# Infrastructure Support for the UCF Driving Simulator

## Final Report

UCF Contract 16-21-724


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16. Abstract

Last year, a proposal was funded to maintain the infrastructure of the UCF Driving Simulator Lab. It was designed to guarantee the long-term presence of support staff with the proper expertise to maintain the operational effectiveness of the driving simulator. Furthermore, the money was used to pay for acquisition of computer hardware and software, maintenance contracts and software licenses, and replacement of malfunctioning equipment.

This proposal requests funding for continued employment of the undergraduate and graduate students and a technician to support further improvements to the UCF Driving Simulator Lab. Additional funding is requested to acquire the necessary hardware and software for a new state of the art driving simulator which will be located in the new Engineering building on the UCF campus.

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Infrastructure support for the UCF Driving Simulator is provided by the engineering students who perform various tasks designed to maintain its state of operational readiness and improve its overall performance as a testbed for traffic and transportation related issues. The students' contributions to this effort over the last year are described in this report.

## Dan Kenney, Computer Engineering PhD Student

Dan's duties fall into 2 categories – simulation improvement and coordination of activities. In the last year the driving simulator has been improved in several ways. The primary purpose of the changes was to improve the reliability of the simulator. The braking, wiring, lab layout, and data acquisition method were all improved.

The car's braking system was improved by installing a new pressure transducer for increased sensitivity. Additionally, a vacuum pump was used to actuate the power braking.

The car's wiring was reorganized and documented. Cables were routed through the ceiling to avoid a potential tripping hazard within the lab. The simulation control room was rearranged to maximize desk space as well as aisle clearance. The ONYX, our graphics generator, was positioned for better cooling by the lab's air conditioning.

The layout of the lab has been improved tremendously. Due to the coordinated efforts of all the lab personnel we've been able to eliminate clutter and tight workspaces. This not only helps our own productivity but it also makes it easier to demonstrate the simulator to groups. The purchase of professional tools, a ladder, shelving and other items have alleviated clutter and improved safety.

Previously the simulator used local analog to digital converters on the ONYX computer to acquire the user inputs. Now a remote data acquisition system captures the analog inputs at the car and sends data packets to the simulation. A PC is used to handshake and verifies the data before it is sent to the primary simulation computer, the ONYX.

## Vaibhav V. Joshi, Computer Engineering MS student

Mr. Joshi has been responsible for the following activities:

- Replacing the existing data acquisition scheme with a new locally mounted, reliable I/O system (hardware) with complete rewiring under the car hood
  .
- Developing new software to communicate with the new I/O system for reading and writing input and outputs. The software performs the following tasks:

1. A data acquisition protocol for the Wago I/O device (with the help of the device driver dll from Wintech Software) to read and write I/O from and to the device

2. Acts as a server for the SGI Onyx, which runs the vehicle dynamics model. A dedicated socket is established for this purpose.
3. Provides user interface with system status indication and other diagnostics for the I/O system

- Vendor selection for purchasing equipment for upgrading and repair of the simulator.

  The following equipment was purchased for the lab:

1. Input sensors and transducers: New Brake sensor with piping and mechanical assembly, DC drive for motor for steering wheel torque feedback, Reed switches on steering wheel.
2. Wago I/O system consisting of Wago I/O system with I/O cards, ethernet module and backup I/O modules, power supplies (with backup)
3. Soldering station and full set of wiring tools
4. Testing equipment - digital storage oscilloscope, digital multimeter, lab tools and supplies.
5. Barco projector voltage tripler with backup.
6. Software modules and firmware (Wintech DLL)

## Chris Hellkamp, Computer Science Undergraduate Student

Chris's primary job is to build and maintain the three-dimensional computer models used in the simulation databases. He also catalogs and maintains important documents.

Over the last year, Chris has created several three-dimensional computer drawings, stored in the form of .FLT files, JPEGs and RGBs, for both of the primary simulation databases. One of these databases is a representation of the University of Central Florida campus. He has created copies of the Administration building, Chemistry building, and Library for this database. He is currently working on replicating the network of roads within the university

The other database is used for testing intelligent traffic generation algorithms. This database consists primarily of computer models of non-campus buildings in order to give the simulator driver an impression of town or suburban driving. Chris has produced computer models of a local Dunkin' Donuts, 7-11, K-mart, and a new Home Depot to add to the illusion of suburban driving. Several of Chris' s models are shown in Figures 1- 4.

In addition to building components of the visual portion of our databases, a significant portion of his duties is to maintain them. Previously, there was no uniform way of organizing the files that previous modelers had created. Different files existed in different directories and had unique access rights. During the last quarter of 2000, Chris reorganized the graphics files associated with both databases into a single logical hierarchy. As a result, the visual database is more predictable and reliable.

Additionally, the lab acquires many paper records such as invoices, receipts, and software licenses. Chris implemented and currently administers a new filing system to limit the time lab workers need to spend finding old purchase orders, licenses, invoices, or other important documents.

**Figure 1**: CREOL Building on the UCF Campus


**Figure 2**: Scene from Visual Database

**Figure 3:** Scene from Visual Database

**Figure 4**: Scene from Visual Database

## Jon Rager, Computer Engineering Undergraduate Student

John was hired in the Fall as a Network Administrator. He has set up a fileserver for our lab with permissions for each user to ensure secure access to files.

He has established a map (Figure 5) of the structure of the internal network in the simulator lab. He is responsible for troubleshooting of the computers, making computers run at peak performance, reloading operating systems when needed, and informing lab personnel of the latest computer-related technology. John is responsible for running backups of important computer files in the lab. John is also becoming proficient with the 3D modeling program MultiGen II for the SGI ONYX simulation host computer.

