



Innovators in Engineering Education Technology

Developing Equipment for Remote Operation

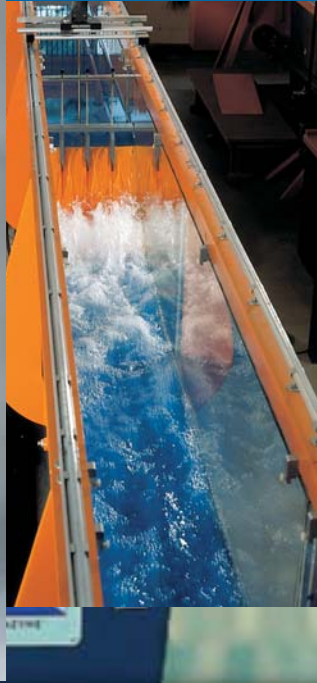
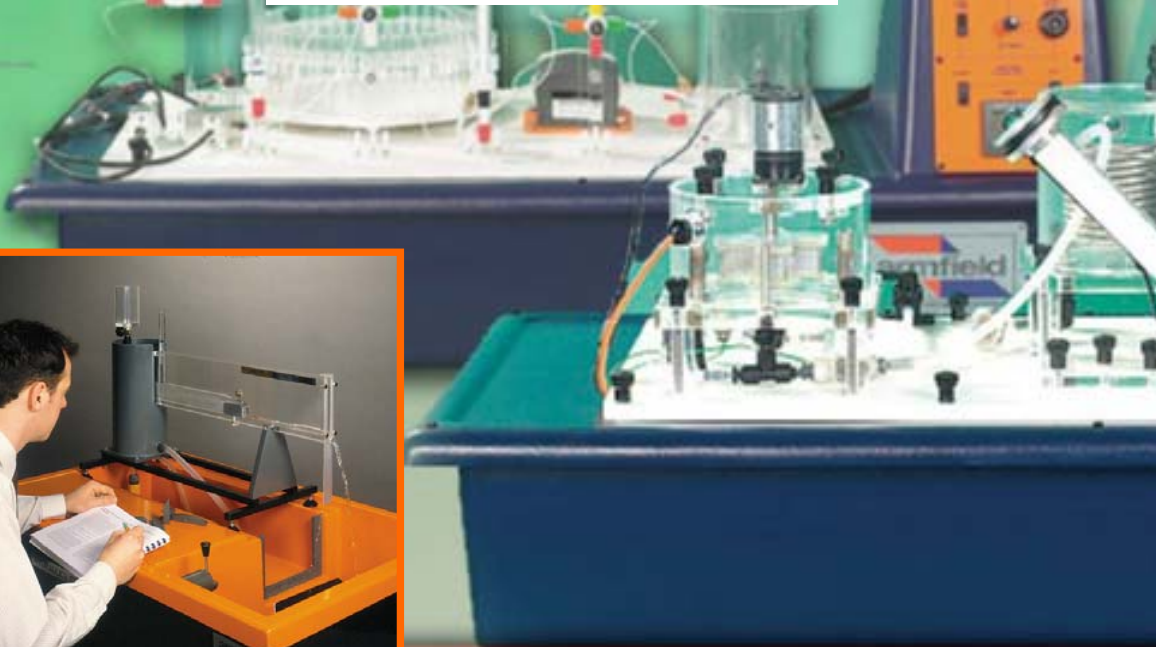
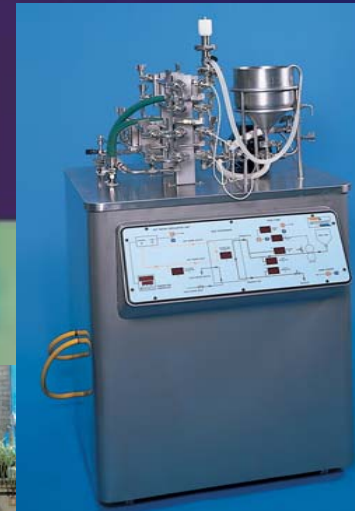
Ted Sansom
Technical Director
Armfield Limited

Topics

- Armfield Background
- Work with MIT
- Requirements for remote operation
- Current Situation
- Future Developments
- Summary

Armfield Background

- Supplier of Laboratory Engineering Teaching Equipment
- Civil, Mechanical and Chemical Engineering
- Wide range of products (300+)
- New products continuously being introduced
 - Increasingly sophisticated
 - Virtually all new products computer compatible
 - Data Logging
- Armfield are totally dependent on supplying Laboratory Equipment to Higher Education



