

Instant HMI

Mobile HMI for Monitoring, Diagnostics and Control

February 2007

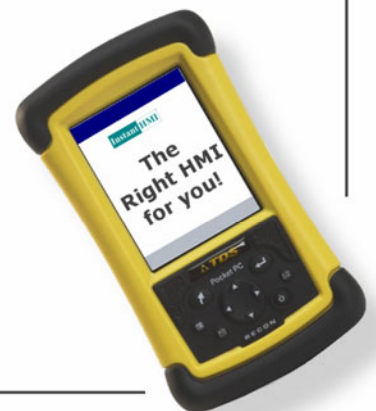


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1 Human Machine Interface is a Crucial Link

Good decisions require timely and accurate information. In Machine / Process control the appropriate sensors provide access to the critical information. Automated control systems can and do perform the control functions. In the absence of adverse events, everything works as it should and no human intervention is necessary.

Our view of 'plant' allows for plants to be outside and distributed as well as inside the four walls of a factory. While PCs in the framework of Data Historians are excellent work horses for collecting huge amounts of data, the InstantHMI philosophy is to enable the incorporation of "Discrimination, Integration and Distillation" into the data collection and analysis process. PDAs bring mobility, flexibility and agility to the data collection process.

InstantHMI maintains information items in a Tag Database. Graphical Display of Screen Objects presents useful information. InstantHMI provides Communication Interface to link Screen Objects with Data Sources (machine sensors) and includes several tools (data logging, trend viewing, etc.) that may be useful in the process of data analysis to extract the useful information from data.

Any enhancements in productivity require a better understanding of the process at hand that can lead to the design and implementation of better monitoring and control strategies. In any process/machine control situation the human operator is the crucial element. The operator can be the strongest or weakest link in the chain depending on the information at hand. Critical process information in your hand enables good decisions. Handheld PDAs can serve as platforms with links to crucial information. Information links to the process/machine under control may be wired (serial / Ethernet cable) or wireless (Infrared, WiFi, Bluetooth or Cellular). Wireless links un-tether the operator and enable **'any time, any place'** connectivity to the crucial information in a timely manner.

Portability and mobility are essential in many applications involving Configuration, Data Collection, Monitoring, Diagnostics and Trouble Shooting. The Windows CE, Pocket PC, Windows Mobile and Palm OS operating systems residing in portable platforms such as PDAs from HP/Compaq, Dell, Palm and others beckon application developers to harness these platforms to provide a convenient, cost effective and portable Human Machine Interface (HMI) solution. Companies such as Symbol, Intermec Technologies, and TDS provide PDAs that trade off some compactness for ruggedness while incorporating additional functionality such as barcode scanning. Wired communication links are the norm with most controllers. Since most PDAs also have built-in Infrared transceivers and readily support wireless RF (WiFi and



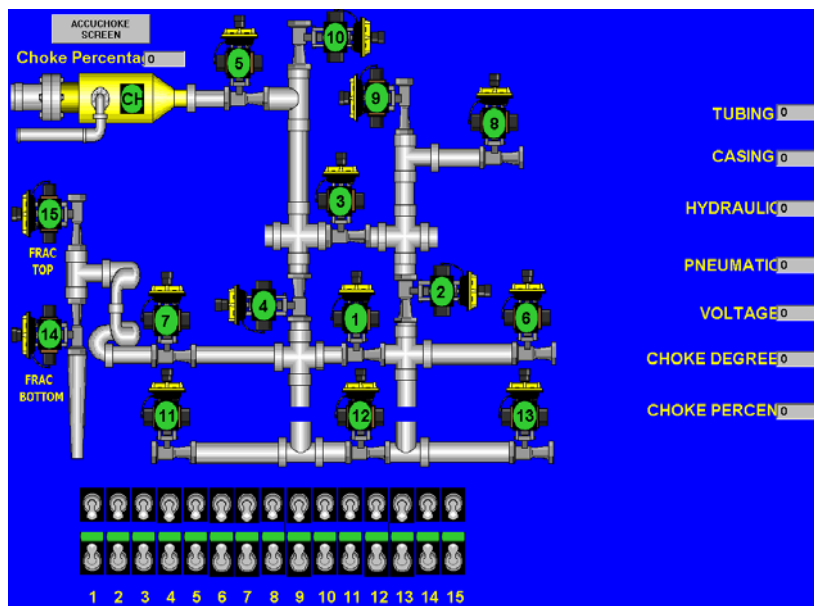
Bluetooth) capability, un-tethered (Electro-magnetic) communication links to the controllers is possible wherever the controller communication interface can be converted to a wireless medium.

