The Evolution of a Long-Term Mutual Beneficial Industry Partnership from Concept to Implementation

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Abstract

This paper reports the results of an effective partnership with a local company involved in manufacturing hydraulic and pneumatic actuators for domestic and international customers. Although such successful endeavors with other industrial partners have been initiated in the university's College of Technology in the past, this unique case was further expanded. Initially, the goal was to support the development of a state-of-the-art pneumatic laboratory for an undergraduate course on fluid power. However, through the authors' continuous work with the company and study, the following two goals were identified: (1) to provide necessary facility and technical assistance for the company to host its technical school and training sessions for its domestic and international workforce, and (2) further incorporate safety knowledge pertaining to hydraulic and pneumatic systems for the laboratory. The latter was identified because authors discovered students' lack of understanding of hydraulic and pneumatic safety. This goal is yet to be achieved.

1. Introduction

The College of Technology at Purdue University Northwest includes four departments: Computer Information and Technology Graphic, Construction Science and Organizational Leadership, and Engineering Technology. The latter hosts several majors, two of which are Mechanical Engineering Technology (MET) and Mechatronics Engineering Technology (MECH). Fluid Power is a 3-credit-hour course in the MET curriculum which is offered twice a year with an average enrollment of 28 students per semester [1].

The collaboration with Bimba Manufacturing Company, recently acquired by IMI Precision, started in 2014 when a senior faculty member reached out to learn about projects for MET senior students and possible co-op/internship opportunities. Bimba is one of the leading manufacturing companies in the area of hydraulic and pneumatic actuators, valves, fittings, electric actuators, and such [2].

Through further discussion, mutual interest developed to expand the relation beyond above-mentioned opportunities. As a result, several meetings were held from 2015 until 2017 to discuss the collaboration on building four state-of-the-art pneumatic training workstations. The original discussion and agreement was to collaborate on building four workstations with two sides (Figure 1): one to be used for educational purposes (i.e., introductory labs), and the other side for advanced lab experiments involving programmable logic controllers (PLCs), which can be used either in the fluid power course or by the company for training its sales and engineering teams.

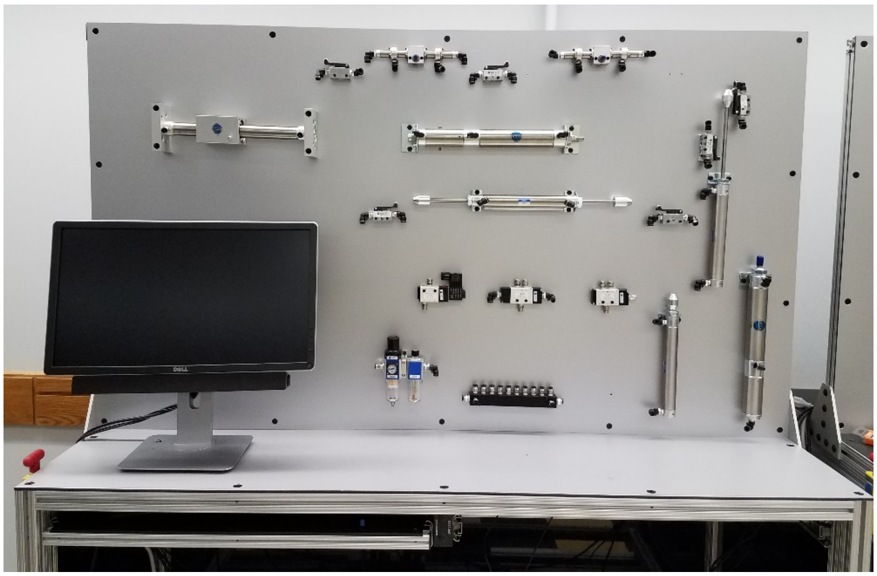

Figure 1. One of the four pneumatic workstations (introductory lab side)

The introductory side was started in summer of 2016 and continued until its completion in summer of 2017. The advanced side, however, is still under consideration due to the company's acquisition.

2. Design Details

The design of the aluminum frame and the lab activates were a collaboration among a group of MET undergraduate and graduate students and the machine shop personnel at the college. Table 1 shows the components used to build the workstations, excluding the computer and monitor (introductory side). More details about the design and assembly of these workstations can be found in a previous paper [3].

