Proceedings of the 2024 Winter Simulation Conference
H. Lam, E. Azar, D. Batur, S. Gao, W. Xie, S. R. Hunter, and M. D. Rossetti, eds.

UNIVERSAL VIRTUAL ATTRACTION CONTROLS EMULATION

Howard Mall[1], Wanyea Barbel[1], Jason Heinritz[1], Angelica Samsoe[1], and Christopher Welch[1]

[1]Universal Destinations and Experiences, Universal Creative, Advanced Technology Initiatives, Orlando, FL, USA

ABSTRACT

Control systems for theme park attractions are increasingly complex integrations of hardware and software. Opening dates for theme park attractions don't move which leads to compressed commissioning schedules. Virtual Attraction Controls Emulation (VACE) is the platform Universal Creative uses to push the schedule back in time and reduce risk, effort, and costs in the field for all Universal parks in the Universal Destination and Experiences (UDX) portfolio. VACE enables virtual commissioning and the application of Test Driven Development (TDD) principles to industrial software. This platform enables real-time simulation of ride performance, emulation of the ride components, and automated testing as a stand-in for the actual ride. Significant parts of the control system can be tested even before ground is broken for construction. Its successful application to recently opened roller coasters and dark rides will be presented showing the architecture, integration with commercial industrial programming environments, challenges, and measures of success.

1 PROBLEM

Things happen. Plans go awry. Opening dates are rock solid. How do we make more time? Universal Creative is the division of Universal Destinations and Experiences (UDX) responsible for delivering new rides and attractions. At Universal Creative, a virtual attraction stands in for the actual attraction before it is built to allow the controls system to be tested ahead of time. This addresses a variety of problems that might arise:

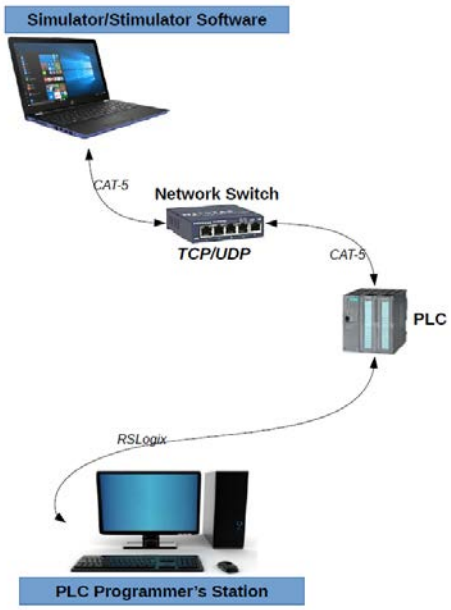

Figure 1: *VACE Architecture.*

- Validating that the design of the algorithms and layout of equipment will be able to perform the functions expected of the control system.
- Assuring that the software in the control system does not contain errors (i.e. bugs) that will cause the system to perform improperly or not run at all.
- Pre-running tests that will be performed in-field to assure that they are correct and appropriate to the desired validation outcome.
- Saving time in the field by testing the software on the virtual (i.e. second) track instead of in the field thus allowing the commissioning team to address other issues such as physical problems
- Improving software quality by fully testing the controls system in an automated way as changes are made

2 METHODS

To create a virtual attraction we connect the control system through network protocols to a software that emulates the behaviors and signals of the attraction. Looking at Figure 1, the control system software is run on a Programmable Logic Controller (PLC). A PLC is a ruggedized industrial computer that runs software typically in a visual programming language akin to circuit diagrams called ladder logic. In Figure 1, you can see that the PLC is connected to a computer that is running the virtual attraction software and allows the developers to connect to the PLC using the Integrated Development Environment (IDE) for the PLC platform (e.g. Rockwell, Siemens, Beckhoff, etc.). Of late, many of the PLC platform companies provide simulated PLC's specifically to support virtual commissioning. This changes the structure of our test environment from a hardware-in-the-loop to a software-in-the-loop configuration.

Our virtual attraction models are developed using the Unity 3D game engine. A game engine offers real-time performance for communication, an easy component-based development and debugging environment, a physics engine, and an easy way to represent the geometric relationships between elements of the attraction. The game engine emulates all of the sensors, motors, and other pieces of equipment. The state of the ride is communicated to the control system every frame of execution.

Other elements of the control system are also emulated including all the control panels, integration with the Human Machine Interface (HMI, a user interface for automation controls), and any data collection systems (see Figure 2). This allows a user to operate the attraction the same as if it were communicating with actual hardware. Those users can conduct informal and formal testing on the system to assure that the control system will perform as expected. It acts just as if it were communicating with the real attraction.

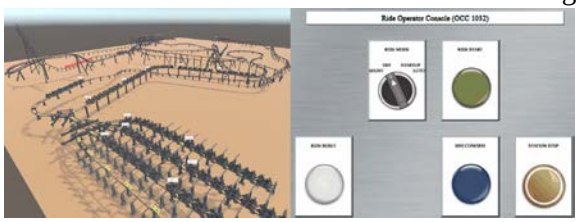

Figure 2: *Screenshot of VACE platform.*

3 RESULTS

The ability to model and emulate our attractions before they are built has resulted in controls software being delivered early. The quality of software has been installed in the field with less issues and with more complete features. The system has provided a venue for on-boarding commissioning engineers to the operation and testing of the ride before they are to go in-field. An automated testing system has been implemented on this platform to allow for rapid verification and re-verification. The quality of the tests to be run on the actual attraction have also improved as issues or problems with the tests are found earlier. Achieving optimal attraction performance occurs with less time and earlier than scheduled. After opening of the attraction, the VACE platform is being employed to optimize the attraction with the least impact to its operation.

4 BENEFITS

The major benefits of the Virtual Attraction Controls Emulation (VACE) program can be measured in quality, time, and money. The VACE model Controls code can be verified during development achieving a higher quality software. Because the development and testing can be completed without the actual attraction it can be done earlier in the schedule resulting in more complete controls software. With better training of personnel and the ability to complete a significant number of tasks on the emulator, there is less time spent in-field and thus less cost. Bugs squashed early are less expensive than bugs squashed later. Also, because the attraction can be opened with less problems, the amount of guests who can ride is closer to optimal on the first day which has a huge impact on revenue.

Finally, the intangible impact of this platform is the increasing number of extended applications that are now being explored. Current initiatives include the formal training of operators and technical staff to handle "black swan" events, the exploration of synthetic data generation to aid in developing data analysis models, the verification of creative show elements in concert with the ride elements of the attraction, and the ability to collect real-world data from the ride and pass it through the model to create an on-line and off-line digital twin.