MediSense

P-NET
DATA ACQUISITION SYSTEM

Andrew Stanton – MediSense [UK] Inc

Contents   Page

Introduction

MediSense, an Abbot Laboratories Company, is the manufacturer and distributor of diagnostic medical sensors to the home test market. This enables diabetics to monitor their blood glucose level. The measurement system comprises of a credit card sized instrument and a disposable test electrode. This test strip can measure the blood glucose level from a small sample of blood in approximately 20 seconds.

MediSense [UK] Inc is located in Abingdon, Oxfordshire, and employs approximately 800 staff, the site is primarily involved in the development and manufacture of the diagnostic test strip. MediSense is currently dispersed over 13 buildings occupying a total of 160,000 sq. feet. The manufacturing facility operates 24 hours 7 days a week. Since 1988 MediSense has shipped over 2 billion strips world-wide, the last billion were manufactured in just a 2 year period. Each test strip has to pass through approximately 35 manufacturing stages and takes approximately 7 days to complete.

System Overview

P-NET was introduced to MediSense in 1992 as a single PC and slave system, designed to monitor the efficiency of one of our packaging machines. The systems task was to provide the machine operators with real time process counters, detailing the machine yield and to highlight product loss. From these small beginnings the system has expanded into a site wide system.

The system comprises of 7 physical P-NET loops; these loops are interconnected using 5 P-NET controllers and 2 pairs of PD3285 optic fibre repeater modules. The P-NET system has expanded along with the company's needs, as each new building is acquired a new loop is added and joined to an existing controller on the previous loop.

Each loop is configured to accept 20 masters; nodes 21 to 32 are reserved for possible later expansion. Maintaining the same master number on all loops aids installation and allows reserved node numbers, i.e. 1 and 20 to be used for engineering use, or to enable pre-configured emergency replacement PC's to be installed on any loop without the immediate requirement for an engineer to re-configure the P-NET drivers.

The 5 controllers used to bridge the loops have been assigned consecutive node numbers. The assigned number is used on both controller ports, and the controllers are orientated so that port 1 is always in the same direction of travel through the facility. An example of our addressing structure is as follows: **02** 02 **03** 02 **04** 02 **05** 02 **06** 02 **50**. This shows the addressing required from a PC located on the first loop at one end of the site accessing a

slave module (50) on a loop at the other end of site. The highlighted numbers represent the controller node numbers and the slave module, the remaining numbers represent the controller port, in this case port 2 as we travel in the same direction across the site. This standardisation of master numbers and controller numbers allows a P-NET engineer the ability to easily navigate the P-NET system from any location on site.

Process systems designed to perform a specific monitoring or controlling task are always located on the same physical loop. This ensures that the system can continue to function if an interconnecting bridge is removed. Only supervisory and remote monitoring of the process requires the need to navigate more than one loop.
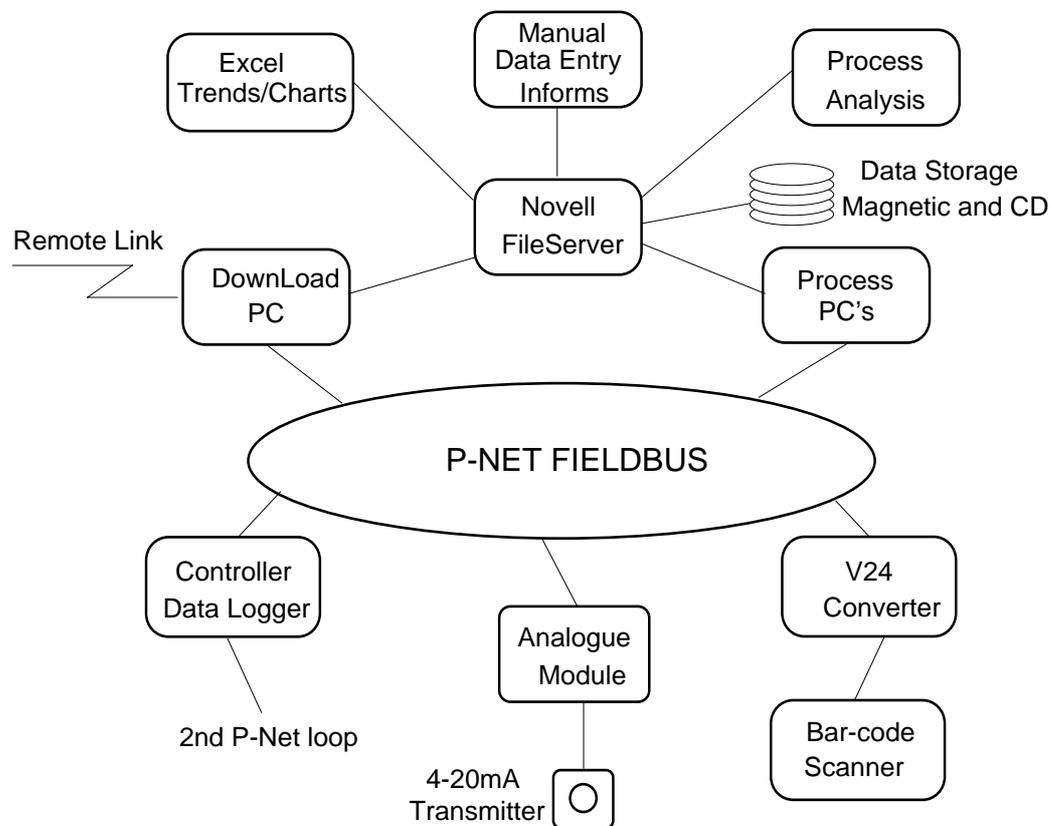
Figure 1. Schematics of the MediSense data acquisition system.

A program is executed automatically each night to synchronise all controller clocks to one 'master' controller time. All PC clocks are synchronised at the start of each batch, and then on every hour change to that of the nearest controller. This synchronisation ensures that events logged by any part of the P-NET system are using the same system time. Another program is automatically executed twice a year to advance or retard all system timers by one hour to synchronise with 'British Summer Time' or 'Greenwich Mean Time'.

The loops are wired with the standard twin axle cable, P-NET connection points have been placed throughout the manufacturing facility, all access points on the loops are terminated with military style connectors. P-NET equipment is then connected to these points by short link cables. This approach has allowed nodes to be added and removed without breaking the loop, enabling problems to be quickly isolated, and in the event of a loop failure the ability to speedily remove self contained aspects of the system reducing data loss.

All PCs at MediSense are connected to the main Novell® 'Local Area Network', the server is a Hewlett Packard SFT3 fault tolerant system running NetWare® 4.11 with a 500 user license. The MediSense network forms part of the Abbott 'Wide Area Network'.

A Novell/P-NET gateway has been installed to enable access to the P-NET system from any PC on site running the Windows program 'PnetView'. The program uses the main Novell 'LAN' system as a transport media to the gateway PC, users are able to design their own process views at run-time, linking display items with predefined P-NET elements.

Remote access connections to the P-NET system are available via two routes, the first is using a 'pcANYWHERE™' link supported by the Novell/P-NET gateway. This approach allows a remote PC to dial-in and take control of the host PC at MediSense, any program supported by the host, including the 'PnetView' program can be executed.

