Agenda

• Moog Inc. – The Company
• Who is the Moog Industrial Group?
• Simulation and Test Solutions and Services
• Wind Energy Solutions and Services
• Marine Solutions and Services
• Medical Solutions
• Products, Systems and Services
• We want to be your supplier of choice
Moog Inc. – The Company
Three Operating Groups

MOOG INC.

Employees worldwide: > 10,600±
Headquartered in East Aurora, New York, USA
Publicly listed company NYSE (MOG.A and MOG.B), since 1959

$2.5 Billion 2017 Sales*

Aircraft Group
$1,125 MM

Industrial Group
$843 MM

Space and Defense Group
$529 MM

**FY 2017 Source: Moog Inc. Nov. 2017**
Balanced and Diversified Revenue Stream

Industrial Group: 34%
Space and Defense Group: 21%
Aircraft Group: 45%

% Revenue by Operating Group

Note: FY 2017 Source: Moog Inc. Nov. 2017
Financial Performance

*Sales (US$ billions)

Earnings Per Share (US$)

**FY 2017 Source: Moog Inc. Nov. 2017
Moog Culture

• Since our founding in 1951, the leadership has had a profound commitment to maintaining our unique company culture

• Employees in every office enjoy mutual trust and respect

• Moog teams approach work with energy, enthusiasm and the promise of success

“We are All in this Together”

“Communication is Crucial”

“Trust is a Must”
Who is the Moog Industrial Group?
What – Products, Solutions and Services for Industrial Customers

Moog Industrial Group

Products and Services
- EH Motion Control
- EM Motion Control
- Slip Rings
- Medical Devices

Solutions and Services
- Wind
- Simulation
- Test
- Marine

Lean Transformation
Process Focus
Growth and Innovation
What - Motion Control and Power/Data Transmission

- Electro-Hydraulic
- Electro-Mechanical
- Electro-Hydrostatic
- Power/Data Transmission
What - Growth and Innovation Technologies

We are investing in R&D to develop different technologies to help solve your unique problems

- Haptics and force feedback technologies to help train medical professionals
- Unique large motors for more efficient servo-presses
- Additive manufacturing and IoT for next generation solutions
Where – Global Approach to Business

USA
Canada
Brazil

Germany
Luxembourg
United Kingdom
France
The Netherlands
Ireland

Italy
Russia
South Africa
Spain
Turkey

Japan
Philippines
China
India
Korea
Australia
Singapore
Markets – Reliable, High Performance Industrial Solutions and Services

Wind Energy

Simulation

Test

Marine
Markets – Industrial World-Class Products and Responsive Services

- Gas and Steam Turbines
- Oil and Gas Exploration and Production
- Injection and Blow Molding Equipment
- Metal Forming Machinery and Presses
- Steel Mill Equipment
- Industrial Automation, Robotics and Material Handling
- Paper, Pulp and Saw Mill Equipment
Markets – Products Used in these Medical OEMs Applications

Medical Centrifuges
Respiratory Care
Computed Tomography (CT) Scanners
Therapeutic Patient Beds
Medical Pumps, Blowers and Compressors
Markets – Medical Devices

- Infusion Pumps
- Safety Software
- Administration Sets
- Accessories
How – Meeting Customer Needs

MOOG CUSTOMERS

Deep Application Knowledge
- Solutions based on mapping your needs
- Long legacy in motion control products and power and data transmission products
- Able to find best fit for your machine

Focus on Adding Value
- Support your success
- Help you build machines that offer outstanding value
- Ensure we add value from design to delivery to after sales service

Responsive Global Support
- Offer flexible, comprehensive and timely services
- Help you transform from “break and fix” to planned maintenance
- Deliver motion control expertise with products and services that meet your needs
Why Choose Industrial Products?

Moog’s deep expertise coupled with our technology-neutral approach guarantees the best fit for your machine.

Long legacy in motion control and power and data applications

Easily integrated, easily configured high performance products to meet your application requirements

Experts who help you find products that meet your needs
Why Choose Moog Industrial Products?

