

A New Responsive Model for Educational Programs for Industry: The University of Detroit Mercy Advanced Electric Vehicle Graduate Certificate Program

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ABSTRACT

Today's automotive and electronics technologies are evolving so rapidly that educators and industry are both challenged to re-educate the technological workforce in the new area before they are replaced with yet another generation. In early November 2009 Ford's Product Development senior management formally approved a proposal by the University of Detroit Mercy to transform 125 of Ford's "IC Engine Automotive Engineers" into "Advanced Electric Vehicle Automotive Engineers." Two months later, the first course of the Advanced Electric Vehicle Program began in Dearborn.

UDM's response to Ford's needs (and those of other OEM's and suppliers) was not only at the rate of "academic light speed," but it involved direct collaboration of Ford's electric vehicle leaders and subject matter experts and the UDM AEV Program faculty. In fact, before teaching each course, the UDM engineering and science professors will work for one or two months in the Ford engineering group that is directly involved in the design and development of the systems that the course focuses on (batteries, e-drive systems, power electronics, etc). The prime architects of this process and curriculum include the UDM dean, associate dean and faculty of engineering and science from UDM, and Ford Learning & Development managers and Product Development leaders from Sustainable Mobility Technologies and Research & Advanced organizations.

Such a rapid and highly responsive curriculum development is not the norm in academia. To accomplish this outcome UDM had to be more customer-focused like industry and Ford needed to embrace academic priorities and provide access to its electric vehicle SME's by UDM faculty.

The paper will discuss the following related issues: building the relationship and trust between Ford and UDM; collaborative development; "just in time" development and deployment of curriculum; shared investment; modularizing education (it doesn't always have to be in "degree-sized chunks"), linking suppliers and OEMs; balancing service to corporations and service to students.

INTRODUCTION

"All we want is a cohesive educational program that includes the latest knowledge that is most relevant to my job that's delivered in a convenient way by exceptional teachers."

- the working engineer

"All we want is an educational program that infuses those unique competencies and technologies into our engineering team such that our strategic goals and product plans are efficiently accomplished with high quality ... but we can't really tell you too much about our strategic goals nor product plans."

- the corporation

"All we want to do is to provide exceptional graduate education that provides longstanding value to our graduates by developing deep sustainable competencies ... not just technology training that fades in value as the technology changes."

- the university

That sounds simple enough. Create curriculum that meets the needs of fast changing industry needs to be competitive, retrain the workforce and infuse new methods, concepts and technologies.

The discussion of the relevance of engineering education and its service to industry is not a new issue. Here are four quotes from studies of engineering education within the last decade:

- "In an era of unprecedented technological advancement, engineering practice continues to evolve but engineering education has not changed appreciably since the 1950s." [1]
- "When we walk into an arbitrarily chosen engineering classroom in 2000, what do we see? Too often the same thing we would have seen in 1970, or 1940. The professor stands at the front of the room, copying a derivation from his notes onto the board and repeating aloud what he writes." [2]
- "But we must ask if it serves the nation well to permit the engineering profession and engineering education to lag technology and society, especially as technological change occurs at a faster and faster pace. Rather, should the engineering profession anticipate needed advances and prepare for a future where it will provide more benefit to humankind? Likewise, should engineering education evolve to do the same?" [3]
- Challenges for lifelong learning in engineering could be summarized as "faculty won't play & industry won't pay" [4]

Over the last decade there have been a series of studies that led to calls for recasting engineering education such that it is more effective in terms of such areas as design[5, 6], product development [7, 8], manufacturing and quality[9, 10] and innovation[11]. Many national initiatives have been undertaken to respond to those calls, including ABET 2000 [12], the NSF Engineering Education Coalitions [13,14] and Engineering Teaching Centers [15]. Most of these have focused on new pedagogical methods and the development of faculty members' teaching competence, not on how industry leaders and faculty member (how corporations and universities) can effectively collaborate.

One key aspect of making graduate engineering education relevant is the speed with which it is developed and revised to incorporate emerging technologies that are ready for commercialization and to create new products that are desired by customers and/or needed by society. The field of advanced electric vehicles is quintessential as a confluence of time

driven factors. Society is concerned about the impact of burning fossil fuels on our environment, both locally and globally, and the nation's dependence on the dwindling supply of oil, especially from foreign sources. While these issues make advanced electric vehicle desirable, the lack of scale and robustness of technologies have not made them economically competitive with internal combustion engines. Technological advancement in key areas, especially batteries and "smart grids", will be needed to overcome cost disadvantages and power distribution challenges. As such, AEV engineering and education must both develop and guide the emergence of key technologies and systems to be effective and they must evolve and respond as those technologies become more commercially viable.

Thus, AEV engineering education programs must be created not only from traditional academic knowledge sources, such as journal papers from university and government laboratory sources, but also from less traditional sources, such as the lead engineers in companies that are driving those technologies forward. However, the access to those lead engineers (or "subject matter experts") is limited by the degree to which their employers allow them to openly discuss the emerging technologies and products and technology trajectories with university faculty.

