Michael Holland received his BSME from Purdue University in 2005. Michael remained at Purdue and completed his MSE in 2007, investigating embedded sensors in polymer structures. Upon completion of the master's degree, Michael worked as a test engineer at the John Deere Product Engineering Center in Waterloo, IA. In January of 2009, Michael returned to Purdue University to pursue a PhD, working on the development of digital pump/motors. Michael intends to return to John Deere in Waterloo, IA at the completion of his degree.

Agricultural & Biological ENGINEERING

Dissertation Defense

Speaker: Michael A. Holland

Title: **Design of Digital Pump/Motors and Experimental Validation of Operating Strategies**

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

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

Time: **9:00 AM**

Location: **ABE 301**

Abstract:

This work defines novel operating strategies of a digital pump/motor in the context of both pumping and motoring. Unit displacement can be continuously varied by switching valves during the piston stroke. Alternatively, digital operation can be implemented by enabling or disabling individual displacement chambers over a sequence of pumping or motoring events. A three-piston digital pump/motor was fabricated to experimentally evaluate the operating characteristics of the digital pump/motor and to investigate tradeoffs in operating strategies and in the overall configuration. Algorithms were established for continuous and sequenced variation of displacement in flow-diverting and flow-limited operating strategies for both pumping and motoring. These algorithms were implemented through a model operating on a real-time controller with execution through a field programmable gate array. Over the tested range of displacements, digitally sequenced implementation of the flow-limited operating strategy yielded the highest overall efficiency.

Application:

Most fluid power systems involve conversion of mechanical work to fluid work through a pump. Similarly, many fluid power systems also convert the fluid work to mechanical work through a hydraulic motor. Thus, the overall efficiency of hydraulic pumps and motors is critical to the efficiency of fluid power systems. The emerging field of digital hydraulics is providing opportunities to widen the operating conditions where a pump/motor can operate at high efficiency by incorporating high-speed on/off valves to decouple the unit shaft position from the commutation of the displacement chambers to the unit working ports. This freedom permits operating strategies unique to digital pump/motors, but the main advantage is that leakage and friction losses can scale more closely with pump flow.