Mobile Monitoring & Control systems are being used in various fields: Oil & Gas, Transportation, Agriculture, Public Safety and Law Enforcement, Sports and Athletics, Manufacturing, Supply Chain, Healthcare, etc. The example applications discussed in this article illustrate some of these aspects by providing answers to questions such as the following:

- How does InstantHMI enable access to data through mobile devices such as PDAs and cell phones?
- How can InstantHMI help process plants to improve their operations?
- What are some of the technical challenges involved with implementing and using these mobile monitoring products?

2 Oil & Gas industry Applications

2.1 Wireless Hazardous Area Off-shore Oil Rig Monitoring & Control



Oil and gas industries require reliable and secure communications to ensure operational safety and safeguard production. When our customer decided to construct a handheld wireless control system for onshore and offshore usage in a classified area, they identified three important aspects for a solution applicable to the project:

- Operating in a Class 1 Division 1 area necessitated a handheld control panel or a PDA rated for the classified area that would be capable of successfully functioning as an HMI device.
- The HMI software must be capable of running stand-alone in the above handheld device with data logging and other desirable HMI functionality.
- Since the HMI software would also have to coordinate with existing PLC system from other non-wireless or non-classified systems, communication drivers and wireless links will be the key to the solution.

As the design process proceeded the customer discovered that they needed at least a Class 1 Division 2 wireless PC. This PC was to interact with and control their system, along with the PDA including data logging for pressure and position recording and monitoring purposes.

The customer was satisfied that Software Horizons' InstantHMI provided the solutions to their conceptual problems. InstantHMI running in a Class I Div 1 PDA makes the position, pressure, and other pertinent system data available in the palm of his hand. This affords the customer the luxury of controlling the positions of 16 very high pressure devices from a safe distance in a classed area with precision and dependability. (Pressure is 10,000 - 15,000 PSI (and can cause great bodily harm if it blows up).)

The system also includes InstantHMI running and logging data on a portable Class 1 Division 2 wireless touch screen PC for the customer's use inside of a control room nearby. The system controls a skid. Accu-choke initiates a PID control in the PLC - proportional valve pressure goes from 10,000 PSI to ambient. If it deviates more than 2 % system goes into manual mode.

Toggle switches on InstantHMI screens Open and Close the valve. The valve state is indicated by Green (Open), Red (Closed), Yellow (opening or closing-in motion), Blue (Stuck - not moving) in Alarm condition. Valve position, hydraulic pressure and other data are logged in the PDA for wireless transfer to PC.



Previously the operators of this hazardous activity were bound to long runs of cable and air-lines as well as other needed lines. With InstantHMI, today everything to operate the system is located on a single skid. The control interface action of the system is 100% located on the Class 1 division 1 PDA and the portable Div 2 PC. Everything is wireless.

2.2 Engine Control in Gas Flow and Compression Applications



Interface to Well Manager used in oilfield automation (using Modbus RTU protocol). Used for datalogging oil field controller variables of interest (about 70 registers to be logged using 'Rodometer' register as a trigger).

This application uses a Pocket PC with built-in WiFi to communicate with the controller on the engine. A Serial to Ethernet converter and an access point were used to give the Modbus port wireless capability to link with the Pocket PC. The 24 channel trends of interest are monitored on screen using any selected group of channels. The screens consisting of data fields, touch zones (with bitmaps to provide desired appearance), screen navigation zones, trend plots etc. are created using the InstantHMI LaunchPad development system and deployed on the platform(s) of choice. Trends may be captured and their History reviewed and analyzed later as desired.

3 Transportation Industry Applications

Mobile PDA-based InstantHMI has been used in Airline Cabin Training Simulator for a major airline (B747/A300 Cabin Evacuation Procedures Trainer). The trainer is designed to provide the following:

- a. Training of crew members in normal and emergency procedure evacuation drills
- b. Passenger handling
- c. In-flight fire fighting
- d. Cockpit crew disentanglement/escape procedures

The Instructor Station executes and controls the computer lesson plans developed by the instructor. InstantHMI on a wireless PDA provides access to control menus available to the roving instructor.



