

Simulating Test Conditions on an Aircraft Heat Exchanger

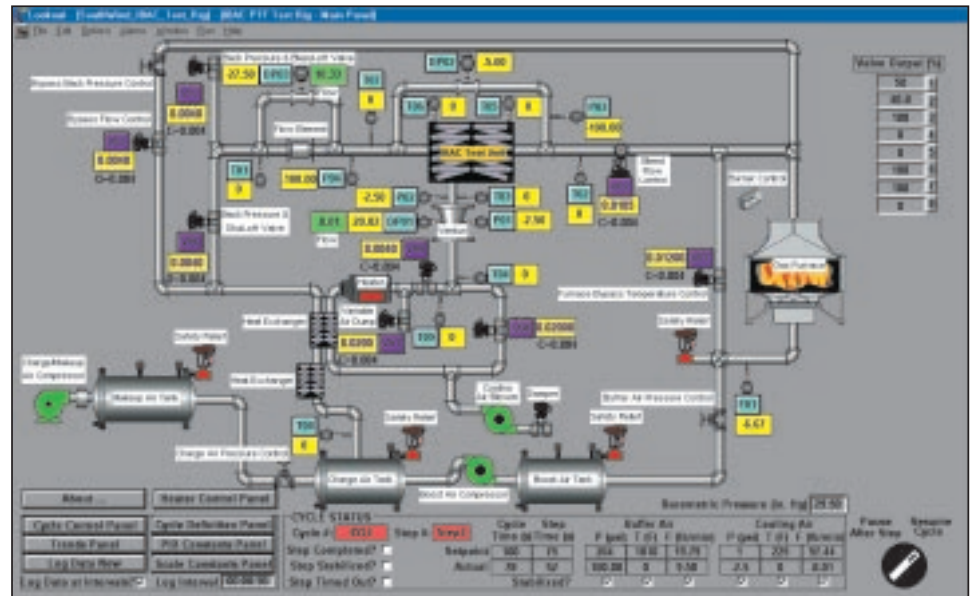
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The Challenge: Simulating test conditions on an aircraft heat exchanger to accurately measure cycle flow, temperature, and pressure according to a user-specified test recipe.

The Solution: Employing Lookout and FieldPoint modules, VI Engineering, Inc., developed a test system that simultaneously manipulates eight valves, utilizing several PID loops to modulate the temperatures, pressures, and flow rates according to the test recipe.

PID Control of Six Interdependent Variables Executing 35,000 Times

A customer asked our company, VI Engineering, Inc., a Select Integrator in the NI Alliance Program, to develop a control system for an aircraft heat exchanger test system. As part of the design validation process, we expose the test unit to conditions experienced during a flight. We adjust the temperatures, pressures, and flow rates of hot and cold airflows using valves, an electric heater, a furnace, and compressors. Using Lookout, we developed a test system that provided PID control of the eight valves regulating hot air (also called “buffer air”) and cold air flow. We specify temperatures, pressures, and flow rates at various times, thus defining a “recipe” describing a complete cycle. The system then executes the cycle repeatedly and logs data to the Citadel database as well as to a Microsoft Excel file. The system updates the main GUI with the latest input and output values. The trend charts communicate directly with the Citadel database and run parallel with the test system. Each test executes a recipe 35,000 times. A test that performs PID control using six interdependent variables would tax any system for a day. Our customer needs a system that could perform precise temperature, pressure, and flow control for several days, as well as log data to a database and provide



Main User Interface of the Heat Exchanger Test System

feedback to the user during execution. Lookout proved up to the task.

Lookout designs an intuitive user interface for a real-world system. With the software’s security features, we easily limit access of control actions to authorized users. This allows access control such that only authorized users perform certain actions, such as pressing buttons and changing set-points.

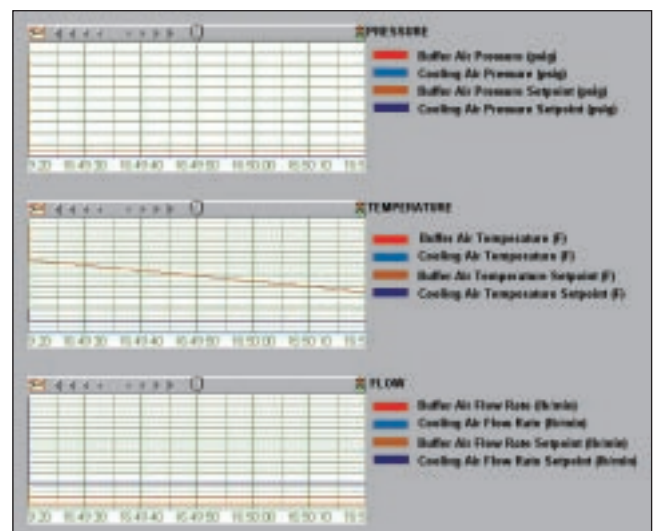
Lookout users can create or edit objects on the fly without stopping test execution – a very useful feature.