Technology-Neutral Approach

- The right motion control solution depends on the machine, the application, the region and the budget constraints.
- Expertise in electro-hydraulic, electro-mechanical and electro-hydrostatic technologies, means we collaborate to find the best solution for you.
- Our products, solutions and services works together seamlessly to reduce machine development time and increase flexibility.

<table>
<thead>
<tr>
<th>Main Advantages and Disadvantages</th>
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<tbody>
<tr>
<td>Energy Efficiency</td>
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<tr>
<td>Environmental Cleanliness</td>
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<tr>
<td>Low Noise Emission</td>
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<td>High Forces</td>
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<td>No Backlash</td>
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Example benefits of actuation technology for a machine application.
Why Choose Industrial Services?

We are the trusted motion control partner who understands your needs and offers flexible, comprehensive and timely services, resulting in excellent value.

- Support operation and maintenance professionals globally and locally.
- Provide services that help you obtain repairs and spare parts when and wherever needed.
- Transform maintenance by helping you move from reactive to planned.
Simulation and Test
Solutions and Services
Flight Simulation - Systems

Proven technology delivers greater than 99.5% system availability

• Delivering the industry’s widest breadth of payloads, technologies and experience in flight simulation

• More than 700 Level D systems installed and operational worldwide

• Capacity to produce 120 14,000 KG motion systems/year
Automotive Test Products and Systems

Validate and launch new designs faster with more cost effective testing

- Remove product development boundaries
- React faster to market changes
- Adapt faster to new safety and environmental regulations

Simulation Tables
Hydraulic & Electric

Controllers and Software

Multi-Axis Test Systems
Electric & Hydraulic

Simulation Tables
Hydraulic & Electric

MOOG
Aerospace Test – Products and Systems

Set up tests faster and run them efficiently while protecting the test specimen

- Solutions for a variety of test including iron bird, aircraft/airframe and spacecraft structural integrity, landing gear, engine casting load and many more

- Turnkey solutions for complex test subjects with increased test accuracy

- Variety of test controllers with advanced control technology and user-friendly operation
Services – Simulation and Test

Local teams in 26 countries who understand your language and provide responsive support

- OEM Factory Repair delivers uptime and like-new performance
- Flexible Parts Options: Regional stocking depots in Americas, Europe and Asia Pacific for quick delivery, on-site spares and exchange programs
- Field service support by phone, email or on-site
Wind Energy
Solutions and Services
Pitch Control – Solutions for Greater Reliability, Safer Operation and Lower Operating Cost

• In-depth system expertise combined with years of experience in the energy sector

• Proven partner to leading wind turbine manufacturers and wind farm operators for pitch control solutions

• Global supply chain for production and global presence for sales and service ensuring support of customers

… reduce Levelized Cost of Energy
… increase reliability up to 50%
… minimize downtime up to 50%
… extend life of products and systems
… simplify installation and troubleshooting
… reduce scheduled services up to 50%
… enhance technical skills with training
… offer service and support anywhere in the world
Pitch Control – Products and Solutions

Moog Pitch System 3 provides high reliability with low maintenance to reduce downtime and enable wind turbines to generate more power, which reduces the Levelized Cost of Energy

- Electric pitch systems for on-shore and off-shore wind turbines
- Blade sensing systems
- Electric and hydraulic pitch products
- Slip ring and rotary solutions
- Multiplexers and media converters
Services – Maximum Turbine Availability with Responsive Support

Moog Global Support is our promise to help wind farm maintenance professionals worldwide to maximize availability, ensure pitch system reliability and lower the cost of energy

• Hands-on training
• Expert technical support
• OEM replacement parts and factory repairs
• Reliable retrofits and fleet upgrade projects
• Flexible service agreements

Global Support Where and When You Need it
Marine Solutions and Services
Marine – Products, Solutions and Services

- Specializing in providing custom electrical slip ring, fiber optic, fluid swivel, optical multiplexer and servo valve solutions
- Design and manufacture custom and built-to-order proven products for the harshest marine environments
- Providing in-house and global service and maintenance, testing and overhauls
Marine – Product Offering