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Heat Exchanger Bench

- Accepted order from MIT to modify an existing heat exchanger bench design for remote operation (joint funded)
 - Co and Counter flow under computer control
 - Flow Control Valve under computer control
 - Electric Heater under computer control
 - ‘Watchdog’ circuit added to shut down power in case of communications failure
- Ended up being a total redesign
- Defined principles for future products

HT30XC



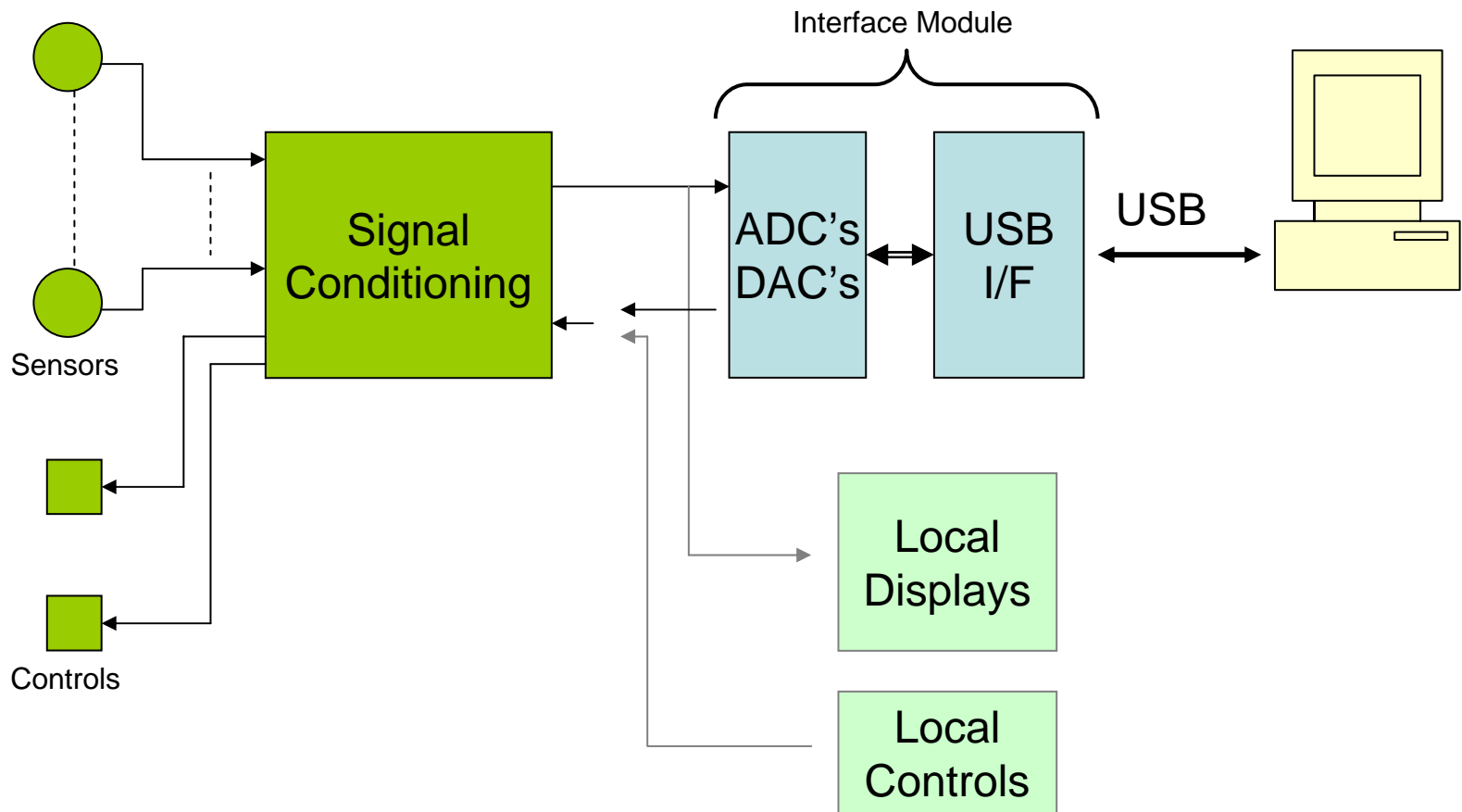
Now available as a standard Armfield product

