World Leader in the Design and Integration of Flight Control and Utility Actuation Systems

Over the last 60 years, Moog has developed a reputation throughout the world as a company whose people and products are at the forefront of the aerospace industry. We are known for our successful solutions to motion control challenges that are viewed by others as impossible. This directly reflects the creativity, work ethic, and remarkable attention to purpose of our people.

Over this period, Moog has expanded its capability base to become a leading supplier of integrated flight control systems. We are continuously investing to extend the depth of our systems capability while simultaneously expanding our core component expertise to take on the challenges and responsibilities of a changing industry. As a result we are positioned today on virtually every aircraft in the marketplace, supplying reliable system solutions that are highly supportable and add significant value for our customers.

Moog Selected to Provide Actuation System for Boeing Next-Generation KC-46 Tanker

Moog Aircraft Group was selected by Boeing to provide the refueling boom actuation system on the KC-46 aircraft. In 2011, the United States Air Force selected Boeing to build the next generation KC-46 aerial refueling tanker to replace 179 of the service’s 400 KC-135 tankers.

Moog will provide the design, integration and qualification of the complete actuation system used to extend, retract and guide the refueling boom during in-flight refueling operations. Moog’s system will include fly-by-wire actuators to provide precision control of the boom’s rudder and elevator flight surfaces. Moog will also provide the telescoping and hoist actuators used to extend and retract the entire boom.

Moog Acquires Crossbow Technologies

In 2011, Moog acquired Crossbow Technology Inc. Crossbow, headquartered in Milpitas, California, is a designer and manufacturer of sensing and inertial management products that are integrated into mission critical navigation and guidance systems. The products are used in a variety of aerospace, defense and transportation applications.

Crossbow’s innovative use of MEMS-based technology allows them to deliver products that achieve significant improvements in performance, size, and cost over competitive products in widespread use today. Crossbow’s advanced sensing products complement Moog’s established controls business and provide a unique opportunity to offer more comprehensive systems to our customers. For more information visit www.moog-crossbow.com.
Moog Supplying Primary Flight Control Actuation and Trailing Edge Actuation Systems for Airbus A350 XWB

Moog was selected by Airbus to provide design, integration and certification support for the Primary Flight Control Actuation on the A350 XWB. Moog is providing 27 discrete actuators and associated control electronics on this program. This system includes a mix of electrohydraulic and advanced electrohydroslastic (EHA) actuators to control the aileron, elevator, rudder and spoiler flight surfaces. Moog’s products feature:

- More electric actuation technology
- On-board electronics for actuator power and control
- Highly integrated assemblies to meet challenging envelope constraints

Moog was also selected to supply the Trailing Edge actuation system for the A350 XWB including the power control unit, inboard and outboard geared rotary actuators, gearboxes, wing tip brakes and other miscellaneous components.

Moog Providing Flight Control Computer and Software for 747-8

Moog is supplying Boeing with the Lateral Control Electronics (LCE) for the new Boeing 747-8. The Boeing 747-8 Inter-continental and the 747-8 Freighter are the new high-capacity 747’s, which recently entered revenue operations.

As part of the program, Moog designed, manufactured, qualified and provided certification support for the LCE. The function of the LCE is the control of fly-by-wire aileron and spoiler actuators.

The system leverages Moog’s proprietary dual redundant, triplex dissimilar architecture and builds upon expertise gained designing and certifying flight control systems on other civil programs.

System Provider for 787 Primary Flight Control and High Lift Actuation

Moog is the system integrator for the 787 Primary Flight Control Actuation System (PFCAS) and the High Lift Actuation System. Moog is providing the design, integration and certification support for both of these systems. The Moog systems control the primary, secondary and high lift surfaces in response to pilot commands.

The 787 PFCAS controls 21 flight surfaces and includes a mix of electrohydraulic (EH) and electromechanical (EM) servoactuators and all associated control electronics. The system includes EH servoactuators, with remote loop closure electronics for the ailerons, flaperons, inboard and outboard spoilers, elevator and rudder. The horizontal stabilizer and mid-board spoilers employ EM servoactuators with associated motor drive control.

The High Lift System includes the complete flap and slat actuation systems compromising nearly 450 discrete assemblies including: power drives, electronic controls, trim controls, geared rotary actuators, rack and pinion roller assemblies, transmissions shafts, offset gearboxes, sensors and accessory components. The High Lift System features a number of technical advancements to improve wing aerodynamics. To decrease system weight, a number of advancements were also incorporated, including the use of advanced composites and increased use of electronic controls.
Moog Supplies Integrated Flight Control System for Gulfstream G280

Moog was selected by Gulfstream Aerospace, a wholly owned subsidiary of General Dynamics, to supply an integrated flight control system for the G280 business jet. Moog was awarded all flight control design packages for the airplane including flight control computers, primary and secondary flight control actuation, flap drive actuation and horizontal stabilizer trim.

Moog’s architecture allows common functions to be integrated, allowing for a net reduction in line replaceable units, system weight and size, while maintaining or exceeding requirements for performance and reliability. Moog is also providing integration and certification support for the G280, which is now conducting final activities for type certification.

Moog Selected for COMAC C919 High Lift System

Earlier this year, Moog and the Commercial Aircraft Corporation of China (COMAC) signed a contract for the development of the High Lift System for the C919, COMAC’s new narrow body commercial transport. The High Lift System includes all flap and slat actuation, pilot interfaces, electronic controls, power drive units, wing tip brakes, gearboxes and miscellaneous components.

Moog has been working with COMAC in the joint development phase of the High Lift System including such activities as architecture definition, design trade-off analysis, preliminary hardware designs and hardware volume integration. The formal joint concept definition phase was completed in September.

COMAC has forecasted a global market for more than 2,000 C919 aircraft over the 20 years following entry into service, currently planned for 2016.

Moog Supplies High Lift System for Gulfstream G650

Moog has been a long-term supplier to Gulfstream, having supplied flap drive actuation solutions since the mid 1970’s. Following on the heels of the win on the G280, Gulfstream again selected Moog to design, integrate and manufacture the Flap Drive System for their largest, long-range business jet, the G650.

