INDUSTRY-UNIVERSITY PARTNERSHIP – A MODEL FOR FACULTY PROFFESSIONAL DEVELOPMENT AND CURRICULAR INNOVATION

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ABSTRACT

Youngstown State University and Parker Hannifin Corporation have jointly created the Hydraulics Research and Education Center at Youngstown State University. The goal of this center is to channel faculty research activities with industrial partners toward promoting teaching, training and learning. The current activity in connection with this center is the conversion of faculty development activities into curricular innovations.

A systematic approach is being investigated for the development, capture and distribution of curricular materials. Faculty, students and Parker-Hannifin engineers and managers are presently being organized to develop and use this system and its content material. Moreover, this pilot system is intended to demonstrate the capability of the new partnership toward innovating the undergraduate curriculum. For example, the multiple targets for innovation could range from recruitment activities to freshman year courses, to sophomore laboratories, to junior co-operative education experiences, to the capstone experience in the senior year.

Therefore, this center has catalyzed the collaboration of multiple participants with interests in a variety of curricular features. Innovations are proposed in the form of new or different content, new delivery methods, and expanded points of delivery. This center is also helping to redefine interactions with institutional entities such as the Office of Grants and Sponsored Programs, the Center for the Advancement of Teaching and Learning, the University Assessment Council, and the Office of Professional Practice. This center will created opportunities to streamline the undergraduate curriculum and share resources more roundly.

Learning outcomes of curricular innovation stemming from this partnerships include increased exposure to emerging technologies, multi-disciplined activities, team learning, communications, and project management [1]. There also exist many beneficial institutional outcomes including faculty development in research interests, improved industrial partnerships,

improved aesthetic to curriculum throughout the four years, and graduate placement among industrial partners.

Highlighted in this paper is what is hoped to be the first of many state-of-the-art centers, the Hydraulics Research and Education Center at Youngstown State University. With generous donation from Parker Hannifin Corporation, curricular innovations are being brought to the forefront of pedagogical advancement.

1. INTRODUCTION

The Parker Hannifin Hydraulics Research and Education Center at Youngstown State University is a prime example of integrating an industry-sponsored program with curricular innovation. Such a center, described below, provides the opportunity to design and develop multi-disciplinary experiments and creates project opportunities for students both in the laboratory and in the field. Furthermore, it sets the framework for proposed experimentation capstone courses, improves the "demonstrations" in the freshman program, and sustains a four-year research-influenced experience for qualified and interested students. These aspects of innovation are discussed later in this paper with the other multiple dimensions of engagement.

See Figure 1, which depicts the framework for faculty development through curricular innovation. Faculty research interests are the source of curricular innovation [2]. They provide the motivation and the vehicle for creating new learning outcomes. Partnering faculty research interests with both emerging technologies and cognitive theory allows for curricular innovations that are most beneficial to the student. Not only are teaching and research integrated in the curricular innovations proposed in this paper, but continuous faculty development is also emphasized.

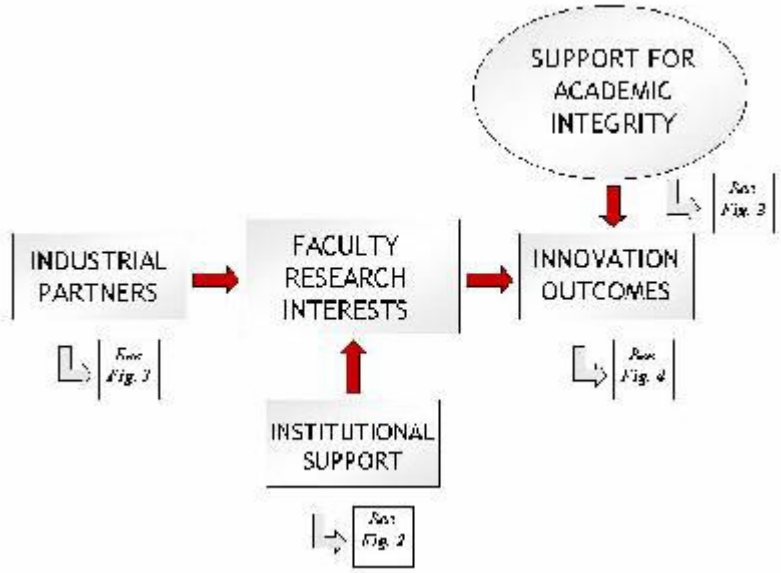

Fig 1. Framework for Faculty Development Through Curricular Innovation

2. INNOVATION WITHIN THE CURRICULUM

It is generally understood that faculty scholarship activity improves teaching and learning in a number of ways. Certainly, it is the norm that faculty engages in the three components of faculty accountability, teaching, scholarship, and service. This project has as an objective the identification of both content and delivery innovations that can be expected to arise from increased applied research activities. The infusion of new and emerging knowledge will be paramount. A knowledge management approach that assures an impact on student outcomes will be supported by collaboration with instructional design experts and validated through collaboration with educational assessment experts.

