Addressing New Skills Needs for the Automotive Industry through Motorsports Educational Pathway

Vukica Jovanovic
Old Dominion University
v2jovano@odu.edu

Mileta M. Tomovic
Old Dominion University
mtomovic@odu.edu

Alok Verma
Old Dominion University
averma@odu.edu

Nathan Luetke
Old Dominion University
nluetke@odu.edu

Steve Branch
Patrick Henry Community College
sbranch@patrickhenry.edu

Abstract

The automotive industry has available, higher-skilled positions that need engineers and engineering technologists who are qualified and capable to work in a high-paced, advanced manufacturing sector. Various educational programs across the country offer programs related to the motorsports area at the associate of science level, and there are various articulation agreements that enable students to continue their education to the bachelor's degree. These programs try to fill the gap related to the skills shortage in systems and new design methods and processes. The main strength of such educational pathways is that students, trained to work as technicians in the automotive/motorsports area and with a completed four-year undergraduate degree, have specific skills highly sought by the automotive industry. Old Dominion University (ODU) and Patrick Henry Community College (PHCC) have partnered to offer a motorsports program to students who have passion for this highly exciting and rewarding technical profession of motorsports. The program is designed as an Associate of Applied Sciences to a Bachelor of Science program, where students receive an Associate in Applied Sciences motorsports degree from Patrick Henry Community College, followed by one year of leveling courses at either PHCC, another community college, or ODU, and then complete a BS degree in Mechanical Engineering

Technology at Old Dominion University with a minor in Motorsports. This paper gives an example of such an educational pathway.

Introduction

In the beginning, motorsports competitions started as testing venues for the performance and reliability of engines and automotive vehicles [1]. *La Petit Journal* organized the first car race in France in 1894. This was a competition in which companies, such as those of inventors Karl Benz and Gottlieb Daimler, had their vehicles competing with one another. The first race competition in the US was held in Evanston, Illinois, in 1895 [1]. The main goal of this race was to showcase the "horseless carriage" as "an admitted mechanical achievement, highly adapted to some of the most urgent needs of our civilization."

Various studies have shown an impact of the motorsports industry to manufacturing sectors in the US. and across the globe [2]. For example, in the state of Indiana, it contributes to more than 23,000 jobs directly and 421,000 jobs indirectly with the annual wage of around $63,000, which is well above the state average, as stated in a report by Purdue University researchers, "Race to the Future: The Statewide Impact of Motorsports Industry in Indiana" [2].

There are not many career paths for science, technology, engineering, and math (STEM) areas that are as dynamic, exciting, and engaging to prospective students as motorsports [3]. The speed and color of the sport engages students in thinking about how cars are designed and made in a very different way than almost any other industry.

Skills Shortage in the Automotive Sector

Skill shortages in the automotive sector are not just related to traditional causes of skill shortage, such as high levels of separation from the trades, low take-up of apprentices, or low levels of stock of skills in the work force [4]. They are also related to rapid changes in technology. Typical problems reported were related to recruiting skilled labor, especially maintenance engineers, electrical engineers, and production cell managers [5].

Technical Skills

Motorsports programs and student competitions are allowing students to stay current with the technology and develop skills needed for the workforce of the future through various courses in an engineering curriculum. Motorsports projects engage students in problem-based learning with many different multidisciplinary challenges.

Project and Team Skills

Students involved in motorsports projects are learning engineering concepts through hands-on experience and teamwork, leadership, and critical thinking skills that are applicable to real-life situations [6]. Another engineering management skill that might be beneficial is related to the mechanics and production crews engaging in planning, setting up, and running a motorsports event, such as a monster truck show [7].

Competencies needed for automotive technicians are mapped by the National Automotive Technicians Education Foundation [8]. The competencies in the automotive technology program are directly correlated with the knowledge required to prepare an individual for the certification test given by the National Institute for Automotive Service Excellence.

Re-Profiling of Skills in the Automotive Sector

The automotive sector includes technologies transferable to other industries, such as defense, aerospace, energy, and transport [9]. Innovation is a key asset of a successful motorsport team. One such skill is welding, which can be transferred to a wide array of industrial jobs in various sectors [10].

Race teams spend a significant time in the research and development of high-end engineering systems, while adopting new technologies under strict deadlines. Examples of new technology developed for motorsports application and transferred over to the defense sector include the development of more efficient engine-cooling systems, radiators, and filter systems for armored vehicles, which need to work in very hot and dusty conditions in Afghanistan [9]. Aside from these systems, other transferable skills include aerodynamics, lightweight structures, electronics, embedded systems, and general onboard car systems. Furthermore, other new technologies include kinetic energy recovery systems through composite flywheel systems, which could be implemented in public transportation systems to enable more efficient starting and stopping of buses (Figure 1).

