Virtual Automotive Engine

Description of initiative and key individuals involved in major tasks or activities

Our initiative set out to create a three-dimensional (3D) virtual learning tool that allows instructors and students to view and interact with models in a virtual simulated platform.

The process involved:

1) Streamlining the 3D model creation procedure
2) Building a model viewer for parts familiarization and task training
3) Creating an efficient production workflow for getting content into the custom model viewer

1) Streamlining the 3D model creation process

Initially, engine assembly was identified and selected as appropriate course material for virtual learning. In order to achieve effective simulation learning, high fidelity models are required, so there was an initial investment in a hand held 3D model scanner. The 3D scanner helped to improve the workflow for the 3D modeler by allowing highly accurate digitization of engine parts for modeling.

In this way, the team was able to build the Hyundai automotive engine. Working with the subject matter expert and 3D modeler, each part of the engine was disassembled, scanned, optimized and prepped for development.

2) Building a model viewer for parts familiarization and task training

Concurrently with model creation, a multimedia developer worked on developing the platform to display the model, allowing students and instructors to interact with parts, show parts list and simulate assembly/disassembly tasks.

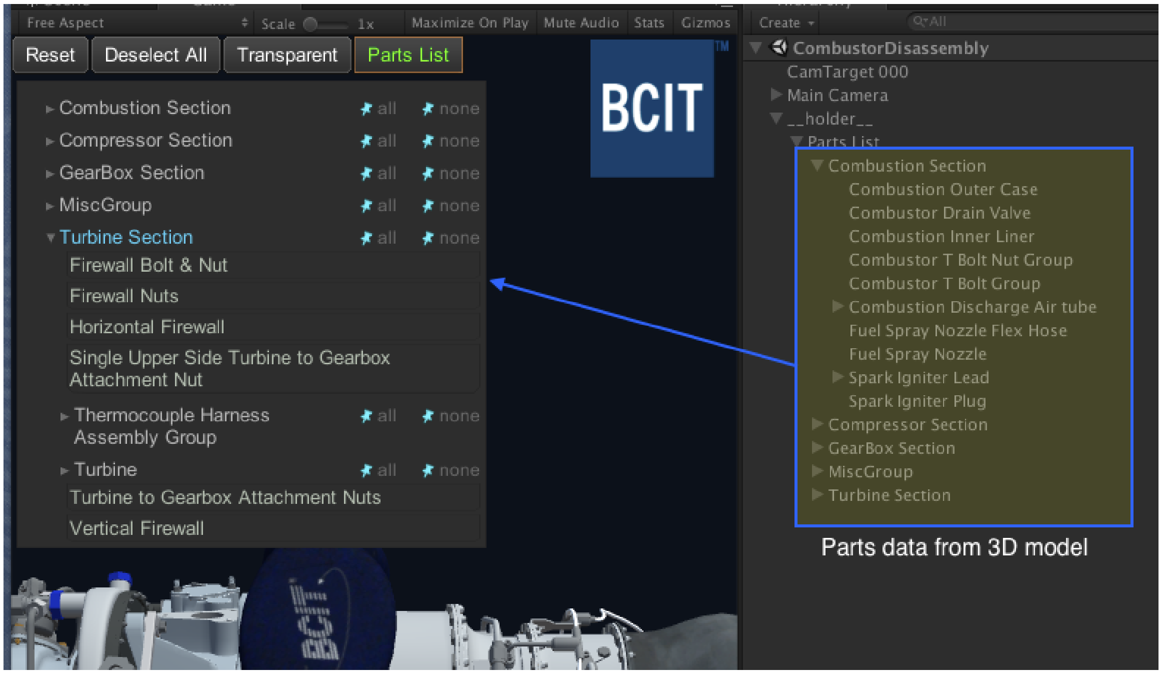
Initially, the platform was built to publish to web browsers, which allowed for the most flexibility and reach of distribution. Students would be able to access the learning tool online, in-class, or at a distance.

