*Kyle Merrill received his BSME from Utah State University in 2000. He then received his MSME from Purdue University in 2003. Kyle went to work for Denison Hydraulics and then Parker Hannifin as a hydraulic pump design engineer. He was the team leader of the integrated digital electronic control of a variable displacement axial piston pump. In January of 2009 he returned to Purdue University to pursue a PhD. He is working on the development of the digital pump/motor technology. He will be returning to Parker Hannifin Hydraulic Pump Division.*

Agricultural & Biological ENGINEERING

# Dissertation Defense

**Speaker:** **Kyle J. Merrill**

**Title:** **Modeling and Analysis of Active Valve Control of a Digital Pump-Motor**

**Major Professor(s):** **John H. Lumkes, Jr.**

**Date:** **Tuesday, July 03, 2012**

**Time:** **11:00 A.M.**

**Location:** **ABE 301**

## Abstract:

This work involves the development of a hydraulic pump/motor that incorporates actively controlled high speed on/off valves connected to each piston cylinder displacement chamber. The fluid is commutated between the ports and the displacement chamber by the on/off valves and there is no longer a need for the valve plate. Unit displacement is electronically controlled by on/off valve timing, not by a swash plate or other typical means. Pump/motors of this design can have increased efficiency due to reduction of friction, leakage, and compressibility losses as well as increased displacement control bandwidth. The coupled dynamic model of the hydraulic pump/motor developed during this project is crucial to facilitate the development of the pump/motor. The simulation model is used to characterize and predict pump/motor efficiency, define the dynamic response and flow requirements of on/off valves required to provide significant improvements in efficiency and dynamic response over traditional pump/motors, and perform design optimization studies. Different operating strategies have been analyzed to characterize the effects on pump/motor efficiency and flow ripple (valve timing effects, partial fill methods, etc.). A single piston pump/motor test rig has been built for initial testing of valves and operating strategies. A multi-piston pump/motor unit will be built to experimentally validate the model, design, and operating strategies.

## Application:

At the heart of a fluid power system is the pump/motor. Current state-of-the-art variable displacement pump/motors have fairly good efficiency when operating at maximum displacement. However, when operating at lower displacements the efficiency dramatically decreases down to 50% to 80%. Through this work the large improvements possible in overall efficiency with this concept of an active valve controlled digital pump-motor will be demonstrated. These improvements in overall efficiency lead to reduced energy consumption and emissions in fluid power systems.

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