4 Agriculture Industry Applications

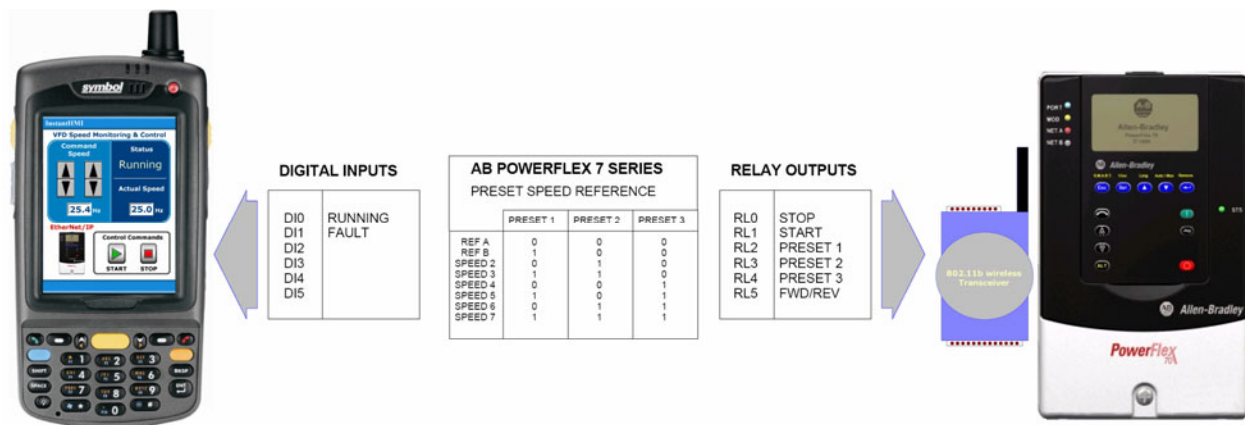
4.1 Agricultural Research - Field Planting R&D

Instant HMI is used in an 'agricultural research implement (tractor)' for field data acquisition. The machine uses a Unitronics PLC to control the equipment functions and collect bench mark data. This data is then passed to an IPAQ Pocket PC running Instant HMI in a datalogging mode to store each bench mark test. The Pocket PC allows immediate review of data being collected, and stores all tests for later download and analysis. InstantHMI provides a handshaking bit with data logging to ensure no data will be lost while transferring from the PLC to the Pocket PC.

4.2 Winery Tank Farm Application



The task is controlling pumps in a tank farm equipped only with basic starters with the option of controlling VFD pumps as well. Attached block diagram shows the basic concept.



We have shown the Allen Bradley Powerflex 7 Series as an example, but the Yaskawa and others are similar in function. Essentially we are configuring the relay contacts to duplicate the hardwired controls normally found on the local pump control panel with the exception of the speed control pot. Most such applications do not need infinitely variable speed control, three discrete speeds will cover 99% of customer's applications.

InstantHMI on a PDA differentiates among 20 or so different pumps, however only a maximum of 5 may be running at any one time, and usually no more than two. Customer has plans to install access points in a mesh network to cover the entire tank farm shown in the picture.

4.3 Fertilizer Application

A two-tank fertilizer industry biometric blending system 'status monitoring and control' is implemented in the wireless PDA.



