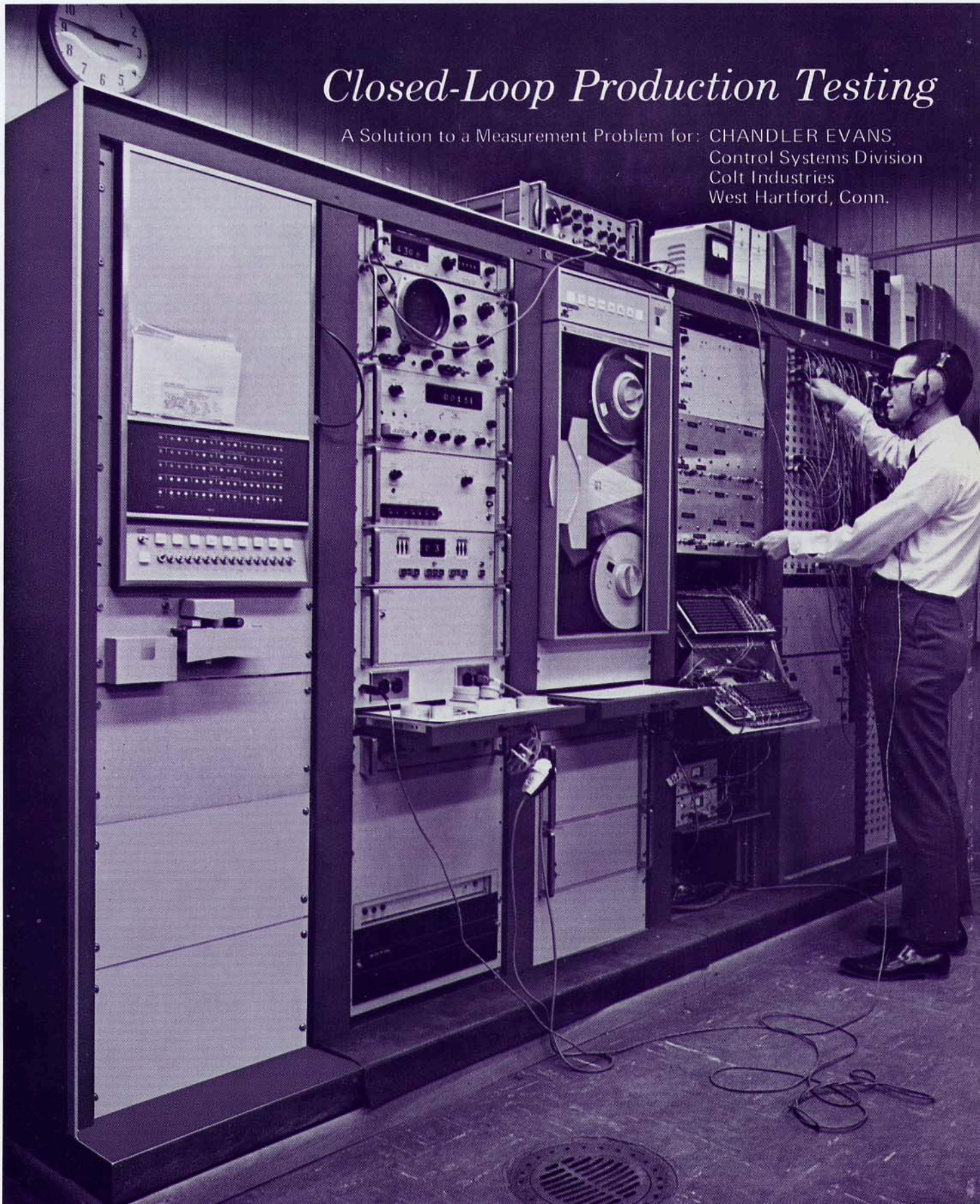
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APPLICATIONS OF COMPUTERIZED DIGITAL DATA ACQUISITION SYSTEMS

Closed-Loop Production Testing

A Solution to a Measurement Problem for: CHANDLER EVANS
Control Systems Division
Colt Industries
West Hartford, Conn.



