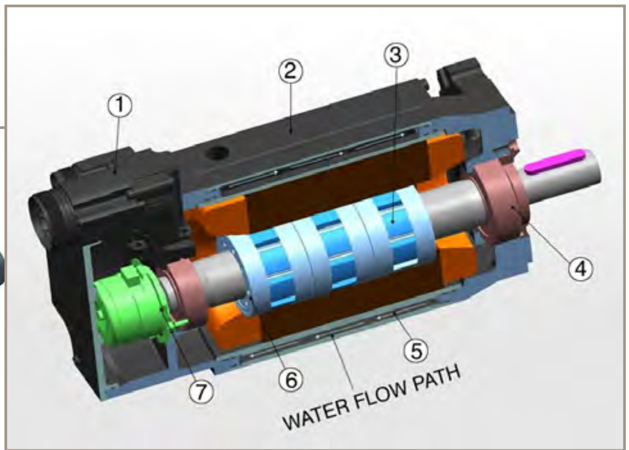
Superior Motor Dynamics Reduces Costs and Improves Cycle Time

The new Fastact J Series Servomotor design is the result of working with high performance machine builders to combine a very low inertia rotor with an electromagnetic design having exceptional overload capacity. It uses a fully laminated, weight and inertia optimized rotor to provide a significant inertia reduction over conventional solid rotor designs. It is able to achieve a high overload capacity through the use of high-energy rare magnets, and an efficient thermal construction. The result is an increase in the effective torque available to accelerate and decelerate the load, enabling higher dynamics and improved cycle times. The performance summary is in Appendix A.

For over two decades, Moog has been involved in the design and supply of brushless servomotors offering the highest dynamics and reliability. Using a modular design and supported by a variety of options, Moog's application staff are capable of supplying fully customized J Series Servomotor solutions.

Fig. 1: Cutaway Diagrams of Fastact J Series motors, natural cooled and water cooled.





1) Metal CE/UL compliant connectors

2) Proprietary stator design

3) Rare earth magnets

4) Sealed life-time lubricated bearings

5) Lightweight extruded aluminum housing

6) Fully laminated low-inertia rotor

7) Feedback device

continued page 8

Flexible Module Design Ensures Easy Integration

The Fastact J Series Servomotor is available with the following options:

- Cooling Options: natural convection, fan cooled or water cooled.
- Integral holding brakes
- Resolver or encoder based feedback
- Various Connector options
- Plain or slot & key type shafts
- Teflon shaft seal (IP67 sealing)
- Custom motor windings
- Custom shafts and flanges
- Custom frameless designs
- Custom designs for unique environments including high temperature, high shock levels, oil and water immersion, areas with explosive gases and areas with elevated radiation levels.

Figure 5: Air cooled JHC5 with straight connectors

Figure 6: Water cooled JHW5 with standard connectors

All Moog servomotors are manufactured in-house and utilize tight machining tolerances, precision balancing and thorough production testing to guarantee a long service life. The use of high reliability feedback devices, sealed lifetime lubricated bearings, precision balanced rotors (Class G 6.3 of ISO 1940), reduced run-out machining tolerances (Class R of DIN 42955-R) and IP65 construction combine to extend service life.

Successful Applications

The Fastact J Series Servomotors can be successfully applied to many applications and markets.

Benefits for Injection Molding Machine Applications

- 20-30% cost reduction on servomotor and servodrive combination because of higher efficiency (e.g. same performance and similar pressure deviation achievable with a smaller motor on injection axis)
- Higher injection speeds possible thanks to better Inertia to Motor-Torque ratio
- Possibility to reduce wall thickness because a shorter filling time is achievable
- Improving cycle times because of reduced cooling times (smaller wall thickness) and shorter clamping movement (higher acceleration, maximum speed and deceleration)
- Improved mold protection because of shorter deceleration times after detection of excessive external forces while clamping

Source: Netstal Maschinen AG

Figure 7: High Performance Injection Molding Machine

continued page 9

Benefits for Die Casting Machinery

Specific die casting process properties including a sudden change of state (liquid to solid) and the good thermal conductivity of the processed material, require short filling times and rapid deceleration. Meeting these requirements will improve the quality of the part (surface and structural consistence, degree of filling) and reduce the size and wall thickness of the part, offering significant benefits to the user in quality and reduced part cost.