There are also barriers to this ideal partnership in most universities. The "academic freedom" of individual faculty member in teaching their courses can work against having a cohesive program where the whole (program) is much more valuable than sum of the individual parts (courses). Also, academic governance processes can be so time consuming and cumbersome that a new program can take a year or more to be approved by departmental, college and university level committees. Further, the sense of some faculty members that "we are the experts" with the deep knowledge, and the engineers working in industry are not, can lead faculty members to disregard or devalue the input of very competent engineering leaders, many of whom have graduate degrees including doctorates, and regularly develop graduate level R&D findings from their work. If such lack of cohesion, respect and timely delivery are not dealt with effectively, the ultimate value of the resulting programs is severely compromised.

Today's automotive and electronics technologies are evolving so rapidly that educators and industry are both challenged to re-educate the technological workforce in the new area before it is replaced with yet another generation. State and federal government agencies also recognize the importance of AEV technology and the impact to job creation and retention. As such, the speed with which commitments are made, curriculum is developed and students are recruited or selected are all critical to assuring that students learn the very latest and most relevant technologies. In order to address the fast changing needs and to overcome the barriers described in this

section UDM and Ford responded with a unique partnership that is described in the next section.

Establishing the partnership

The ideal first step in overcoming these barriers to an effective partnership is to establish a high level of mutual respect and trust. Between the Ford engineering community and the UDM College of Engineering and Science, that step was accomplished many years ago. Since the early 1900's, the university has been a significant source of engineering talent for Ford. In the past two decades, UDM has developed and delivered several programs that were specifically designed to provide key competencies for Ford employers. These included on-site Bachelors degree programs in mechanical engineering, manufacturing engineering and computer science, all containing customized cases and projects based on deep dialogue with Ford's engineering leadership. Later in the 90's, UDM partnered with Ford and other leading international corporations and MIT to provide the Masters of Science in Product Development to engineers at Ford and Detroit-based companies. These experiences demonstrated UDM's effectiveness in creating curriculum that was responsive to the specific needs of Ford, and developed in Ford the trust needed to be open in conveying both the current and desired state of their engineering capabilities to UDM. The longstanding success of those education programs also developed UDM's trust that Ford's guidance was not focused on short-term needs that would not justify the level of effort needed to develop such responsive curriculum.

Furthermore, both UDM and Ford are actively participating in a Michigan Department of Energy, Labor & Economic Growth's sectoral skill alliance, the Michigan Academy for Green Mobility, whose mission is to provide rapid skill growth in green technology solutions for advanced mobility to meet industry needs. The MAGM is a group of automotive manufacturing employers, education and training providers, industry associations, and the workforce system working to develop a mechanism for providing that training. Such participation ensures alignment with the industry's view of AEV training and educational priorities.

Even with the long history of effective partnership and the MAGM participation, the following important steps were needed to assure that the curriculum would be on target and on time:

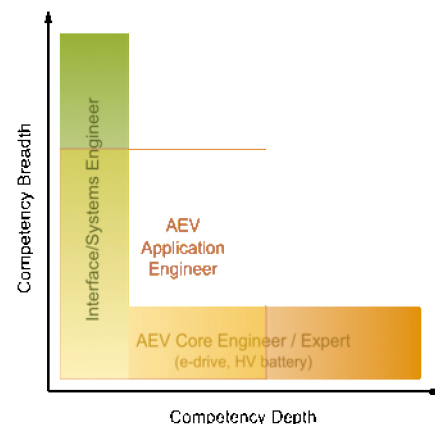
Step 1. Define the target audience: what engineers would be taking the curriculum? What will be their roles and responsibilities in developing world class advanced electric vehicles (AEVs)? It was decided that this program would educate the AEV application engineers who are expected to directly contribute to the design and analysis of Advanced Electric Vehicles. (These are not the core experts in the essential subsystems of AEV, such as batteries or electric

drive motors who require far more depth that might be provided by single courses in their areas.)

Step 2. Define the competencies required to perform those responsibilities: This step involved extensive meetings and dialogue between leaders from Ford and UDM.

Step 3. Define the learning outcomes for the courses and curriculum that will build those competencies: The entire team of instructors was defined early in this process and that team defined a cohesive curriculum. The syllabus for each course, including learning outcomes, was drafted and reviewed by technical leaders from Ford. [Timeline : Steps 1 - 3 were developed between April and August 2010 when key electric vehicle engineering leaders and Learning & Development leaders from Ford engaged in extensive discussion with UDM faculty and administration. This defined the program structure and course descriptions. Teams from Ford and UDM also visited the University of Wisconsin and Pennsylvania State University to learn from their programs and explore possible collaboration with their programs.

Step 4. Shared Investment: Before further progress could occur UDM and Ford needed to commit the resources to develop the curriculum and laboratories, and the enrollments to justify that development of the program. This was done in November 2009 by both UDM and Ford making formal commitments to provide the financial support and the time of their people to develop the curriculum. Ford senior Product Development leadership also committed to sending 125 of their employees through the program over a five year period.



Step 5. Link UDM instructors with Ford subject matter experts (SMEs): For each of the seven courses in the program, the instructor(s) were introduced to the technical leaders at Ford who were the most knowledgeable and responsible for the subject areas. In early 2010 preliminary meetings better defined the processes and challenges in developing the related AEV systems, and the appropriate work area for instructor assignment at Ford (Step 7).