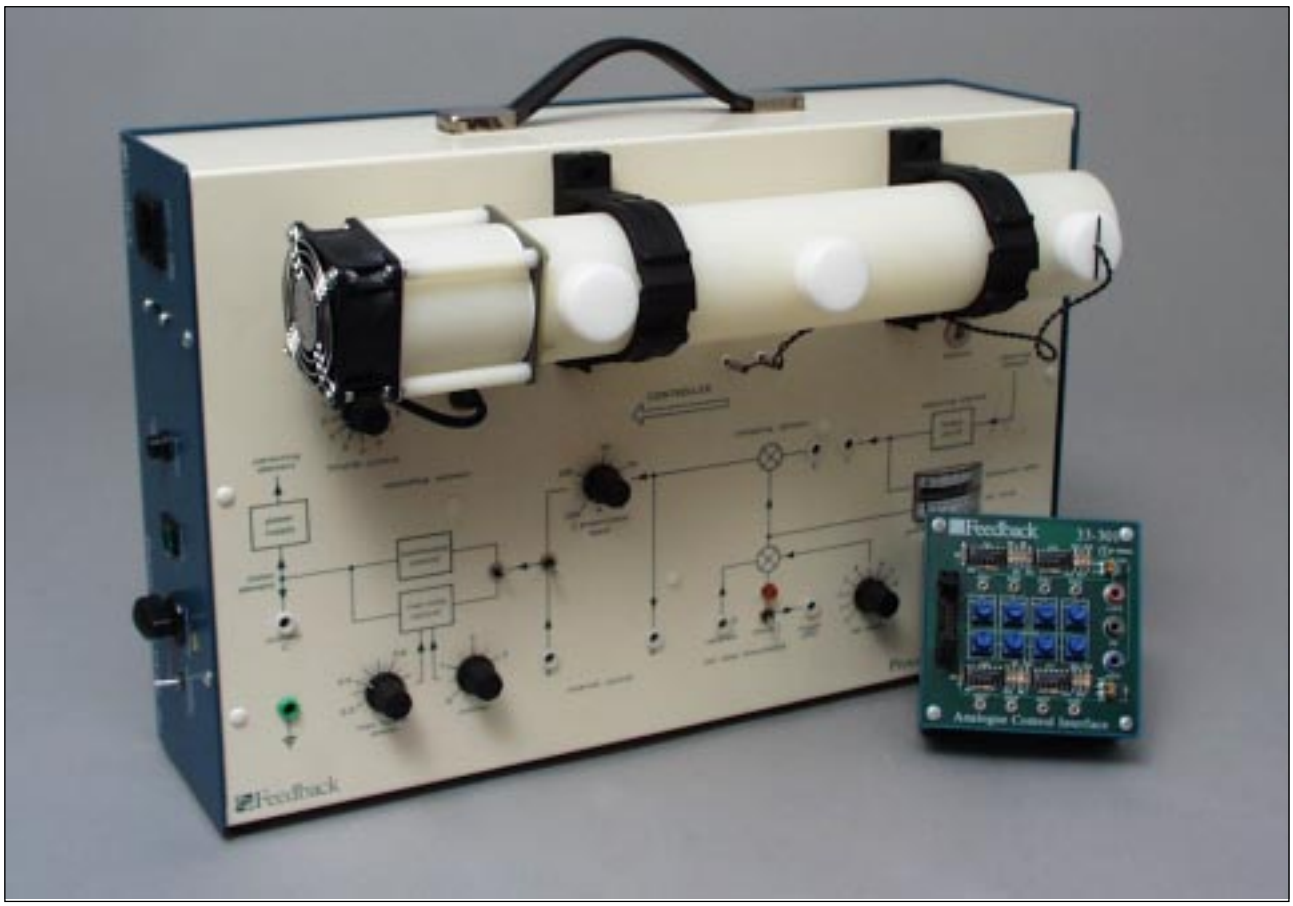
Feedback

Process Control Workshop using MATLAB® Software 37-001



The 37-001 Process Control Workshop is a Process Trainer with control interface and simulation for use with MATLAB® software.

- **Representative of transport-delay control problem.**
- **Real-Time control system with embedded algorithms via MATLAB®/SIMULINK®.**
- **Integrated software supports identification, modeling, design and simulation, real-time implementation.**
- **Ideal for teaching the basic principles of Process Control to technicians and engineers.**
- **Suitable for both laboratory and projects work.**

The Process Control Workshop contains:

- **37-100 Process Control Trainer**
- **37-102 Interface**
- **37-901 Software Pack with advanced I/F card to work with MATLAB® (includes Advantech card).**

Description

The Process Control Workshop is used to introduce process control techniques and with the additional software and MATLAB®/SIMULINK® software will provide an insight into advanced control principles.