The board is 59 inches in length and 35 inches in height. There are also two large drawers (29 × 24 × 5.5 inches) to accommodate various components such as tubes, and four small drawers (29 × 24 × 3.8 inches) to accommodate valves, fittings, and accessories [3]. The frame was built using aluminum tubing. The tubing and the drawers were purchased using college funding. The total cost is to build one workstation was approximately $6,000.

Table 1. The list of all the components needed to build four workstations

Item or Part No.	Quantity	Description
CM-096-DXDET2(2x, D-129)	6	Air cylinders w/ adjustable cushions
PT-037180-A1C1MRT	12	Three-position pneu-turn rotary actuator
MV-15	48	MV-micro-line 3-way air switches
NRM-172/3-DXPK(2x, D-241)	6	Original line three-position cylinder
M4A220-06	6	Double air-piloted valve
M4A210-06	6	Single air-piloted valve
M3V210-06-NC-24VDC	6	M3V solenoid valve
M-172/3-D(F, D-241)	6	Original line three-position cylinder
CM-096-DT2(F, D-129)	12	Air cylinder w/ adjustable cushion
DA10-125-55	6	Dual air manifold
MGFC200-06-S	6	FRL
PIV-20-025/038	6	Pneumatic isolation valve
US-096-B	6	Ultran rodless cylinder
MV-140	24	Push button valve
MV-35	12	Toggle valve
PU-250F-25	12	Connecting pipe roll
PLS250-1/8	10	Elbow connector pack
PB250-1/8	10	Straight connector pack
PXC058	12	Pipe cutter
MB-09	12	Bracket for Rodless cylinders
UNION (CPOS) TEE ¼ PI	10	T-connectors

The company was an integral part of the design and assembly of these workstations. During the initial meeting in 2016, the layout of the workstations (Figure 1) and possible lab activities were discussed with the company and the faculty/staff members. A graduate student, who had already expressed interest in helping with the design and construction of the workstations, was assigned to supervise the project. After the initial meeting, at some point, a prototype was built and shipped to Bimba's facility. The graduate student worked closely with the company's technical staff to identify the locations of the components onto the board and to pre-drill the holes that were needed to mount the components. The company employees provided necessary supervision and recommendation as the student was working on the design.

These workstations were used first time in fluid power course in fall of 2017 with a newly-developed lab manual prepared by the course instructor. As students were going through various activities, notes were taken to improve the lab activities accordingly. In addition, engineers from the company visited the fluid power lab to learn about how the lab is being utilized and the senior management was interested in using the workstations to train their sales personnel.

This led to another collaboration where, since summer of 2018, the company has held four domestic and international workshops for its technical and sales staff to discuss the latest technologies they have developed, as well as to show an example of collaboration with a higher educational institution. Based on the feedback received from the company's senior management and workshop attendees, the workshops at the university have been very informative and satisfactory and the company is planning on hosting future workshops as this campus.

3. Essential Safety within an Organizations

One of the essential tasks for academic institutions is to develop curriculum to prepare students for an employment. To achieve this goal, the curriculum must meet those skillsets or knowledge essential to industry, one of which is safety.

In addition to knowing how things work, how to improve processes, and design new components, another critical element essential to the engineering technology discipline is to incorporate safety. One could assume an incident would never happen in an organization, but that is not the case. This can be supported by the number of workers being fatally injured annually. According to the Bureau of Labor Statistics, 5,147 fatal work injuries was recorded and approximately 2.8million nonfatal workplace injuries and illnesses was reported in 2017 [4].

While the fatal occupational injuries in the private manufacturing industry was the lowest since 2003, still 101 workers were fatally injured in 2017 [5]. Back in 2008, Occupational Safety and Health Administration stated that occupational injuries were costing businesses approximately $170 billion, which comes straight out of company's profits. While the cost has decreased slightly since 2008, work injuries still cost U.S. businesses approximately $161.5 billion even after 9 years [6].

Roughton and Mercurio [7] have indicated that, in 2002, the most effective way to control hazards is by designing out the hazards. Therefore, it is essential that graduates understand the importance of their role in reducing incidents by incorporating safety into their design and processes. Manuele has also indicated the importance of emphasizing safety principles and concepts among graduates of business, architecture, and engineering schools [8].