5 Public Safety and Law Enforcement

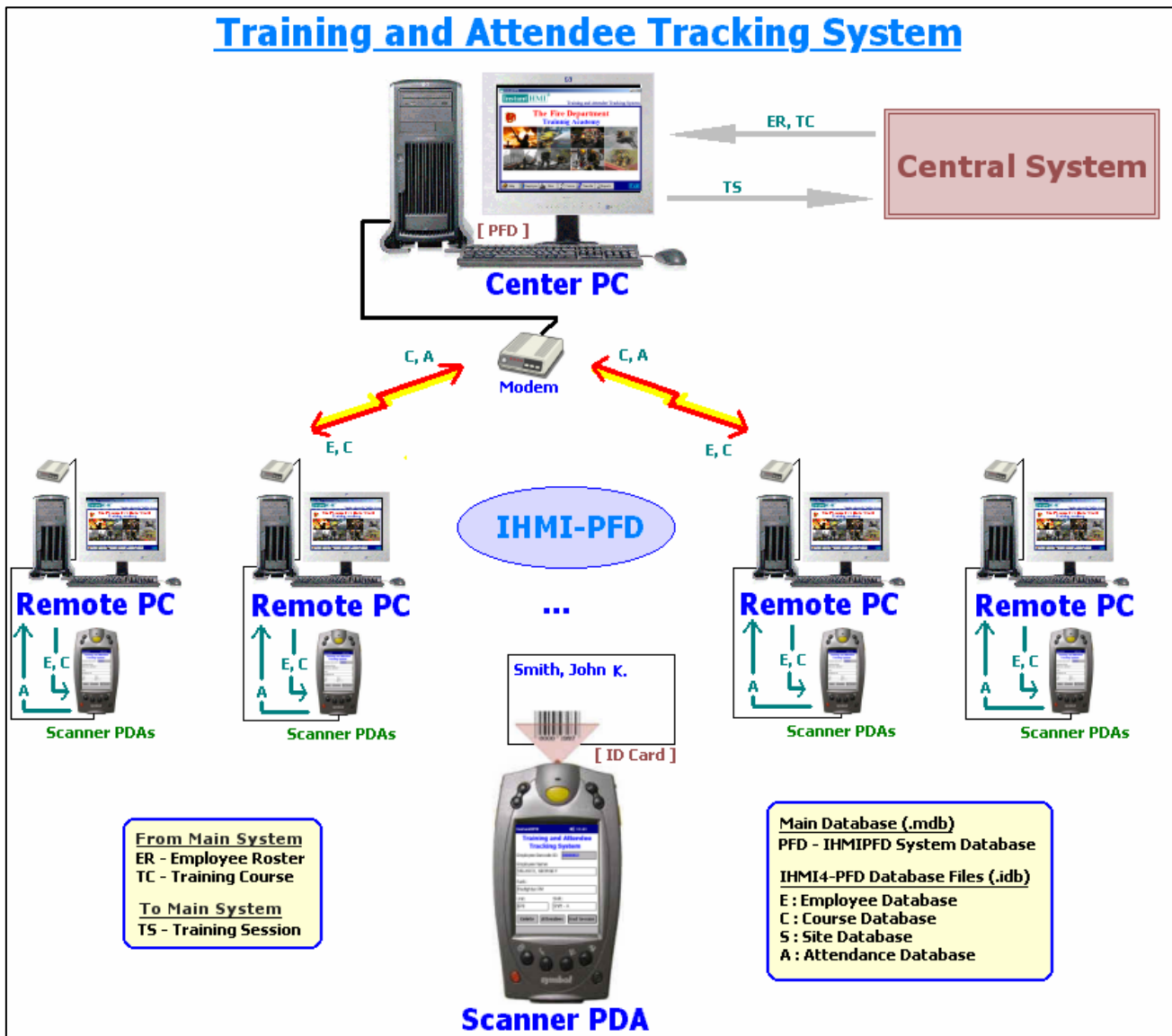
5.1 Attendee Training & Tracking

The City Fire Department conducts Training classes on hundreds of topics intended for over 1400 employees. The Training Sessions may last over several days and may be conducted at several sites. The department needs to track attendance by its employees at various training sessions and provide this data to the Central System.

The InstantHMI Training and Attendee tracking system includes InstantHMI (Server) software deployed on the Training Center PC, InstantHMI (Client) software deployed on six Remote PCs, and InstantHMI (PDA) software deployed on several portable handheld barcode scanners to accomplish the above objectives. InstantHMI accepts Employee ID data and Training Class ID data from the Central System, and generates Trainee attendance data for transfer back to Central System.



InstantHMI software running on the Training Center PC allows the transfer of Employee/Course information from the Central System. The bar-coded badges for Employees (Attendees) are printed here on plastic cards using the barcode printer. The Badges are delivered to the attendees by the Training Center. The Employee/Course information may be entered or edited on the Training Center PC; however, Employee/Course data is not sent back to Central System which is responsible for maintaining the integrity of the employee/course data. Training attendance data (generated at the training sessions and transferred to Center PC) may be printed at the Center PC as a Session Report (list of attendees at any specific Training Session) or Attendee Report (list of courses attended by a selected Attendee).