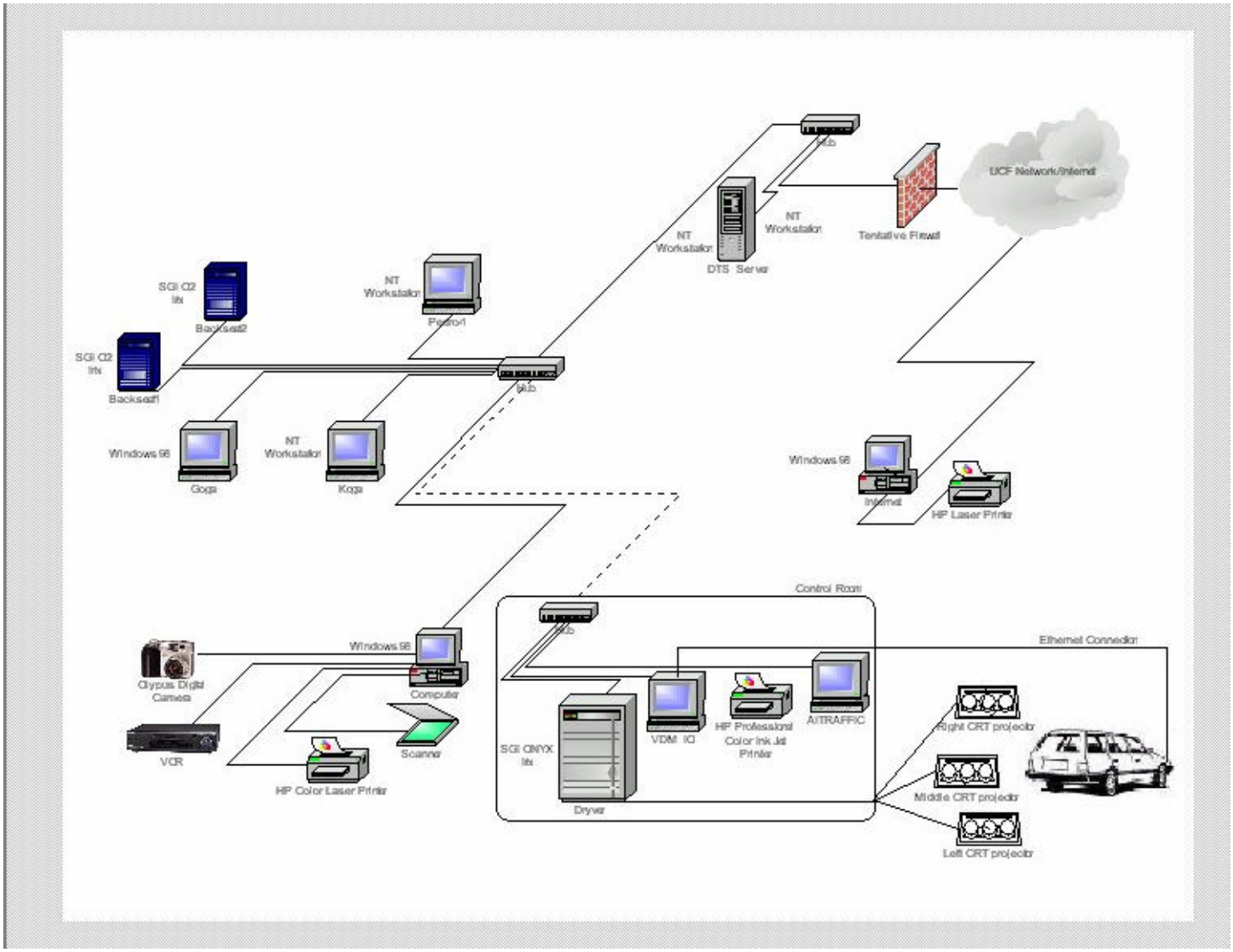


**Figure 5:** Simulator Lab Computer Network

There were several meetings with Lockheed Martin(LM) representatives to discuss the functional requirements of a driving simulator destined for the new engineering building simulation laboratory. An initial set of specs has been forwarded to LM for their engineers to evaluate. These are listed below.

# UCF Driving Simulator Requirements

## Hardware

| | |
|---|---|
| Vehicle Cab | Interchangeable cabs for compact car, truck or bus operator stations. |
| Host Computer | PC/Linux cluster and modular configuration for ease of upgrade. |
| Visual System | Minimums: Sustained frame rate of 30 Hz, 180 degrees horizontal and 40 degrees vertical field of view, 6 channels with resolution appropriate to road signs and marking studies as well as generic driver training applications. |
| Audio System | Capable of replicating own-vehicle and surrounding traffic/environmental sounds. |
| Motion System | Electric 6 degree of freedom platform, minimum 1000 kg load capacity. |
| Display | Integrated with motion platform. Projectors and screens or flat panel displays as cost effective. |
| Instrumentation | Vendor to supply interfacing to cab control sensors, instrument panel operation and control loading. |

## Software

| | |
|---|---|
| Operating System | Real-time Linux. |
| Vehicle Dynamics | Models shall be furnished with source code for baseline truck, passenger car and bus. Feedback from the visual data base to the dynamics model, e.g., road surfaces and hills and curves should be shown visually and reflected in the vehicle motion computations. |
| Intelligent Traffic | Models shall be furnished with source code for controlling traffic environment surrounding the simulator vehicle. |
| Scenario Generation | Capability for rapidly loading of appropriate data base with associated environmental and traffic performance characteristics. |
| Data Logging | Recording capability for session playback and analysis to include driver's eye and overhead views. |
| Collision Detection | Software capable of detecting simulator vehicle collisions with moving and stationary objects. |