The Moog system includes flap actuation, control electronics and software, pilot interfaces, power drive, transmission components and accessories. In addition Moog will provide integration and certification support for the G650, which is on schedule for entry-into-service in 2012.
Moog is leading an industry team in the development and integration of the Primary Flight Control and Leading Edge Flap Actuation Systems for the Joint Strike Fighter Program. The F-35 “power-by-wire” system represents an advancement on the more electric aircraft topology integrating:

- Self-contained electrohydrostatic actuators (EHA) to position primary flight surfaces
- Electronic Control Units to remotely drive and control the EHAs
- Electrically-driven PDUs to position the maneuvering leading edge flaps

As the prime contract holder, Moog’s role includes management of the industry team, integration of the complete actuation system, and supplier of critical technologies and major sub-systems. Moog is also supplying the wingfold actuation system on the F-35 C-variant.

Moog is providing the design, manufacture and integration of 19 primary flight control actuators including the main rotor swashplate, flaperon, rudder and elevator.

In addition, Moog is providing the active vibration control system, bladefold actuation, nose-wheel steering servovalves, main prop rotor slip ring, hydraulic fluid compensation module and engine fuel control servovalves. Key attributes of the flight control system include a 5000 psi operating pressure, duplex hydraulic – triplex electrical redundancy on the Swashplate actuators and ballistic tolerant elevator and swashplate actuators.

Moog is the Primary Flight Control Actuation Systems Integrator for Northrop Grumman’s X-47B unmanned combat air system. The system includes a fully redundant architecture featuring multifunction system controllers and modular electrohydraulic (EH) actuators. The system controller features a high speed 1394 bus interface, redundancy management, and full digital closed loop control for all flight surfaces and advanced vehicle functionality. The high-dynamic dual tandem EH actuators position the aileron, elevon and spoiler flight control surfaces.

Moog is providing the design, manufacture and integration of 8 fly-by-wire servoactuators for the Airbus A400M primary flight control surfaces. Moog is supplying electrohydraulic (EH) actuators for the aileron, elevator and certain spoiler surfaces and electric backup hydraulic actuators (EBHA) for positioning other Spoiler panels. The EBHA includes a self-contained electrohydrostatic actuator (EHA) with integral pump and electronic controls. During normal operation, the EBHA operates as a conventional EH actuator using the aircraft’s main or backup hydraulic systems. When in backup mode, the onboard pump and controller provide hydraulic power for positioning the spoiler surfaces, allowing the elimination of the third hydraulic channel.
Moog Supplies Lift Fan and Swivel Module Actuation Systems for F-35B STOVL

The F-35B is a Short Take-Off and Vertical Landing (STOVL) variant of the Joint Strike Fighter. The “hovering” ability of this distinctive aircraft is provided through a combination of a thrust vectoring nozzle directing main engine exhaust downward to generate aft vertical lift, and a centrally mounted lift fan which provides counterbalancing forward vertical lift. Moog designed, qualified and now manufactures the sophisticated actuation systems for both of these applications. Specifically, Moog supplies the actuation system for the three-bearing swivel nozzle which rotates the main engine’s exhaust downward through 90 degrees. In addition, Moog provides the actuation system controlling the lift fan’s Variable Area Nozzle and Inlet Guide Vane which control airflow through the lift fan. These actuation systems use electronically-controlled hydraulic and fuel hydraulic servoactuators specially designed for operation in extreme temperature and vibration environments.

Supplier of Primary Flight Control Actuation for AW159

The AW159 Lynx Wildcat is a modern twin engine, multi-role helicopter designed for battlefield utility, search and rescue and anti-submarine warfare roles with the British Army and Royal Navy. Moog was selected by AgustaWestland to design, qualify and manufacture the tail rotor actuator for this aircraft. Moog’s actuator directly interfaces with the helicopter’s automatic flight control system, allowing the aircraft to be flown on autopilot. First flight occurred on 12 November 2009 and initial production deliveries are underway.

Moog Supplies Primary Flight Control Actuation for M346

The M346 is Europe’s first fly-by-wire jet trainer with transonic capability. Aermacchi selected what is now Moog’s Wolverhampton operation to design, qualify and manufacture the Primary Flight Control Actuation for this advanced jet trainer. Moog’s system controls all primary flight control surfaces including ailerons, rudder and horizontal tail. The fly-by-wire system includes quadruplex redundancy and leverages direct drive valve technology for optimal reliability.

All Electric Primary Flight Control Actuation System for Mantis Unmanned Air System

Mantis is an advanced technology demonstrator for Medium Altitude Long Endurance (MALE) Unmanned Air Systems (UAS) jointly sponsored by the UK MOD and industry. It celebrated its first flight in October 2009 and has completed operational testing in Australia. Moog was selected by vehicle prime contractor BAE Systems to design, manufacture and integrate an “All Electric” primary flight control actuation system to control aileron, elevator and rudder flight surfaces. To meet the program’s aggressive development schedule – contract award to hardware delivery in less than 9 months Moog developed a modular system architecture which included common electromechanical actuator (EMA) designs, high power EM drives, and a remote electronics unit for distributed control. Moog also leveraged this same modular solution for the aircraft’s nosewheel steering.
Moog Develops Next-Gen Electronic Control Units for Spacecraft

Moog is tapping Application Specific Integrated Circuit technology to design a new versatile electronic driver module for stepper-based applications used in spacecraft mechanisms. The module also lends itself to drive and control solenoid valves in other spacecraft applications. This development is part of Moog’s ongoing effort to provide state-of-the-art core motion-control components, as well as higher subsystem avionics for satellites and launch vehicles.

For satellite makers, the module is self-contained with well-defined interfaces for all functional modes. Customers can easily integrate the module into their subsystem electronics, and still maintain simplicity together with expanded functionality. Customers can also use the next-generation of versatile electronic control units which integrate the driver module with other higher subsystem electronics. Currently, the driver module is completing development. Engineering units will be available for customer evaluation by September 2012, and flight units will be available by September 2013.