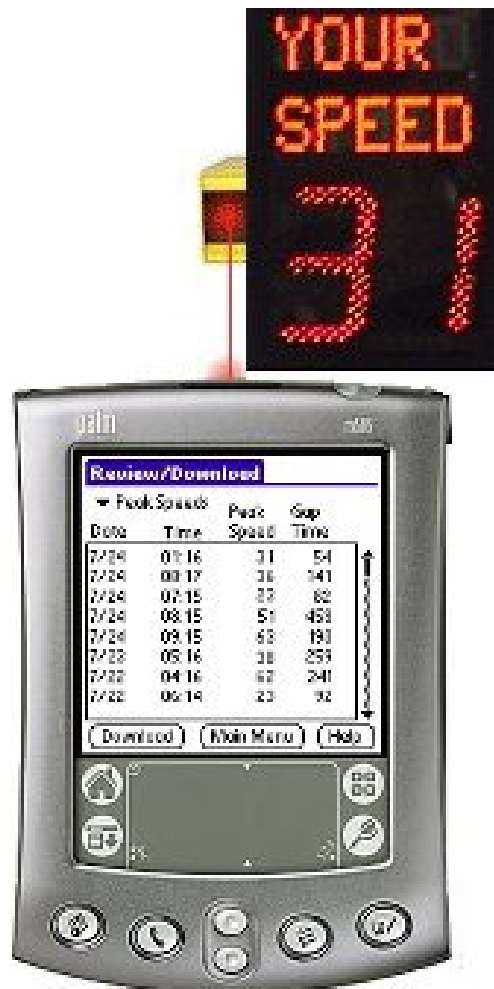


The InstantHMI software running on Training Center PC and Remote PCs may be used to transfer data files over telephone lines using modems pre-configured for this purpose. The Employee and Course information is transferred from the Center PC to Remote PCs. New course information may be created at the Remote PCs or the Center PC. The Employee and Course database will be transferred from the PCs (Center or Remote) to the Scanner PDAs using a serial cradle connection.

The Training sites use InstantHMI software on PDA with barcode scanners to scan the attendee badges at any training Session. The scanned attendance data is stored in the PDAs so that it can be transferred at a convenient time to a Remote PC (or Center PC). The attendance data can be transferred from the Remote PC to Center PC at a later time. The transfers between the Remote PCs and the Center PC will be made using modems via simple Buttons provided for Dial out, Transfer etc. The transfer between the PDA and the PCs will be done using a serial cradle.

5.2 Traffic Monitoring

Traffic Calming Signs display motor vehicle speeds to make the operator aware of unsafe speeds. InstantHMI in a PDA with Infrared interface is used to access and download data logged in Traffic Calming Signs. Such data may be used for deploying enforcement officers to areas recording unusually large safety violations in critical areas such as School Zones.



5.3 Prison Security Monitoring & Control

Correctional Institution application in a rugged PDA Symbol PPT8800 involving wireless access to PLC data (status of gates, presence of guards, etc.).

6 Sports and Athletics

6.1 Sports Training Evaluation System)

InstantHMI is used in an OEM application involving Sports Training Equipment used in Football training - Blocking sled with sensors load cells, Toshiba PLC T1, 24V control box - portable, Data transmitted (about 2000 registers unsigned integers) wirelessly to the sidelines about 50' away, to touch panel InstantHMI.

6.2 Snow Making System/Process Monitoring and Control

This is a PLC based control, with InstantHMI wireless network of PDA and PC nodes for supervisory control, data acquisition, system verification and trouble shooting. The prototype checkout system includes some items for testing and gathering data on the snowmaking nozzle performance.



Snow making begins at about -2 degrees C. A gun is used to mix compressed air with water and blast it into the air where it will freeze and fall as snow. Colder the temperature greater the amount of snow that can be produced. InstantHMI Datalogs the current outside conditions (temperature, wind speed/direction etc.) and gun settings. This information is then used (along with knowledge of the process) to fine tune gun settings based on datalogged outside condition information and thus optimize snow making.

During the testing period, most data logging in the PDA was user initiated. For example, while making snow it is desired to log the current conditions and gun settings (on demand when a screen button is tapped). During the testing period, the InstantHMI interface helped finalize baseline flow values and multipliers to be used in the final system, where the multipliers will be pre-set and not user adjustable.

7 Industrial Machinery

7.1 Commercial Sewing Machine Setup and Control



This application implements a 'language free interface' for the setup of a line of commercial sewing machines from a multi-national corporation. The Palm PDA displays iconic touch zones for the various functions implemented in a Yaskawa programmable motion controller. The InstantHMI interface includes a PLC program flashing capability. The communication link is either serial or infrared using an IR-Kit to convert the serial port to infrared.