Additional impact on student learning outcomes will be provided by a strong industrial partner aspect of this work. Service-learning has been introduced at the sophomore level of the undergraduate experience through the establishment of the Engineering Student Consulting Clinic (ESCC), which exposes engineering students to real world undergraduate consulting opportunities in the community [3, 4, 5, 6]. This aspect of the project meets the intellectual merit and the broader impacts criteria.

3. MULTIPLE DIMENSIONS OF ENGAGEMENT

The Parker Hannifin Hydraulics Research and Education Center at Youngstown State University is a prime example of integrating an industry-sponsored program with curricular innovation. This center, described below, provides the opportunity to design and develop multi-disciplinary experiments, and creates project opportunities for students both in the laboratory and in the field. Furthermore, it sets the framework for proposed experimentation capstone courses, improves the "demonstrations" in the freshman program, and sustains a four-year research-influenced experience for qualified and interested students. These examples of curricular reform are discussed later in this proposal.

As outlined above, curricular innovations stemming from faculty research interests and industry-university partnerships address broad areas of interest and address the needs of a diverse student body. Foremost, they integrate faculty research interests and teaching while addressing the educational needs of students entering the industrial workforce. Furthermore, They integrate multidisciplinary teams in the lab environment, as well as in the field, while also allowing more service learning experiences for students and faculty on a department-wide basis. The sub-projects selected for inclusion in this work have potential for industrial partnering, serve individual department-wide transformations in each of the engineering disciplines, and represent a variety of content and format.

The overall goal of making the engineering degree programs more modern and relevant will be served by identifying multiple approaches that can be applied to a variety of curricular features. These include proposing new interdisciplinary curricula, introducing modern learning strategies, collaborating with experts in the field of education, increasing interdisciplinary

laboratory and research experiences, integrating current software and hardware tools, and infusing emerging technologies to the curriculum.

4. INDUSTRY-SPONSORSED HYDRAULIC RESEARCH LABORATORY

Youngstown State University (YSU) along with the College of Engineering and Mechanical Engineering Program, entered into a cooperative research program agreement with Parker Hannifin Corporation, a leading engineering company to develop undergraduate / graduate research program in product simulation, analysis, and testing of Parker's hydraulic piston-pumps [7]. YSU received funding for the project from Parker in summer of 2003. The funding enabled the setup of a computational laboratory equipped with state-of –the-art software programs such as FLUENT, ADAMS, PRO-E, PATRAN, and NASTRAN, and several Dell computer workstations for use by undergraduate and graduate students, and faculty involved in the research.

Our students already have familiarized with some commercially popular programs such as ADAMS, PATRAN, and NASTRAN, and have conducted simulation studies on a Parker pump under the supervision of Kudav (Principal Investigator of the project), and a Parker engineer. One of our graduate students was trained at the company's plant on the piston pump concepts and operation. In addition to his duties as a research assistant he mentors the undergraduate student assistants working on this project. The undergraduate student takes an active role in showcasing the research work to the freshmen class in Engineering Fundamentals, and speaking at the engineering open houses for prospective students. The students meet with the supervisors on regular basis with the project advisors. Some samples of the student work appear in Figs. 2 through 6 below.