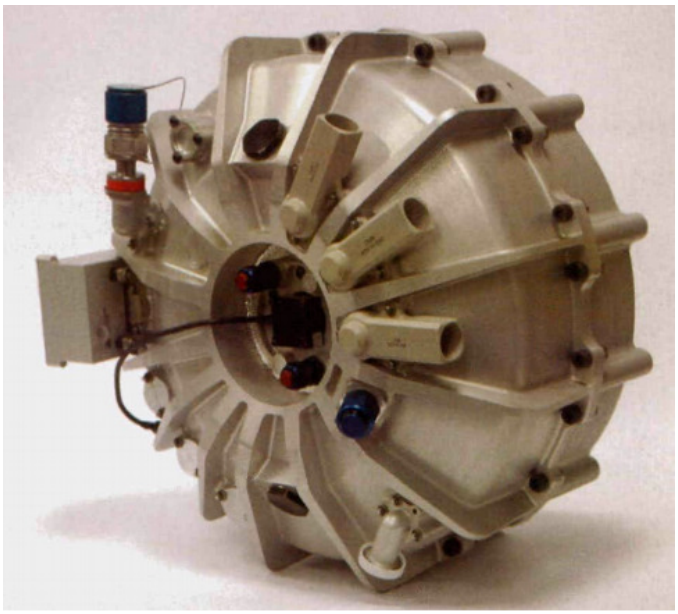

Figure 1. Application of Williams' flywheel, originally developed for F1 in urban buses [9]

The design of vehicles for motorsports includes engineering design principles and the use of computer-aided design. As shown in Figure 2, various material options and alternatives can be analyzed in a digital model so that engineering decisions could be made as early as the design stage, before the realization phase begins. In this way, successful collaboration with people who are not located in one company is enabled,and skills gained during work in virtual teams could be used in any other industry.

Figure 2. Engine with different materials options, Autodesk Inventor [11]

Educational Pathway for Automotive Sector

The first bachelor's degree in Motorsports Engineering and Motorsports Engineering Technology in the US was offered at Indiana University-Purdue University Indianapolis [3, 12]. In addition, various summer camps and pre-engineering curriculum modules were developed to enable the pipeline to this educational pathway. Examples of such modules are related to concepts of a modern racecar working. Examples of educational materials related to motorsports are safety design concepts, such as safety structure design and investigations of previous crashes and the development of design improvements based on them. These materials have had a positive effect on high school students and also on their teachers. In Great Britain, similar initiatives are taking place to engage young populations in activities related to motorsports to spark their interests in STEM careers, including four-day intensive courses in motorsports. For example, the Formula Student initiative focuses on teamwork, management, and marketing skills to bring more students into the motorsports educational pipeline [13]. Another example is the study of engineering concepts through an analysis of monster truck competitions [7].

Students' motorsports education continues at the university through their participation in Formula SAE teams and use of the ODU facility, The Virginia Institute for performance engineering and research (VIPER) Lab, which is both a facility for teaching and hands-on experience and a commercial race facility. Old Dominion University in Norfolk, NASA Langley Research Center in Hampton, and Virginia Tech in Blacksburg collaborated to offer a graduate degree in motorsports engineering and consulting services to automakers and race car teams [14].

Old Dominion University offers a minor in motorsports engineering for mechanical engineering and engineering technology students. Students are introduced to important engineering concepts related to aerodynamics, chassis dynamics, piston engines, and racecar performance. These areas are important for working with high performance racecars. Graduates with this minor are qualified to work in entry-level positions in motorsports or the automobile sector. Various facilities are available to students in this minor: wind tunnel, engine dynamometers, and labs at Virginia International Raceway, which include a modified Formula Mazda and advanced data acquisition system. All junior and senior level courses in the motorsports minor are delivered on campus and through the distance learning program [15].

ODU and the New College Institute have partnered to offer motorsports engineering education in Martinsville for students, professionals, and companies involved in motorsports [15]. ODU and Patrick Henry Community College (Figure 3), located in Martinsville, VA, are offering educational pathways in motorsports. A motorsports minor is available to ODU students who have completed lower-division credit requirements in education, and a group of technical-based credits that heavily stress subjects related to the field of motorsports.

Students may complete general education credits at a local community college, but few programs can provide technical courses directly related to motorsports.

