Actuator History - Old Technology

Existing technology has been available +100 years. Two choices: Electro Mechanical Actuators or Hydraulic Actuation Systems

Usually driven by an AC Induction motor. These devices have very basic motion profile capability.
Actuator History - Old Technology

Electro Mechanical Actuators – These are multi-stage systems with many components. Limited motion profile control capability.

Linear to Rotary Stage:
- Ball screw
- Acme Screw
- Roller Screw
- Belt drive
- Rack and pinion

Gear Reduction Stage
- Worm gears
- Belts
- Spur/Helical
- Miter/Bevel etc. Gears

Each stage lowers efficiency, requires additional lubrication, adds lash and inertia and requires support structures for each set of bearings/bushings.
Actuator History - Old Technology

Hydraulic Actuator Systems – These are cylinders with a hydraulic power source and many components. Limited by no real motion control capability

Hydraulic power Supply:
• Tanks
• Valving
• Cooler
• Pump/Motor

System Components
• Hoses
• Regulator Valve
• Fittings
• Control Valves

Each component becomes a potential leak point, lowers efficiency, generates heat, affects flow and requires maintenance.
Actuator History

Introduction of Servo Technology – Can be used with Mechanical or Hydraulic systems.

Implementation in Electro-Mechanics:
• Direct drive – High speed but torque limited
• Gearbox drive – High torque but potential control problems due to cumulative lash in the system.
• Must account for load and component inertia.

Implementation in Hydraulics:
• Servo-Valve – Susceptible to contamination
• Pump Drives – Mostly energy saving, minimal effect on motion profile.

Servo Technology has also brought: Programming complexity, introduction of feedback devices.
# Smart Hydraulic Actuator (SHA)

## A New Technology

If developing a new actuator, what are the requirements?

<table>
<thead>
<tr>
<th>Requirement</th>
<th>SHA Must Have</th>
<th>Feature / Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Force Density / Small Footprint</td>
<td>X</td>
<td>Hydraulics provide the highest force density.</td>
</tr>
<tr>
<td>Variable Speed Servo Technology</td>
<td>X</td>
<td>Precise servo-controlled solution (Force, Speed and Position).</td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>X</td>
<td>Power on demand, no gear stages to reduce efficiency</td>
</tr>
<tr>
<td>All-In-One System</td>
<td>X</td>
<td>No hoses, fittings, components to leak, no system design required</td>
</tr>
<tr>
<td>Ability to sustain &quot;shock loading&quot; conditions</td>
<td>X</td>
<td>Hydraulics is the ideal solution for repeat high impact loads.</td>
</tr>
<tr>
<td>Cost Effective / Lower Equipment Cost</td>
<td>X</td>
<td>Higher efficiency and power density leads to lower costs.</td>
</tr>
<tr>
<td>Reliability / Low Maintenance</td>
<td>X</td>
<td>No metal to metal wear items. No filters to change or fluid to add.</td>
</tr>
<tr>
<td>Fieldbus Connectivity, IoT integration</td>
<td>X</td>
<td>Easy to use control, simple IoT integration</td>
</tr>
<tr>
<td>Versatile Configuration</td>
<td>X</td>
<td>In-line, right angle and “T” form factor with trunnion, foot and flange mount</td>
</tr>
</tbody>
</table>
SMART Hydraulic Actuator Overview

- **High-Resolution Position Sensor**
- **Inner Pressure Cylinder**
- **Foam**
- **Outer Cylinder (Reservoir)**
- **Heavy-Duty Rod / Cylinder w/Patent-Pending Rod Compensation**
- **Precision Controlled Brushless Servo Motor**
- **Positive Displacement Bi-Directional Variable Speed Pump**
- **Valve Control / Manifold**
SHA — New Technology Benefits

• All-in-One Solution
  – (Motor, Drive & Actuator included)

• Energy Efficient, Power-On-Demand
  – (Up to 50% more efficient)

• No Maintenance
  – (No filters to change or fluid to add)

• Cost effective, no hydraulic infrastructure
  – (No hoses, fittings or valves to leak)

• High-Shock & Vibration Capability
  – (Ideal solution for repeat high impact loads)

• Precise servo control of force and position
  – (No backlash, no brake required)

• Flexible fieldbus control
  – (Coordinated motion capable, process data reporting)
EMA vs. SHA – Reliability

Failure mode of a Ball or Roller screw is through fatigue. In addition, shock loads, excessive loads or repeated small strokes can cause subsurface brineling which leads to spalling of the screw surface and failure.

**Screw based EMA:**

**Load Dependent**

**EMA (Electro-Mechanical Actuation)**
- At 10,000lbf (44kN) EMA life is 100,000 inches of travel
- At 1,000lbf (4.4kN), EMA life is 10,000,000 inches of travel

Acme Screws wear rate (Life) comes from pressure at the area of contact of the screw and nut. Higher loads cause higher force per unit area resulting in faster wear.
EMA vs. SHA – Reliability

Failure mode of an SHA comes primarily from seal wear. Shaft seal technology is very well understood and seal cartridges are easily installed. Rod seals give predictable operation and are typically unaffected by load.