The second access method is by 'Dial-Up Networking' using a Windows NT® Remote Access Server as a gateway to the network. This enables a remote user running the 'PnetView' program to directly access the Novell/P-NET gateway via the Remote Access Server. These services have been provided to allow certain engineering groups the ability to provide 24-hour process support outside of normal working hours.

MediSense's current inventory of P-NET equipment is as follows: -

46	PD3240	Analog 16 Channel
25	PD3920	PC to P-NET Interface Card
22	PD3120	Digital 16 Channel
21	PD3221	UPI Module
15	PD1611	Analog 6 Channel
10	PD4000	Controller
6	PD3010	Controller + LCD
5	PD3285	Repeater Module
5	5904	Ultrakust P-NET – RS232 Module
4	PD5015	Controller + LCD
4	PD5000	Controller
4	PD3940	P-NET - RS232 Module
3	PD3100	Digital 32 Channel
2	PD3000	Controller
1	PD3020	Graphics Interface
26		HUGO/VIGO licenses

The MediSense data acquisition system can be divided into 4 basic types of operation. These are as follows:

- **Environment Monitoring**

- **Process Monitoring**

- **Machine Utilisation**

- **Supervisory and Remote Monitoring**

Environmental Monitoring

To comply with 'Good Manufacturing Practises' the production of the test strip is performed under strict environmental conditions, manufacturing rooms, fridges, freezers and ovens are monitored for temperature and humidity.

The P-NET system provides two aspects of our environmental monitoring needs. The first is to provide continuous alarm monitoring and recording of all process areas during the manufacture of the product. Secondly, to collect information during the room mapping phase. Mapping is performed on a regular basis in over 50 production areas to ensure that the measurement probe used during the process manufacture is representative of the entire room. During mapping, up to 30 temperature and humidity probes are placed in a matrix fashion throughout the room, the room is then logged at 5-minute intervals over a 3-day period.

Currently 6 environmental logging panels are installed. Each monitoring system is based around either a PD3010 or PD5015 controller, inputs are provided via analog channels within PD3240 modules and alarm outputs via PD3120 digital channels. The memory in the PD5015 controller enables 300 measurement points to be monitored and logged ever 5 minutes, holding up to 5 days of logged information in memory.

The system provides 4-state alarm monitoring on each measurement point, this allows Hi-Lo 'Warning' alarm levels and Hi-Lo 'Critical' levels to be configured. An out of condition event causes a record to be logged within the controller and the activation of a digital output. Critical areas are backed up with the use of telephone auto-diallers to ensure alarm notifications are received from unmanned building and storage areas. Alarms generated by the controllers can be acknowledged from the controller keypad or from PC's local to where the alarm event has occurred. The system has been designed to enable alarm set-points to be configured by the local area PC based on the current process, all probe points associated with the line are configured using a 'read-only' lookup table held in the controller.

The controller provides a 'set' or 'clear' alarm status flag to the output channel in the digital module, extra functionality can be added using the PD3120's internal calculator program. Programming the calculator channel allows various output configurations to be tailored to suit the physical requirements. These have included fail-safe control, i.e. outputs de-energised during the alarm event, re-alarm timers following an acknowledgement, and the ability to have a status indicator static 'ON', changing to flashing during the alarm event.

Trend and alarm information held within the data loggers can be accessed real time from any PC on site running the 'PnetView' program. This program provides the user with the ability to create custom views of the process, trend information can be accessed up to the 5-day retention period, auto scaling, zooming and printing is available. This program has provided many groups with the ability to have the data at their fingertips. MediSense Facilities department for example is responsible for maintaining the plant and environmental conditions, current trend information can be viewed direct from the office or at home outside normal working hours.

A 'Download' program is automatically executed at midnight to acquire a permanent record of the previous 24-hours. The program saves the data in a 'Comma Separated Variable' (.CSV) format to enable direct importing into Microsoft® Excel and also SAS® (data warehouse system) to enable data set summarisation to be performed with data collected from the process monitoring systems on the process lines.

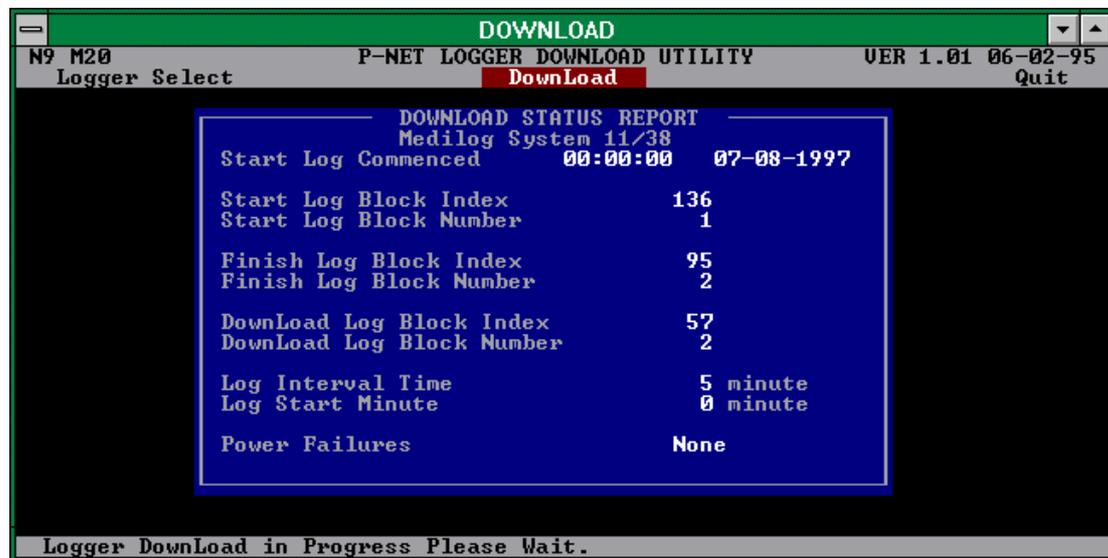

Figure 2. *Screen layout from the logger 'DownLoad' program. Trend data is stored within the logger in nine 32k memory blocks known as 'Log Blocks', every 5 minutes new probe data over-writes the oldest event and increments the index counter.*