The ASIC offers the following advantages:

- Small physical packaging with high reliability
- Discrete command interface
- Broader range of input power voltage
- 100krad radiation tolerance
- Resistance to component obsolescence
- Programmable functionality
- 2-, 3- and 4-phase drivers for stepper motors

Green Propulsion Technology from ECAPS and Moog Outperforms Hydrazine

After a year-long series of in-space tests, a High-Performance Green Propulsion (HPGP) system has won a head-to-head competition against a hydrazine propulsion system. The two systems battled one another aboard the satellite Mango, which is part of the PRISMA mission.

Sweden-based ECAPS developed Mango’s HPGP system. Moog Inc.’s Space and Defense Group supplied the high-performance valves including the HPGP thruster valves, which Moog based on its existing, flight-proven designs. Moog also integrated the hydrazine system for PRISMA.

“High-performance green propulsion has achieved flight-proven status and shown us that it is safer and performs better than hydrazine,” said Paul T. King, engineering manager of Spacecraft Fluid Controls for Moog’s Space and Defense Group. “The data from this mission validates HPGP from launch through mission operations.”

Moog Lifts Secondary Satellites with ESPA Ring

Moog Space and Defense Group displayed a flight equivalent Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter, also known as an ESPA ring, at the 28th National Space Symposium in Colorado Springs, Colorado in April. Moog has designed its latest generation of ESPA rings for duty as either small satellite payload adapters, intermediate uses such as orbital transfer or maneuvering vehicles, or satellite busses with avionics, solar panels and propulsion.

The Moog ESPA ring gives up to six 400 lb (180 kg) secondary satellites a ride into space along with a primary satellite. Moog’s ESPA ring bolts atop the launch stack and under the primary satellite on launch vehicles such as Atlas V, Delta IV, Falcon 9, and Antares.
Innovative Solutions for Antares

Upon launch in 2012, Antares will provide responsive, low-cost and reliable access to space. In addition, it will have the capability to perform commercial re-supply missions for the International Space Station under a NASA Commercial Orbital Transportation Services (COTS) agreement. Moog has been part of the Orbital Sciences team since the design of the Pegasus rocket, supplying integrated cold gas thruster systems. Decades later, we are again working with Orbital on electrohydraulic and electromechanical TVC actuation systems for both the 1st and 2nd stage of this rocket, along with roll and reaction control thrusters and electronic control units. We are proud to be part of the next generation of spaceflight, supplying affordable and reliable hardware for commercial space.

Moog Acquires Bradford Engineering B.V.


“Bradford Engineering complements our existing European spacecraft components business. We believe there is a strong demand for their products in the U.S. and we will now have an established manufacturing base for space components in Europe,” said Jay Hennig, President of Moog’s Space and Defense Group.

NASA Tests Launch Abort System

In a spectacular $220 million test, NASA fired a new astronaut escape system rocket in New Mexico, boosting a dummy crew module more than a mile up in just 20 seconds to demonstrate how a future manned spacecraft could be pulled to safety in the event of a catastrophic on-pad rocket failure. The Launch Abort System (LAS) ignited with a torrent of orange fire and smoke, pulling the dummy crew module to nearly 450 mph in just 2.5 seconds with an acceleration of 16 times the force of gravity. An Attitude Control Motor with eight computer-controlled exhaust ports helped maintain the craft’s stability during the initial climb away from the White Sands Missile Range launch pad.

Moog’s Space and Defense Group designed and manufactured the eight dual-motor electric actuators and manufactured the sixteen-channel electronic controller used by the LAS Attitude Control Motor, as well as the shock/vibration isolation system for the vehicle’s Safe & Arm device.
Moog Crossbow Offers Affordable MEMS GPS/IMU Solutions

The Moog Crossbow NAV440 is an integrated GPS and Attitude & Heading Reference System (AHRS) that utilizes low drift MEMS-based inertial sensors with GPS aiding to provide unmatched price and performance. Developed in response to years of extensive application experience in a wide variety of commercial and COTS-military airborne, marine and land applications, the NAV440 also incorporates many new and enhanced design features. Typical applications include navigation, control and stabilization in marine and land environments.

Electrohydrostatic Actuation–Based Flight Controls

As the leader in control and actuation technology for the aerospace industry, it’s no surprise that Moog has emerged as the leader in electrohydrostatic actuation (EHA). Moog has spent nearly 3 decades refining and maturing EHA technology readying it for today’s modern aircraft.

Over this period, Moog developed simplex and dual redundant actuators, dual and triplex redundant actuator controllers and demonstrated this technology to DARPA, USAF, USN and NASA on numerous applications including the F-15 FLASH project, F-18 EACS project, J/IST, JSF PWSC, F-35, A400M, 350XWB, and NASA’s Second Generation RLV. Moog’s range of proven EHA-based flight controls include subsystems rated up to 50HP and capable of delivering a continuous force in excess of 65,000 lbf.

Active Vibration Control Systems for Military and Civil Rotorcraft

Moog is supplying its active vibration controls for Sikorsky’s UH-60M Blackhawk helicopter.

Moog’s Vibration Suppression Actuation System (VSAS) includes a DSP-based Controller and a pair of counter-rotating Force Generators per channel. Vibration levels within the air vehicle are monitored and the Force Generators inject cancellation forces at discrete locations throughout the airframe, dynamically adapting to changes in the vibration environment. By eliminating the need for heavy passive vibration absorbers, the system offers weight savings while providing a number of secondary benefits including enhanced situational awareness, passenger comfort and increased aircraft component life. The system is currently flying aboard the Sikorsky S-92, Bell/Boeing V-22, UH-60 Blackhawk and SH-60 Seahawk rotorcraft.

Advanced Electronic Controls for Aerospace and Defense

Moog is a leading supplier of electronic controls for mission critical applications in the aerospace and defense industry. Our state-of-the-art systems are used wherever precision control is required, including aircraft flight control, launch vehicle thrust vector control, aiming and stabilization, and missile steering. Our expertise includes advanced digital control, distributed system architectures, high power drives, redundancy management and designs for harsh environments. We have designed, qualified and provided certification support to civil and military level A standards. Our products are well-suited for both OEM and product upgrade programs.
**Landing Gear Extension and Retraction Systems**

Moog has an extensive breadth of actuation technology that is well-suited for many aircraft utility systems. However, unlike many other suppliers, Moog is able to tailor these products to meet unique customer requirements and provide the technical expertise to integrate and qualify the complete system.