The use of a Fastact J Series Servomotor with their outstanding maximum torque to inertia ratio will achieve increased acceleration, cast speed and deceleration. As a result, the application can gain the following advantages:

- Increased part-quality due to shorter deceleration time and higher cast speed prevents the material from unintended changes of state
- Shorter cooling time because of thin parts as well as unheated casts (both due to the ability of shorter filling times) results in shorter cycle times
- Thin walled parts reduce parts costs due to lower weight
- Reduced risk of "over casting"; deceleration of the axis is started before the cast is completely filled; with shorter deceleration times, the overcast protection has less impact on filling time (i.e. shorter filling times); in addition, improved part quality is achieved

Appendix A:
Performance Summary of Fastact J-Series Motors

Motor Type Decription

Example JSx3

- J = Fastact J Series
- S = Standard or H = High Dynamic
- X = Cooling Options (Natural convection, Fan cooled, Water cooled)
- 3 = Motor size 70 mm (2.75 in) flange

Motor Type	Square Flange	Stack Length	Stall Torque Nm (lb-in)			Max Torque	Inertia	Angular Acceleration
See Example	mm (in)	mm (in)	Air Cooling	Fan Cooling	Water Cooling	Nm (lb-in)	kgcm2 (lb-insec^{2}x10^{-4})	RPM/ms
JSx3	70 (2.75)	102-191 (4.0 – 7.5)	4.0 – 7.0 (35 – 62)	–	7.8 – 14 (69 – 124)	16-30 (142 – 265)	0.97- 1.66 (8.6 – 14.7)	1,575+
JSx4	100 (3.98)	102-203 (4.0 – 8.0)	6.7 – 13.0 (59 – 115)	–	13.3 - 27.5 (274 – 558)	31 – 63 (274 -558)	2.9 – 5.5 (25.7 – 48.7)	1,036+
JHx5	140 (5.51)	120-240 (4.7 – 9.4)	21.3–39.2 (188 – 347)	30.5 – 51.5 (270 – 456)	45.3 – 89.4 (556 – 1,133)	64 – 128 (556 -1, 133)	10.9 – 20.2 (96.5 – 178.8)	564+
JSx5	140 (5.51)	160-320 (6.3 – 12.6)	29.3-55.1 (259 – 488)	39.3 – 66.6 (348 – 589)	63.6 –125.7 (1,195 – 2390)	135 – 270 (1,195-2,390)	27 – 49 (239 – 434)	497+
JHx6	190 (7.48)	200-400 (7.9 – 15.7)	70.7-136.6 (626 – 1,209)	95.2 – 170 (843 – 1,505)	113 – 226 (2,310 – 4,620)	261 – 522 (2,310-4,620)	81 – 155 (717 – 1,372)	308+
JSx6	190 (7.48)	255-510 (10 – 20)	100-194 (885 -1,717)	128 – 230 (1,133 – 2,035)	153 – 291 (4,425 -8,850)	500 – 1000 (4,425-8,850)	226 – 445 (2,000-3,938)	212+
JSx7	275 (10.8)	320-640 (12.6 -25.2)	252-500 (2,230 -4,425)	326 – 650 (2,885 – 5,753)	447 – 895 (8,833-17,666)	998 – 1996 (8,833-17,666)	907 – 1790 (8,027– 15,843)	105+

Motor type in bold implies still under development

Authors

Andrew Barrett, B.E.(electrical), M.Eng.Sc. (control electronics), MBA, is Product Line Manager for Moog's Industrial Servomotors. He brings 17 years of experience in engineering, operations and product line management, gained during a career with several multinational companies.

Manuel Niedermann, B.E.(electrical), MAS (business administration and engineering), Project Manager for Application Engineering of Electromechanical systems. He brings 8 years of experience in engineering and project management. His previous experiences have been in the semiconductor and textiles machine manufacturing industries.

MOOG OFFERS ADVANCED BLADE PITCH CONTROL TECHNOLOGY FOR WIND TURBINES

By Jochen Heuveldop, Director of Sales, Moog in Unna, Germany

Pitching (adjusting the blade pitch angle for wind turbines) presents unique challenges for motion control performance. These solutions need to maximize energy production as well as accommodate different technologies (e.g. hydraulic and electric), withstand extreme conditions (e.g. temperature, vibration), and perform reliably in continuous operation over a lifetime of ~20 years and more.

Moog offers integrated solutions to turbine manufacturers and operators that include pitch control systems, slip rings and blade load sensing systems. Our application expertise in wind energy has been recently enhanced with the acquisition of the wind energy business of LTi REEnergy, the leader in electric pitch control systems based in Unna, Germany and Shanghai, China.

Blade Pitching for Wind Turbines

Accurately controlling the pitch of a turbine's blades is essential to the overall performance of a wind turbine. During operation each blade is subjected to instantaneously changing loads and forces, often in extreme environments. Pitching is vital to both enhancing energy production as well as ensuring safety of the multi-million dollar turbine.