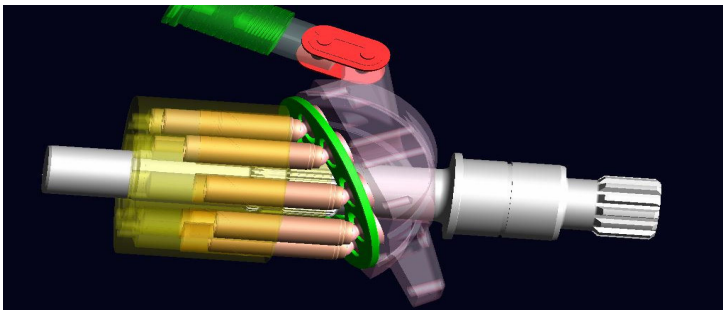

Fig. 2: Simulation Model of a Piston-Pump

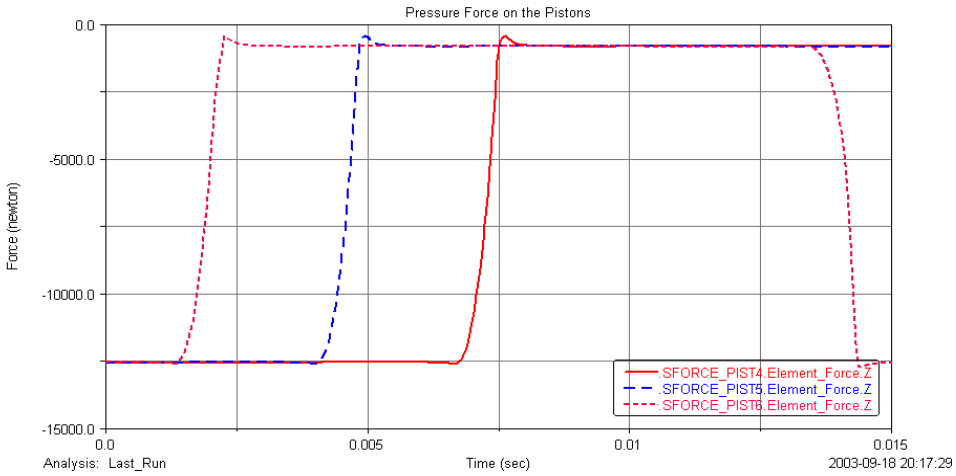

Fig. 3: Cyclic Pressure Variations in Three Pump Pistons

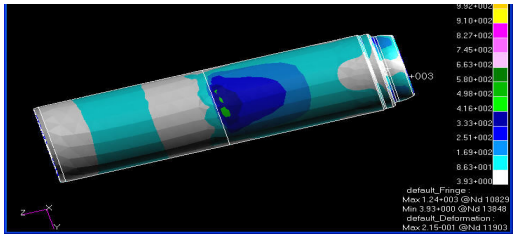

Fig. 4: Finite-Element Analysis on Pump Piston

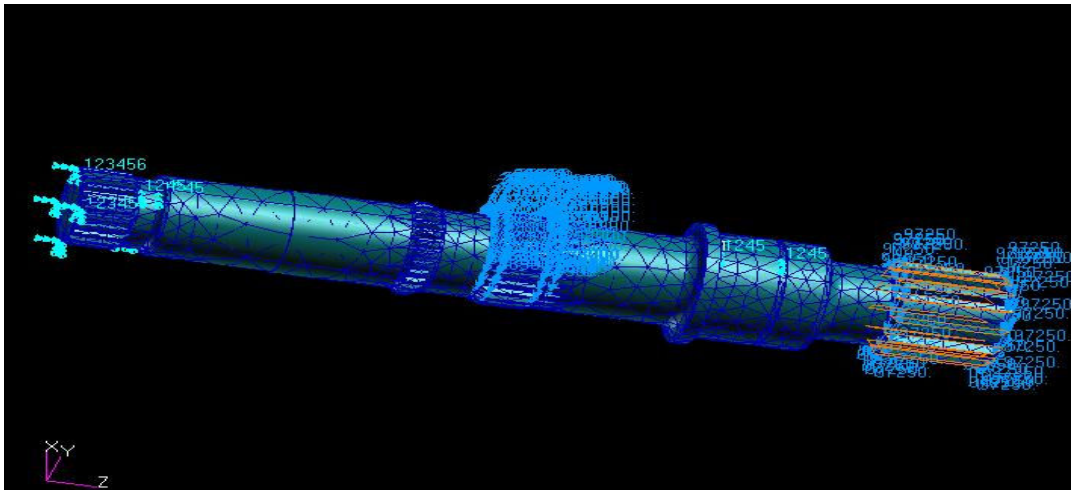

Fig. 5: Finite-Element Analysis (loading and boundary conditions) on Pump Shaft

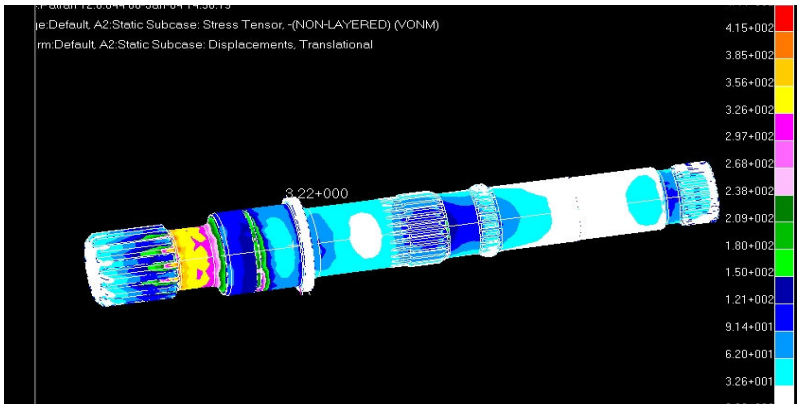

Fig. 6: Finite-Element Analysis (stresses and displacements) on Pump Shaft

Figures 5 through 9 convey the important connection between the academic courses and the real-world experience brought in through the industry-sponsored research. The engineering principles that are presented are reinforced when they validate some of the results output by the computer simulation programs through analytic relationships in the courses such as fluid mechanics, finite-element methods, stress analysis, dynamics, and dynamic and control systems. Based on the pump specifications, the input parameters such as inlet and outlet pressures, displacement volume, angular speed, etc., an ADAMS rigid-body simulation model is developed and run. The simulation results are used to conduct finite element studies on critical pump components such as pistons, shaft, barrel, swash plate, and retainer plate.

The pump simulation results have to be carefully validated by appropriate tests using the pump test stand. When any computer analysis and design are undertaken there may be significant risks associated with "blind faith" acceptance of the computational results. It is a known fact that relying solely on computational results may lead to misleading conclusions and design failures. The uncertainties in computational results are due to inherent limitations of the software, program "bugs", and the nature of processes simulated. For example, regardless of how well a CFD program performs, it cannot accurately model turbulence in flow. Sometimes the computer results could be in error due to the incorrect implementation and interpretation of the input/output parameters of the software by the end-user.

After rigid body simulation and finite-element analysis, the cyclic deformations and temperatures of piston, barrel, swash plate, and port plate will be available. . Parker is donating a hydraulic test stand replete with pumps, motors, valves, accumulators, cylinders, etc. The other challenge is to design an integrated hardware/software package consisting of: **1)** an independent National Instruments data-collection "satellite" module dedicated to measure a given test parameter, such as pressures at various locations in the pump; **2)** another module dedicated to measure the temperatures, flow rates, torque, forces, rotational speeds, linear speeds, etc. **3)** a "host" laptop computer with LABVIEW software, a powerful modular program used to perform