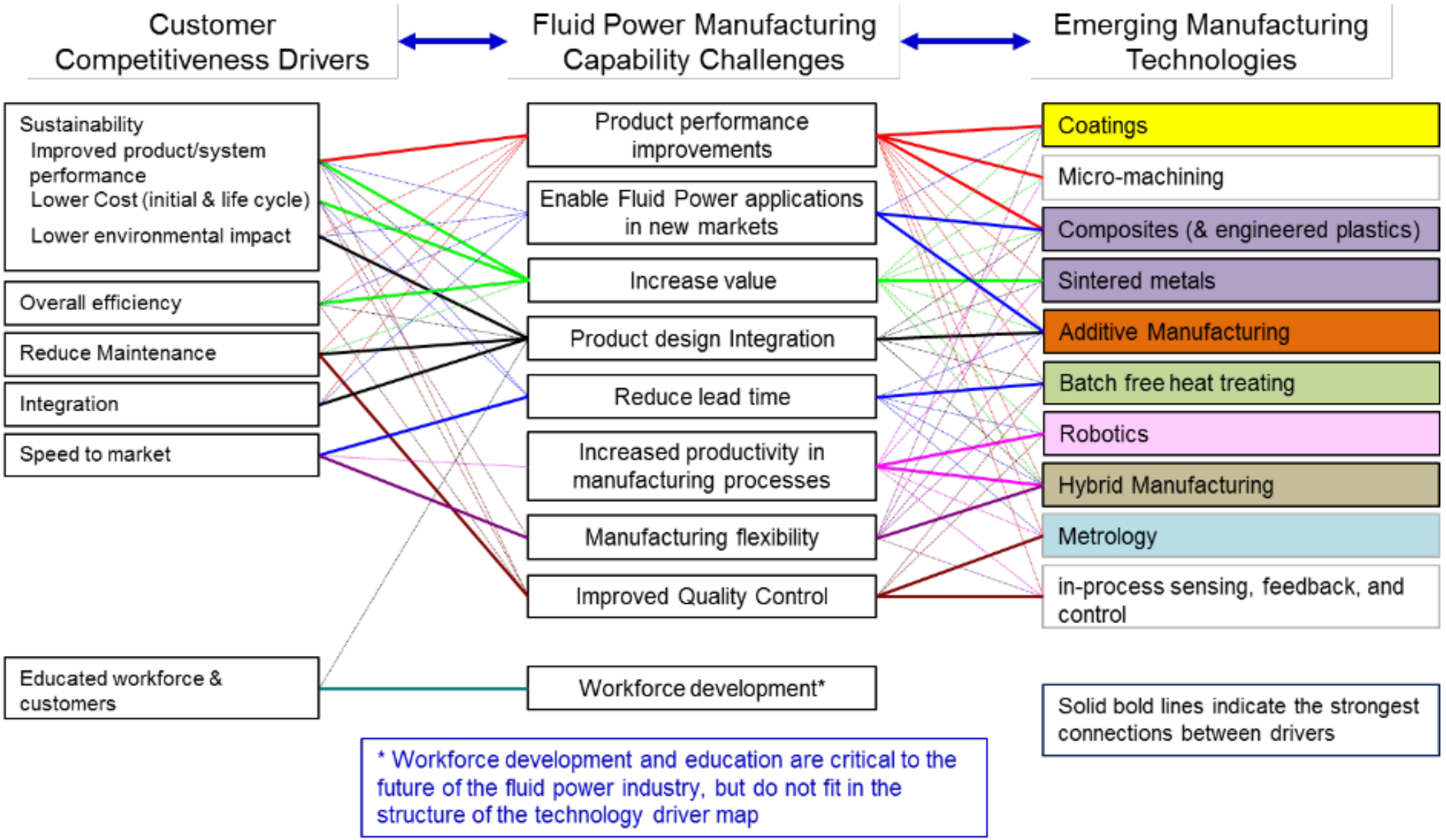
Fluid Power Manufacturing Roadmap

Summary

as presented March 9, 2017

Roadmap Schematic



Cross Cutting Themes

- High precision coupled with multiple product configurations and small orders sizes present unique challenges
- Single piece flow (batch size of one)
- Increased production rates
- Meet quality levels that are matched to requirements that reflect real world operation
- Environmentally friendly processes

Coatings – Research Needs

- Coatings that are cost effective
- Easy to apply including shapes that are difficult to coat
- Improved substrate interface strengths, including inter-coating bonds
- Improved anti-friction, anti-wear and corrosion resistant properties
- Environmentally friendly processes (replace hexavalent chrome)

Micro-Machining – Research Needs

- Increased through-put without affecting accuracy or statistical process control (SPC)
- Reduced cost of capital (includes machining centers, tooling and fixturing)
- Reduced setup time
- Improved Takt time (German word for pulse or baton)

Composites/Engineered Plastics – Research Needs

- Better simulation modeling and predictive tools to eliminate uncertainty from manufacturing processes and tooling design
- Increase in the number and complexity of net shape components produced via molding
- Lower cost
- Decrease weight using components with material properties that allows replacement of metals and castings

Sintered Metals – Research Needs

- Better simulation modeling and predictive tools to eliminate uncertainty from manufacturing processes and tooling design
- Increase in the number and complexity of net shape components produced via pressing of sintered metals
- Lower cost
- Improved prediction of material properties, especially fatigue strength

Additive Manufacturing – Research Needs

- High pressure (350 bar) capability without leaks or weeping
- Material strength standards, including fatigue
- Increased printing speeds without compromising part complexity, strength or surface finish
- Improved finishing techniques and processes
- Lower cost
- Improved design tools

Batch-Free Heat Treating – Research Needs

- Investigate alternative energy sources including lasers, electron beam, induction, friction, etc., for shafts, rotating groups and thrust plates
- Investigate fluidized sand bed for castings
- Process models and design tools
- Low distortion heat treating
- Heat treating at the work center

Robotics – Research Needs

- Integrated sensor networks with low-cost non-contacting sensors
- Intrinsically safe co-bot (cooperative robot) HMIs (human machine interfaces)
- Lightweight and efficient fluid power components and systems
- Big data and analytics

Hybrid Manufacturing – Research Needs

- Defined as combination of subtractive, additive and secondary processing (machining, welding, brazing, inspection, heat treating and coatings) in one setup
- Develop guidelines for identifying candidate parts for hybrid manufacturing
- Methods for stress relief, flaw detection, and distortion correction
- Better understanding of process interactions

Metrology – Research Needs

- Automated and digital metrology systems that can be integrated by simple connectivity tools such as Wi-Fi or Bluetooth
- Methods to define inspection and quality plans that leverage connected and digital metrology capabilities
- Better coordinate metrology and non-contacting systems that generate large quantities of digitized data
- Real-time and big data feedback connected to the cloud for rapid information delivery and utilization (this ties in well with automation and sensors)
- Statistical and other types of models to be formulated such that the data can be used in real-time, or near real-time
- Expand metrology to include more than just dimensions such as material characteristics, residual stress, internal structures, etc.

In-Process Sensing, Feedback & Control – Research Needs

The desired future state is intelligent adaptive control (IAC) as described below:

- Ability to interface with any controller, whether proprietary (e.g., Haas) or generic (e.g., Siemens and Fanuc)
- Have physics-based kernel that allows them to make intelligent changes to the process so that the outcome of the change is known with precision
- Physics-based software with access to the Cloud, specifically big data in the Cloud; include tooling information from cutting tool companies to further enhance predictive nature