	1	2	3	4	5	6	7	8	9	10	11	12
1	P-NET LOGGER	Medilog System 11/38										
2	VERSION 1.01											
3	18/08/97 00:00											
4	18/08/97 23:55											
5	TIMED											
6	Channel Number	27	1	2	3	4	5	9	10	11	12	1
7	Sensor Type	27	3240	3240	3240	3240	3240	3240	3240	3240	3240	324
8	Label	27	BLOOD 1T	BLOOD 2T	BLOOD 3T	BLOOD 4T	BLOOD 5T	BLOOD RM	BLOOD RM	INKS 1T	INKS 2T	INKS 3T
9	Unit	27	Deg C	Deg C	Deg C	Deg C	Deg C	Deg C	% RH	Deg C	Deg C	Deg C
10	Minimum Value	27	1.18	19.78	3.52	3.40	-21.37	19.48	46.24	3.60	58.37	50.5
11	Maximum Value	27	8.93	20.61	7.94	8.78	-2.81	22.32	55.82	4.63	61.73	50.7
12	18/08/97 00:00	27	6.47	19.80	6.03	8.48	-20.56	20.28	47.57	3.98	59.78	50.6
13	18/08/97 00:05	27	6.86	19.80	6.21	8.50	-20.14	19.89	53.07	4.47	59.78	50.6
14	18/08/97 00:10	27	7.17	19.80	6.36	8.49	-20.39	20.17	48.93	3.93	59.80	50.6
15	18/08/97 00:15	27	5.97	19.79	6.49	8.44	-20.19	20.00	47.55	3.65	59.81	50.8
16	18/08/97 00:20	27	4.70	19.80	6.60	8.36	-20.39	20.40	50.84	3.99	59.74	50.6
17	18/08/97 00:25	27	3.83	19.81	6.70	8.24	-20.32	19.89	48.98	4.49	59.75	50.7
18	18/08/97 00:30	27	3.15	19.80	6.00	8.10	-20.27	20.26	46.69	3.87	59.76	50.6
19	18/08/97 00:35	27	2.59	19.81	5.27	7.99	-20.48	20.05	51.39	3.63	59.77	50.6
20	18/08/97 00:40	27	2.38	19.80	4.64	7.86	-20.09	20.34	47.93	3.97	59.75	50.6
21	18/08/97 00:45	27	3.04	19.81	4.15	7.75	-20.62	19.88	47.73	4.48	59.76	50.6
22	18/08/97 00:50	27	3.82	19.81	4.06	7.66	-19.95	20.38	49.94	3.89	59.74	50.6
23	18/08/97 00:55	27	4.39	19.81	4.21	7.56	-20.72	19.87	48.61	3.66	59.75	50.6
24	18/08/97 01:00	27	4.84	19.81	4.59	7.47	-19.83	20.07	49.62	4.16	59.74	50.6
25	18/08/97 01:05	27	5.23	19.81	4.88	7.39	-20.82	20.08	49.79	4.31	59.75	50.6
26	18/08/97 01:10	27	5.61	19.81	5.16	7.31	-19.72	20.13	46.96	3.67	59.74	50.6
27	18/08/97 01:15	27	6.07	19.81	5.45	7.23	-21.02	20.27	51.70	4.07	59.71	50.6
28	18/08/97 01:20	27	6.47	19.82	5.72	6.96	-19.53	20.17	48.30	4.44	59.75	50.6
29	18/08/97 01:25	27	6.84	19.82	5.94	7.01	-21.07	19.92	47.54	3.82	59.72	50.6
30	18/08/97 01:30	27	6.99	19.82	6.14	7.05	-19.46	20.42	49.00	3.71	59.72	50.6
31	18/08/97 01:35	27	5.72	19.82	6.28	7.13	-21.14	19.81	48.12	4.36	59.76	50.6
32	18/08/97 01:40	27	4.50	19.82	6.41	7.20	-19.38	20.15	52.06	3.90	59.77	50.6
33	18/08/97 01:45	27	3.64	19.82	6.52	7.24	-21.21	19.84	48.92	3.78	59.74	50.6

Figure 3. *'CSV' Data file produced by the 'DownLoad' program directly imported into Microsoft Excel. This file represents data collected for a 24-hour period from a PD3010 controller used to monitor incubators, ovens, fridges and freezers.*

P-NET controllers were chosen for the design to allow uninterrupted monitoring during a mains power failure, the system has backup capacity to continue to function for a minimum 48-hours. It is during a power loss that the product is at it's most vulnerable, plant equipment can no longer maintain the environmental conditions in the manufacturing areas. Product contained in rooms that fall outside the environmental specification has to be scrapped.

The use of the controllers has provided us with a segmented approach to the installation, with the controllers forming the bridged links between P-NET loops. Having this architecture provides several advantages, these include process redundancy in the event of a loop failure, ease of maintenance and the ability to expand without effecting the existing installation.

The PD3240 Analog modules are calibrated every 6 months against a NAMAS traceable current source, to a tolerance of ± 0.1% across the measurement range. To limit the process downtime a newly calibrated module is swapped with the in-process module.

To ensure the replacement module contains an identical configuration i.e. node number, probe configurations etc. A PC program 'PDModCal' is used, the operator can select from a list of module configuration files. Once the calibration is started the current source is directed

into each channel under test using a PD3120 digital module and switching relays, no further user intervention is required until all 16 channels have been calibrated and the test completed. A result file and printout is produced, any channel failing to meet the calibration tolerance is highlighted and disabled from use.

Serial Number: 9622629PD
Module Identity: PD3240
Calibrated: 07-08-1997
Area Configuration: UNIT 14/15 DATA PANEL2 NODE 68

	PASSED	PASSED	PASSED	PASSED	PASSED	PASSED	PASSED	PASSED
	CHAN 1	CHAN 2	CHAN 3	CHAN 4	CHAN 5	CHAN 6	CHAN 7	CHAN 8
	DEW	DEW	DEW	DEW	DEW	DEW	TEMP	HUMID
4mA	-40.01	-40.01	-40.01	-40.01	-40.01	-40.01	-20.01	-0.01
8mA	-15.00	-15.00	-15.01	-15.00	-15.00	-15.01	5.00	24.99
12mA	10.01	10.01	10.01	10.00	10.00	10.01	30.01	50.01
16mA	35.01	35.01	35.00	35.01	35.01	35.01	55.01	75.01
20mA	59.99	59.99	60.00	59.99	59.98	59.98	79.99	99.99

	PASSED	PASSED	PASSED	PASSED	PASSED	PASSED	PASSED	PASSED
	CHAN 9	CHAN 10	CHAN 11	CHAN 12	CHAN 13	CHAN 14	CHAN 15	CHAN 16
	TEMP	HUMID	TEMP	HUMID	TEMP	HUMID	TEMP	HUMID
4mA	-20.01	-0.01	-20.01	-0.01	-20.01	-0.01	-20.01	-0.01
8mA	5.00	25.00	4.99	25.00	4.99	25.00	4.99	25.00
12mA	30.00	50.01	30.00	50.01	30.00	50.00	30.01	50.01
16mA	55.01	75.01	55.01	75.01	55.02	75.01	55.01	75.01
20mA	79.99	99.99	79.99	99.99	79.99	99.99	80.00	100.00

Test Instrument: Keithley 220 Programmable Current Source
Allied Calibration Service
Cal No. CE018/001
Inst No. 456866
Cal Date   23-10-96
ReCal Date 21-10-97
NAMAS Cert No.35618E

Tested By:

Figure 4. *Calibration certificate produced by the 'PDModCal' program. Channel results falling outside ± 0.05% of range are highlighted in red in the program and identified with a 'WARNING' status on the certificate. Channel results falling outside ± 0.1% of range are highlighted by flashing red in the program and identified with a 'FAIL' status on the certificate.*

The maintenance register of each analog channel is updated during the calibration procedure with the current date. A verification program is executed on a daily basis to ensure all modules on the P-NET system fall within the calibration period, modules due within a 5-day period are highlighted and logged to file.