7.2 Configure and Monitor Temperature Controllers

InstantHMI has provided a portable IR link to configure and monitor data from Watlow SD Temperature Controllers with built in IR transceivers. The operator does not need to carry any cables, and can upload and download configurations, perform diagnostics etc. using a Palm PDA that he can carry in his shirt pocket. The efficiency and simplicity of being able to pre-create, save, and download controller configurations in multiple controllers saves valuable engineering time and guaranteed high return on investment.

Figure shows the IrDA protocol in action. Application 1 (InstantHMI with IR communication driver) running on a Palm PDA is beamed at the IR transceiver of a Watlow SD controller running Application 2 (Watlow SD firmware incorporating a complementary IR communication driver). The communication link is 'air' and the Physical IrDA hardware layer in the PDA and SD.

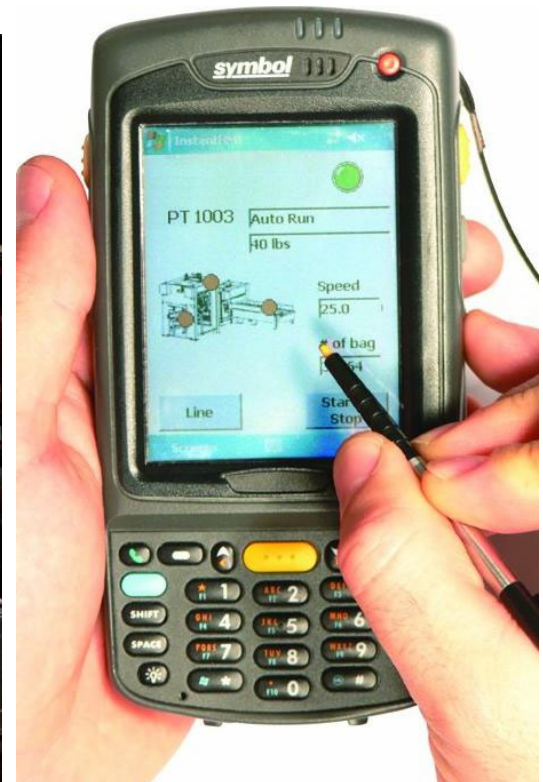


7.3 Robot Programming using Infrared

InstantHMI on a Palm PDA enables 6 axis ABB Robots to be programmed and serviced without lugging a cart full of equipment around. An IR-kit was used to convert the serial port to Infrared, to link with the built-in IR port on the Palm.

7.4 Packaging Machinery Monitoring & Control

These machines are used for packaging peat moss products. The controllers on these machines mostly are Allen-Bradley ControlLogix. The OEM customer has started to introduce InstantHMI on Pocket PC using WiFi as the communication link for monitoring purposes. Before introducing InstantHMI, customers had to walk to the top of the machine to start/stop the machine or determine any problem with the machine. With the use of the PDA customers are able to see the issue with the machine directly on the wireless PDA and start/stop the machine remotely, minimizing valuable down time. The machines include the Form, Fill, and Seal Baggers, Automatic Palletizer, Robotic Palletizer, and Stretch Wrapper machines.



7.5 Quality Assurance Testing of New Trucks

A large truck manufacturing company is interested in quality control of the drives on their two axle and three axle, 185 – 365 HP trucks on the dynamometer. The control system includes programming for 4-axle testing capability and the selection of four wheelbase lengths. The operation requires the operator to drive the truck on to a platform lift and then lower it on to four sets of rollers for testing. Using InstantHMI software on the Symbol ruggedized PDA serving as an Operator Station, the operator can perform all his tasks from the driver's seat in the cab of the truck. The Operator uses the integrated Barcode scanner on the handheld PDA to scan the VIN (Vehicle ID) into the system in addition to the Operator ID. This allows activation of the test procedure. InstantHMI processes the scanned bar codes and uses the wireless RF capability built into the Symbol PDA to transmit the barcode to the Allen Bradley PLC, which is programmed to perform the test sequence. The wireless unit allows for operation of the motor lifts and test sequences all from the cab of the truck. Test results are presented by HMI software on a Windows PC monitor positioned in front of the truck. InstantHMI provides this Windows based HMI access to the crucial barcode information wirelessly over RF link. Testing includes brakes, flywheel horsepower, cruise control, parasitic losses, and transmission shifting