**Kyntronics SHA:**
*Load Independent*
No metal to metal contact

**SHA (SMART Hydraulic Actuator)**
- Exceeds 50,000,000 in \(127,000,000 \text{ cm}\) of travel with no Maintenance
- Exceeds 100,000,000 in \(254,000,000 \text{ cm}\) of travel with a Rod Seal Cartridge change
Because of the increase in size and precision of the components, the cost of screw based actuators increases exponentially as load increases. SHA costs are similar to a traditional hydraulic system designed for motion control.

**SHA**: Significantly more cost effective vs. EMA as the load increases. Also, lower parts count.
SHA - The All-In-One Actuation Solution

System Includes:

- Servo Controller/System (Designed, wired & tested)
- Servo Motor
- Actuator – Configured to the Application
- Software - - Factory Programmed as Desired

- Optimal System Sizing (work closely with our customers) - *Motor, Pump, Drive & Actuator*
- Cooling as Required
- Precision Feedback Devices
  - PSI (Force)
  - Position
- Factory Tested to Customer Specifications
  - Cycled & Tuned
- Simple to use Setup / Installation Instructions
  - Manuals & Wiring Diagrams

The SHA provides substantial hardware savings and Minimizes Engineering, Assembly and Testing time
Applications
Successful Application Targets

Central Hydraulic System Replacement –
*(systems requiring motion control)*

- Power-On-Demand - only runs when commanded
- Eliminates ALL hosing, leaks and associated environmental issues
- Versatile force and position control
- Smaller footprint, saves significant space

Replacing Electro-Mechanical Actuators

- Very cost effective, especially with higher forces
- Significant increase in reliability 2-3x more uptime (no metal to metal contact)
HPU & Hydraulic Cylinder Replacement – Auto Tier 1

Before - A Mess of Hydraulic Components

After - 16 Kyntronics SHAs; machine footprint 50% less, machine productivity 25% greater, cleaner, more accurate control than before
**Advantages**

- Needs higher speeds at a low force most of the stroke, high force at low speed for a small segment of the stroke
- Significant power, replacing the large HPU
- Accurate Position and Force control
- Easy to install, saves time and money
Punching / Coining / Clamping

Advantages
- Significant power, replacing the large HPU
- No hoses, no leaks & more efficient
- Smaller footprint
- Versatile control capabilities
- Easy to install, saves time and money

Coin & Pierce - 58,000lbf

Valve Pressure Test - Clamping

Automotive Punch and Clamp Hydroform Machine

Wire Bending Machine – Clamp
Advantages

• Significant power, replacing the large HPU
• No hoses, no leaks & more efficient
• Smaller footprint
• Higher reliability
• Versatile control capabilities
• Easy to install, saves time and money

CBD Extractor – H Series High-Speed/High-Force - 84,000lbf

Automotive Axle Assembly Station – SHA Replaced roller screw EMA that had very poor reliability and at 35% less cost

6-Axis Automotive Powertrain Damper Assembly – 30,000lbf
Testing

F18 Tail Hook Damper Test Machine
- Accurate from 20lbs – 12,000lbs force range
- Replaced hydraulic system

US Navy – Hexapod material testing system.
Multiple modes, with one actuator design
- 2in/sec (5cm/s) at 900lbf (4kN)
- 0.5in/min (1.3cm/m) at 4200lbf (18.7kN)

C-Frame Fatigue Test Actuator
- All-In-One Solution, Tested & Setup
- Frequency testing (3-5Hz)
- Closed Loop Force control with Load Cell
- Amplitude adjustment

Advantages
- Portable – removes the HPU
- No hoses, no leaks & more efficient
- Smaller footprint
- Versatile control capabilities
- Easy to install, saves time and money
- Fieldbus connectivity
Advantages

- Integrated 24Vdc drive / controller
- Brushless Servo Motor
- Precision Position Control
- IP68 rated actuator – sealed solution
- Replacing mechanical actuators which have a significant down time – do not perform well under shock loading / environment

Industries

- Steel – Tubing – Bar
- Lumber
- Fracking
High Impact Applications

Kyntronics Advantages:
- Impact resistant (high shock)
- Accurate positioning
- Fast cycle times
- Fieldbus connectivity
- Force limiting valves (like a clutch) to avoid excess loading on the actuator

Industries
- Steel – Tubing – Bar
- Lumber
- Entertainment
Summary – Kyntronics Advantages

Unique product with many benefits

• All-in-One Solution
• Most reliable actuation offering
• Most efficient actuation offering
• Versatile & accurate control
• Very cost-effective solution
• Modular solution from low forces to 170,000lbf
Contact Kyntronics
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