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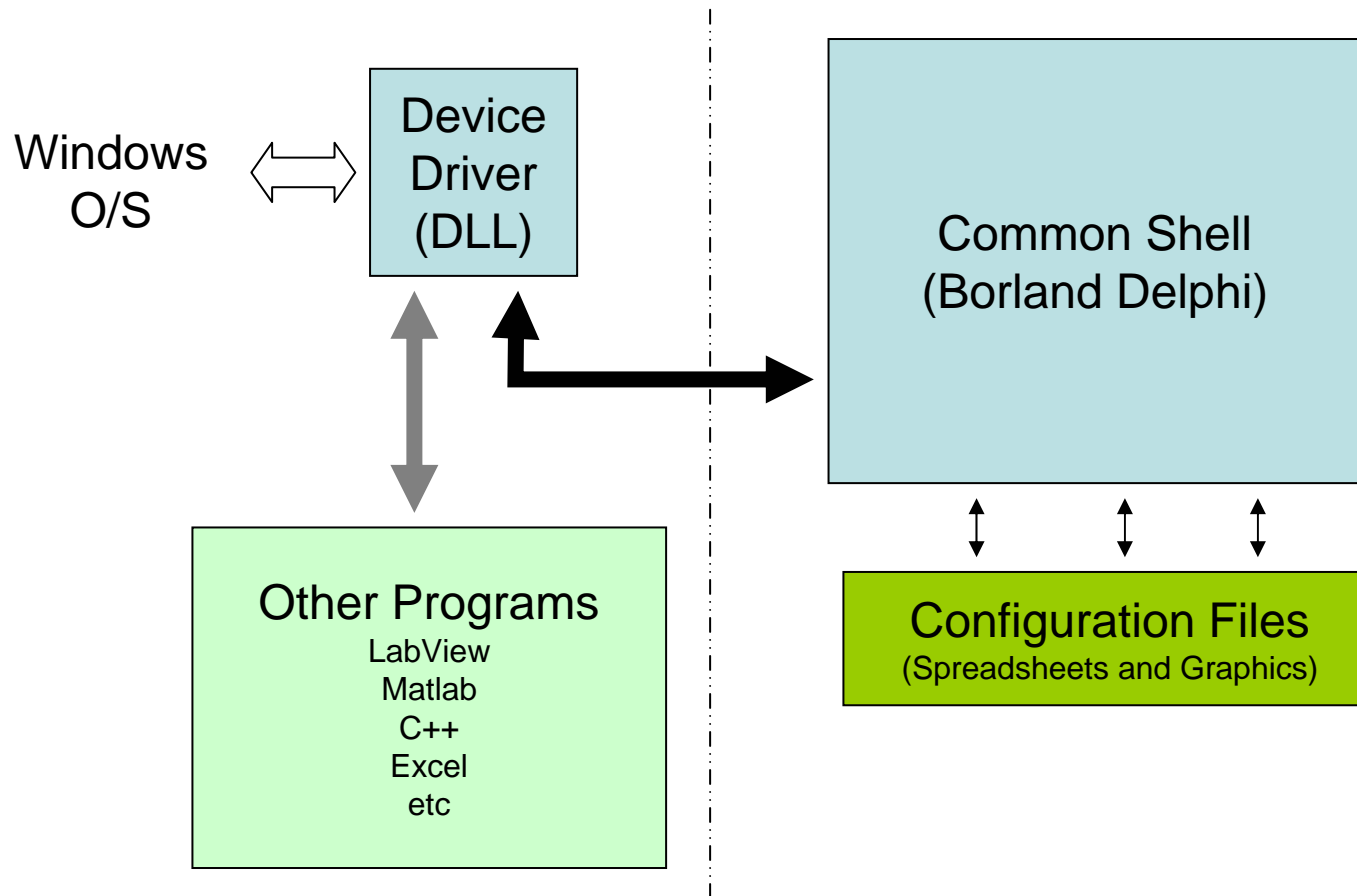
Generic Architecture

(Hardware)



Generic Architecture

Software



General Considerations

- Eliminate Manual Operations
 - Some things can be manually controlled on a day by day basis
- Enable Software Control
 - Compatible with user developed software
- Communications can be unreliable
 - Personnel Safety Paramount
 - Equipment Protection Important

Heat Transfer Equipment



- Similar Modifications to control unit
- 3 phase fan and inverter control for airflow equipment
- Flow Meters and Control Valves added
- Motorised screen on thermocouple apparatus
- Again all available as standard products (HT10XC family)

Centrifugal Pump Test Rig

- Coming soon!