Typically, wind turbines use blade pitch control systems to fulfill two main functions:

- To monitor and adjust the inclination angle of the rotor blades, thereby controlling the speed of the turbine rotor to maximize the turbine's energy production
- To turn the blade out of the wind in cases of a regular "Turbine Stop Command" or an "Emergency Feather Command (EFC)" thereby decreasing the rotor speed and stopping the rotor to avoid any damages on the wind turbine and ensure safe operation

The pitch system has to work reliably in any environment specified by the customer. The ambient conditions can differ greatly in terms of temperature, humidity, and vibration since turbines are often installed in areas with extreme climate, (e.g., Inner Mongolia in China or desert-like climates in the US or Spain). Thus robust and reliable hardware designed specifically for this application is critical to the performance and operation of a pitch system.

Blade Pitching Technology

Modern pitch systems are designed to independently control each blade by using three single actuators, which receive control commands on the blade's target position from the turbine main controller over a slip ring. The slip ring is considered the key device to ensure reliable power and data transmission between the rotating hub and the nacelle.

When considering current turbine designs, wind turbine manufacturers use different technologies: Electric Blade Pitch Control Systems (EM) and Hydraulic Blade Pitch Control Systems (EH).

The choice of one technology or the other is mostly based on the customer's historical preferences. Today, approximately one half of all erected turbines are equipped with EH systems while the other half is using EM systems (see figure 1 on next page).

continued page 11

	HYDRAULIC	ELECTRIC
Design / Composition	Consists of a Hydraulic Power Unit (HPU) in the nacelle and three actuators with control valves and accumulators in the hub	Includes three sets of motors/gears, drives, controllers, and energy storage units. Ranges from 3 to 8 switchgear cabinets depending on the functionality of each cabinet.
Strengths	• High forces, no need for gears • No backlash • Failsafe powered by accumulator	• Low energy consumption • Quiet operation (no pump) • Modular design facilitates maintenance
Weaknesses	• Management of hydraulic fluid, possible oil leakage • High energy consumption as pump runs continuously • Repetitive maintenance as filtration and oil replacement. Fluid Rotary Union required. • Accumulator pressure loss	• Maintenance of batteries • Backlash • Increased probability of failure due to higher number of components (energy storage unit, motor/gear, controller)
Cost	Initial cost lower; running cost higher due to higher maintenance cost	Initial cost higher; running cost lower due to lower maintenance cost
Maintenance	Cylinder seals need to be replaced every 7 to 10 years	Largely maintenance-free except battery change
Working Environment	• Noisy due to pump • Risk of oil leakage	Little room for movement in hub
Image	Highly reliable due to proven failsafe functionality	Environmentally friendly system

Fig. 1: Comparison of Hydraulic and Electric Pitching Technologies

Moog is able to provide both EH and EM blade pitch control depending on the customer requirements as well as the slip ring systems. Moog has a heritage in hydraulic products and solutions and the recently completed acquisition of LTi REEnergy's wind business brought well-established EM technology to our customers (see Figure 2).

When it comes to electric systems, turbine manufacturers must decide whether the actuators will use AC or DC technology. Due to our extensive experience in both technologies, our customers are able to select a solution which will be best for their special turbine requirements.