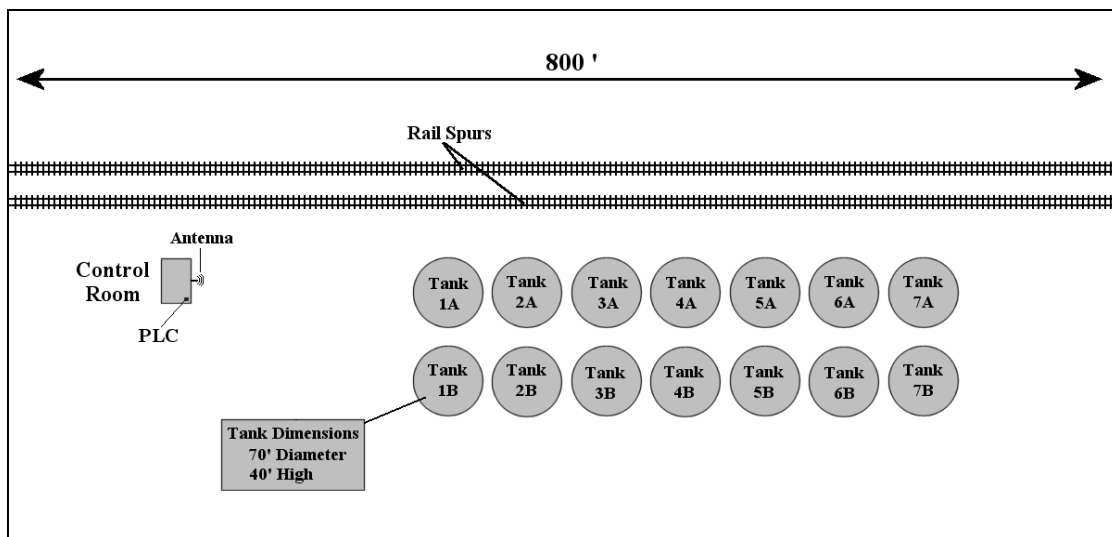
all initiated from the cab of the truck. Upon completion of tests the results are printed. The Operator then drives the truck off the test stand and starts the procedure over with the next brand new truck. The test duration is approximately 20 minutes.

InstantHMI makes it more convenient to initiate the different aspects of the test without leaving the driver's seat in the cab of the truck and thus affords a hassle-free setup. In addition, avoiding cumbersome cable and other wired connections to the new truck protects damage to the new truck body and protects its mint-condition. Simplified testing procedure helps minimize errors, allows fault diagnosis, and provides corrective actions to ensure reliable testing. Efficient throughput in terms of number of vehicles tested is assured with minimal waste of time. Due to immediate feedback on the handheld, barcode efficiencies are 100%, human errors due to data entry are eliminated, and test results are reported promptly, thus ensuring the highest possible system efficiency.



7.6 Off-loading of Ship cargo onto Railroad Cars

InstantHMI has been used in an application involving off-loading of ship cargo onto railroad cars where the operator moves from car to car while the PLC and the control room are several hundred feet away. It is not feasible to have a display monitor for operator feedback. A handheld PDA equipped with a CF (compact flash) wireless adapter and InstantHMI software gives immediate real time wireless access from anywhere in the coverage area (800'x 200') to the relevant PLC variables and enables remote monitoring and data entry. Mobile range of over ¼ of a mile was accomplished with a di-pole antenna mounted at the PLC end while the PDA had an easily portable tiny CF adapter with built in antenna.

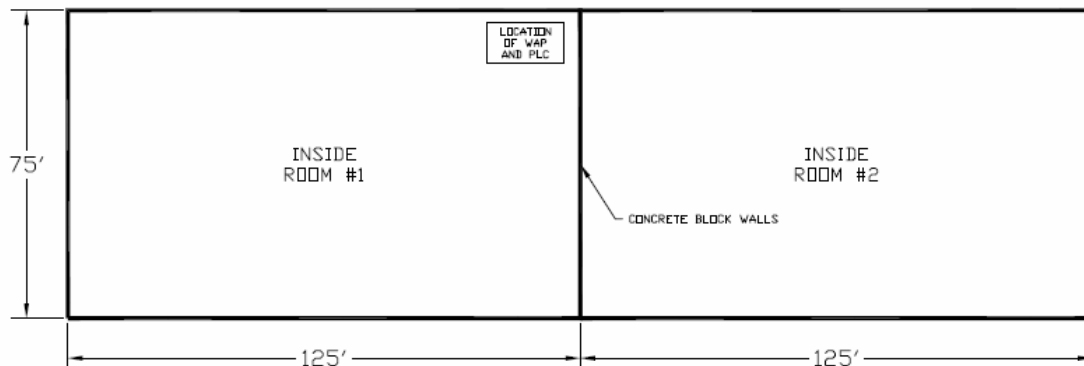
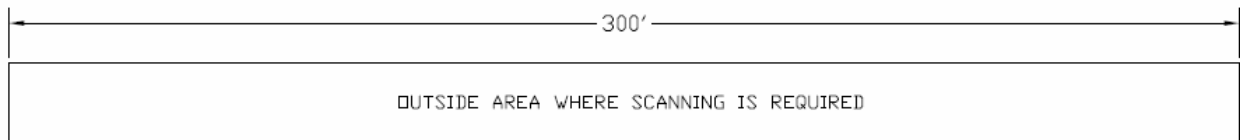