Future Software Developments

Typical Software Implementation

'Executive' Software

- Registration
- Organisation
- TimeSlots/Bookings
- Lectures Notes
- Setting up info, Comms/
Addresses
- DataBase

Equipment Specific

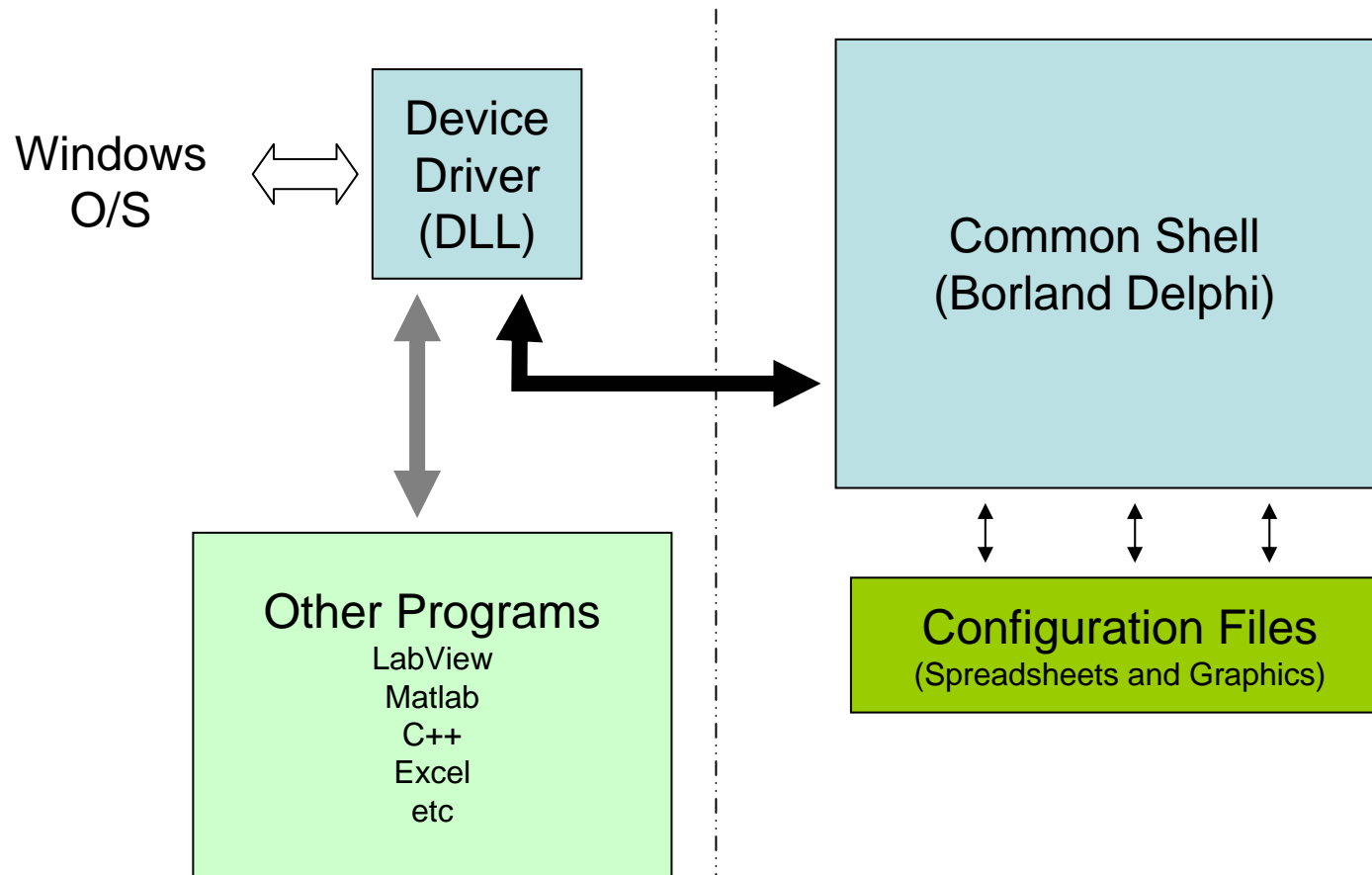
- Communications with
Hardware
- Graphical Display
- Data Processing and
display
- Data Logging
- Graph Plotting

Equipment Specific Software

- Has to be written for each piece of equipment
- Needs to be written by someone who understands the equipment and what is being taught
- Needs maintenance
- Potentially a lot of work if several pieces of equipment used