Process Equipment Monitoring

P-NET modules have been utilised throughout the process, this provides:

- A process tracking system that logs to database key process parameters.

- The ability to perform in-depth analysis of the database to identify key process dependencies and control limits.

- To provide real-time process control feedback.

This has been achieved by placing additional measurement transmitters and sensors on production machinery, or interfacing directly with the machines PC or PLC serial port, to integrate what would otherwise be a stand alone machine or instrument into the one P-NET system.

An example of a standalone measurement system is the interface used to acquire results from one of our Macintosh based 'Acuity Image Inspection Systems'. The system has been configured to measure certain aspects of the product from images produced by 4 video cameras, the measurement results are transmitted through the serial port to a PD5000 controller, where the internal Process Pascal program reads and strips the string placing the measurement results into internal registers.

Now that the measurement results are available in the PD5000 module, the once standalone system is now integrated into the P-NET system and can be monitored from any location on site. Equipment designs now incorporate P-NET modules and interfaces to allow direct access to the measurement information. One such system developed recently for MediSense in America arrived complete with a PD5000 module installed and configured ready for use.

Manufacturing Machinery

PCs have been located in each process area to display and record detailed process information on a card by card basis. The collection of real time data is achieved by using the environmental data obtained from the analog modules used by the data logging system, and machine specific information by extensive use of the channels within the PD3221 UPI module.

The Pulse Processor and Calculator channels are combined to measure various machine speeds, the Pulse Processor provides accurate time measurements between digital input events. The Calculator channel is programmed to convert these time measurements in to real units of measurements, such as mm/sec, cm/min, C.P.H (Cards Per Hour) etc.

Machine pressure is measured using 4-20mA pressure transmitters and the two analog input channels of the UPI module.

The PC monitors and records all machine variables to Borland Paradox® relation database tables on a card by card basis. Bar coding can be used to uniquely identify each card in the process. Out of specification events are alarmed in the process area, highlighted on the local PC screen and recorded in the database. The database tables reside locally on the PC until the end of the current batch when they are transferred to shared tables located on the central file server. Shared tables enable data set summarisation and queries to be produced for all lines in a single pass of the database.

PD4000 user interfaces are located on each machine to enable operators to enter machine utilisation codes when the machine is stopped or a change to the set-up performed. Configuration data entered by the operator at the keyboard e.g. Batch No., Layer, Leader, run codes etc. is transmitted to holding registers within the UPI module, this provides supervisory level programs with the ability to access all the information. Trend information is also stored within spare memory in the PD4000 module to provide remote access users with the same information.
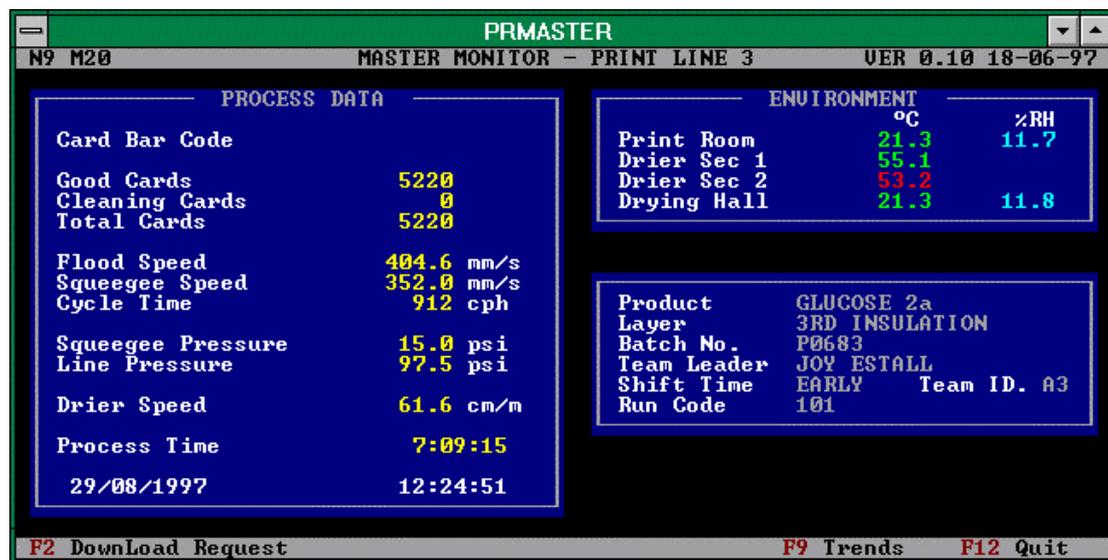
Figure 5. *Screen layout from the 'PRMASTER' program. The master program is for supervisory and remote access use and is capable of viewing all Production lines, a machine specific version is installed for each process line providing the machine operators with an identical screen layout, machine control and data entry. Batch No., Supervisor names etc. have been stored in P-NET registers by the local program to enable access to non P-NET generated information. 'PRMASTER' can be executed from several PCs at the same time from any point on the P-NET system.*
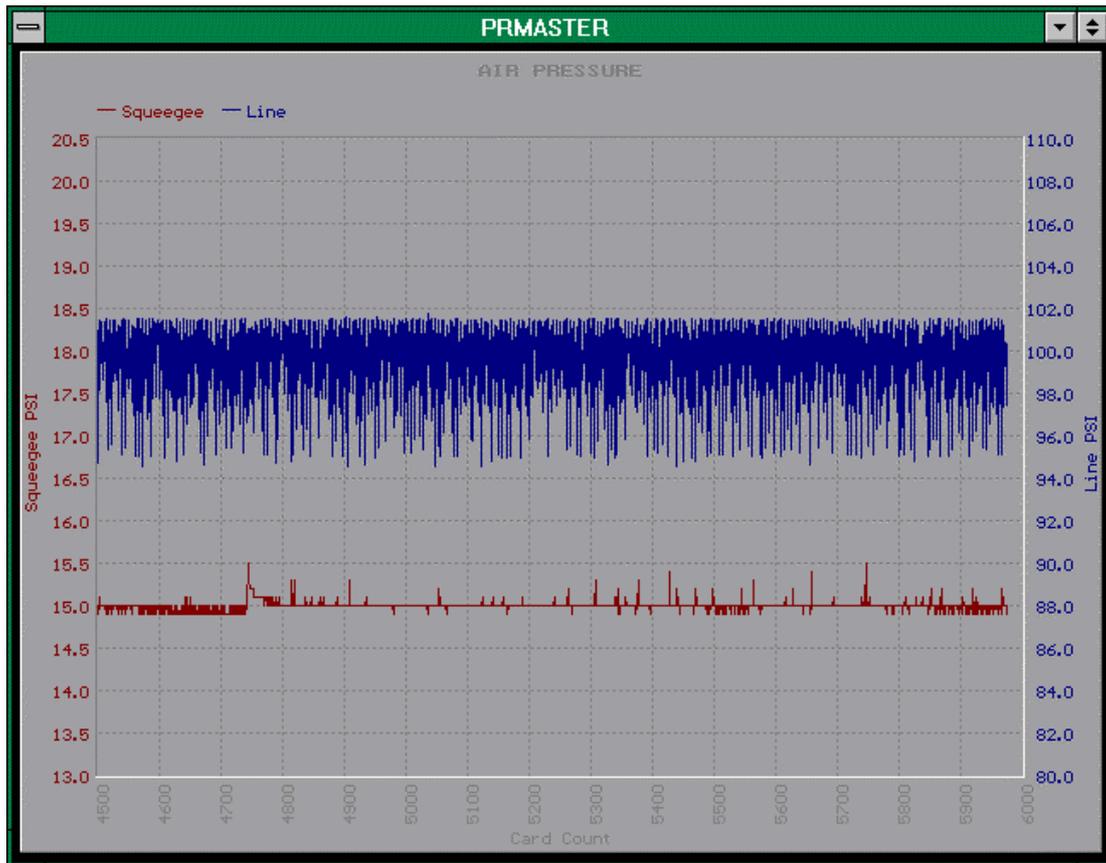
Figure 6. *View of 'PRMASTER's' multiple trend screen, the graphs are held in pages that can be cycled through using the cursor keys. To enable trend information to be available to all P-NET users, the local process version of the program stores the trend data into spare memory space located in a PD4000 controller on each line. This space is accessible by supervisory / remote versions of the program to enable the same trends to be viewed for any process line at any time.*

