

BAHRAIN POLYTECHNIC

DESIGNING AND BUILDING A CAR WITH SOLIDWORKS SOLUTIONS



Above is Bahrain Polytechnic's first completed car—a desert buggy. It was designed from first principles, analyzed, developed, and manufactured by mechanical engineering degree students using SOLIDWORKS software.

Challenge:

Facilitate a senior design project in which students use skills learned in the classroom to build a car based on specific design requirements.

Solution:

Standardize on SOLIDWORKS Education Edition and SOLIDWORKS Simulation solutions.

Benefits:

- Prepared students for real-world engineering careers
- Developed senior design project curriculum to provide hands-on experience for students
- Facilitated teamwork and leadership skills in student body
- Helped foster Bahrain manufacturing and engineering industry

ABOUT BAHRAIN POLYTECHNIC

Bahrain Polytechnic opened its doors in 2008 with approximately 200 foundation students and a mission to fill a gap in Bahrain's labor market for applied professional and technical graduates. Today it boasts more than 2,000 students who study a wide range of disciplines, each designed in cooperation with local industry to meet the country's needs for homegrown talent. The polytechnic offers career-focused programs that produce professional and enterprising work-ready graduates through the application of a problem-based learning (PBL) approach.

The Bachelor of Engineering Technology degree (Mechanical) program was designed to meet the needs of the existing and future manufacturing industry in Bahrain. The mechanical engineering program strives to achieve this goal by applying a "staircased" PBL approach. In the first two years of the four-year degree program, students are exposed to PBL through short projects embedded within traditional subject areas. This approach culminates in year three with the inclusion of a full-time design project using theme-based PBL.

YEAR THREE PROJECT: BUILDING A CAR

Tutors at Bahrain Polytechnic chose to have students design and build a car as their year three project. They believed this project would maintain student interest and motivate learning. It also had the breadth, depth, and flexibility to produce many different learning outcomes. This project provided a variety of learning experiences among the diverse learners within any particular cohort, while still enabling students to acquire the minimum skills and knowledge required by industry. The project also included the added advantage that, by changing the "client" requirements slightly, the same course could be repeated each semester and result in a different outcome. For example, the students may be required to design a buggy, a sports car, or a racing car.

And although similar design parameters existed, the application of these parameters changes greatly and the material specifications, geometry, and layout vary dramatically from one application to the next.

A purpose-built workspace was designed on site to house this engineering PBL project to simulate the environment that students would likely encounter in their professional careers as engineering technologists.

GETTING STARTED WITH INITIAL DESIGN

Simulating a real-world industry experience, polytechnic tutors acting in the role of "clients" and facilitators first gave students the design brief. After discussing a broad outline of the design requirements and parameters with their tutors, students then researched how each problem is to be resolved in a basic sense before they started a more detailed analysis. Students identified any conflicting or non-aligning requirements and began to see how the design and manufacture of one component can impact the placement, design, and manufacture of many others. The design process was not constrained and students were encouraged to research alternatives and use any material or manufacturing process they chose. In addition to the books in the library and the Moodle web resources provided, the workshop also had Westfield kit cars and a Jaguar® E-Type that students used as study tools.

ASSESSING DESIGN OPTIONS

As the students progressed, they asked questions about the methods used and design options chosen by a manufacturer. Once their design became more refined, students considered constraints such as cost, availability of materials, and manufacturability (Can you make it?), time-frame, and available machinery. For example, the front suspension topic used the following learning outcomes that were integrated into a single, multidisciplinary assignment:

- Explain why components and materials fail and how stresses can be safely applied
- Use appropriate methods of joining materials in an assembly
- Analyze the effect of a load on a member
- Analyze complex stress and strains and location of principle stress planes and stress concentrations in a material
- Evaluate an engineering design

Students examined alternative requirements from a design, geometry, material, and manufacturing perspective. They selected a suitable type based on these desired properties:

"SOLIDWORKS has become an invaluable tool for us. The ability to graphically design components, then stress test them without having to manufacture test rigs and prototypes saves a huge amount of time."

— John Donald, Engineering Tutor

camber gain, castor, Ackermann angle, roll center, steering axis inclination, and steering geometry.

The students then designed each element, citing calculations that proved that the correct materials were specified for components, brackets, and fixings by defining the loads imposed upon each component that also incorporated a suitable factor of safety (FoS). Students calculated these loads using the estimated mass, center of gravity, and expected forces generated under acceleration, braking, cornering, and hitting a bump.

Students calculated the forces and expected stresses within the material, and then checked them manually. Values obtained from the simulations (for example, Von Mises stress, deflection) were compared with manually calculated values to confirm (or refute) appropriate material or design selections. This enabled students to identify whether the stress concentrations highlighted by SOLIDWORKS® were reasonable or feasible, and provided a good method of verifying the initial findings, as well as the full and combined effects they expected to occur within their system.

MOVING FORWARD FROM DESIGN TO MANUFACTURING

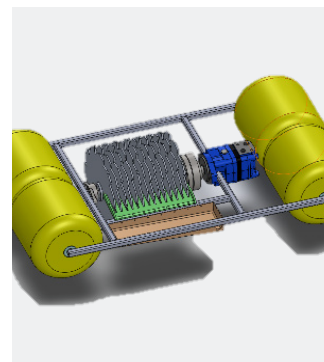
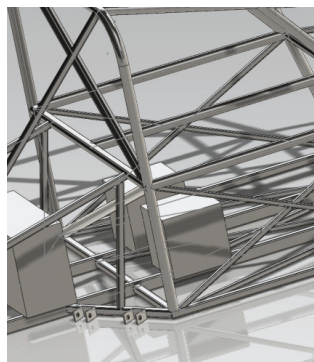
As the design became more complete, the vehicle began to materialize, evolving from a series of individual components to the finished article. Once the suspension components passed the stress tests successfully, they were fitted in place onto the chassis. This exercise continued until the entire vehicle was assembled with all of the major components tested and fit-for-purpose approved by both the students and the clients.

After each component completed the design cycle—investigation, synthesis, analysis, optimization, and justification—students began manufacturing their suspension, chassis, and steering designs. They managed and ran this project themselves, again with guidance and input from the tutorial staff. This was an interesting experience for them, as they discovered that not every aspect of a SOLIDWORKS design can be directly translated into a real-world solution. Students had to redesign components or structures to accommodate tooling, fixturing, or manufacturing constraints. Problem-solving, teamwork, and initiative reflected real-world experiences that students will need to be successful within the industry.

Focus on Bahrain Polytechnic
VAR: Cad/Cam./Cim Inc. APAC, Dubai,
United Arab Emirates

Headquarters: Road 4003
Block 840, Isa Town
Kingdom of Bahrain
Phone: +973 1789 7000

For more information
<http://www.polytechnic.bh/>



After each component completed the design cycle—investigation, synthesis, analysis, optimization, and justification—students began manufacturing their suspension, chassis, and steering designs.

Our 3DEXPERIENCE® platform powers our brand applications, serving 12 industries, and provides a rich portfolio of industry solution experiences.

Dassault Systèmes, the 3DEXPERIENCE® Company, provides business and people with virtual universes to imagine sustainable innovations. Its world-leading solutions transform the way products are designed, produced, and supported. Dassault Systèmes' collaborative solutions foster social innovation, expanding possibilities for the virtual world to improve the real world. The group brings value to over 210,000 customers of all sizes in all industries in more than 140 countries. For more information, visit www.3ds.com.