Because bringing the system to the correct temperature and pressure after each start-up takes 30 minutes, shutting down the system for software changes would make the development and testing process excruciatingly slow.

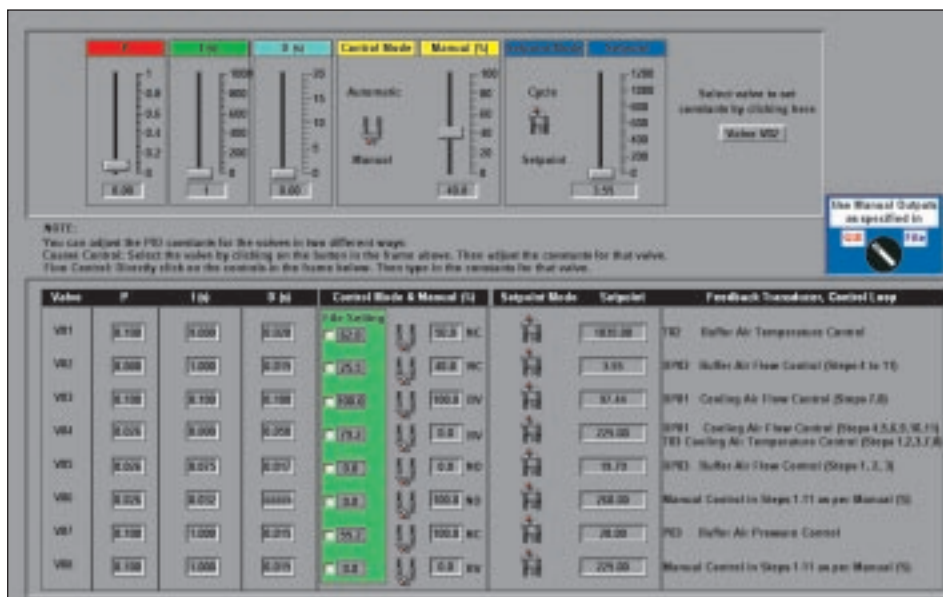
Lookout Provides Improved Access and Control

Interference between various control valves created challenges during system testing. We initially assumed that each valve would control one process

variable – for example, V07 would control only buffer air pressure – but the process variables related according to the laws of physics of gas flows. The different time constants for each process variable create another challenge. For example, pressures and flow rates change more quickly than temperature. This causes instability problems during PID control. Because of this, we set the role of each control valve to vary during the test cycle. For example, valve V04 controls



The Trends Panel displays data for up to one year.



With Lookout, users have complete control over the test execution.

cooling air flow in steps 4-6 and 9-11, and then cooling air temperature in steps 1-3 and 7-8. The new control scheme also stages and directly controls (non-PID control) the valves during set-point changes, and then switches to PID control of the valves after

Although the system presented many challenges and a few surprises, we achieved successful development and testing of the control software with Lookout.

the error between set-points and process variables minimize. In other words, flows, temperatures, and pressures are not the only variables. The valves themselves also play a part in the control scheme.

With Lookout, users can tune the PID loops with considerable access, and have

complete control over the test execution. The DataTable object linked to the selected valves PID parameters with the control mode, and we set a valve to PID or direct control. With another Lookout feature, we import direct control settings of valves from a file, and also ramp set-points (PID) or manual outputs (direct). With the set-point mode, we can control set points of the cycle while under PID control. Under normal test conditions, the system operates in cycle control, with the system

following the recipe defined by the user. In set-point mode, a user interactively changes set-points, providing override control of set-points defined in the recipe at any point within the test cycle.

Although the system presented many challenges and a few surprises, we achieved

successful development and testing of the control software with Lookout. Amazingly, the software developed for the system easily fits on a standard 1.44 MB diskette. ■

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