The Process is represented by a heating element controlled by a thyristor circuit that feeds heat into the airstream circulated by an axial fan along a polypropylene tube.

A thyristor detector can be placed at one of three points along the tube, sensing the temperature at that point.

The volume of air flow is controlled by varying the speed of the fan via a potentiometer ('throttle control') in the range 10% to 100% efficiency.

Curriculum covered

- **Distance/Velocity Lag**
- **Transfer Log**
- **Calibration**
- **Two-step control**
- **Proportional control**
- **Disturbance & system response**
- **Frequency response**
- **Compound controller action**

Using MATLAB®/SIMULINK® and associated Toolboxes

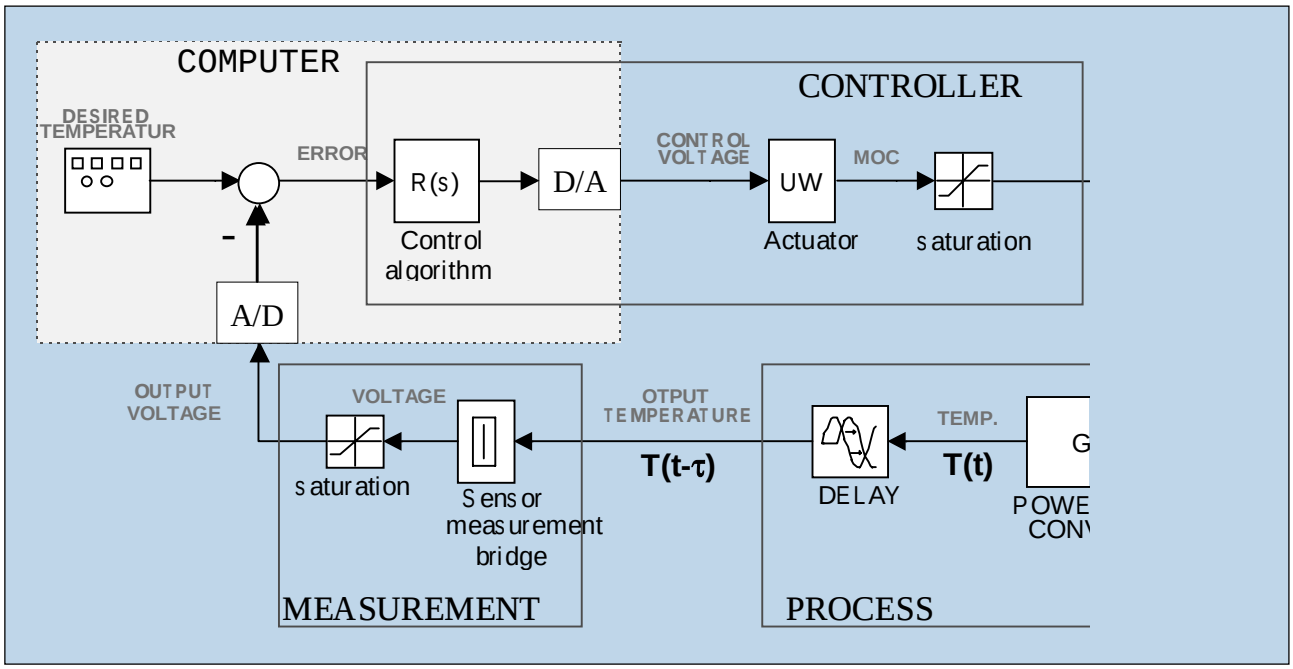
- **Real-time Digital Control**
- **Mathematical Modelling**
- **Transfer Function & State-space representation**
- **Single input/Single output feedback control time domain**
- **PID Control**
- **Linear Quadratic (LQ) Control**

Applications

Closed loop digital control

The system (hardware & software) is divided into four categories:

- **Computer**
- **Controller**
- **Process**
- **Measurement**



Computer

The output voltage signal corresponding to the measured temperature is converted by 12-bit ADC and applied to the computer. The desired (reference) temperature is generated by a software ***excitation source***. The error is applied to the ***control algorithm***, which then calculates a digital control signal. A DAC using zero-order-hold principles converts the control output into an analogue signal.