Moog Component Group’s linear electromechanical actuators (EMA) and associated controllers are especially well-suited for landing gear extension and retraction systems on helicopters or unmanned aircraft. Our linear EMA’s use high performance brushless motors that offer favorable size and weight advantages and superior reliability. Our system controllers are based upon proven building blocks and are flexible enough to accommodate special system functionality.

**Moog Crossbow Fiber Optic Vertical Gyro Supports Critical Aircraft Navigation and Guidance Applications**

The VG700MB is a MIL-Qualified vertical gyro used for measuring roll, pitch and heading angles in dynamic environments. VG700MB applications include avionics, platform stabilization, land vehicle guidance, and control of sophisticated robotic systems. Moog Crossbow has fielded thousands of systems worldwide for use by the US DOD and Coalition Forces. Major customers include the IAI family of Searcher, Hunter, and Heron family of Unmanned Aircraft which utilize the VG700MB for primary navigation and control.

The VG700MB incorporates Moog Crossbow’s third generation Fiber Optic Rate Gyro technology providing superior performance, reliability, and long term stability.

**Product Features:**
- MIL-Qualified Vertical Gyro
- Fiber Optic Gyro Stability <20°/hr
- Stabilized Roll and Pitch Angle Outputs
- Optional Relative Heading Output (206 Model)
- Environmentally Sealed Enclosure
- MIL-STD-810E, MIL-STD-461D

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**Moog Crossbow Introduces New Card Level MEMS-Based Attitude Heading and Reference System**

The ANC1000 is Moog Crossbow’s most compact, card-level MEMS GPS-aided AHRS for embedded use within integrated navigation and guidance systems.

The ANC1000 has a small footprint volume of only 2.5 cubic inches and weighs less than 25 grams. Example applications include UAV flight control, SATCOM on the move, land vehicle and missile guidance, platform stabilization and micro-robotics.

**Product Features:**
- Single card-level Altitude & Heading Solution
- High Reliability MEMS Sensors
- High range sensor option available
- High accuracy < 0.2°
- Small form factor < 2.5 in³
- Low power < 1.5W
- Lightweight < 25 grams
- External SAASM GPS and magnetometer interface
- High vibration immunity

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**Rotary and Linear Electromechanical Actuators and Controls**

Moog leads the industry by designing and producing high-performance linear and rotary electromechanical actuators (EMA) for aerospace and defense applications. Our actuation products are used to control flight surfaces and position sensors on aircraft, missiles and space vehicles; provide stabilization and aiming for land and sea based gun turrets; steer antennas in high bandwidth communication systems; and provide control for various utility applications.

Moog is able to offer precision actuation solutions with rare earth brushless motors, planetary gears and smart servo controllers with integral position control or utility actuation solutions with DC motors, spur gears and analog amplifiers with external position control.

A technology initiative currently underway allows us to offer a fiber optic communication interface for our EMA’s. This technology provides many systems advantages, including EMI immunity and weight savings.
Moog QuickSet Responds to Warfighters Urgent Need Request

When US warfighters requested greater situational awareness on their tactical vehicles, they were supported by Moog QuickSet’s ruggedized low profile yoke pan and tilt design. These pan and tilt mechanisms are part of the Driver Vision Enhancer (DVE) system installed on the windshield frame of the US Army and Marine Corps MRAP vehicles. The DVE system uses advanced infrared imaging to provide improved situational awareness and helps the warfighter see clearly, even in total darkness. The low profile yoke design has a simple base mount that makes deployment or relocation fast and easy and has been certified to withstand pressure change, extreme temperatures, exposure to solar radiation, military shock and vibration levels. Moog QuickSet was able to quickly rearrange its factory floor space to manufacture and deliver 2500 rugged pan and tilts a month to support the warfighters urgent need request. The innovative inventory control and scalable manufacturing capabilities were key to meeting the urgent need request from the US military. To date, over 29,000 pan and tilts have been delivered to support US troops overseas.

Fusion Camera Housing with Thermiq™ Technology

The new Fusion Camera Housing with Thermiq™ Technology from Moog Videolarm of Decatur, GA, is engineered to combat heat in today’s IP surveillance cameras. Thermiq Technology keeps cameras closer to ambient temperature. The philosophy is simple: Security cameras are sensitive pieces of electronic hardware, and they run hot. In fact, with compression and faster processors, they run hotter than ever. All of this heat is trapped by cameras, reducing their life span, and lowering their performance. Thermiq Technology opposes heat by using heat diffusers and high speed blowers, a system designed by Moog Videolarm engineers in concert with Moog Space and Defense experts. Thermiq Technology is available only on Moog Videolarm Fusion Camera housings, which represent the latest in camera enclosure aesthetics, optics, and ease of installation. In cities, on highways and in hot climates, Thermiq Technology protects expensive surveillance investments. www.moogvideolarm.com.

Moog QuickSet, a Global Leader in Integrated Security and Surveillance Systems

Moog QuickSet is a global leader in integrated security and surveillance systems for the military, commercial and government markets.

The demand for high performance day/night surveillance is pressing for smaller, smarter, less expensive products as the environments in which they function are increasingly hostile. Security and surveillance are critical 24/7 operations that can’t afford downtime despite visibility, terrain or environmental challenges.

Responding to this demand, Moog QuickSet developed the GeminEye™ Modular Imaging System, embracing high performance in a small package, and is designed to be configured for various applications.
**Market Leader in Next Generation TACAN Systems**

Moog is the number one TACAN producer on the market today, having sold and fielded more systems than all other TACAN suppliers combined. The 2010 TACAN has set new standards to meet the increasing demands for low life cycle costs, greater reliability, performance and control. Use of the latest technology and more dependable components has set new standards in reliability and maintainability. The 2010 TACAN is available in single and dual configurations for fixed and deployable applications. The 2010 TACAN is now deployed throughout the world to customers including the US Air Force, NATO, and key Air Forces and Navies in the UK, Europe, Middle and Far East.

