

# ASEE-ETD Mini-Grant Project Final Report

## Project

Cost-Effective Upgrade to Instrumentation and Controls Laboratory

## Project Director

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## Description

This project explored the design, fabrication, and integration of relatively low-cost PLC-based laboratory equipment for the automation and control courses offered by LeTourneau University's Engineering Technology Department.

## Accomplishments

The following project milestones were completed:

- Six free-standing PLC training units were designed and fabricated by the Project Director, students in class, and paid student workers. Each unit contains a Siemens S7-1215C PLC, power supply, and various indicators and controls of the type used in industry. Also included are provisions for system expansion through cable connections to other hardware assemblies.
- Six relay logic board assemblies were designed and built using DIN rail-mounted relays interconnected to form simple, hardwired combinational logic circuits. The relay boards were cable-connected to the indicators and controls on the PLC training unit (with PLC disconnected) and provided students with foundational knowledge of pre-PLC relay ladder logic.
- Siemens TIA Portal STEP 7 PLC programming software was installed on each lab PC and the license keys were installed on the campus LAN license server.
- Ethernet jacks were activated in the PLC lab to provide connection points for each PLC.
- Six scale model conveyor belt assemblies were designed and fabricated. Each contains a belt drive motor, a reject arm motor, several proximity sensors, operator pushbuttons, and indicator LEDs. Provisions were included for cable-connection to each PLC training unit for PLC control.
- Development was begun on a prototype floating-ball-in-tube assembly with three-phase blower, VFD, and ultrasonic ball height sensor. A distance sensor was configured to

detect height of ball in clear, vertical tube as input to PID loop for controlling motor speed.

### **Outcomes Realized**

- At the end of this project, six complete RLL racks, six PLC training units, and six conveyor belt assemblies were designed and built to support a variety of PLC experiments.
- Students found the fabrication and experimentation with the new laboratory hardware to be a positive experience.
- Students successfully learned PLC programming through the use of this new hardware.
- Various project-related photographs and video recordings are available at <https://tinyurl.com/PLC-Photos>.
- Design files and laboratory experiment examples are available upon request.
- Overall, this project was a success due to the support of ASEE-ETD and other sponsors.

### **Project Budget**

Details of the project expenses and funding are shown in Table 1 and Table 2, respectively.

*Table 1: Project Expenses*

<b>Fund Source</b>	<b>Amount</b>
ASEE Mini-Grant	\$1,300
Donor	\$5,000
LeTourneau University	\$4,043
<b>Total:</b>	<b>\$10,343</b>

*Table 2: Project Funding*

<b>Unit</b>	<b>Item</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Main PLC Rack (qty 6)	Siemens 1215C PLC, KTP700 HMI, and S7-TIA software license	\$0*	\$0*
	Controls and indicators for PLC rack	\$0*	\$0*
	Aluminum extrusions, power supply, fasteners, wiring, and other electrical/electronic items	\$1,077	\$6,462
	Lab network jack installation and activation	\$150	\$900
Relay Logic Rack (6)	Relays, DIN rail, connector, cable, and miscellaneous hardware	\$65	\$390
Conveyor Belt (6)	Pulleys, motors, aluminum enclosure, fasteners, sensors, wiring, and other electrical/electronic items	\$356	\$2,136
PID Floating Ball-in-tube (1)	Three-phase blower, VFD, enclosure, miscellaneous hardware, fasteners, sensor, and wiring	\$455	\$455
* - \$0 means item was donated		<b>Total:</b>	<b>\$10,343</b>