Generic Architecture

Software



Common Shell

- Easy to configure for different equipment
 - Set up by graphics, spreadsheets, help files
- Well proven Software Code
- Already produced for each new item of Armfield equipment (local operation)
- Maintenance and control procedures in operation (ISO 9000)
- Feature Rich

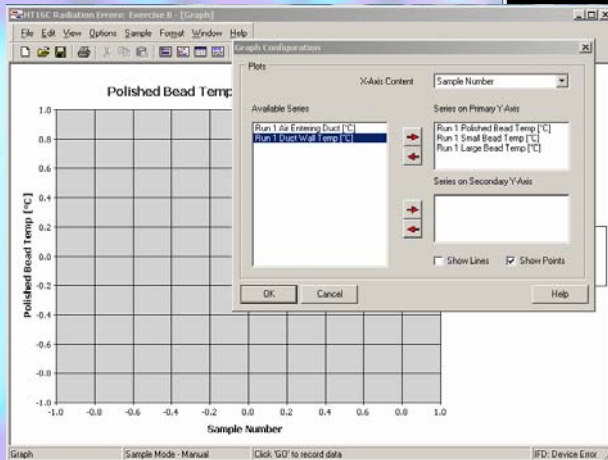
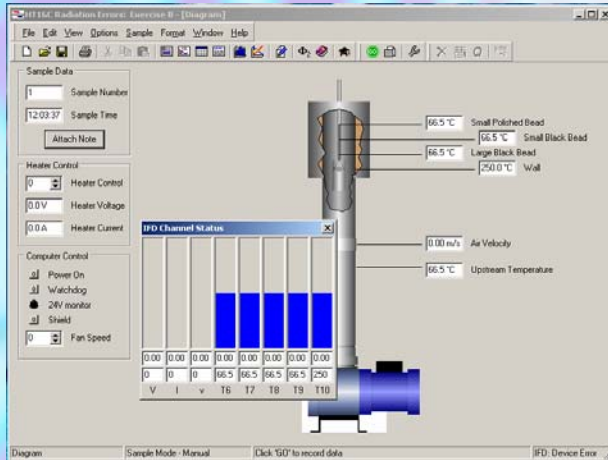
Question

Could the Common Shell be adapted for remote operation?

Major Features

- Graphical Display
- Top Level 'Walk-Throughs'
- Extensive Data Logging Capability
- Sensor Calibration
- Fully flexible Graph plotting
- Help Texts
 - Both Common Shell and Equipment Specific
- Facility for Student Q & A's
- Various Real Time Display options
 - Mimic Diagram, Graph, Spreadsheet, Histogram, Recent History graph

Examples



Errors: Exercise B - [Presentation]

HT16 Temperature Measurement

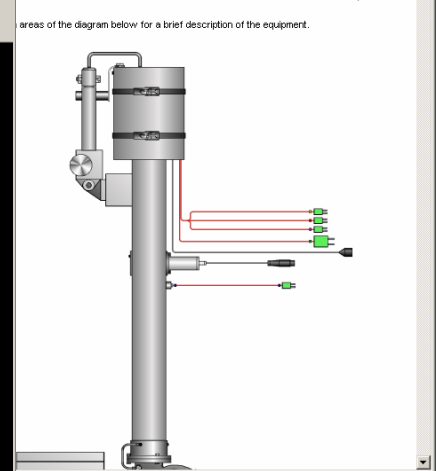
The HT16C Errors in Temperature Measurement accessory consists includes five thermocouples to monitor the temperature of the gas inside the duct.

The gas temperature can be increased by using the heater collar attached to the duct wall.