3) Creating efficient workflow for getting content in to the custom model viewer

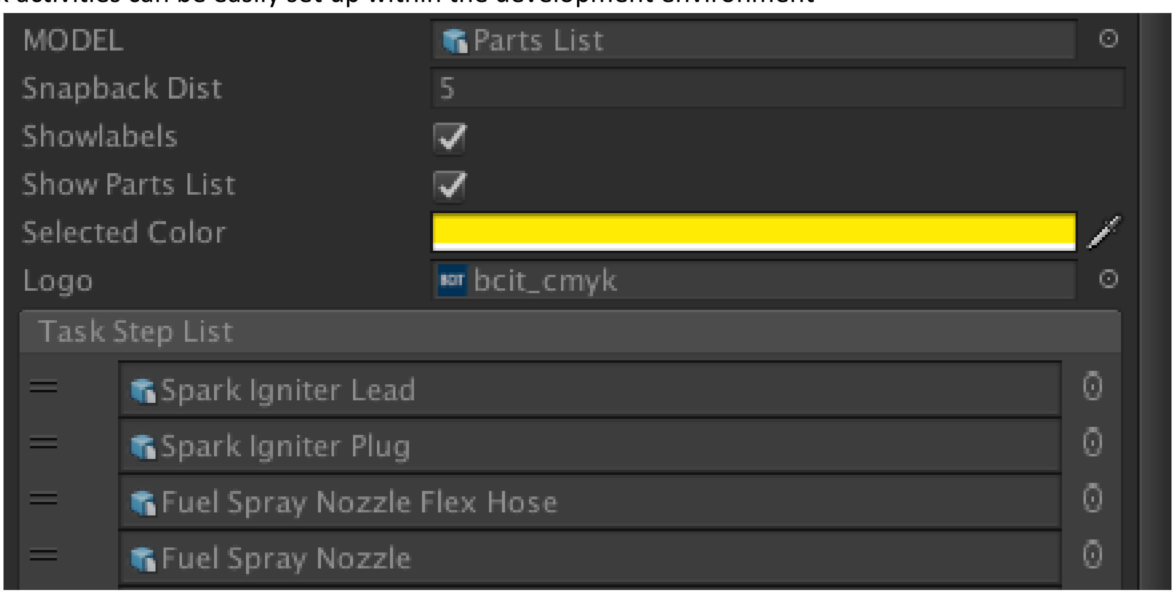
In the process of developing the interactive 3D Hyundai Engine, we have created an optimized workflow for future development.

In the development platform:

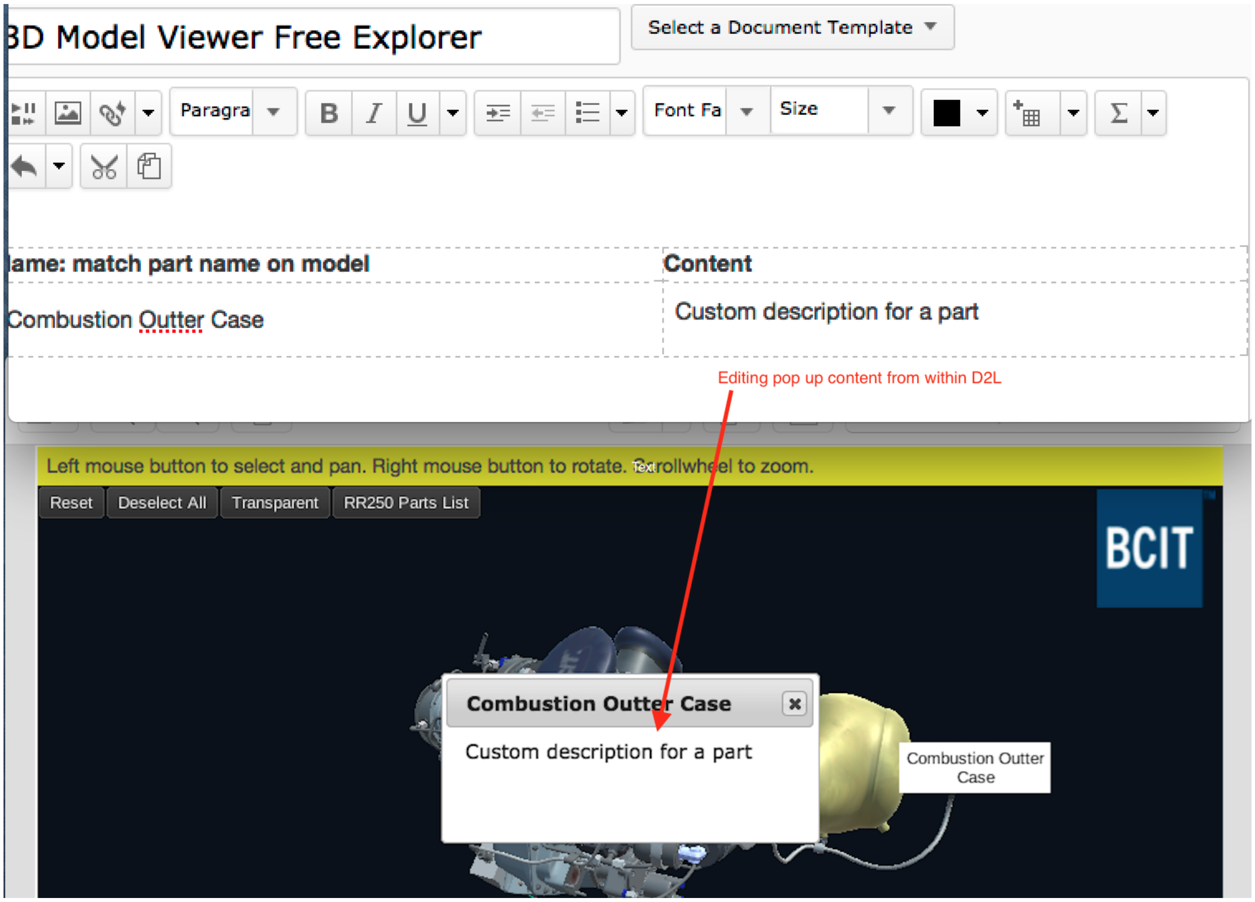
Parts list and interactions are automatically generated from the 3D model data



Task activities can be easily set up within the development environment



Instructors can add descriptions or images for parts through our Learning Management System, D2L



Adding text or images from within D2L that will be associated with a part in the model

This workflow was initially tested and improved upon by building simpler models, for example, a hydraulic pump, engine transmission and RR 250 engine.