- Slip Rings
- Fiber Optic Rotary Joints (FORJs)
- Fluid Rotary Unions (FRUs)
- Servo Valves
- Multiplexers and Media Converters
- Condition Monitoring
- Floating Production Systems
- Sonars
Industrial Products, Systems and Services Overview
Electro-Hydraulic – Product Offering

- Servo and Proportional Valves
- Radial Piston Pumps
- Industrial Cartridges Valves and Covers
- Servo and Proportional Cartridge Valves
- Manifolds and Hydraulic Systems
Brushless DC Motors
SmartMotor™
Servomotors and Integrated Drive Systems

Electro-Mechanical – Product Offering (1/2)

Servo Motors
Linear Motors
Servo Drives
Machine and Motion Controllers
Electro-Mechanical – Product Offering (2/2)

- Actuators
- Ball and Planetary Roller Screws
- Position Sensors
- Medical/Industrial Ultrasonic Sensors
Electro-Hydrostatic – Product and System Offerings

Hydraulic and electric technology in a self-contained package helps enable a decentralized motion control system and eliminates the need for a hydraulic power unit and complex piping.

Electro-Hydrostatic Pump Unit (EPU)

Electro-Hydrostatic Actuation System (EAS)
Electro-Hydraulic Products
Electro-Hydraulic – Product Offering

- Servo and Proportional Valves
- Radial Piston Pumps
- Servo and Proportional Cartridge Valves
- Industrial Cartridges Valves and Covers
- Manifolds and Hydraulic Systems
Servo and Proportional Valves (1/2)

• Proven reliability and built-in quality for a performance advantage in many different industrial machines

• Numerous models with a range of sizes, performance characteristics and mounting options to better meet your specific requirements

• Convenient selection and configuration of digital valves using Moog configuration software to suit the application needs
Servo and Proportional Valves (2/2)

Technical Summary

- Single and multi stage valves
- Rated flows from 0.15 to 1500 l/min (0.04 to 390 gpm)
- Rated pressures up to 350 bar (5000 psi)
- Integrated pressure, force and axis control options
- Optional fieldbus interfaces
- Variants for hazardous environments
Radial Piston Pumps (1/2)

- Ideal for applications requiring robust performance, low noise, contamination-resistant design and unsurpassed reliability
- Available in various sizes, single and multiple configurations, and a wide array of control options and mounting flanges to meet your specific requirements
Technical Summary

- Variable displacement piston pump
- Single and multiple pump arrangements
- Displacement: from 19 to 250 ccm/rev
- Pressure up to 350 bar permanent pressure and 420 bar pressure peak
- Broad range of compensator types
- Available as RKP with Digital Control (RKP-D) and Explosion-proof versions
Industrial Cartridge Valves and Covers (1/2)

• Available as directional, pressure and check cartridge valves including covers and pilot valves

• High robustness and reliability

• Ideal for applications which require high flow rates and leakage-free control

• Re-designed cartridge valves with best-in-class nominal flow rate
Industrial Cartridge Valves and Covers (2/2)

Technical Summary

• Rated flows up to 20,000 l/min (5400 gpm)
• Rated pressures up to 420 bar (6000 psi)
• Available sizes: NG16 to NG160
• Passive and active cartridge valves available
• Position monitored cartridge valves for safety applications
Servo and Proportional Cartridge Valves (1/2)

- High robustness and reliability
- High flexibility through modular design
- 2- and 3-way design
- Different performance and fail-safe options available
Servo and Proportional Cartridge Valves (2/2)

Technical Summary

• Nominal flow rate up to 20,550 l/min at $\Delta p = 5$ bar
• Maximum operating pressure up to 420 bar (6000 psi)
• Available sizes: NG40 to NG160
Manifold Systems

- Application-specific manifold designs allow enhanced machine performance, reduced system cost, and meet requested safety performance level
- Compact manifold design allows a reduced envelope size and piping efforts
- Fully tested manifolds enable shortest start-up and commissioning time
- Reduced system costs with re-designed cartridge valves for pressure range up to 420 bar (6,000 psi)
- Manifolds up to 12 t
Hydraulic Systems