THE APPLICATION

The Chandler Evans Control Systems Division of Colt Industries in West Hartford, Connecticut designs, develops, and produces control equipment of high reliability and performance for aircraft and missiles. Among these are main fuel pumps, main fuel regulators, fuel pressure control valves, stopcocks, emergency fuel controls, electrohydraulic systems, and aircraft and missile control components.

THE MEASUREMENT PROBLEM

At Chandler Evans product quality control and reliability are an important part of each project, with considerable effort devoted to the final testing of control systems. Manually testing control systems under various operating conditions (pressure, flow, etc.) involves plotting families of curves while an operator "jockeys" interdependent adjustments in an attempt to keep certain variables constant. Thus, the reliability and repeatability of the results are heavily dependent upon the skill of the operator. The problem facing Chandler Evans was: *How to acquire the test data faster and more accurately and at the same time improve repeatability of tests.*

THE SOLUTION

Chandler Evans found the answer to their measurement problem in the system shown in the block diagram. It consists of standard HP systems-oriented instruments and computer interfaces plus customer-furnished input patch panels which allow the system to be interconnected to a number of test stands. Output data from control system tests are reduced and available in tabular printout and graphic plot in final form. Repeatability of tests carried out with the HP computer system has proved to be much higher than with manual tests. The measurement system initially installed proved to be so successful that it was expanded (by increasing the core memory to 16K and adding the disc memory) to permit simultaneous measurement and control of multiple test stations, through addition of the HP real time executive (RTE) operating system.

SYSTEM OPERATION

The data acquisition system is located in a room about 200 feet from the engineering test lab. Signal and control connections from the system are routed to test stations located at various points in the lab. The test stations interface the system to test stands located in the lab. The test stands simulate (and exceed) normal operating conditions for the control system under test. Interconnections between the system and the particular test points to be monitored or controlled are made on two patch panels on the front of the system cabinet.

COVER:
Computerized Data Acquisition System for Closed-Loop Testing of Control Systems

The system measures *temperatures, pressures, flows, rotational speeds, torques, displacements* (measuring resistance of shaft-mounted potentiometers), and *voltages* (e.g., checking voltage applied to a solenoid). Typically, temperature inputs are in the order of millivolts, pressure and torque inputs are in the range 0 to 5 volts, and flows are in the range 50 to 1500 Hz.

For differential pressure measurements, Chandler Evans found it best to use two separate, single-ended transducers, and let the computer calculate the difference or ratio. Also, with the computer in the system it is possible to use pressure transducers which are non-linear but have *good repeatability,* and obtain excellent accuracy by applying corrections from a least-squares curve fit. To obtain the desired accuracy, the curve fit is segmented for areas of extreme non-linearity.

