

Emerging Mobile Hydraulic Technologies for More Electric Applications



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Motion Systems Group
Systems Engineering

- Drivers / Trends for More Electric
- Areas of Fluid Power Innovation
- Emerging Technologies
 - Systems
 - Electric / Hydraulic Power Transmission
 - Variable Speed Pumps

ENGINEERING YOUR SUCCESS.

Market Drivers

- Safe and confident operation
- Improve productivity & efficiency
- Reduce energy / emissions / GHG
- Simplify machine design
- Reduce Total Cost of Ownership

Technology Trends

Speed Coupled Systems



Power Coupled Systems

Large Inefficient Engine



Smaller Efficient Engine

Dynamic Braking Loss



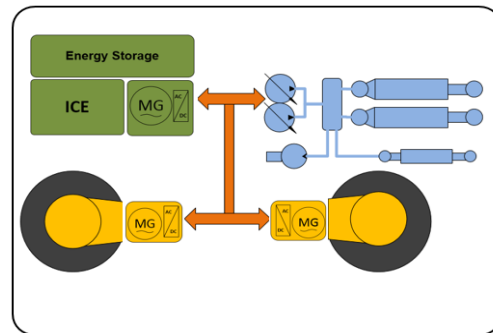
Dynamic Braking Recovery

Machine Focused Operator



Work Focused Operator

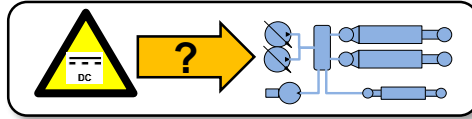
More Electric



- Electric IVT
- Energy storage
- Power management
- Power on demand
- Adaptable controls

Objectives

- Improved efficiency
- Brake energy recovery
- Adaptable controls

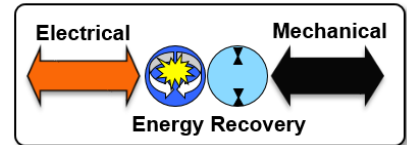


Challenges

- Power Density
- Cost

Areas of Fluid Power Innovation

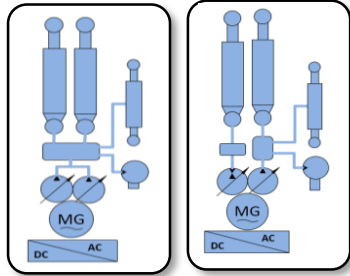
- Power on Demand Systems
- Electric / Hydraulic Power Transmission
- Servo Motor + Hydraulic Controls
- Variable Speed Pumps
- Highly Integrated Electric Hydraulic Assemblies



Emerging Technologies

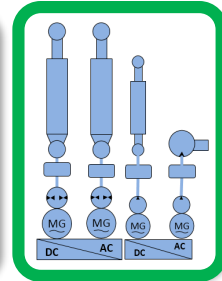
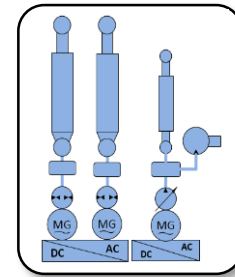
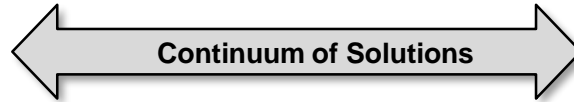
Power on Demand Systems

Electric / Hydraulic Power Distribution Optimization



Goals

- Strategy
- Minimum Change
- Fuel Savings
- Total Cost of Ownership ...
- Productivity
- Safety



Hydraulic

Power Distribution

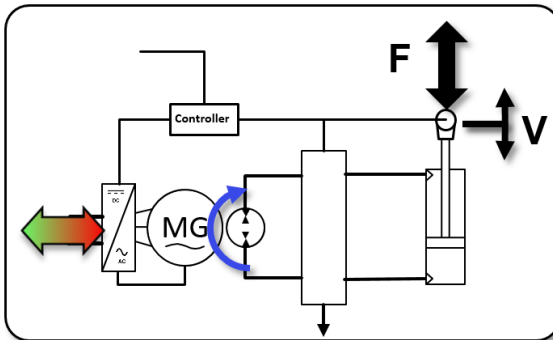
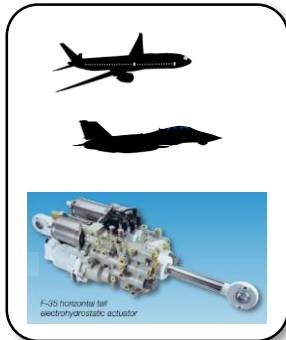
Electric

Increasing Energy Efficiency / Complexity / Cost

Emerging Technologies

Electric Hydraulic Power Transmission

Electro Hydrostatic Actuation



- Fixed displacement, variable speed
- Closed loop, hydrostatic
- Servo inverter & electric motor
- Mode select manifold
- Controller, machine interface