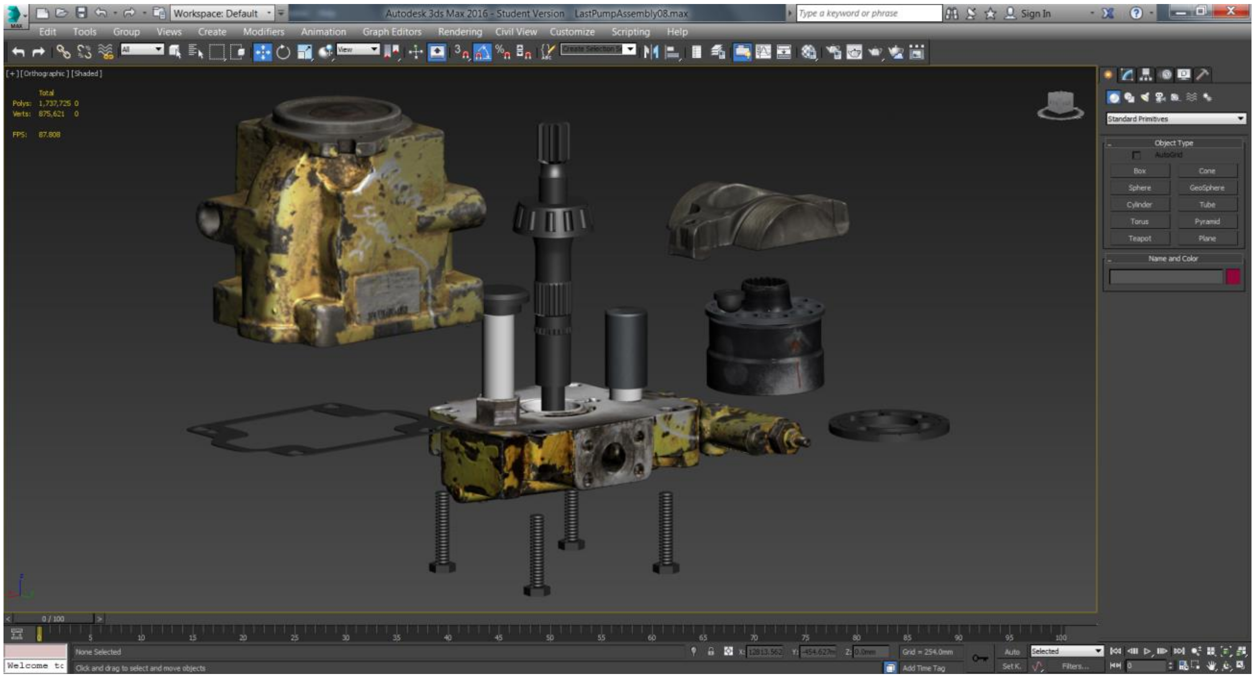


Figure 1 3D hydraulic pump, cleaned up and optimized from digital scan

Figure 2 Transmission model in early version of model viewer browser app

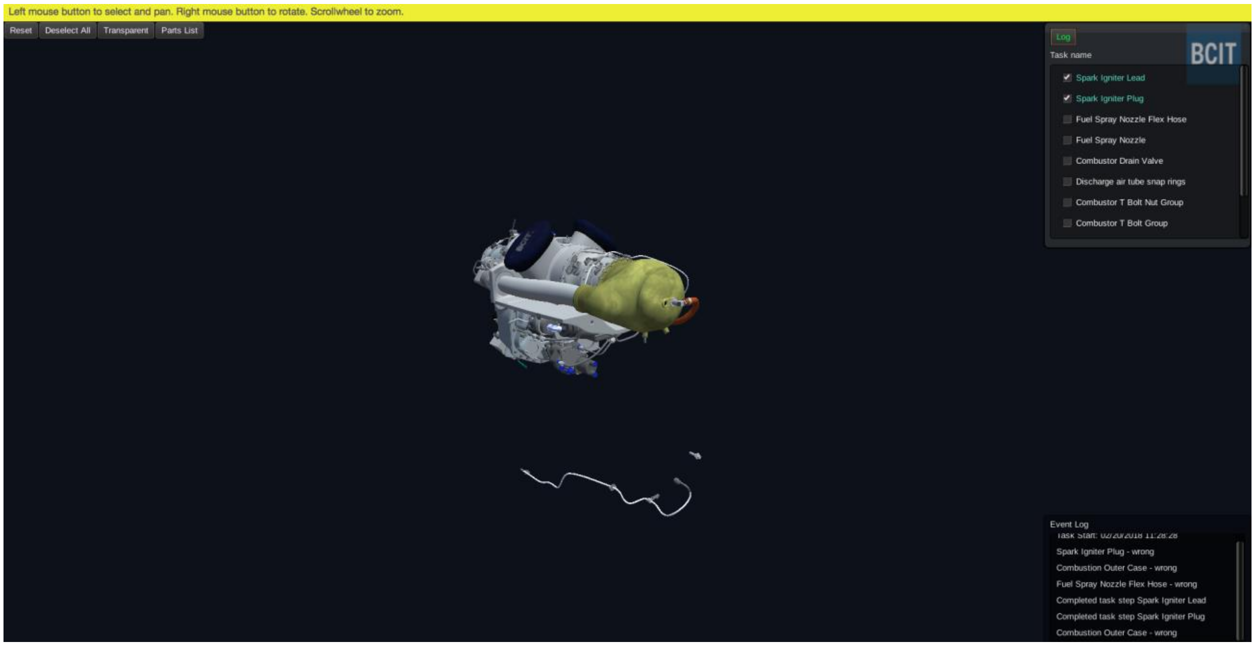


Figure 3 RR250 engine in model viewer browser app set up for disassembly task

Figure 4 Hyundai engine in current version of model viewer web app set up for Intake Manifold Disassembly Task

Looking forward, the application was built to be adaptable for deployment on other platforms, including virtual reality systems, like the HoloLens.

