

Final Report  
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“Computer Controlled Scenery: Industrial Networking Applications  
for Scenery Automation”

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Project Activities

The scope of this research project included several segments: assemble two stage winches with off-the-shelf industrial automation components, test the application of these components for stage scenery positioning, test the use of positioning encoders and limit switches, and examine the application of networking communications of programmable logic controllers (PLCs) for scenery automation.

I have constructed, from scratch, two stage winches. A local vendor, Northern Electrical Company, Inc., and a national automation vendor, Automation Direct.com, were able to provide educational pricing for many components involved in the project. An AC electric motor, gearbox, and output shaft were installed into two custom built winch frames to create two self-contained portable stage winches. A control enclosure was created for each winch, consisting of a Safetronics PC10 Mini-vector drive, 24VDC power supply, a DL05 Programmable Logic Controller, and assorted wiring hardware. The AC Mini-vector drives control parameters critical to the winch including speed, direction, torque, and transition frequency for the motors. A programmable logic controller (PLC) was connected to each motor drive. The PLC carries out instructions that give the motor drives commands that in turn produce operating conditions for the AC motor drive to carry out. For example, one set of commands from the PLC might tell the motor drive to turn the motor in a forward direction, for a specified speed, and for a specified amount of time. Then, with the flip of a switch, the PLC will send entirely different commands for a different motor speed, direction, etc. These presets represent “cues” for stage performances, and allow safe and consistent recreation of scenic movements while eliminating inaccuracies associated with traditional “human-powered” scenery movements. Ultimately, this programmable operation translates into precise artistic capabilities for moving stage wagons, turntables, and other similar scenery items that was previously unavailable at such a low cost.

Project Findings

The time needed to learn encoder data collection and manipulation inside of PLC programming logic was drastically underestimated. Once the initial learning curve for programming was overcome, the application of encoders and simple feedback systems such as limit switches, magnetic proximity switches, and photoelectric sensors for positioning was accomplished. The

use of two stage winches allowed for very precise side-by-side positioning comparisons in the scenery laboratory. Eventually, the programming code for encoder data collection needs to be simplified with subroutines. More efficient code is necessary to eliminate time delays associated with the current programming that, among other issues, creates a large safety concern. This will be best accomplished when the winches are incorporated into realized stage productions.

The use of industrial networking in this project was preliminary. As a result of unfortunate timing, a great many advances – and price decreases - were released into the industrial networking market during the 12 months of this research project. These advances use isolated Ethernet networks to greatly speed up communications, reduce delays inherent in RS232 protocols, and reduce the overall cost of industrial networks. I anticipate continuing this project by acquiring a laptop or mobile PC computer to facilitate programming and on-stage system monitoring. Also, the addition of an isolated industrial ethernet network will replace the RS232 protocol that has very recently experienced wide-spread disapproval among industrial automation experts because of network vulnerabilities inherent in the RS232 standard.

Each winch in this project can be easily customized for a wide range of production applications. This technology will be applied to future stage productions in the Theatre and Dance Area on campus. Also, access to the equipment used in this project is given to advanced scenery technology students through the scenery laboratory and independent study. A course, Stagecraft II, which is typically offered every three years, will make extensive use of the stage winch equipment as part of course projects.