**Contract Awarded for Littoral Combat Ships**

Moog has been awarded a contract to provide TACAN equipment for both of the new Littoral Combat Ships (LCS). The MM-7000 variant for the LCS vessels is a smaller, lighter, less expensive version of the US Navy’s AN/URN-32 and provides 1kw transmitter power. All modules include the most modern, current technology by utilizing state-of-the-art components and devices. The use of current technology significantly reduces the vulnerability to future component obsolescence and improves reliability and maintainability while virtually eliminating the requirement for on-site routine and preventative maintenance. First delivery is on schedule for summer of 2012.

**US Navy Selects Moog to Supply Shipboard and Shore-Based TACAN Upgrades**

Moog has been selected by two divisions of the US Navy to redesign and upgrade legacy URN-25 (URN-32 or MM-7000) TACAN systems. The US Navy’s Space and Naval Warfare Systems Center in San Diego, California awarded Moog a contract to upgrade shore-based TACAN systems, and the Naval Warfare Center Aircraft Division in Patuxent River, Maryland awarded Moog a contract to upgrade shipboard TACAN systems.

The URN-25 is the first newly designed 21st century Tactical Air Navigation (TACAN) beacon–transponder. The upgrade (URN-32/MM-7000) has a flexible configuration, requiring only half of the existing cabinet space. The TACAN has met all of the requirements set forth by the US Navy, is suitable for fixed-site and shipboard installations, and is compatible with the US Navy’s standard OE-273 antenna and other mechanically rotating TACAN antennas.

**TRN-47 Supplier for Abbreviated Acquisition Program**

Moog recently completed its contract with the US Navy to supply the TRN-47 as part of their Abbreviated Acquisition Program (AAP), a program designed to deliver capabilities on an accelerated schedule. Deliveries were completed ahead of schedule and Moog currently has a new contract with NAVSUP for post-production support as the mini-stock-point repair station for all AN/TRN-47 needs. This manportable AN/ TRN-47 can be set up and torn down in less than fifteen minutes by a two-person team, providing for various missions including Operation Enduring Freedom, Operation Iraqi Freedom and the Haiti Relief Effort. Moog has been a significant provider of TACANs, including the TRN-47, to the US Navy for over 50 years.
Moog Introduces Total Support for Commercial Aircraft

Moog recently launched Moog Total Support (MTS), a comprehensive support program for its flight control systems. By combining asset pooling, maintenance, technical support and logistics, Moog can provide a highly-customized support package that unites its OEM expertise with decades of experience as a world-class MRO provider. MTS provides airlines with an unrivaled one stop solution tailored specifically to individual needs. This helps to reduce cost, inventory levels, AOG risk and exposure to obsolescence. These flexible life-cycle cost solutions include:

- 24/7 access to spares with regional pooling locations around the world
- Guaranteed availability of replacement components
- On-site consignment
- 24/7 customer support
- Lease, loan and exchange options
- Reliability monitoring and maintenance recommendations

Moog Acquires Flight Control Actuation Business from GE Aviation Systems

The business, located in Wolverhampton, U.K., designs and manufactures primary and secondary flight control actuation for a number of commercial and military programs. Key commercial products that have been added to Moog’s support capabilities include:

- 737 – Primary Flight Actuation
- 787 – High Lift Actuation
- A330/A340 – High Lift Actuation
- A380 – High Lift Actuation
- BAE 146 – Primary and High Lift Flight Actuation

The General Electric Company acquired this business as part of its acquisition of Smiths Aerospace in May of 2007. The acquisition is now part of Moog’s Aircraft Group.

777 Spoiler Reliability Extension Program

On the Boeing 777, Moog is the OEM supplier of inboard, outboard and mechanical flight control actuators with a total of 14 actuators per aircraft. Moog has developed a reliability extension program to enhance dispatch reliability while minimizing unscheduled spoiler PCU removals. The spoiler reliability extension program contains three key elements:

- Field inspections of high time PCUs to assess critical wear that can affect aircraft dispatch
- Specialized repair and overhaul procedures to restore hardware to an enhanced reliability level
- Strategically located rotables in Moog global facilities to enhance turn-around time

Under the program, Moog works with the operator’s technical staff to create in-field inspection instructions, custom test equipment, a health check kit and on-site technical support and training. For spoilers ultimately identified as requiring maintenance, Moog has developed a specialized overhaul protocol to integrate product improvements and restore hardware to an enhanced reliability level.

Moog Expanding Asset Management Network

Moog recently expanded its worldwide asset management network by prepositioning consignment stock within Beijing, China. Through a partnership agreement with the Air China Import/Export Division, Moog is providing rapid response support for Moog Aircraft products to airlines operating within China. The inventory includes a variety of units for Boeing and Airbus aircraft.

The Beijing operation is part of Moog’s Worldwide Asset Management network which includes forward stock inventory in New York, Los Angeles, London, and Tokyo, and will soon include Dubai, Singapore and Melbourne.
Moog Provides 787 Entry Into Service Support

Moog is the designer, manufacturer and integrator for the 787 primary and high lift flight control actuation systems. As the aircraft approaches entry into service, Moog is prepared to provide the airlines with industry leading support including expert training from our OEM technical team, first class responsiveness and global spares availability. This includes a team of field service engineers, inventory located in all major world regions, and a variety of spares provisioning and maintenance options.

Moog is working closely with the airlines to customize support packages that meet their exacting needs ranging from initial provisioning buy or lease, access to pool options and flight hour maintenance programs.

Schaefer to Lead Moog Commercial Aftermarket Support Team

Kate Schaefer recently joined Moog Aircraft Group as General Manager, Commercial Aftermarket Sector. In her new role, Kate will be leading the development of Moog’s commercial repair and support organization as we prepare for the much anticipated entry into service of the 787 and A350.

The group will be providing a new suite of product offerings and services tailored to suit a broad range of customers, while continuing to provide world class engineering support and adapting to specific customer needs.

Kate comes to Moog with over 20 years of business leadership and aerospace industry experience, holding a variety of operations and business development management positions. Kate is based out of Moog’s headquarter facilities in East Aurora, New York.