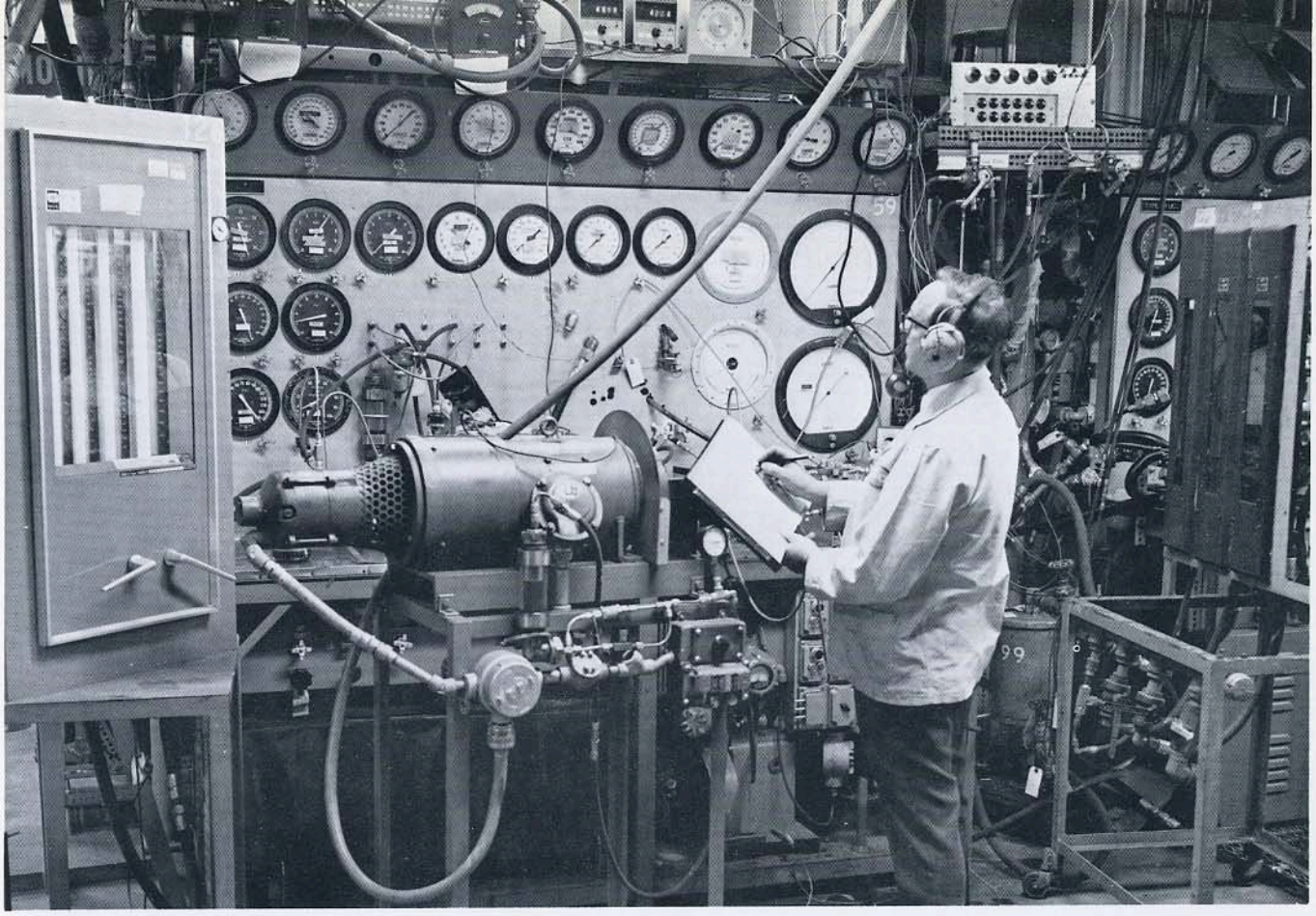
The system operates in *closed-loop* mode, programming as well as monitoring variables such as motor speed, fuel flow, pressures, and temperatures. Control signals are generated using a 16-bit duplex register. The digital output drives precision potentiometers, from which analog voltages are derived to activate the drive motor speed control. In addition, the stepping motors are used to position various control valves.

All data are recorded on magnetic tape, in 7-channel format. Most reduction (units conversion, linearization, etc.) is performed on-line. (For thermocouple linearizing, both equations and table look-up are used.) Subsequently, test results are plotted in the form desired, and also printed out in report form on the teleprinter complete with headings, page advance, and page numbering (using a program written in-house for this purpose).