the data acquisition, actuate PID controllers, gather all network data for real-time analysis and graphical representation; and **5)** a PID Controller (PLC) for controlling pressures, flow rates, and motor speed. Some measurements can be quite daunting due to limited or lack of ability to mount the sensors. For example, if elastic deformation or forces on any piston have to be measured, some innovative ways will have to be explored as the piston reciprocates within the

barrel and rotates with it. The initial goal is to develop validation tests that are relatively easy and will provide a fair amount of useful data such as cyclic changes in pressures, temperatures, flow rates, motor torque, and volumetric efficiency as a function of motor speed. Critical input will be sought from Parker engineers on what parameters to measure and validate. One undergraduate student has already completed the task of integrating sensor hardware and data acquisition system on a mini hydraulic pump/motor system. Work is in progress to install a similar system on a hydraulic trainer set donated by Parker.

The research funds are also being used to develop a hydraulics laboratory that will use modern sensors, controls, and data acquisition systems to conduct performance, endurance, and reliability tests on Parker pumps, and other hydraulic components.

5. CONCLUSIONS

Conclusively, when faculty research interests are combined with an industry-university partnership, the application of cognitive theory and emerging technologies to curricular innovation results in enhanced educational outcomes that prepare engineering students for the emerging needs of the workforce and industry. The avenues of institutional support guarantee assessment validation and determination of the ability of faculty and students to meet industry needs. Furthermore, the multiple dimensions of engagement of curricular innovation stemming from industry-university partnerships can be applied at all levels of the undergraduate experience with pedagogical advancements emphasizing a multi-disciplined approach to educational enhancement which is not only benefiting for students, but also for faculty and their research interests. The needs of the industry partner are also met, as students emerging from the innovated curriculum are prepared for the workforce and are already trained and developed to be familiar with the technology of not only the company, but of current technologies applied on a national and international level.

6. ACKNOWLEDGEMENT

The authors would like to express gratitude to Parker-Hannifin for financial support provided to YSU. We also would like to thank Mr. Lewis Kasper and Mr. Howard Zhang of Parker for their efforts in making this partnership a success.

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BIOGRAPHICAL INFORMATION

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