Moog’s Baguio Customer Support Center Continues to Expand

Moog continues to grow at its newest repair station in Baguio City, Philippines. The facility, located in Moog’s modern aircraft controls manufacturing facility, provides repair and overhaul services to customers in the Asia-Pacific region.

Originally established in 1984 to produce Boeing, Airbus and business jet products, the facility now offers full service repair and overhaul of Moog content on the 777, 747, 737, A330 and A340, and also supports exchange and repair on servovalves. The center has its own dedicated technical and support staff, test equipment and inventory.

Since 2009, the station has received repair certification from FAA, EASA, CAAC, CAAP Philippines, CAAS Singapore, DCA Thailand, DGCA Indonesia and DCA Malaysia.

Displays and Avionics

With over 35 years of experience in cockpit displays, avionics and instrumentation, Moog Components Group has contributed to the success of numerous aerospace platforms. We offer total in-house engineering capabilities for design, manufacture and test of a full range of products. We offer a number of stand-by and utility navigation instruments for the commercial, business jet and regional jet community and also provide support to many TSO and STC efforts for retrofit applications. In addition to our traditional electromechanical product line, Moog offers a line of fixed format LCD engine instruments and can accommodate numerous Signal Data Conversion (SDC) needs as well.
Moog Expands H-60/S-70 Flight Control Overhaul and Upgrade Services

Moog developed the capabilities to provide overhaul services for the entire family of integrated Trim/Boost Servoactuator Assemblies on the H-60/S-70, including the Pitch Trim, Roll Trim and Yaw Boost Servoactuator configurations. Moog inspects and disassembles the integrated assembly, overhauls and tests the individual LRU’s, and reassembles and tests the integrated assembly before delivery to the customer. Moog has recently won its second consecutive 5-year contract with the US Coast Guard (USCG) to provide overhaul services for their HH-60J/T flight controls, previously demonstrating a 50% improvement on turnaround time while significantly lowering the USCG’s total overhaul cost.

In addition, Moog is now offering an endurance upgrade to the H-60/S-70 Pitch Trim Actuator. This upgrade, available only through Moog’s exclusive overhaul process, will enable the Pitch Trim to stay on wing longer and provide better performance in harsh climates such as salt water, humidity and sand. HVOF coating has been added to the Booster Piston providing additional corrosion and scratch protection. The design of the dust boot has been modified to help keep the Pitch Trim flying longer, and the newly designed mounting feet will prevent corrosion by better allowing the surface to shed water. The upgrade will offer a 3X improvement in mean time between unit removals versus the current configuration.

Moog Expands Global Support Capability for Military Aircraft Products

As part of a recent acquisition, Moog now offers full-service capabilities for the relevant actuation products originally sold under the GE Wolverhampton, Smiths Wolverhampton and Dowty Wolverhampton names. Key products which have been added to Moog’s support capabilities include:

- CN235 – Trailing Edge Flap Actuation & Controls
- Typhoon – Primary Flight Actuation
- A129 – Primary Flight Actuation
- C295 – Trailing Edge Flap Actuation & Controls
- F-35 STOVL – Lift Fan & Swivel Module Actuation
- AMX – Primary Flight Actuation

USAF Selects Moog to Provide Overhaul Support on B-1B Primary Flight Control Servoactuators

The United States Air Force (USAF) recently awarded Moog contracts to provide overhaul services for the primary flight control servoactuators on the B-1B weapon system. These 5-year contracts encompass a total of 25 different line items including Horizontal Stabilators, Pitch Roll SCAS, Yaw SCAS, Forward and Aft Structural Mode Controls, Lower Rudders, Inboard and Outboard Spoilers and the Master Pitch Roll Servoactuator. The first deliveries of overhauled servoactuators began in June 2010. These contracts typify Moog’s commitment to support the USAF’s operational readiness goals for high priority weapon systems.

World Class Repair and Overhaul Support for F-16 Leading Edge Flap Drive System

Moog is the OEM supplier for the F-16 maneuvering Leading Edge Flap Drive System (LEFDS). Products include the Power Drive Units, Hydromechanical Actuators, Rotary Mechanical Actuators, EM Control Actuators, Angle Gear Boxes, Torque Shafts and Asymmetry Brakes. Through the use of modern test equipment, factory trained technicians, and the latest approved repair procedures, we maintain a leadership position in the repair, overhaul, modification and upgrade of the F-16 LEFDS hardware. Moog prides itself on being able to deliver the highest quality of customer service and is capable of creating flexible support programs to best meet our customer’s unique needs.
Moog Supports Ongoing Public-Private Partnerships

Moog is committed to supporting its customers through the use of Public-Private Partnerships. Moog currently has several partnerships in place, covering multiple platforms and applications. These partnerships provide significant value by leveraging the specialized expertise, equipment and facilities of each organization.

Since March of 2008, Moog has been under a Public-Private Partnership with Ogden Air Logistics Center for the overhaul and upgrade of the F-15 pitch and roll channel assembly. Moog has also been under a Public-Private Partnership since August of 2007 with the Fleet Readiness Center Southeast for the F/A-18 leading edge flap system. In November of 2011, Moog also entered into a commercial service agreement with the Fleet Readiness Center East for the V-22 Osprey. Moog Military Product Support is actively engaged in discussion for future commercial service agreements with the Tinker Air Force Base for the B-2, and with the Fleet Readiness Center Southwest for the F/A-18 E/F and F-35.

Moog Providing F/A-18 C/D Leading Edge Flap System Safety Upgrade for Worldwide Hornet User Community

Moog is the original design authority for the F/A-18 C/D Leading Edge Flap System and has developed and qualified a safety upgrade to improve system reliability, enhance effectiveness of periodic inspections, and ensure control during possible fault condition. The changes include a redesigned Torque Limiter and Stop Module and a replacement Torque Shaft. The upgrades can be installed at the Organizational (O) level and retrofit actions are planned for worldwide distribution in late 2011.

The changes to the torque limiter include the addition of a brake wear indicator and trip indicator that enable periodic inspection of the brake stack and a means to visually determine whether the torque limiter has experienced a lock-up. The improvements to the stop module control the inboard flap from moving beyond the stroke limits during a run-away, thereby preventing a loss of control condition. Lastly, the torque shaft that connects the hydraulic drive unit to the angle gearbox was redesigned to add a second universal joint, thereby improving shaft support and ensuring any misalignment is handled by the U-Joint.