The PC program and all process configuration files are stored both locally and on the Novell file server, system upgrades including the program and configuration files can be performed by changing the version that resides on the file server. When a new batch is started the PC program verifies that the local copies of software match those on the server, if any of the server files have a newer time stamp, they are automatically copied from the server to the local drive. The program is executed locally so that in the event of a server failure the manufacturing process may continue.

Program version numbers are stored to the database tables at the start of each batch so that the software revision history for a particular line can be traced. Over forty configuration files are currently used to tailor the program to suit the process line, these include alarm tables, graph set-ups, line leader names, database table configurations, machine numbers and P-NET addresses etc.

Packaging Machinery

P-NET equipment has been installed on our three packaging machines. These machines take the completed product and place it into sealed foil packs. The machines are PLC controlled and incorporate several test systems to provide pass/fail signals to the PLC. These machines currently have the ability to reject the product for 13 different reasons, these may include vision system rejects, sealing faults or hole in foil faults for example. Generally excessive rejects are machine related rather than product related, excessive reject levels can be a sign of machine wear, sensor failure, or a damaged sealing roller causing holes in the foil etc.
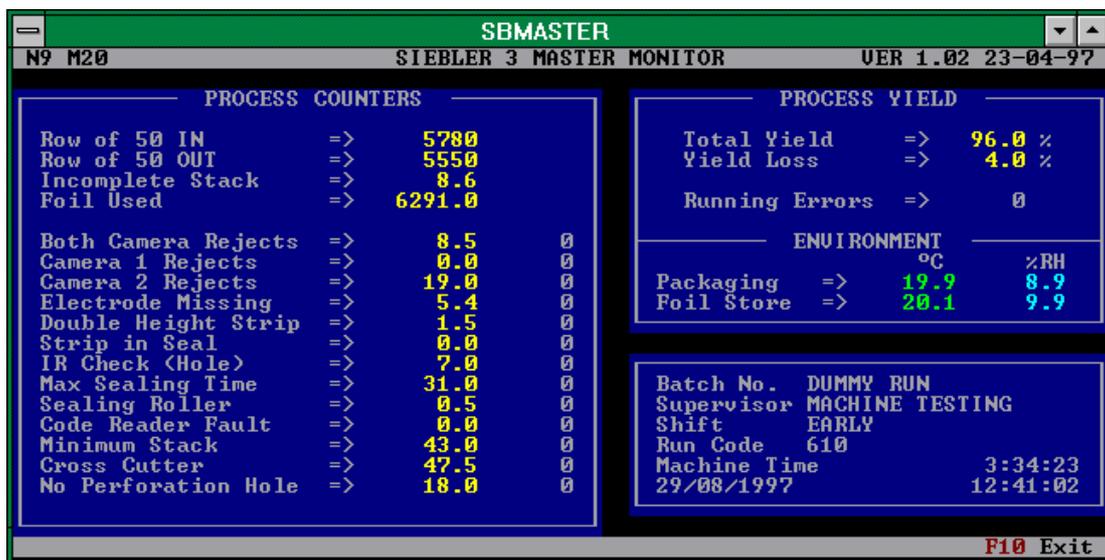

Figure 7. *Screen layout from the 'SBMASTER' program, The master program is for supervisory use and is capable of viewing all Siebler packaging lines, a machine specific version is installed for each line providing the machine operators with an almost identical screen layout, machine control and data entry. Batch No., Supervisor names etc. have been stored in P-NET registers by the local program to enable access to non P-NET generated information. 'SBMASTER' can be executed from several PCs at the same time from any point on the P-NET system.*

To ensure product loss is kept within acceptable levels, PD3120 or PD3100 digital modules are interfaced with the PLC's product counters, the system provides the operators with real time machine status information, including the machine yield and the running total of all process and reject counters since the batch started. A second column of counters reflects the total number of rejects that have occurred within the last 100 units placed in the machine. If the product is rejected on a regular basis these counters will rise quickly, if more than 5 single errors are reported an alarm output is set and after 10 errors the machine is automatically stopped. Each time the machine is stopped the operator is prompted to enter a 'run time code' detailing the reason for stopping, once entered the machine can be restarted.

Machine utilisation and counter information is examined on a daily basis and can show signs of pending machine failure, potential problems can be identified early and rectified during a

scheduled maintenance period. Several PCs in the Maintenance Department run the 'PnetView' program to monitor these machines, again this program can provide the user with the means to identify and respond to real time situations quickly and efficiently.

The P-NET system has been used on these machines since 1992. Due to its continual use and enhancements to the machines and maintenance producers, the yield figures have improved by approximately 25%.

Machine Utilisation

The ability to view a machine's current and past utilisation record is another feature made possible by the use of the P-NET equipment. Operators are prompted each time the machine is stopped to enter a 'Run Time Code', these codes describe every possible state that a machine is in, these include: 'Running'; 'Planned Maintenance'; 'Set-up' etc. Until a code is entered the machine cannot be restarted. The 'Run Codes' and their duration times are saved to database tables to form a complete history for the machine.

'Set-up' codes will prompt the operator to enter further information relating to all changes made to the machine, this information can be summarised with the card by card process data to explain possible changes seen in the process parameters.

PD4000 controllers are used on each line as remote interfaces, these allow the operators to enter utilisation information whilst at the machine without moving to the controlling PC, the PD4000 basically acts as a message centre, mirroring the PC's prompt for information to the operator. Code numbers can be entered from either the PC or the controller, once completed the controller returns to displaying the time and date.

The utilisation records are examined on a daily basis and can show evidence of reoccurring faults, and can also provide the necessary evidence for investment in new machinery if all process lines are fully utilised.