Scope includes:

• Manifolds, hydraulic power units, cylinders, accumulators, piping

• Axis closed loop control including hardware, software, start-up support and commissioning

• Simulation of the entire system to meet the required performance and to minimize the start-up time

• **Hardware in the Loop (HIL)** supports the software check of the closed loop control and the PLC
Electro-Mechanical Products
Electro-Mechanical – Product Offering (1/2)
Electro-Mechanical – Product Offering (2/2)

- Actuators
- Ball and Planetary Roller Screws
- Position Sensors
- Medical/Industrial Ultrasonic Sensors
Silencer® BN Series Brushless DC Motors

- Diameters from 30.48 to 106.68 mm (1.2 to 4.2 in)
- Lengths from 33.02 to 139.7 mm (1.3 to 5.5 in)
- Continuous torques from 2.4 to 519 oz-in
- Speeds up to 20,000 rpm
- Precise, variable speed control
- Extremely quiet operation
- Long-life operation
SmartMotor™ Integrated Servo Motors

- Fully integrated motion control servo system incorporating a multi-axis motion controller
- Supports serial and many optional fieldbus protocols
- Combitronic™ technology for a parallel-processing network up to 120 axes
- NEMA 17, 23 and 34 frame sizes to meet any application requirements
- Compact, feature-rich controls allow for rapid solution development
- Wide array of standard catalog products; custom designs are also available
Brushless Servo Motors

- Superior motor dynamics improving cycle time
- Modular and compact lightweight construction
- Proprietary, low cog design for smooth low speed operation
- Flexible options for easy integration
- Available as frameless package
- Custom windings and designs
Compact Dynamics Servo Motors

Technical Summary

- Continuous Torque from 0.15 to 74.2 Nm
- Peak Torque from 0.5 to 240 Nm
- Speed up to up to 11,700 rpm
- Sizes 3 to 6, Flanges from 40 to 190 mm
Maximum Dynamics Servo Motors

Technical Summary

- Continuous Torque from 2.2 to 1,034 Nm
- Peak Torque from 10 to 2,012 Nm
- Speed up to 11,700 rpm
- Sizes 3 to 7, Flanges from 70 to 275 mm
Fastact H Servo Motors

- Comprised of air cooled (Fastact H) and liquid cooled (Fastact WH) motors
- Available in a wide range of sizes, each with multiple lengths and varying torques and speeds
- Normal and high pole count versions
- Integral feedback, including resolver or optional encoder
- Flexible and modular design available
Explosion Proof Servo Motors

Technical Summary

- Continuous Torque from 0.52 to 66.68 Nm
- Peak Torque from 1.0 to 239.3 Nm
- Speed up to 7,800 rpm
- Sizes 3 to 6, Flanges from 70 to 190 mm
Large Motor Solutions

- High power and high dynamic servo motors up to 1 MW Continuous Power

- Application Markets:
  - Metal Forming Servo Press
  - Industrial Machinery
  - Marine Winches and Propulsion

- Integrated system consists of high power servo motors, servo drives, controllers, an energy management system, power supplies and motion application software

- Scalable system architecture, customizable hardware and collaborative engineering support reduce machine development time and increase flexibility

- Incorporates the latest energy management and motion control knowhow

Sizes 630 and 1,000 Large Motor Solutions for 300 T and Larger Servo Presses
Linear Motors

• Encoder with 0.01 μm resolution, optical and Hall types available

• High force motors up to (22.25 kN) 5,000 lbf force

• All electric solution with direct linear motion and only bearings that need 5 ml of oil each 6 months to maintain

• Fan cooled and liquid cooled options for maximum performance

• Available as a component in a complete system solution - includes brushless linear motors, drives, motion controllers, cabling, filters and accessories
Programmable Multi-Axis Servo Drive System (MSD) (1/2)

• Available in wide variety of power sizes and various fieldbus communications that work with virtually all machine designs