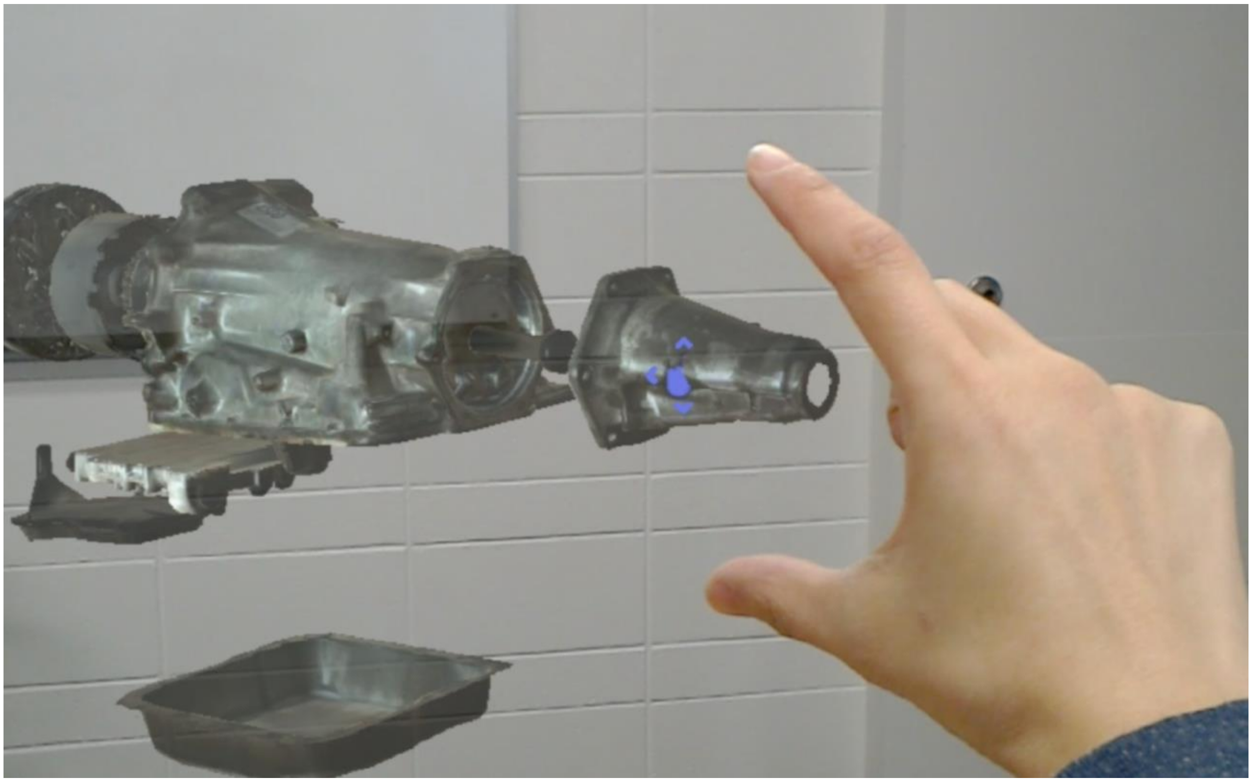


Figure 5 Test model viewer Hololens deployment

As shown, beyond creating an interactive 3D Hyundai Engine, the workflow and tools developed in the process will now allow us to scale up production for other parts and platforms.

Describe the contribution made to education/training:

Three-dimensional virtual learning tools allow for the creation of powerful learning spaces for students. These tools allow instructors to create immersive learning experiences where students interact with content in a meaningful and authentic way that closely simulates “real-world” application. This interactive technology revolutionizes the way students learn and increases student engagement.

In this specific application, students acquire the vocabulary and learn the order of operation for disassembly and reassembly of an engine at the computer display. As they practice, there is no real-world penalty for mistakes and no cost associated with broken parts. Any attempts to reposition parts in a flawed sequence provides instantaneous feedback that a specific operation cannot be performed, allowing for remediation of learning as students interact with the tool in a simulated real-world environment. Students are able to repeat and practice at times and locations convenient to them until they master their skills and knowledge. Once they are familiar with disassembly and reassembly, the students move onto the real engine. At this time, students are well versed with the parts and sequencing of the task they must perform while learning in a safe environment.