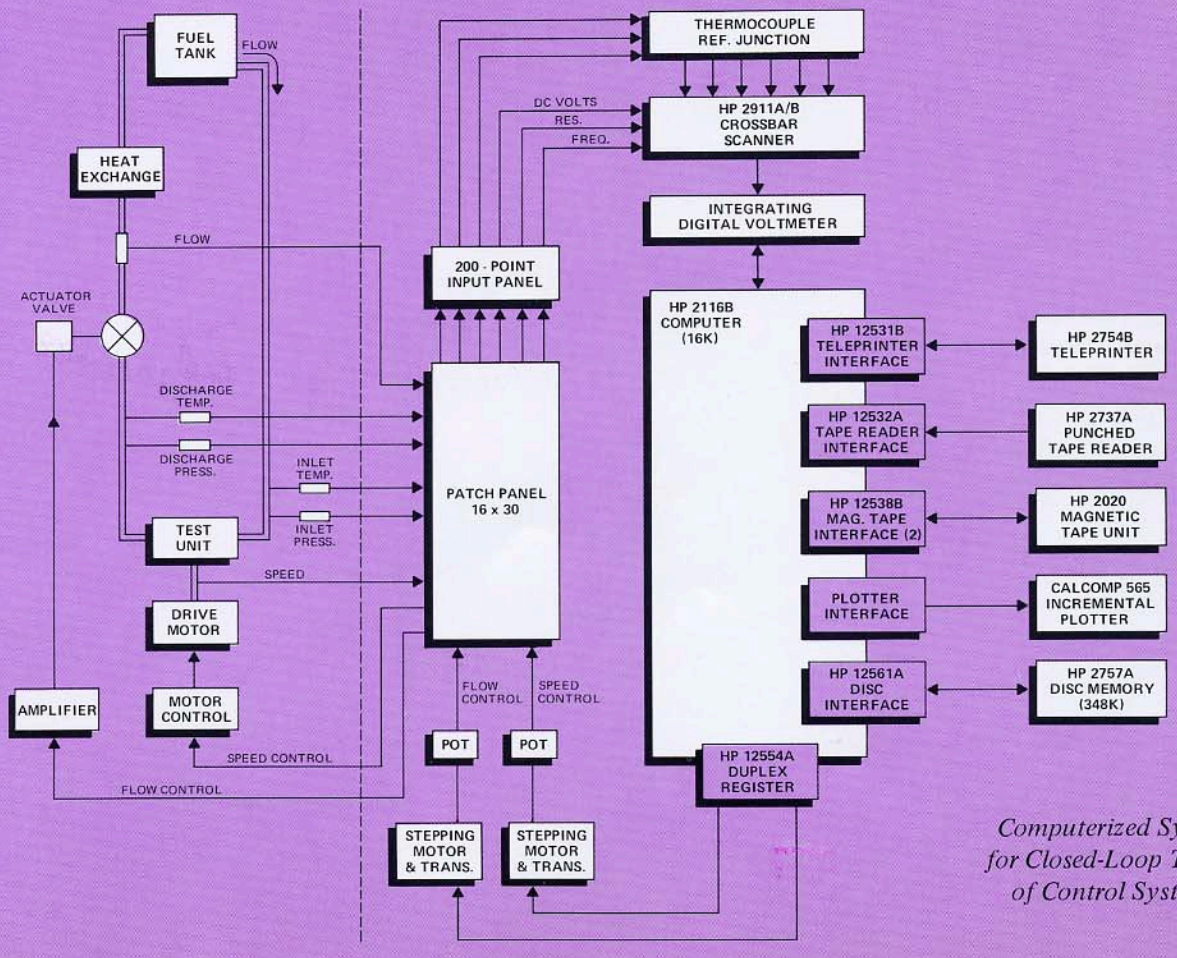
Besides short-term tests involving continuous monitoring and control, the system is used for periodic monitoring of long-term endurance tests. The data acquisition system measures a set of test parameters at predetermined time intervals, and records data only after assuring all variables have stabilized. In addition, the computer is programmed to shut off the test equipment if predetermined limits are exceeded (either too high or too low).

BENEFIT OF COMPUTERIZED DATA ACQUISITION

The HP computer system has greatly alleviated the necessity for constant operator intervention and at the same time has improved repeatability of test results.



Test Stand for Control Systems Testing (Intercommunication Gear Worn by Technician Aids in Initial Test Set-up)



Computerized System for Closed-Loop Testing of Control Systems



For more information, call your local HP Sales Office or East (201) 265-5000 • Midwest (312) 677-0400 • South (404) 436-6181
West (213) 877-1282. Or, write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94303. In Europe, 1217 Meyrin-Geneva, Switzerland

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