Figure 3. Motorsports program participants at Patrick Henry Community College

Upper-division courses are delivered by ODU at the New College Institute in Martinsville, Virginia, through conventional lectures in classrooms, practice at relevant sites, and laboratory facilities, which include a driving simulator, vehicle dynamics rig, chassis dynamometer, and engine instrumentation laboratories at the Virginia International Raceway (VIR), the Virginia Motorsports Technology Center Motorsports at Patrick Henry Community College, and NASA's full-scale wind tunnel operated by ODU.

VIPER focuses on the development of more engineering jobs in the automotive industry. The program was established by support from NASA, Virginia Tech, and the Virginia Tobacco Commission.

The lab facility is designed to support hands-on teaching of undergraduate and graduate motorsports engineering courses at ODU, the New College Institute, and PHCC, and to conduct engine and drivetrain research while operating as a commercial entity. The engine and drivetrain lab has three main areas of commercial concentration that complement the research and teaching aspects: engine diagnosis and performance testing, engine performance optimization (tuning), and vehicle data acquisition and analysis [15].

Figure 4. Engine and drivetrain lab director with VIPER vehicle [15]

VIPER lab is located at PHCC in Danville, Virginia. It is a 12,000-square-foot building next to the Virginia International Raceway where teams can bring their race cars and simulate track conditions on a seven-post "shaker" rig [14]. The engine and drivetrain lab is used commercially during weekend race events to evaluate horsepower output and other capabilities of a car's drive train and chassis.

During the week, the state-of-the-art facility is utilized by students seeking advanced degrees in motorsports engineering and by researchers investigating the potential of alternative fuels [16]. The VIPER vehicle, as shown in Figure 5, is a Stohr, powered by a 1.4-liter, Suzuki motorcycle engine, heavily modified to produce 250-horsepower. The car is an example of the application of technology and engineering in motorsports, with features such as a lightweight carbon fiber body and an aerodynamics package that it generates enough downforce for the car to race upside down—if such a track existed [17].

Figure 5. VIPER vehicle

Formula SAE Team at ODU

ODU has competed in the Formula SAE Competition since 1998. The event is hosted by the Society of Automotive Engineers and has taken place annually since 1981. Each year, universities from around the globe are given the opportunity to register for the Formula SAE competition [18].

The objective of the ODU Formula SAE program is to design, fabricate, and compete with a formula-style racecar. The goal of the work to be completed by the university's Formula SAE team is to ensure overall vehicle success by planning, implementing, and validating good design of all aspects of the car [18].

The plan of work for this project includes the chassis, suspension, controls, engine and drivetrain, and aerodynamic components; the fabrication and integration of these assemblies; and the testing of all critical components to ensure high levels of performance, operator safety, and marketability. High levels of project achievement will follow from mitigating design problems through careful planning, minimalizing cost through effective project management, and successfully operating of the vehicle at the competition [18].

Figure 6. ODU IV (built in 2008)

Summary/Conclusions

Motorsports is a rapidly growing industry in the US and worldwide. Motorsports is the forerunner of vehicle design, manufacturing, and testing. Today, racecars run on ethanol, diesel, hybrid drive, and electricity. Future racecars will test the limits with technologies, such as fuel cells, and the industry needs engineers ready for tomorrow's technologies. As a result, students will gain in-depth practical knowledge and understanding of engineering principles required to optimize race vehicle performance.

References

[1] Lopez. G. (2008). *Brief History of Motorsports*. Retrieved from http://ww2. -odu.edu/~glopez/MTS/About/About_Motorpsorts.html

[2] Weisenbach, T. (2013). Purdue Study Quantifies Motorsports' Economic Impact. *Site Selection, 58*, 138-143.

[3] Hylton, P. (2010, March 1). Using Motorsports Design Concepts to Further STEM Education. *Journal of Technology Studies, 36*, 12-15.

[4] Borthwick, J., John, D., & Werner, M. (2000). *Evidence of Skill Shortages in the Automotive Repairs and Service Trades*. Adelaid, Australia: National Centre for Vocational Education Research.

[5] Duval Smith, S. (2013). Automotive Industry Faces Labour Shortages. *Automotive Manufacturing Solutions, 14*, 16-17.

[6] Thomas, I. (2008, May). Revving Up Students' Skills with Motorsports, *Techniques: Connecting Education & Careers,* 83, 28.

[7] Burgin, S., & Ritz, J. (2013, March). Monster Trucks: Innovations in Motor Sports26. *Technology & Engineering Teacher, 72*, 26-31.