Energy Recovery

Component Efficiency

Distribution Losses

Power On Demand

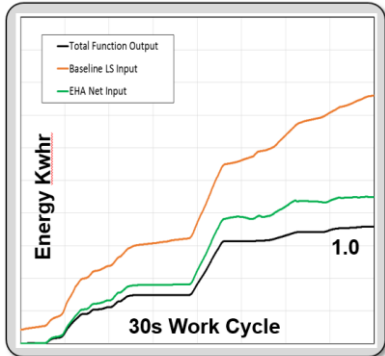
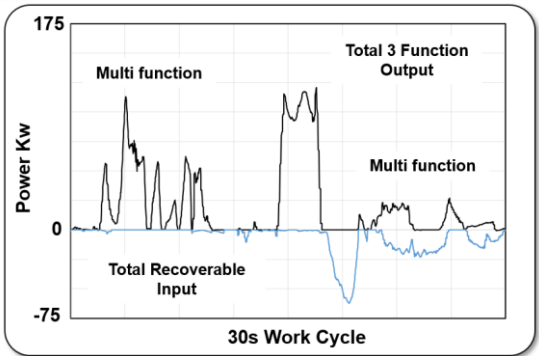
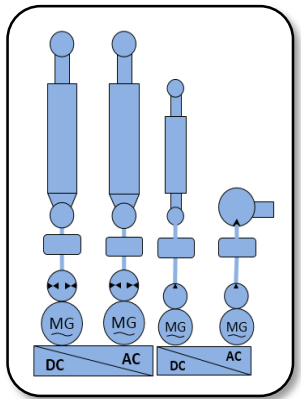
Advanced Controls

Emerging Technologies

Electric Hydraulic Power Transmission

Application Test Data

Electro Hydrostatic Actuation



System	Baseline		EHA		% Improvement
	Kwhr	%Eff Metric	Kwhr	%Eff Metric	%Eff Metric or % Kw
Work Cycle	2.2	45%	1.3	80%	77%
Transport	9 Kw		5 Kw		44%
Idle	1.5 Kw		.2 Kw		87%



Emerging Technologies

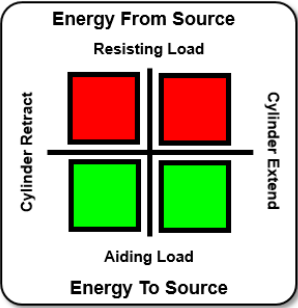
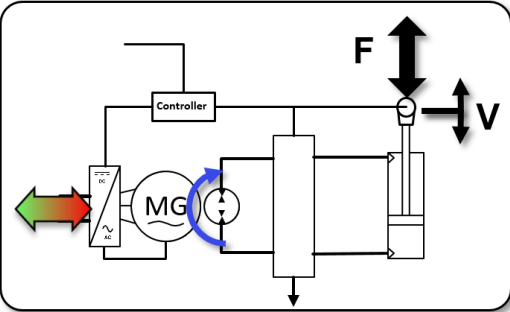
Electric Hydraulic Power Transmission

Electro Hydrostatic Actuation

Areas of Innovation

Servo Motor Control & Valve Development

- Mode switch control
- Pressure transitioning
- Augmented cylinder speed control



Motor
Speed
Torque
Direction

= Pump
Flow
Pressure
Direction

= Cylinder
Speed
Force
Direction

4 Q Control



Emerging Technologies

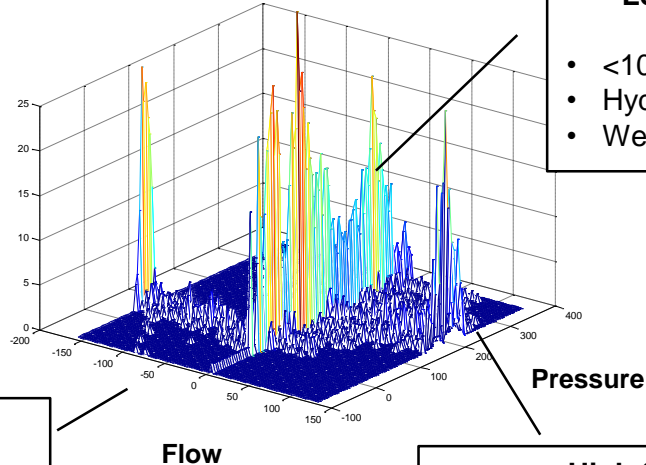
Variable Speed Pumps

Areas of Innovation



Occurrence

3D Plot of Flow vs Pressure Difference Operating Conditions with Largest Bin Removed



Low Speed, High Pressure

- <100 rpm operation
- Hydro dynamic bearing conditions
- Wear interface design & materials

Pump Noise

- Variable speed, Bi directional
- Understanding sound quality
- Targeted timing optimization

High Speed Performance

- Motor size, Pump cc optimization
- Bi directional inlet optimization
- Inlet boost development

Thankyou