Students appreciate the virtual setting and prefer it as many have played computer games with similar characteristics. They learn the correct terminology as listed in the manufacturer's manual and this helps them learn communication for service reports and customer interaction.

Learning outcomes and the effectiveness of learning improve as a result of using 3D virtual learning tools. As learners cue on visual, auditory and special elements in 3D environments, they demonstrate better application of learning. They can practice on-the-job behaviours in realistic learning contexts, as close to the real job environment as possible.

As part of this specific project, we were able to create a technical framework that will allow for the integration of this technology in other learning activities. We can now scale this initiative up to deploy additional 3D learning environments in other classes, to teach other engines and parts, create better learning experiences for students and facilitate innovative teaching practices for instructors.

Describe the realized or anticipated benefits resulting from the project or initiative

There are multiple anticipated benefits of this project for aspiring automotive service technicians. Using this technology, students may use a HoloLens projection rather than a flat screen and assemble or disassemble mechanical assemblies; currently the transmission is completed; other assemblies will follow in the near future.

Students appreciate the virtualized setting and prefer it as many have played computer games with similar characteristics. They learn the correct terminology as listed in the manufacturer's manual and this helps them learn communication for service reports and customer interaction. Learning outcomes and the effectiveness of learning improve as a result.

Current vehicle power plants (engines) are complex with many innovation and engineering features. Students who find working from the manufacturer's manual a slow and tedious process find it much more accessible to have a HoloLens assembly to practice on or as a reference. Specific exercises are in development, which will allow students to practice common maintenance procedures. This learning methodology significantly reduces the likelihood that a student servicing an assembly or component will remove parts unnecessarily or drop parts resulting in damage.

Additionally, students with English as a second language may have difficulties in understanding a manual or lecture, resulting in sub-optimal learning outcomes. The augmented reality projection appeals to the kinesthetic leaner and results in improved engagement.

The virtual learning model will definitely enhance hands-on activities. Faculty confirm that students who prepared using the 3D tools are appropriately prepared to work on an actual engine more quickly when compared with students who prepared only with lectures and manuals as learning tools. When a faculty champion demonstrated and asked a group of 2nd year apprentices what they thought about using a 3D 'augmented' reality presentation, they were enthusiastic and asked: "Why didn't we have this earlier?"

In addition to building student proficiency, the 3D augmented reality tool supports student interaction giving learners plenty of opportunity to work as a focused team and interact with their peers in a satisfying learning environment. As a result of the development of this technology and incorporating it into the classroom, graduates will become even better technicians working in the transportation (automotive) trade.

Describe the value of the project or initiative to the Canadian transportation community

The virtual training environment will result in better-trained technicians who perform both diagnostics and repairs more quickly and with far fewer errors. This results in lower maintenance costs and better performing vehicles, ships, planes and trains with less down time.

Service reports are likely to be more accurate and thorough, improving interaction with clients and manufacturers.

Although this is a young project, industry is showing interest in it. The local Hyundai dealer wants to use our technology now so that their Automotive Service Technicians can perform diagnosis more quickly.

As more examples are developed, the potential impact as more examples are developed is staggering. Imagine a service technician repairing a complex wiring harness no longer needs to interpret a manual or remove a good harness from a finished vehicle. It will be possible to see a perfect sample in the HoloLens while working on the diagnosis and repair. This makes it easy to determine the correct terminations. The job will be performed faster and with fewer defects and more timely and accurate service reports due to fewer distractions and false starts. This can even impact warranty claims.

Another potential example occurs when a sensor reports a defect on given component. The Component is not obvious or visible to the naked eye. It is internal somewhere. The service technician can use the HoloLens image to highlight exactly where component xyz is located, resulting in significant time savings.

Simulation has been available for pilots, drivers and mariners for some time. This project is focused on augmented and mixed reality to enhance the training, diagnostics and work performance for technicians in the rapidly evolving world of transportation.