For more information please contact Russ Wainwright, Director F/A-18 Global Product Support, +1.801.557.6567; e-mail: rwainwright@moog.com

Moog Signs Umbrella Corporate Contract with DLA

Moog has recently signed an umbrella contract with DLA - Defense Supply Center Richmond. The corporate contract covers critical component parts and sub-assemblies required to support depot repair activity for all Moog Aircraft Group products. This new contract benefits DLA, the USAF depots and Moog by streamlining the procurement process and providing more cost effective and timely access to parts required to support legacy aircraft systems.

Defense Supply Center Richmond is the aviation supply and demand chain manager for the Defense Logistics Agency and serves within the Defense Department as the primary source of supply for more than 1.2 million repair parts and operating supply items. DLA recently assumed responsibility for procurement management and related support functions for depot-level repairables at the Oklahoma City, Ogden and Warner Robins Air Logistics Centers. DLA’s mission is to provide best value aviation weapon systems and logistics support to America’s armed forces—on land, at sea and in the air.

Boeing Selects Moog to Develop and Qualify Fly by Wire Rudder for the F-15

Moog has been participating as a key supplier to Boeing for the F-15 since the early 1970s. This program will upgrade the existing mechanical flight control actuators with advanced fly by wire technology to simplify the aircraft’s overall flight control architecture and reduce system weight. This award provides us a position to support the next generation of F-15 Strike Eagles through the next decade.
Moog Adds New F-16 Flight Control Support Capabilities

Moog has recently expanded its capability to support F-16 customers with repairs, overhauls and spares for the Leading Edge Flap (LEF) Power Drive Unit (PDU). The PDU is a complex electro-hydro-mechanical system that accurately controls the position of the leading edge flaps in response to changes in aerodynamic conditions.

Moog has also developed internal capabilities to provide cost effective repair and overhaul services for the complete PDU and for all of the subassemblies that make up the PDU. Modifications of older design PDU’s into the latest configuration can also be accomplished to minimize support costs for the end user.

Moog Improves Product Support for Legacy Aircraft

Moog is the designer and OEM for the leading edge slat system on a legacy military cargo / transport aircraft. A ship-set of slat system hardware includes 28 actuators plus a variety of torque tubes, angle gearboxes, etc. In recent years, the procurement of the ballscrews, a key subassembly of the actuator assembly, has become increasing difficult as the sole-source supplier of these critical parts increased prices and stretched out production lead times.

In order to improve product support to the end customer, Moog developed and qualified a form, fit and functional replacement to the existing design. All engineering, CAD modeling, assembly and environmental testing were conducted at Moog’s facilities in East Aurora, NY and Torrance, CA. The Moog ballscrew is now in production and is fully interchangeable with the previous supplier’s design.

AC-130 Landing Gear System Upgrade for USAF

Moog developed and qualified a reliability improvement to the AC-130U Main Landing Gear System which is being incorporated into the USAF fleet. Under contract to Boeing Integrated Defense Systems, Moog redesigned the Main landing gear power transfer valve to boost overall system performance and reliability. The redesign included changing the 6-port linear control valve to a 9-port configuration to eliminate unacceptable pressure transients during switching operations, while at the same time minimizing physical interface and envelope changes.

Moog Expands Support for International C-130 Operators

In 2010, Moog Aircraft Group acquired the Milwaukee Operations of Triumph Accessory Services. With a long history of supporting international operators with turnkey logistics services, the Moog Milwaukee office enhances and expands Moog’s military aftermarket support program. This program includes comprehensive repair and overhaul support, spare parts support, performance upgrades, reliability enhancements and obsolescence management, and provides nose to tail solutions to C.130/L-100 operators and maintenance facilities around the world.

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Motion Control Technology for Defense and Security

Moog designs, manufactures and integrates motion control systems and components for military vehicle platforms. Moog's expertise in stabilization, fire control, weapons integration, power distribution and management, data acquisition and management, and C4I systems can be found on more than 30 of the world's leading military vehicle platforms.

Moog builds its systems from heritage components designed and manufactured in-house. Key components include:
- Gun controllers
- Electromechanical and electrohydraulic actuators
- Single to multiple axis controllers
- Fire control computers
- Power management units
- Slip rings
- Fiber optic multiplexers

Moog Develops Non-Lethal Grenade Launcher for Rapid Deployment

Moog debuted and demonstrated its new EAGLS (Electrically Articulated Grenade Launcher System) non-lethal grenade launcher at Eurosatory 2012. This unit has been developed to support the military's need for rapidly deployable, escalation of force, mission ready equipment. The applique system gives troops the ability to accurately target and disperse a crowd without using lethal force.

EAGLS is designed to accommodate the 66mm family of non-lethal grenades, including both smoke and anti-riot. The system is comprised of an electromechanically controlled, dual-axis positioner supporting two grenade discharge racks and a wide angle day sight camera. Each discharge rack has the capacity for six grenades and allows troops to individually position and deploy grenades up to 100 meters. The launcher is continuously adjustable in azimuth and discretely adjustable in elevation for range select. It also features an optional surveillance suite for 360° situational awareness and active stabilization for low bandwidth, shoot on the move capability.

Moog Unveils ProtectIR

Moog is debuting the ProtectIR ISR Targeting (T) pod, which is a fully integrated, rapidly deployable COTS ISR (T) pod for use on existing fixed and heavy rotary wing aircraft. It is a valuable capability for allied air forces that want to conduct ISR operations using a flexibly-mounted ProtectIR kit.

The ProtectIR allows allied military forces to have ISR (T) dominance without significant expense. The ProtectIR is a 5th generation high-definition electro-optical infra-red (FLIR) system with a tightly integrated moving map, stores management computer, GEO location, and state of the art data links. Optional payloads can be configured to include Ground Moving Target Indication (GMTI)/Synthetic aperture radar or a mobile phone tracking in a sub-136 kg (300 lb) package.