• Fully digital control over position, velocity or torque for servo motors incl. synchronous, asynchronous, linear or torque motors

• Deliver the highest dynamics, total reliability, smooth low-speed performance, thermal management for operation in demanding environments
Programmable Multi-Axis Servo Drive System (MSD) (2/2)

Technical Summary

• Continuous Current from 4.0 to 450 amps
• Peak Current from 8.0 to 765 amps
• Operating Voltage from 115 to 460 VAC
DS2020 Single Servo Drives

• DS2020 integrates the power supply with the drive in one enclosure
• Compact design helps reduce cabinet space and installation costs
• Complete analog interface available for backwards compatibility with analog drives
• Supports single multi-turn fully digital or Sin/cos encoders and any type of resolver
• High-speed communication via field bus connection to a wide range of control systems via EtherCat and CANopen
DM2020 Multi-Axis Servo Drives

• DM2020 uses one power supply with multiple single and two axis drives

• Maximum synchronization between the axes with the dual-axis layout in a single module

• High-speed field bus connection via EtherCat and CANopen

• Multi-axis architecture reduces the overall dimensions by roughly 50% compared to stand-alone configurations

• Safe Torque Off function available with independent management on all axes

• User friendly graphic interface allows rapid access to all functions for easy setup, start up and monitoring
DI2020 Drive-Integrated Servo Motor

- DI2020 with on-board electronics and decentralized servo drives
- Decentralized solution allows a reduction in the number of connections
- Cost savings due to reduced wiring (no feedback cabling)
- Decentralized architecture saves up to 90% of cabinet space
- High resolution and high sampling rate of its control loops provide high accuracy and fast execution of movements
DR2020 Decentralized Servo Drive

- DR2020 is a high performance drive with IP67 protection grade for liquid and dust resistant applications
  - Ruggedized for harsh working environments
  - Streamlines wire configurations and saves cabinet space
  - Single connector for power and signal
  - Safe Torque Off and Safe Brake Control safety functions
  - Fully integrable into a multi-axis configuration
Motion and Machine Controllers

- Motion Controllers and Software for electric and hydraulic servo actuation applications that offer rapid set-up
- Modular design enables the solution to be scaled to the needs of the machine
- High CPU performance for fast and accurate control
- Version for harsh environments available

Motion and Machine Controllers
Machine Controller Series 600 (MC 600)

• Modular hardware design for greater precision and faster reaction time
• Choose centralized or decentralized architectures without any application software modifications
• Uses the Moog Application Software Suite with easy-to-use template library for faster application development
• Wide operating temperature range
• Scalable hardware and software structure for applications of all sizes
• Integrated with the rest of Moog products for a total solution
Servo Actuators (1/2)

- Available in Inline, foldback and compact designs for effortless integration into existing systems
- Offer long-lasting performance and reliability that increases lifetime and return on investment for machine builders
Servo Actuators (2/2)

Technical Summary

• Continuous Force from 1.0 to 96 kN
• Peak Force from 3.6 to 115.6 kN
• Rod Speed up to 1,600 mm/sec
• Stroke Length up to 2,500 mm
Ball, Planetary and Inverted Roller Screws

• Available as ball screws, roller screws and inverted roller screws in a full range of sizes with a wide selection of static and dynamic loads to allow easy integration into the machine

• Extended range of accelerations (up to extremely fast duty cycles) that meet noise and vibration requirements

• Robust design suited for heavy duty applications, vibrations and harsh environments

Ball and Planetary Roller Screws
Ball Screws

Technical Summary

• Dynamic Load Rating up to 1,450 kN
• Static Load Rating up to 3,300 kN
• Diameter from 12 to 125 mm
• Stroke Length up to 6,200 mm
• Leads from 1.5 to 80 mm
Roller Screws

Technical Summary

- Dynamic Load Rating up to 1,380 kN
- Static Load Rating up to 3,500 kN
- Diameter from 16 to 90 mm
- Stroke Length up to 4,000 mm
- Leads from 2 to 40 mm
Inverted Roller Screws