Supervisory and Remote Monitoring

Process Programs

The process programs were originally developed for the DOS operating system and therefore do not benefit from the advantages that HUGO/VIGO now provide. Even so, these programs have been developed to provide two levels of use, the first is the full control version that is executed in the process area. The second version is the 'Master' program, which is for supervisory and remote use, the program displays identical information and can be executed from several PCs at the same time, from any location. The 'Master' version is produced using

'pre-compiler directives' to remove all control functionality (e.g. P-NET 'STORE' commands) from the program. Single source code changes are reflected in both program versions just by re-compiling.

Information displayed by the 'Master' version is acquired directly from the P-NET measurement channels or accessed from holding registers. These registers are located within spare memory space available in P-NET controllers or process modules. Their task is to reflect information that has been manually entered or calculated by the local PC, this information includes Batch No. Supervisor names etc. Trend data is transmitted via the local PC to holding registers located in the PD4000 user interfaces. When the 'Master' program is executed these holding registers are accessed to provide the remote user with a common source of information. The data held for the graph trends relate to several hours of process history, without this ability the 'Master' program would have no historical process information and could only trend data from the time the program is executed.

This same approach can be used with the HUGO/VIGO software, this communications interface simplifies the address configurations on multi-net systems, and also enables PCs connected to the 'Local Area Network' to interrogate the P-NET system, without the requirement for a PD3920 PC to P-NET interface card being installed.

The PnetView Program

The 'PnetView' has been designed to run with Microsoft Windows® and the Proces-Data HUGO/VIGO P-NET interface, the program has been developed in house using Microsoft Visual C++® and the Microsoft Foundation Classes®.

The program has the following features: -

- Enables access to the P-NET system from any PC connected to the P-NET Fieldbus or the Novell 'Local Area Network'. The Fieldbus only runs within the manufacturing areas, whereas the 'LAN' goes to every PC at MediSense.

- Enables users to design custom process views, or select from a library of pre-created views.

- Provides a common set of controls to allow access to all process types, including real time trend information located in the data loggers.

- Hides all the complexities of the P-NET system from the user, the user selects from a list containing familiar identity names relating to process.

- Process view information is held within Microsoft® Access relational databases, accessed by ODBC drivers.

- Provides printed copies of trend displays and alarm information.

- When the TCP/IP protocol is supported by the HUGO interface, the 'PnetView' program should be capable of operation over the 'Wide Area Network' and enable monitoring of P-NET equipment installed at other sites.

The use of the HUGO/VIGO and the 'PnetView' program has made the P-NET system accessible to any person or office on site, this has increased the general awareness of what the system is and what it is capable of. Many offices now have dedicated PCs running the program full time to provide managers, supervisors and engineers with an instant status of any manufacturing area.

Figure 8.   *The above 'PnetView' screen is typical of what a user can design at run time. This is an actual snapshot of information from our 3 Siebler Packaging machines, which combined pack over 2 million sensors a day. The darker figures are in RED and are highlighting low yield figures, and run time codes relating to the machine being stopped. In this case all 3 machines are stopped for the following reason; 322 = Print Registration Fault, 712 = Planned Maintenance and 311 = Printer Set-up. This screen has been designed for management interests, more detailed information is available in each process area as detailed in Figure 7.*

The original design of the program was based on the HUGO/VIGO Beta release for Windows 3.11, the design of the 'MIB' database in this version did not allow easy maintenance of the P-NET properties for large multi-net systems. Due to this weakness the P-NET node information was contained in a Microsoft Access database table named 'PnetNode'. This table contains all the information required to configure a VIGO object at runtime including the full IPX to P-NET address strings for each node that could be accessed.

With the latest version for Windows 95 and HUGO/VIGO release version 3.0, the program combines elements of the 'PnetNode' database and the improved 'MIB' database. The 'PnetNode' database removes the complexities of the P-NET from the program user, all the user has to do is select from a list of familiar P-NET reference names. The MIB is used to provide pseudo nodes representing the loops and controller locations. The program appends the 'PnetNode' field to the address supplied by the VIGO object after setting the Physical ID to the pseudo node value contained in the 'PNetMIBIdentity' field e.g. MediView:Loop1. This approach provides easy configuration of the P-NET addressing using the program 'NetEdit' to suit various PC net configurations and locations and to allow a single source 'PnetNode' database to be maintained for all users.

Microsoft Access - [PNETNODES : Table]

File Edit View Insert Format Records Tools Window Help

IDPNet	PNetSelect	PNetEnabled	PNetRef	PNetDev	PNetMIBIdentity	PNetNode	PNetSWNum	PNetOffset	PNetBitNo	PNetDataType	PNet
115	1	0	Siebler 2, Spare	0		00	0x00	0	0	0	
116	1	1	Siebler 2, Time Analysis, Run Code	3010	MediView:Controller1	02	0xE9	106	0	2	
151	1	1	Siebler 2, Environment, Stand Out, Temperature °C	1611	MediView:Loop1	70	0x50	0	0	7	
152	1	1	Siebler 2, Environment, Stand Out, Humidity %RH	1611	MediView:Loop1	70	0x60	0	0	7	
153	1	1	Siebler 2, Environment, Gullotine, Temperature °C	1611	MediView:Loop1	71	0x10	0	0	7	
154	1	1	Siebler 2, Environment, Gullotine, Humidity %RH	1611	MediView:Loop1	71	0x20	0	0	7	
155	1	1	Siebler 2, Yield, Process, %	3010	MediView:Controller1	02	0xE9	100	0	5	
156	1	0	Siebler 2, Spare	0		00	0x00	0	0	0	
157	1	0	Siebler 2, Spare	0		00	0x00	0	0	0	
158	1	0	Siebler 2, Spare	0		00	0x00	0	0	0	
159	1	0	Siebler 2, Spare	0		00	0x00	0	0	0	
160	1	0	Siebler 2, Spare	0		00	0x00	0	0	0	
201	1	1	Siebler 3, Counter, Row of 50 IN	3120	MediView:Loop4	32	0x12	0	0	4	
202	1	1	Siebler 3, Counter, Row of 50 OUT	3120	MediView:Loop4	32	0xD2	0	0	4	
203	1	1	Siebler 3, Counter, Incomplete Stack	3120	MediView:Loop4	32	0xC2	0	0	11	
204	1	1	Siebler 3, Counter, Foil	3120	MediView:Loop4	32	0xA2	0	0	11	
205	1	1	Siebler 3, Reject Pouch Counter, Both Camera's	3120	MediView:Loop4	32	0x102	0	0	11	
206	1	1	Siebler 3, Reject Pouch Counter, Camera 1	3120	MediView:Loop4	32	0xE2	0	0	11	
207	1	1	Siebler 3, Reject Pouch Counter, Camera 2	3120	MediView:Loop4	32	0xF2	0	0	11	
208	1	1	Siebler 3, Reject Pouch Counter, Electrode Missing	3120	MediView:Loop4	32	0x32	0	0	11	
209	1	1	Siebler 3, Reject Pouch Counter, Double Height	3120	MediView:Loop4	32	0x42	0	0	11	
210	1	1	Siebler 3, Reject Pouch Counter, Strip in Seal	3120	MediView:Loop4	32	0x52	0	0	11	
211	1	1	Siebler 3, Reject Pouch Counter, IR Check (Hole)	3120	MediView:Loop4	32	0x62	0	0	11	
212	1	1	Siebler 3, Reject Pouch Counter, Max Sealing Time	3120	MediView:Loop4	32	0x72	0	0	11	
213	1	1	Siebler 3, Reject Pouch Counter, Sealing Roller Lifted	3120	MediView:Loop4	32	0x82	0	0	11	
214	1	1	Siebler 3, Reject Pouch Counter, Code Reader Fault	3120	MediView:Loop4	32	0x92	0	0	11	
215	1	1	Siebler 3, Reject Pouch Counter, Minimum Stack	3120	MediView:Loop4	32	0xB2	0	0	11	
216	1	1	Siebler 3, Reject Pouch Counter, Cross Cutter	3120	MediView:Loop4	33	0x12	0	0	11	
251	1	1	Siebler 3, Reject Pouch Counter, No Perforation Hole	3120	MediView:Loop4	33	0x22	0	0	11	
252	1	0	Siebler 3, Spare	0		00	0x00	0	0	0	
253	1	0	Siebler 3, Spare	0		00	0x00	0	0	0	
254	1	0	Siebler 3, Spare	0		00	0x00	0	0	0	
255	1	1	Siebler 3, Time Analysis, Run Code	3010	MediView:Controller4	05	0xE9	6	0	2	
256	1	1	Siebler 3, Environment, Packing Hall, Temperature °C	3240	MediView:Loop4	6A	0x90	0	0	5	
257	1	1	Siebler 3, Environment, Packing Hall, Humidity %RH	3240	MediView:Loop4	6A	0xA0	0	0	5	
258	1	1	Siebler 3, Environment, Foil Store, Temperature °C	3240	MediView:Loop4	6A	0xB0	0	0	5	
259	1	1	Siebler 3, Environment, Foil Store, Humidity %RH	3240	MediView:Loop4	6A	0xC0	0	0	5	
260	1	1	Siebler 3, Yield, Process, %	3010	MediView:Controller4	05	0xE9	0	0	5	
261	1	0	Siebler 3, Yield, Process, %, Calculated by P-Net Mod	3120	MediView:Loop4	32	0x130	0	0	5	
262		0	Siebler 3, Spare	0		00	0x00	0	0	0	