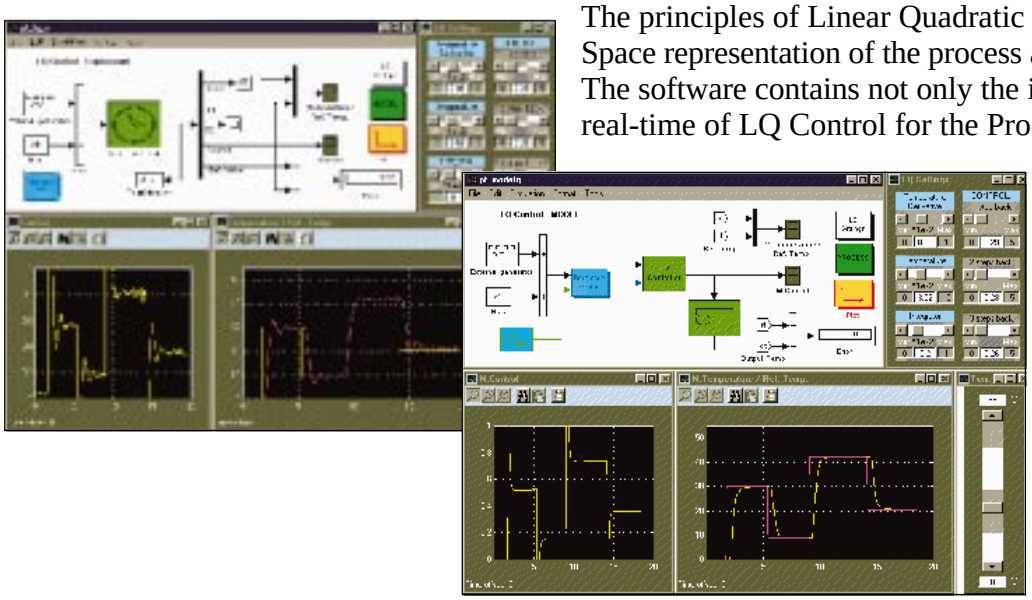
Controller

The variable power supply (***actuator***) provides an electrical output as determined by the controller signal. Since the power applied to the heater is limited (0 to 80W), another saturation block is necessary to represent the behaviour of the system correctly.

PID Control

An extension to the practical and experimental work is the design, simulation and implementation of real-time PID (3-term) controller.
As simple demonstrations, these show the powerful action of a 3-term controller in reducing deviation and improving response time.

Optimal design method: LQ Control



The principles of Linear Quadratic control and State Space representation of the process are introduced. The software contains not only the implementation in real-time of LQ Control for the Process Trainer Unit, but the simulation of complete closed loop control.

Process

The power $P(t)$, applied to the heater is the process input, the temperature measured in the location of the sensor $T(t - \mathrm{t})$ is the output of the process.
Electrical power to heat conversion - represented by a transfer function of the second order, a series combination of heater model and the model of heat transfer between heater and air.
Delay - time taken by the temperature signal between the input (heater: T(t)) and the output (sensor location: $T(t - \mathrm{t})$).

Measurement

Sensor - positioned into the air stream at one of the three points along the tube.
Measurement bridge circuit and amplifier - converting the resistance variations into voltage signal variations in the range (0, 10) volts.
Saturation of the measurement channel - nonlinearityprovided by the limitations of the measurement signal (range: 0 to 60°C).

Specification

Maximum heater power	80W.
Velocity flow range	1 - 10ft/sec (0.304 - 3.05m/sec).
Detector temperature range	Ambient to 80°C.
Heater/detector time constant	400ms.
Typical distance - velocity lag	200ms.
Typical natural period	1.0 second.
Tube length	298mm (11.75in).
Electrical input & output range	±10V.
Manuals supplied	Installation & Comissioning, Getting Started, Reference Manual and Advanced Teaching Manual.
Power requirements	220 - 250V or 100 - 120V. 50 or 60Hz, 170VA.
Dimensions & Weight	Width:520mm, Depth: 292mm, Height: 216mm, Weight: 5.6kg.
Ordering Information	Order: 'Process Control Workshop (37-100, 37-102 & 37-901) 37-001'
Upgrade Pack	37-110 is the Process Control Workshop Upgrade Pack available to customers who already own Process Trainer PT326. It is designed to extend the original assignments so that they can be used with toolbox software within **MATLAB**®. The pack contains 37-102 and 37-901.
Additional Equipment	486DX minimum with 16MB memory; VGA graphics; **Required** Microsoft mouse; CD ROM drive; **MATLAB**® 5.2 and **SIMULINK**® 2.2 with Signal Processing Toolbox and Control System Toolbox. If required, Feedback can provide a suitable computer entirely compatible with the system.

Feedback
Feedback Instruments Limited
Park Road, Crowborough,
East Sussex, TN6 2QR, England.
Telephone: +44 (0) 1892 653322.
Fax: +44 (0) 1892 663719.
E-mail: feedback@fdbk.demon.co.uk
Website: http://www.fbk.com

Printed in England by FI Ltd, Crowborough 1199