Technical Summary

• Dynamic Load Rating up to 300 kN
• Static Load Rating up to 750 kN
• Diameter up to 48 mm
• Stroke Length up to 180 mm
• Leads from 3 to 20 mm
Position Sensors

- Brushless, non-contacting technology
- Repeatable position sensing with infinite resolution
- Housed and frameless versions available
- Single cycle (+/- 80 deg.) or dual cycle (+/- 40 deg.)
- Standard size 8 (housed version) with servo clamp interface available
- Multiple channel (tandem) versions available
- Geared configurations available
Ultrasonic Sensors

- Custom sensor development
- Off-the-shelf sensors for common tubing sizes/reservoirs as well as for prototyping
- The LifeGuard® line of sensors and sensing capabilities offer the perfect starting point for your engineering projects
Electro-Hydrostatic Product and System Offering
Electro-Hydrostatic Pump Unit (EPU)

- Combines servo motor with radial piston pump in a compact package
- High energy efficiency reduces operating costs
- Environmental cleanliness lowers maintenance and operating costs, risk of fire
- High-force capability provides a viable alternative to electrohydraulic actuation
- Unique direct mounting manifold Interface enables reducing piping and machine footprint
Electro-Hydrostatic Actuation System (EAS)

- Combines the EPU with servo drives, manifolds, cylinders and other optional parts a customer may need
- Provides all of the best of both electrohydraulic and electromechanical actuation systems with the EPU as the heart of this system
- Decentralized system eliminates the need for an HPU and complex piping
Power/Data Transmission Products and Solutions
Slip Rings

Products are developed for high performance environments and flexible requirements.

- Compact Slip Ring Capsules
- Ethernet Slip Rings
- High Speed Slip Ring Capsules
- Large Diameter Slip Rings
- Separates
- Slip Rings with Through Bores
- Fiber Optic Rotary Joints
Rekofa Slip Rings

- Standard Slip Rings
- Customized Slip Rings
- Signal and Data Transmission
- Slip Ring Collectors (SRK)
- Media Distributors
- Hybrid Rotary Distributors
- Industrial Carbon Brushes
Fiber Optic Rotary Joints (FORJs) are to optical signals what electrical slip rings are to electrical signals, a means to pass signals across rotating interfaces, particularly when transmitting large amounts of data. Available FORJs include:

- Single Channel
- Multi-channel
- Hybrid
- Complete Rotary Interfaces
Multiplexers and Media Converters

- Standard Multiplexers
- Condition Monitoring
- Pressure Tolerant Electronics and Optics
- Market Specific Multiplexers
- Custom Multiplexers
Fluid Rotary Unions

• Used around the world to ensure reliable transmission of life support, process, power and control fluids
• Rated for pressures up to 1000 bar (15,000 psi) are available
• Seals based on chemical compatibility, design pressure, design temperature, required service life and acceptable leakage rate
• Can be combined with our electrical slip rings and fiber optic rotary joints
Sonars

Products include:

- Imaging Sonars: Multibeam
- Imaging Sonars: Mechanical
- Imagining Sonars: Side Scan
- Mechanical and Hydraulic
- Motion Reference, Positioning, and Data Transfer Systems
- Profiling Sonars: Mechanical and Multibeam
- Survey Sensors
- Controls Units
- Video Imaging
We want to be your supplier of choice
We Add Value for Our Customers

We are ready to help you address the challenges you face on your next generation machines or latest project.

- We support our customers’ success
- We specialize in motion control and power and data transmission
- We offer unsurpassed expertise
We Specialize in High Performance

World class products, solutions and services that solve your machine challenges

- **Products**: Our world class products help you build machines that deliver outstanding value.
- **Solutions**: Our reliable solutions provide greater reliability and enhanced efficiency.
- **Services**: We understand your needs and offer flexible, comprehensive and timely services, resulting in excellent value.
We Are Ready to Work with You

• Motion Control Expertise and Deep Application Know-how
• World Class Products, Collaborative Solutions and Responsive Services
• Extensive global presence with a local office near you

We support our customer’s success
THANK YOU

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