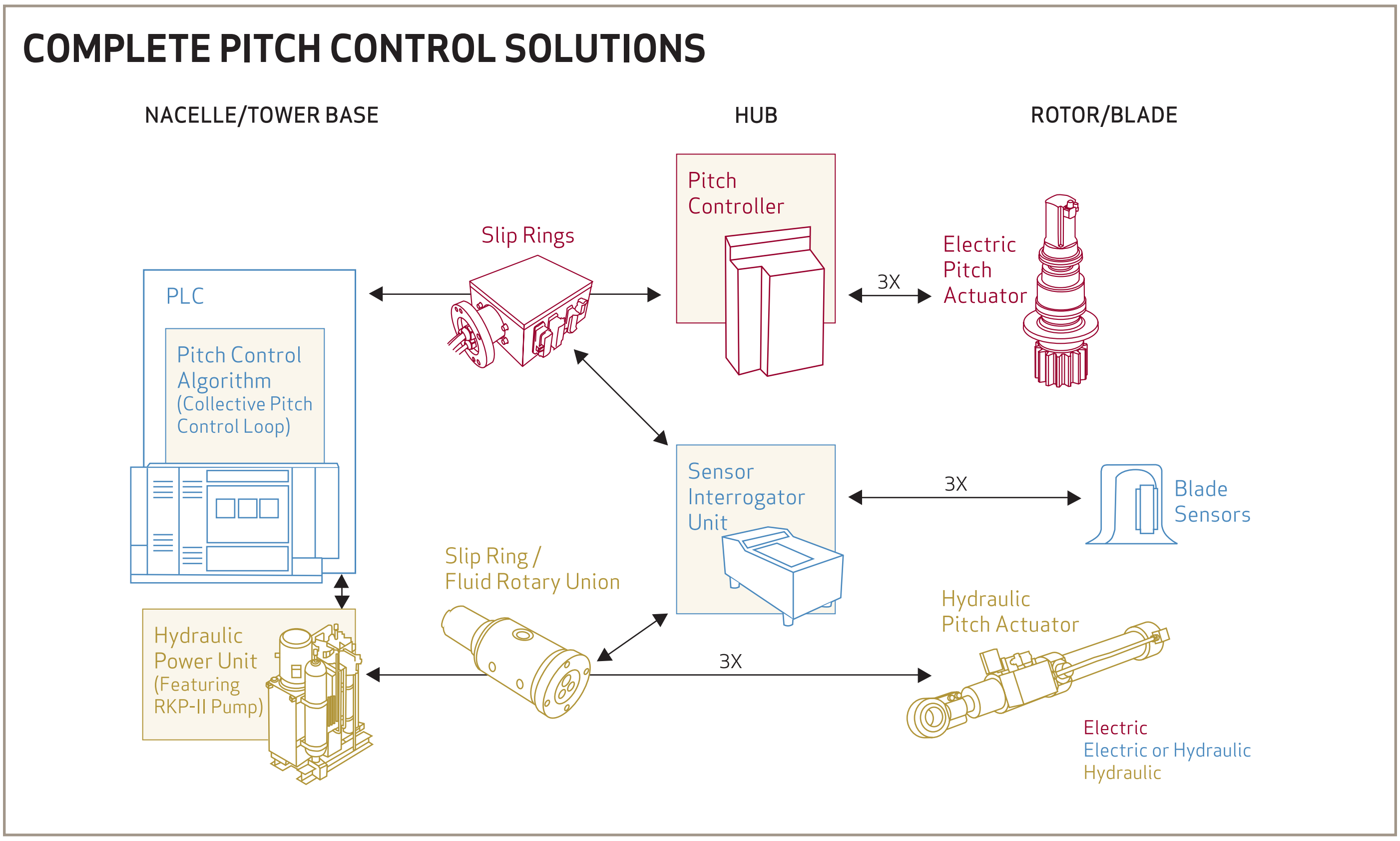


Fig.2: Moog Pitch Control Solutions are designed for both electric and hydraulic systems

continued page 12

Centers of Excellence in Wind Technology

Moog in Unna, Germany is a recent acquisition of Moog to complement its existing capabilities in state-of-the-art motion control solutions for power generation. This location was formerly the headquarters of the LTi REEnergy´s wind business in Germany. Originally formed from a division of German based company Stromag AG, the Unna facility has more than 10 years experience in safety-related motion control solutions for blade pitch control systems in wind turbines and also marine current turbines.

Another former LTi REEnergy facility dedicated to wind technology is located in Shanghai, China and it also became part of Moog in June, 2009. Today, more than 200 employees in Unna (Germany) and Shanghai (China) ensure that our customers receive the latest pitch control technology and related service in time around the world.

Moog has 26 worldwide offices including experts in wind power technology located in Sweden, Spain, Japan, USA and India.

Outlook

In addition to the main functions for pitch systems (e.g., maximizing turbine's production and ensuring safety) there are additional features that will help to increase turbine performance. One of these features is integration of a blade load sensing system to measure the load on the blades, allowing for individual blade pitch control to increase the performance of a wind turbine. Moog has recently acquired Insensys, the market leader in fibre optic sensing solutions for wind applications. These systems perform individual pitch control and also enable wind farm operators to detect ice, yaw misalignment, rotor imbalance and blade damage.

Moog's integrated solutions combine pitch control systems, slip rings and blade load sensing systems, thereby minimizing the amount of components in the hub, reducing the weight and decreasing the life cycle costs of a turbine.

We provide specialized solutions for wind turbines ranging from 300 kW up to 6 MW that have been installed on more than 10,000 wind turbines worldwide recognized by industry leaders as the most safe, reliable and effective option. Moog's collaborative approach, combined with our expertise and global support network, makes us the ideal partner to solve your wind energy challenges.

We look forward to speaking with you about your challenges.

Author

Jochen Heuveldop is Director of Sales at Moog in Unna. He joined the company about 3 years ago after 15 years experience in motion control in power plants and industrial applications.

For the location nearest you, visit:
www.moog.com/contact

MOOG

Industrial Group
www.moog.com/industrial