Record: 43 of 1805

P-Net MIB Identifier   NUM

VIGO

Files   Help

MIB View | Projects | PC Port group

Global identifier   ☑ Show nodes   ☑ Show V

MediView:Loop1

- MediView
  - ⊞ MediLogVer103
  - ⊞ MediLogClock
  - Loop1
  - Loop2
  - Loop3
  - Loop4
  - Loop5
  - Loop11
  - Loop38
  - Controller1
  - Controller1T
  - Controller2

Net Editor

File   Help

Project: MediView

Net Identifier: LOOP1

IDC: P-NETIDC

Local port: IPX

IPX address   00000034-0060080F3561

Remote port   01

Address to net   04 01 03 01 02 01

☐ Initialization required   Details
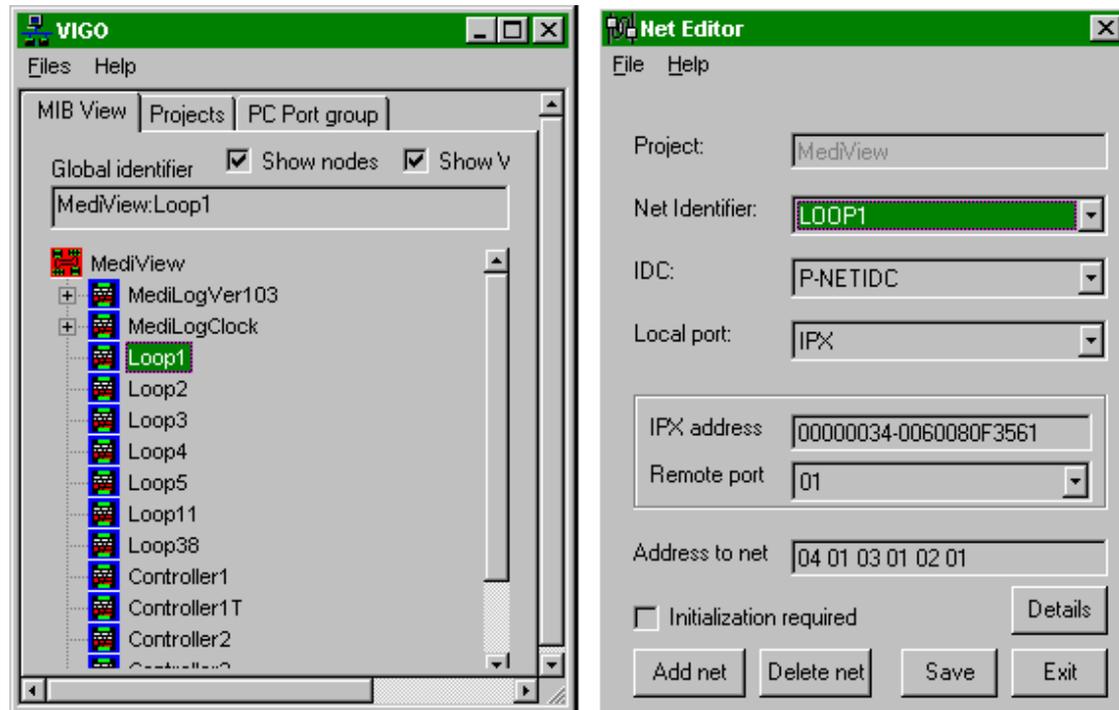
Add net   Delete net   Save   Exit