[8] Careeronestop. (2013). *Models in Action—Automotive*. Retrieved from http://www.careeronestop.org/

[9] Hibbert, L. (2012, October). Refuelling Opportunities. *Professional Engineering Magazine*. # 83194748.

[10] Bilski, C. J. (2009, Fall). Youth Education through Motorsports. *World of Welding,* 27.

[11] Abulrub, A. G., Attridge, A., & Williams, M. A. (2011). Virtual Reality in Engineering Education: The Future of Creative Learning. *International Journal of Emerging Technologies in Learning, 6*, 71-78.

[12] Fisher. R. (2008), Motorsports Engineering Degree Approved at IUPUI. Retrieved from http://info.iupui.edu/news/page/normal/3559.html

[13] Bolton, J. (2012). Motorsports Education. *Motor Sport News*. 31-31.

[14] Connolly, A. (2005, September 11). ODU to Offer Motorsports Degree with High-Tech Emphasis. *The Virginian-Pilot*.

[15] Seaber. V. (2012). *VIPER Engine and Drivetrain Lab*. Retrieved from http://www. oduviper.com/

[16] ODU. (2008). *ODU, VIPER to Open Motorsports Engineering Lab at Vir*. Retrieved from http://ww2.odu.edu/ao/news/index.php?todo=details&id=9907

[17] ODU. (2013, July). Victor Seaber of ODU's VIPER Lab Bests Professional Driver at VIR's Ultimate Track Car Challenge. Retrieved from http://www.odu.edu/news/ 2013/7/viper_lab#sthash.gZ3w9Jhw.dpuf

[18] ODU. (2010). *ODU Formula SAE 2010*. Retrieved from http://orgs.odu.edu/sae/ projects/formula/index.html

Biographies

VUKICA JOVANOVIC is currently an assistant professor at the Engineering Technology department at Old Dominion University. Her research focuses on mechatronics, product identification, product life cycle management, assembly systems, collaborative engineering, automation, and energy efficiency. She had internships in engineering services, aerospace, and power generation industries. Dr. Jovanovic received M.Eng.(dipl.ing.) degree from University of Novi Sad, Serbia, in Robotics, Mechatronics and Automation and M.Sc. (magistar) degree in Production Systems Design, both at then Department of Industrial Engineering. She received a PhD in Mechanical Engineering Technology from Purdue University.

MILETA TOMOVIC is currently a professor and the chair of the Engineering Technology Department at Old Dominion University. Dr. Tomovic received his BS in Mechanical Engineering from University of Belgrade, MS in Mechanical Engineering from MIT, and PhD in Mechanical Engineering from the University of Michigan. Prior to joining ODU, Dr. Tomovic had 17 years of teaching and research experience at Purdue University, with emphasis on the development and delivery of manufacturing curriculum, conducting applied research, and engagement with Indiana industry. While at Purdue University, Dr. Tomovic served as W. C. Furnas Professor of Enterprise Excellence, University Faculty Scholar, director of Digital Enterprise Center, and special assistant to the dean for Advanced Manufacturing.

ALOK VERMA is Ray Ferrari Professor and director of the Lean Institute at Old Dominion University. He also serves as the director of the Automated Manufacturing Laboratory. Dr. Alok Verma received his BS in Aeronautical Engineering from the famed institution, IIT Kanpur, MS in Engineering Mechanics, and PhD in Mechanical Engineering from ODU. Prof. Verma is a licensed professional engineer in the state of Virginia, a certified manufacturing engineer and has certifications in lean manufacturing and Six Sigma. He has organized several international conferences as general chair, including ICAM-2006 and ICAM-1999 and also serves as associate editor for three international journals. He serves as the president of the International Society of Agile Manufacturing and as the chief editor of the *International Journal of Agile Manufacturing*.

NATHAN LUETKE is currently a senior lecturer in the Engineering Technology Department at Old Dominion University. Nathan Luetke Received his BS in Mechanical Engineering Technology from Old Dominion University, followed shortly after by an MS in Mechanical Engineering. While pursuing his master's degree, Nathan spent two years at Swales Aerospace, followed by one year at Lockheed Martin contracting for NASA Langley Research Center in Hampton, VA.

STEVE BRANCH is currently a dean at Dean of Science, Technology, Engineering, and Math at Patrick Henry Community College. He received his master's degree from

Appalachian State University and his bachelor's from UNC Pembroke in Biology with a minor in Chemistry.

ISBN 978-1-60643-379-9