MONTANA STATE UNIVERSITY
College of ENGINEERING

To: NFPA Education Committee and Foundation Board *Date*: 1/20/2014
National Fluid Power Association
3333 N. Mayfair Road, Suite 211
Milwaukee, WI 53222-3219

RE: Status Report on funded Automation Lab Project

Thank you for funding the Automation Lab Project at Montana State University, for equipment to allow students to better study fluid power automation topics. Items purchased from these funds included a PLC, sensors, and valves, used along with other equipment on hand, to construct three lab apparatus that were successfully used during the Fall 2013 semester.

Apparatus #1 – PID Position Feedback Control
A pneumatic gripper on the end of a horizontal pneumatic cylinder was assembled with an ultrasonic sensor and feedback controller to be operated by either manual valves or proportional valves through a NI DAQ and LabView program (figure 1). The students first have an exercise to use the manual valves to extend the horizontal cylinder out to a block's arbitrary position, then grip the block using another manual valve. In order to be successful the students must carefully adjust needle valves to get it to be controllable. Then, after learning about electro-proportional valves and PID control, the students repeat the same task - selecting PID parameters in a LabView program to optimize speed and accuracy of the goal of reaching and gripping the block, whose position is sensed by the ultrasonic sensor.

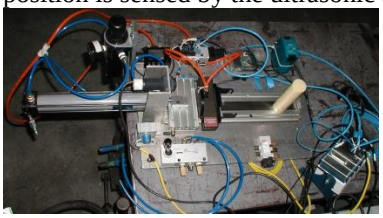

Figure 1, PID position control setup

Apparatus #2 – PLC Controlled Pick-and-Place Robot
A small Pick-and-Place Robot was constructed that the students program to sort blocks based upon material (metal or plastic) as they are moved from one place to another. After learning the basics of PLC fluid power applications and PLC programming in class, the students use this lab setup (shown in figure 2) to program the pneumatic robot to: 1) feed blocks into position, 2) grip the block if the capacitive proximity sensor confirms its position, 3) lift the block, 4) swing the block to a new position, and 5) release the block, as it 6) sorts the blocks into plastic vs. metal piles based upon an inductive proximity sensors reading.

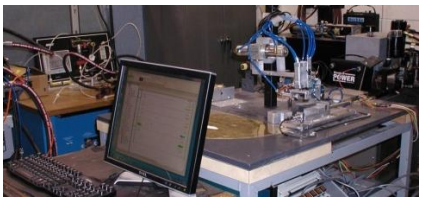

Figure 2, PLC controlled robot being used by students.

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Apparatus #3 – Servo arm
A hydraulic servo arm was constructed that can be worn by a student, as shown in figure 3. The motion of the student's arm actuates the manual hydraulic servo valve which supplies the cylinder that lifts or lowers the arm extension – multiplying the user's movement and arm strength. The arm is connected to a load sense hydraulic power unit so that the flow rate can be easily changed, giving the students a feel for the effect of flow rate change on a servo system's response and stability. This lab setup was very popular and was effective in augmenting the understanding of servo hydraulics presented during lecture.

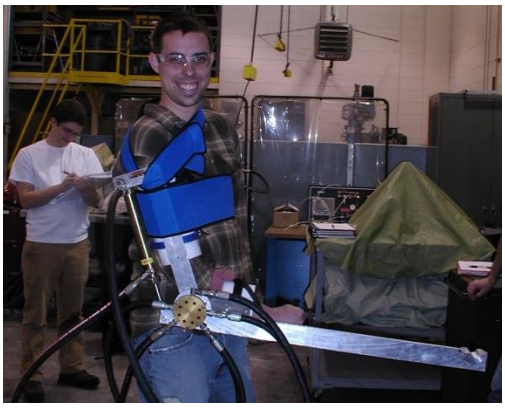
Figure 3, Student using the 'iron man' servo arm.

Future Modifications and Use
Each of the lab setups described were hurriedly constructed in order to have them useable for the fall semester. Each will be further modified to make it more versatile and valuable for learning fluid power automation. The PID position control configuration needs to be remounted for clarity. The PID controlled robot will be modified to increase the flexibility of tasks to be programmed including material feed, and using new sensors for step implementation. The servo arm attachment and plumbing will be reworked to make it easier to use.

I believe the students in the class, ETME 430 Fluid Power Systems Design, will benefit tremendously for many years from the equipment that you have helped us to purchase. I am very grateful for the funding assistance and the benefit to our students.

Regards,

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