Figure 9. *The Screen displays above show the relationship between the 'PNetMIBIdentity' field within the Access database and the address to the net provided by the 'Loop' elements in the MIB and the Net Editor. Controllers are treated separately as these are located between 2 P-NET loops. The 'PnetView' program appends the 'PnetNode' field to the end of the MIB generated address string to complete the full address to the module. The operator of the 'PnetView' program selects an enabled P-NET element from a drop down list box containing the referance names supplied by the 'PnetRef' field.*
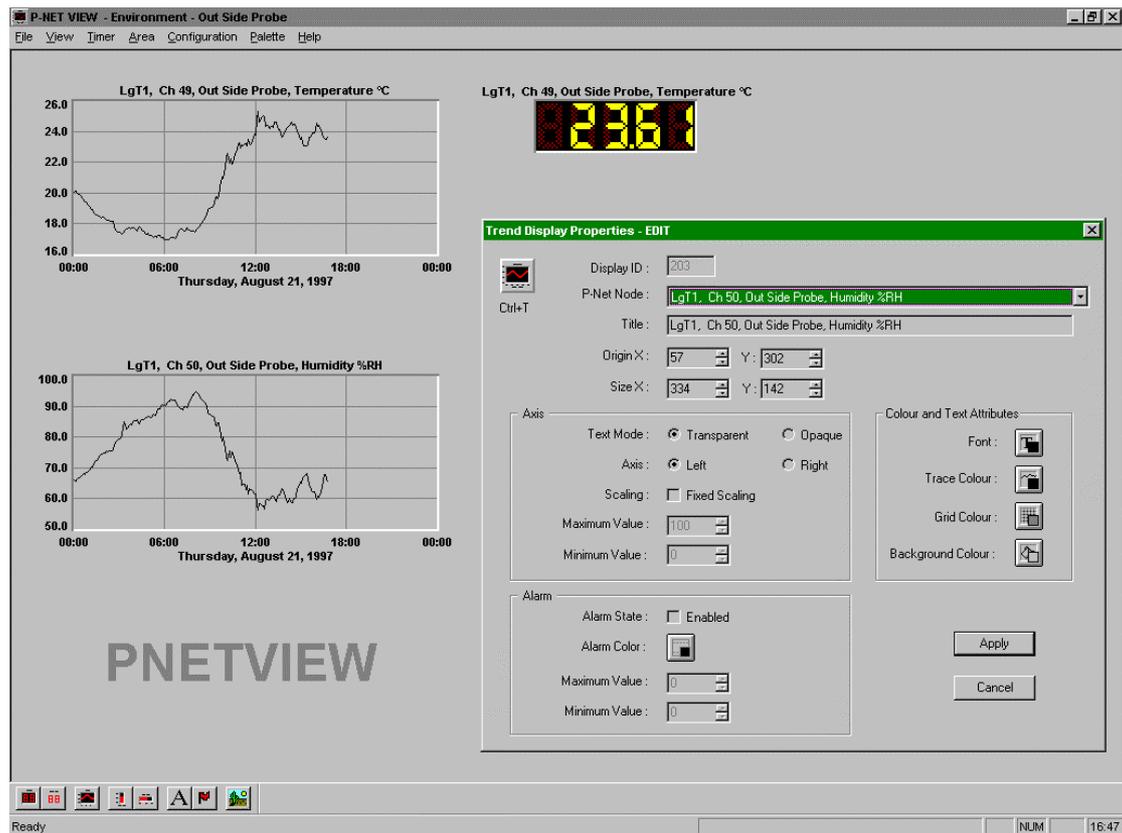
Figure 10. *The above example shows a variety of screen controls; trends, digital and text displays. The trend displays are generated directly from the environmental data loggers and can show up to 5 days of historic information. The digital display shows the measurement value from the same analog module being accessed by the data logger. The dialog box represents the user-defined configuration for the trend display located lower left of the screen. NB. The user selection of the desired P-NET Node is from the highlighted drop down list box, no other P-NET configuration by the user is possible, and the default title becomes that of the selected node. The types of P-NET elements available for selection depend on the display control in use, i.e. Text displays only reference strings, Trends can only access loggers, Status displays can only access Boolean flag states etc.*

A dedicated Novell/P-NET gateway has been installed. This gateway provides simulatanious access to the P-NET system by 'PnetView' users located on the 'Local Area Network'. The gateway consists of a PC with both a 'LAN' and P-NET adapter card installed, the network drivers and VIGO programs are loaded, but the system is not 'logged in' to any network server. The gateway using the beta release of HUGO/VIGO has been in continual use for over 12 months and has not required any hands-on attention.

All new PC based applications will use the HUGO/VIGO program and will contain both P-NET and 'LAN' adapter cards, this configuration will allow each system to perform a dedicated monitoring/control task as well as providing all the requirements of a gateway between the two network systems. This will eventually provide a gateway service on all P-NET loops, increasing performance by reducing cross loop communication.
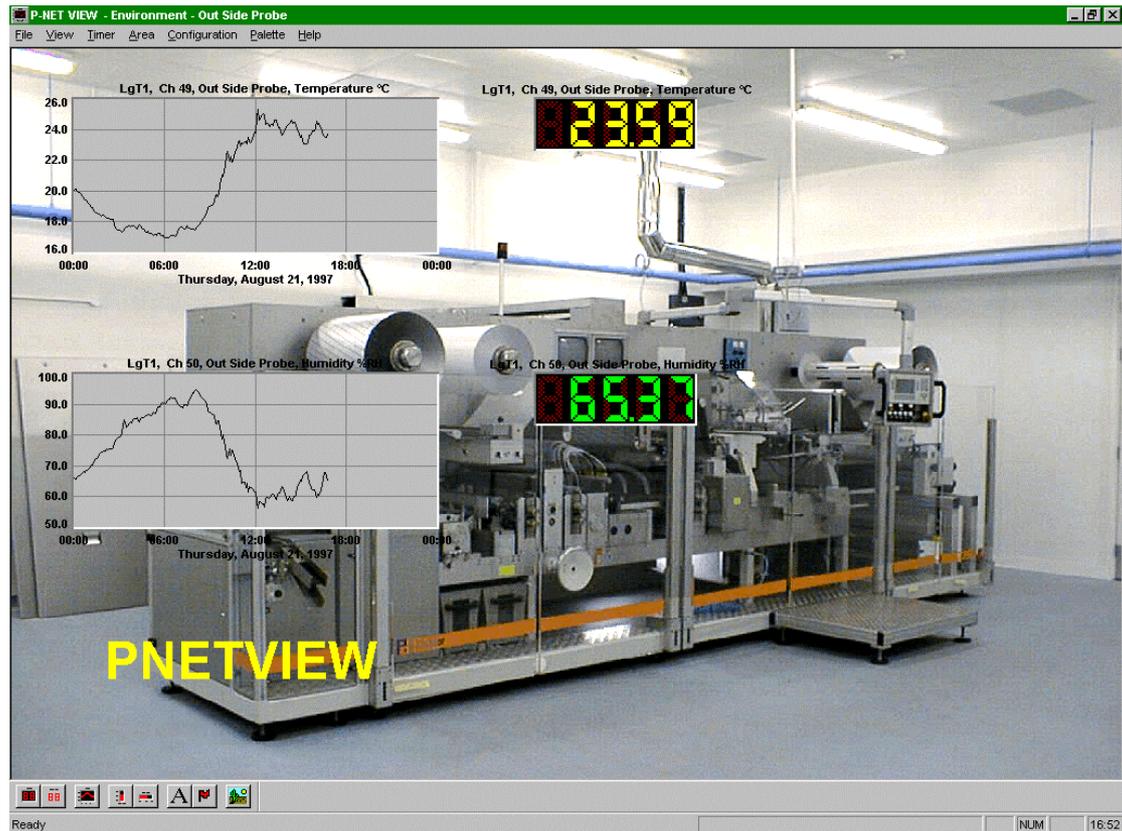
Figure 11. *The program also allows the addition of bitmap images to be displayed, this image is of a packing machine obtained from a digital camera, we have also converted autocad building plans into bitmap images to show the actual temperature, humidity reading in the correct locations on the plan.*

Summary

The P-NET system has grown with MediSense's requirements, due to it's distributed nature each system can be installed and validated as if it they were a self contained installation, with all the additional benefits that the fieldbus system provides. Although MediSense now has a large investment in the P-NET system the original outlay was minimal.

The system has been extremly reliable. From a hardware point of view, MediSense have experienced only 2 module failures in 5 years, both of these failling during the initial bench test.

The ability to combine the P-NET system and the Novell 'LAN' has made the system far more accessable to all departments on site and has raised it's profile from being purely a manufacturing system to an Information System for managerial use. This in turn has promoted the P-NET system for use in all new application areas.