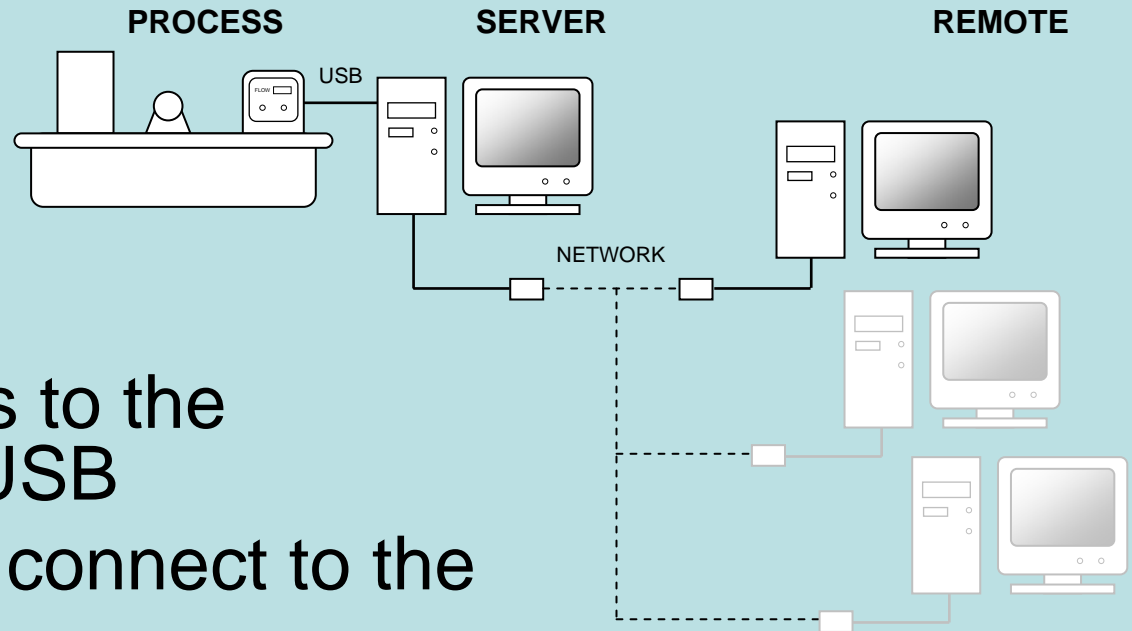
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HT16C Radiation Errors in Temperature Measurement

The 'Radiation Errors in Temperature Measurement' accessory comprises a tubular metal duct through which air, at ambient temperature, is blown vertically upwards. The velocity of the air can be varied and measured. A section of the duct wall is heated, and provides the source of radiation to three test thermocouples which are located adjacent to the heated section. The three test thermocouples are constructed with different bead arrangements. Another thermocouple measures the air temperature upstream of the heated section and another measures the surface temperature of the heated wall. The effect of the duct wall temperature, the air velocity past the test thermocouples and the thermocouple design on the readings from the test thermocouples can be demonstrated. A radiation shield can be lowered to demonstrate the improvement in reading accuracy when the thermocouples are shielded from the source of radiation.



Potential Future Growth



- Local Computer (or server) connects to the equipment via the USB
- Remote computers connect to the server IP address
- The remote computers get real time data from the server as if it came directly from the USB

In Use

- All Facilities available on remote computers
 - Full functionality of 'Common Shell' features
- Each remote computer can control their own data sampling
- Each remote computer controls their own display, graph plotting, etc.
- Any computer can control the process
 - Only one at a time
- Some functions run on the server (e.g. PID algorithms), but the control computer can modify the settings and all users can view the results
- 'Chat' windows and video windows easy to integrate using standard bolt-ons

Example

The screenshot displays the 'HT16C Radiation Errors: Exercise A - [Diagram]' software window. The interface includes a menu bar (File, Edit, View, Options, Connection, Sample, Format, Window, Help) and a toolbar with various icons. The main area is divided into several panels:

- Sample Data:** Sample Number: 1, Sample Time: [empty], Attach Note button.
- Heater Control:** Heater Control: 0, Heater Voltage: 0.0V, Heater Current: 0.0A.
- Computer Control:** Power On, Watchdog, 24V monitor, Shield, Fan Speed: 0.
- Connection Dialog:** Connection Data (IP Address: 217.35.97.97, Host Name: [empty], Port No.: 8135), User Data (User Name: Mark, Password: [masked]), Control (Take Control checkbox), Controlling User: [empty].
- Diagram:** A vertical probe assembly with a blue valve at the bottom. Temperature readings are shown for: Small Polished Bead (66.5 °C), Small Black Bead (66.5 °C), Large Black Bead (66.5 °C), Wall (250.0 °C), Air Velocity (0.00 m/s), and Upstream Temperature (66.5 °C).

At the bottom of the window, the status bar shows: Diagram, Sample Mode - Auto : 1 sec, Stopped - click 'GO' to begin recording data, and NET: Not Connected.

Current Situation

- Demonstration version of Remote Software available to prove feasibility
- Further work required to turn it into a saleable product
 - IT work rather than Engineering
- Hardware available now, and more coming.

Summary

- Armfield are the leading laboratory equipment supplier to engineering education worldwide
- We intend to remain in this position
- Web based experiments are here and growing
 - we will be part of it
- Several items of equipment available now
- Advanced software in development