InstantHMI in HP/Compaq iPaq Pocket PC uses wireless communication to monitor and/or modify data in Allen Bradley PLC remotely from anywhere in the antenna coverage area.

7.7 Plastic Parts Manufacturing-Supply Chain Monitoring

Plastic pellets from Company A (a major plastics manufacturer) arrive via railroad cars at the parts manufacturing facility. The cars are bar-coded for raw material tracking. Trucks from Company B transport the plastics to some locations and use the bar-coding to generate 'bill of lading'. Totes are used for transporting the pellets to near-by locations. Company C manufactures plastic-parts to be shipped to Company D (an automobile manufacturer) which uses the plastic parts in its assembly. A major supply chain problem arises when the wrong plastic parts are supplied to the automotive manufacturer (due to use of wrong color pellets, for example).

InstantHMI provided a rugged-PDA based wireless solution (barcode scanning and validation) to solve this supply chain problem. The application required roving operators to read a Master barcode, read a second 'Rail Car' barcode and read a third 'Tote' barcode and if all three match place the Rail car in the Tote. The manufacturing facility uses Allen Bradley PLCs (serial or Ethernet built-in). The success of the solution depended on the wireless transfer of barcode to PLC (150'-200') by a single roving operator (Room 1, Room 2 and outside Railroad area) using a mobile rugged PDA.



7.8 Sample Preparation in Electron Microscopy



Qualitative analysis of data from an Electron Microscope demands that samples are correctly and consistently prepared. Denton Vacuum incorporates its thin film experience in the Desk III. Using Denton's patented anode grid, the sputter cathode minimizes heating of the sample, which can cause damage to the sample.

A simple to use and intuitive Pocket PC interface is implemented in InstantHMI to efficiently operate the Desk III sample preparation system. Sample preparation details are stored in the PDA while the powerful 'Transfer Data' facility makes it possible to transfer a record of the sample preparation conditions directly to a remote PC or to the microscope itself. Automation and data storage are achieved using InstantHMI installed in a conventional Pocket PC. The deposition characteristics can be saved with the microscope data using a wireless link.

7.9 Wireless Control of Cranes used in Truck Body Finishing

This application requires wireless coverage over a large area covered by the 22 trolleys and hoists used to transport new truck bodies from station to station. Multiple access points are required to enable the roaming operator(s) with PDA based InstantHMI to wirelessly access the programmable controllers mounted on the 22 trolleys. Operator will be alerted to any alarm conditions at any of the trolleys/hoists as it happens. Operator can selectively view any variables of interest and initiate any control commands.

8 Conclusion

Wireless IR and RF (WiFi) technologies supported by low cost PDA hardware and the availability of HMI software that can stand-alone on these platforms have made Truly Mobile HMI a reality. In addition, the emerging Bluetooth option and the plethora of newly released high resolution PDAs have enhanced the functionality of Mobile HMI.

The Human Machine Interface (HMI) software in conjunction with a wireless link to relevant information lends a helping hand to the human decision maker to zero-in on the critical sub-system that needs his attention and take appropriate timely action. The critical information, which may be logged for later thorough analysis, can be accessed remotely (over cellular network or Internet) and available precious human resource can be redirected or dispatched where needed. Next generation HMI technology that can be deployed simultaneously on multiple platforms including Windows PC, PDAs (Palm and Pocket PC handhelds), Smart Phones (Windows Mobile) and Windows CE devices has arrived.