4. Lack of Industrial Knowledge in the Classroom

A pilot study was conducted by the authors to determine possible disconnect between curriculum and skillsets needed by industry. This pilot study was developed to focus on whether one of the important concepts among engineering technology – safety – was missing from the curriculum or not.

As indicated by other authors, designing out hazards by engineers are one of the most important aspects of preventing/reducing incidents. While many MET students work while taking classes, there was no information indicating that they are even aware of the hazards surrounding fluid and power topics.

A survey was developed to determine whether students have knowledge of safety or awareness of hazards surrounding hydraulics and pneumatics system. 54 students in the fluid power course took the survey. It was discovered 89.63% didn't know nor aware of safety precautionary measures recommended by the industry [9]. This outcome indicated that the majority of students had limited or no exposure to safety concepts surrounding hydraulic and/or pneumatic systems. Tables 2 and 3 summarize survey results.

5. Future work

Based on the findings from the pilot study, it was apparent the fluid power course needed to incorporate safety knowledge. This shortcoming would be fulfilled by inviting a qualified employee from the company to hold a workshop on hydraulic and pneumatic safety. With this collaboration effort, both parties would benefit: (1) students would have an opportunity to work on a real world problem and to implement what they have learn in classroom, and (2) a faculty member would hold safety education sessions for the company personnel as he did with another manufacturing firm. This is the latest goal that needs to be achieved.

6. Summary

This collaborative effort was initially begun to expand the fluid power lab for MET students. However, the success of this initial work resulted in further collaborations. For example, the company hired some MET graduates to work as interns and, in addition, the company was able to offer its domestic and international workshops in a facility owned by Purdue University Northwest. This successful partnership demonstrated the importance of mutual academic-industry collaboration to enhance students learning. Such collaborations can be expanded to include other industry sectors.

Table 2. Prior knowledge of hazards associated with hydraulic fluids among fluid power students [9]

Hazards	Semester	Students Reponses	Frequency
1. Can cause skin and eye irritation	Fall 2016	Fluid with skin eye injury	12/23
	Spring 2017	Skin and eye irritation	10/22
2. Can cause medical problems. If ingested; seek medical attention immediately.	Fall 2016	Fluids from hydraulic system	2/23
	Spring 2017	Fluid may be harmful.	2/22
3. May cause medical problems, if repeatedly inhaled (non-toxic)	Fall 2016	None	0/23
	Spring 2017	None	0/22
4. May be corrosive	Fall 2016	Chemical hazards (burns)	1/23
	Spring 2017	Avoid contact	1/22
5. Environmental harm.	Fall 2016	Oils spill (leakage)	9/23
	Spring 2017	Leak, oil spill	2/22
6. Must be disposed of according to environmental regulations	Fall 2016	None	0/23
	Spring 2017	None	0/22
7. High flash point or in certain cases not inflammable at all	Fall 2016	None	0/23
	Spring 2017	Flammable	3/22
8. Chemically neutral (not aggressive at all against all materials it touches)	Fall 2016	None	0/23
	Spring 2017	None	0/22
9. Low air dissolving capability, not inclined to foam formation	Fall 2016	None	0/23
	Spring 2017	None	0/22

Table 3. Prior knowledge of hazards associated with depressurizing pneumatics systems among fluid power students [9]

Experts Recommendations	Semester	Students Reponses	Frequency
1.Isolate compressor from system	Fall 2016	Pressing the button after the FRL and then shutting off the valve, Turn off air supply	6/23
	Spring 2017	Turn off machine, lockout tagout, close the pressure valve, shut the main air lines	10/22
2.Depressurize compressor and pipe work	Fall 2016	Release the air (bleed system of air), disconnect from furthest point (release pressure to greatest pressure source)	6/23
	Spring 2017	Release/Bleed emergency valve	8/22
3 Check that compressor pressure gauge reads zero (air exhausting to atmosphere can be dangerous….)	Fall 2016	None	0/23
	Spring 2017	None	0/22
4.Direct discharge air away from the unit & operator	Fall 2016	None	0/23
	Spring 2017	None	0/22
5.Clear area of any flying hazards before discharge (use hearing protection during any depressurization)	Fall 2016	None	0/23
	Spring 2017	None	0/22

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Biographical Information

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