Moog can install the ProtectIR at the customer site within nine months along with aircrew training and mission planning. Moog offers this product and service capability for less than half of what other OEM's charge for their basic ISR configuration alone.
Moog Test Controller at the Heart of Aero Test System Supporting F-35 Structural and Fatigue Testing

In 2011, BAE Systems took delivery of F-35 test article AJ-1 at its structural test centre in Yorkshire, UK. The test article, an instrumented fully production-representative version of the F-35A, will be subjected to two life-cycles of spectrum fatigue loading in support of structural certification and service life analyses. Hydraulic actuators will apply the service loads to the airframe using a state-of-the-art control system to ensure safety of the specimen and operators is maintained at all time.

The loading actuators are controlled by a digital multi-channel, closed loop servo system supplied by Moog. The Moog test controller is integrated with a data acquisition system so that specific data logging actions can be carried out automatically. The design of the system accommodates the test being run “unattended” for round-the-clock operation. A comprehensive safety system is embodied as part of the controller so that in the event of any system malfunction, the test loads are removed under full system control without risk to the test specimen. With a capacity of 2000 channels, the data acquisition system is configured to log strain gauges, displacements and loads.

Moog Supplies Systems to AgustaWestland for Helicopter Structural and Fatigue Testing

Advanced aerospace test systems are required to create and measure forces to simulate and test real-time durability and resistance of helicopter components, especially fatigue tests on the rotor, hub and blades. Recent initiatives from Moog include the development of a system supplied to AgustaWestland to perform a wide range of structural and fatigue tests for helicopter rotor blades.

To meet AgustaWestland’s demanding specifications, Moog supplied an aerospace test controller with six servo channels, incorporating the latest quad core IPC processor and a real-time Ethernet platform to enable playback of the complex loading spectrum on the helicopter blade. The system’s real-time Ethernet platform increases the functionality of servo controllers and boosts the performance of aerospace testing, providing faster graphics, accurate synchronization of up to 500 control channels, reduced latency time and complete management of many safety procedures to eliminate risk on the test specimen. It provides the test system with a high bandwidth and an unprecedented level of safety, and is particularly suited for high performance aircraft, helicopters and spacecraft testing.

Moog Receives Test System Orders from Airbus

Moog has received an order from Airbus in Hamburg, Germany to supply 11 Moog test systems to provide a test capacity of 136 control channels. This order is in addition to those placed previously under a 10-year frame work contract between Airbus and Moog for the exclusive supply of multi-channel test systems for structural testing of aircraft.

The multi-channel test systems enable Airbus to develop a single platform across all of its structural testing facilities in Germany, United Kingdom and France.

The test controllers and software will be used for both static and dynamic structural tests. The test systems will provide a standard-ized and trans-national platform, making service and support easier and faster. The new systems will be configured with real-time ethernet, offering Airbus more flexibility, higher bandwidth, increased data speed, more reliability and faster test set-up. The Moog test systems can support civil aircraft, military aircraft and technology projects.

Moog Provides Customized Test Solution to Korean Aerospace Research Institute for Helicopter Structural and Fatigue Testing

As part of a multibillion dollar helicopter procurement project by the South Korean Ministry of National Defense, the Korean Aerospace Research Institute (KARI) solicited proposals for a customized test system capable of supporting helicopter structural and fatigue tests. Moog’s winning solution included six cabinets with 16 controller channels each and a 256-channel data acquisition system, integrated seamlessly with KARI’s existing data acquisition systems and hydraulic control equipment in the test lab.

Installed in just three days in 2008, the test rig is now fully operational and running full-scale structural tests. The system has the potential to run up to 12 independent helicopter tests.
**ACTUATION PRODUCTS AND DATA TRANSMISSION**

**Slip Rings and Fiber Optic Rotary Joints for Aerospace and Defense**

Slip rings are used in systems that require unrestrained, continuous rotation while transmitting power and/or data from a stationary device to a rotating structure. Today’s sophisticated battlefield requirements depend on Moog’s slip rings for high bandwidth, high reliability and long life operation. With over 10,000 baseline designs, models are available in standard and custom configurations.

Fiber Optic Rotary Joints (FORJ) pass optical signals across rotating interfaces while maintaining the advantages of fiber such as high bandwidth capability and EMI immunity. These products are designed for high performance operation in extreme environments, including shock and vibration, temperature, humidity and dust. Configurations include: off-axis, singlemode and hybrid FORJ/slip ring assemblies. Electrical to optical media converters are available for end-to-end solutions.

**Housed and Frameless Resolvers (and Synchros) for Aerospace and Defense Applications**

Moog supplies a variety of resolvers and synchros for use in demanding military and aerospace environments. These rugged and reliable devices provide accurate position and velocity feedback as well as commutation, without the structural or temperature restrictions imposed by other electronic feedback devices. They are resistant to the shock and vibration levels often encountered in military and aerospace applications and exhibit high immunity to electrical noise. They are available in brush or brushless designs with a large selection of standard models. Our engineering department is also available to provide application consultation and to tailor custom solutions to meet challenging program needs.

**Catalog and Custom Servo and Torque Motors**

Moog is a market leader in the design and production of housed and frameless servo and torque motors. We offer motors in brush-type, two-phase brushless and three-phase brushless configurations. All utilize high-energy permanent magnets and high-permeable armature lamination materials in producing fast servo response and high starting torque for demanding applications such as gimbaled positioning systems. Reliability and long life are hallmarks of our products. Available in frameless configurations for direct drive systems, or housed with optional gear heads, these motors are designed and proven in aircraft, missile, armored vehicle and naval systems.

**Air Moving Solutions**

Moog Air Moving Solutions designs and manufactures high performance efficient cooling products to solve difficult thermal, airflow and acoustic problems for use in rugged aerospace and military applications. These products are aerodynamically designed for optimized efficiency and acoustics and are combined with Moog’s high-efficiency motors for the lowest overall system power usage.

**Integrated Motors, Resolvers and Slip Rings**

Moog provides integrated assemblies that combine DC torque motors, resolvers and slip rings into custom structures with bearings and seals. These assemblies are used in a two-axis gimbal that can be slewed and pointed at an incoming threat protecting commercial and military aircraft. The Moog assembly provides maximum performance at minimum space and weight.
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