Industrial Technology Vehicle Design Program: Assessment & Improvement

Department: Engineering and Design/Industrial Technology Vehicle Design (ITVD)

Assessment Coordinator: Eric Leonhardt

Departmental Mission:
The Engineering and Design Department at Western Washington University serves current students, industry, the University, and the citizens of the state of Washington by developing industry-ready graduates through a combination of creative problem-solving, analytical skills development, and experiential learning. The educational experience we provide emphasizes teamwork, communication, critical thinking, and an understanding of the impact of design, engineering, and manufacturing solutions in a global, economic, environmental, and societal context.

The Industrial Technology Vehicle Design program at Western Washington University will prepare graduates with the skills to enter careers in the vehicle, manufacturing and composites industries in the areas of: product development, product design, manufacturing, manufacturing process design, sales, technical management and business owner or technical consultant.

Department Student Learning Outcomes: Upon graduation, Vehicle Design program majors will be able to demonstrate the following outcomes. The Accreditation Board for Engineering and Technology (ABET) related outcome is listed in parenthesis.

1. Demonstrate (a) an ability to apply knowledge of mathematics, science, and engineering
2. Demonstrate (b) an ability to design and conduct experiments as well as to analyze and interpret
3. Demonstrate (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. Demonstrate (d) an ability to function on multidisciplinary teams
5. Demonstrate (e) an ability to identify, formulate, and solve engineering problems
6. Demonstrate (f) an understanding of professional and ethical responsibility
7. Demonstrate (g) an ability to communicate effectively
8. Demonstrate (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal
9. Demonstrate (i) a recognition of the need for, and an ability to engage in life-long learning
10. Demonstrate (j) a knowledge of contemporary issues
11. Demonstrate (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
**Student Learning Objectives Assessed:**

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<thead>
<tr>
<th>Measures</th>
<th>SLO's Assessed</th>
<th>Results</th>
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<tbody>
<tr>
<td>VHCL 260—Students create a conceptual engine design based on key parameters: bore, stroke, BMEP, mean piston speed.</td>
<td>1(a), 3(c), 5(e), 11(k)</td>
<td>Target 80% of students will meet expectations on testing for the conceptual engine parameter selection. Target has been met for 2015-2016.</td>
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<td>VHCL 260—Students create an analysis tool to estimate forces and moments including aerodynamic lift, drag, hydrodynamic lift and drag on a wing-in-ground effect vehicle. Thrust estimates and a static weight balance are also determined.</td>
<td>1(a), 3(c), 5(e), 6(f), 11(k)</td>
<td>Target 80% of students will meet expectations to analyze a wing-in-ground effect vehicle. Target met for 2014-2015. Target was not met for 2015-2016. Adjunct faculty taught this course and did not use the tunnel hull project.</td>
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<td>VHCL 260—Students disassemble and assemble an engine in small groups.</td>
<td>4(d)</td>
<td>All students must meet this expectation to complete the course. Target was met for 2015-2016.</td>
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<tr>
<td>VHCL 360—Students design a vehicle chassis complete with suspension design and drivetrain packaging.</td>
<td>1(a), 3(c), 5(e)</td>
<td>80% of the students will meet expectations (obtain an 18 or better) on the chassis design project. Target met for 2015-2016. However, physical models were of low quality for the majority of students with 2 out of 5 for physical model quality.</td>
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<td>VHCL 491, VHCL 492, VHCL 493 Capstone Project</td>
<td>1(a), 3(c), 4(d), 5(e), 6(f), 7(g), 8(h), 10(j), 11(k)</td>
<td>80% of the students will complete team project objectives. This series will be taught for the first time in 2015. This will include written reports and oral presentations. Students for 2015-2016 completed their academic project report and oral presentations. The project vehicle, however, was not completed.</td>
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**Program Changes Based on Assessment**

The 2015-2016 year was the first year to graduate students who have completed a capstone project. This was also the first year to link a vehicle design and build project directly with coursework and an academic timeline. Each student produced a report for the area of design for which they were responsible. Each student successfully completed an oral report on the project as well. However, the overall project, designing and building an electric utility vehicle, was not completed. The expectation was to complete the chassis structure by the first week of June, 2016. The original timeline was to complete the design by the end of fall term, 2015. Then during winter and spring term the structure would be built. Several significant factors limited the student’s success. When students evaluated the design completed in December, 2015, they determined that they had not addressed all of the requirements correctly, specifically for headroom and visibility. This led to a redesigned body structure during the winter term with a significant project delay. Material testing that occurred during the
winter term developed a specification for a structural epoxy adhesive. A product was located, however, it had to be manufactured and this took six weeks. In hindsight, I wish I had rejected the students' product selection in favor of a product that could be easily procured. Although almost all of the panels for the chassis structure were cut, fit and bent, the lack of epoxy meant the team wasn't able to complete fabrication of the chassis panels or to join them. Finally, roughly 40% of the students were also working to support the construction of two other vehicles, an SAE Baja and Formula SAE vehicle. So some of the most talented and capable students were spread thin to support all of the projects. A subset of the advisory board and a group of alumni will be meeting in June to review this issue and suggest solutions. Other programs have used the Formula SAE or SAE Baja projects as the focus of their capstone projects and to demonstrate program outcomes. We will consider this option.

The vehicle program advisory board met spring term, 2016, to review curriculum and program changes. The most significant recommendation was to study how to automate the assessment process. We are targeting 11 outcomes, as specified by ABET for an engineering program. ABET would like to see 3-5 measures per outcome. We currently collect data from roughly 100 data points per class, per student. This data is relevant to the ABET outcomes and could be used to meet the requirements. However, the process of collating, aggregating and then manipulating the data for display or analysis is onerous. We will be looking over the summer how to accomplish this task.

The collected data was used to change the curriculum in VHCL 261 Vehicle Systems II. This course marks the entry of students into the vehicle design program. The students have all had statics and they take mechanics of materials concurrently or as a prerequisite. For the past two terms, the VHCL 261 course has been taught using a machine design textbook. Students review tensile stress, shear stress, torsional stress, bending stress and bending and torsional deflection. This course highlighted that students had challenges drawing a moment diagram, and as a result, could not calculate bending stress correctly. Students are assessed every two weeks in this course. The problem persisted through three assessment periods. The advisory board suggested I meet with the faculty teaching statics and mechanics of materials to see how students are being tested on this concept. I met with the mechanics of materials instructor. I plan to meet with a statics faculty member this summer. The students will also be assessed in the fall for review.