PRIMS™ 1993126
COMPUTER INTEGRATED SHOT PEENING SYSTEM

by D. DeVos and W. Barker
Progressive Technologies, Inc.

ABSTRACT

Many surface enhancement applications must monitor and log process-critical parameters. These requirements stem from a need to perform SPC analyses on the process database and provide a historical record of process information for future analysis and adjustments. In 1990, S.A.E. issued specification AMS-2432 establishing engineering requirements for computer monitored shot peening. To meet this specification, shot peening control systems must continuously monitor and record virtually all aspects of the peening operation.

PROGRESSIVE TECHNOLOGIES developed the **P**rocess **R**eporting **I**ntegrated **M**onitoring **S**ystem or **PRIMS™**. The PRIMS™ systems is our latest generation user interface and data logging system developed for shot peening, grit blasting, waterjet, and other similar processes.

KEYWORDS

Data logging, SPC, shot peening, waterjet, blasting, PRIMS, GUI

BACKGROUND

Shot Peening Process

Shot peening involves propelling steel, glass, ceramic or other materials onto a material substrate in order to convert the shot's kinetic energy into residual compressive stresses at the substrate surface. The applications and reasons for peening are many, but the fundamental process parameters remain the same. For the purposes of this paper, we will be discussing pneumatic methods of propelling shot.

Key Process Parameters

There are many methods to determine the residual stresses imparted to a material's substrate. However, most if not all of the methods require the parts to be inspected off-line and requires destructive testing.

Because of these facts, most peening applications require a setup person to check the peening coverage and intensity at production start-up and then periodically check them throughout the process to "monitor" the peening results. But this method is based on the assumption that the main peening parameters are consistent between test samples. If one desired to know if each part was peeked properly, the typical methods would prove to be impractical for a production operation.

With no other real-time measurement alternative, the logical next step involved monitoring the vital peening parameters on a continuous basis throughout the peening process in order to assume proper results. This method still requires that the correct parameters be determined via traditional methods, but once the parameters are identified they can be stored as a process recipe and computer controlled in closed-loop fashion.

As long as no one can identify the proper media flow, air flow, air pressure and relative part and nozzle motions that produce acceptable parts, then it is possible to control them for each peened part and provide for data logging of the results. Our PRIMS™ Process Recording and Integrated Monitoring System is based on these simple principles.

Related Specifications

A number of shot peening specifications call for computer monitored shot peening including: Society of Automotive Engineers (SAE) AMS-2432, United States Military MIL-S-13165C, and General Electric Aircraft Engines P11TF8. In addition, a growing number of peening processes are now using SPC and require extensive data collection.

PRIMS™ SYSTEM HARDWARE

Transducers

Sensors are used on the process to provide relevant information on the critical parameters that define if the process is "in control". For shot peening, this includes:

- Shot Flow Sensors - Available when metallic medias are used. This can take the form of a flow sensor, or a combination flow sensor/metering valve combination. This equipment has been well marketed, and is widely used. Current technology is repeatable to 5% of full scale.
- Air Pressure Sensors - Provide data on the blasting pressure. Current technologies provide excellent, low-cost transducers in the 1% accuracy range.
- Air Flow Sensors - Measure the blasting air stream flow. Vortex shedding, or thermal measuring techniques are used to produce a signal with 5% repeatability.

Knowing these three variables, along with media size, allows us to very accurately predict and monitor the peening effects on the parts to be processed. When used with water jet processes, PRIMS™ uses sensors for that process such as water pressure and water flow.

Computer Hardware

A standard PC-compatible computer is used as the center of the hardware system. This provides good compatibility with other equipment, puts the user's mind at ease in terms of maintenance, and provides an excellent price/performance ratio that improves daily, as new equipment comes to the marketplace.

Input/output boards are Industry Standard Architecture (ISA) bus designs, available from many vendors. High speed is not required, as most sampling is done at a rate of 2-10 Hz. Either 12 bit or 16 bit resolution is available, with 12 bit being used most often.

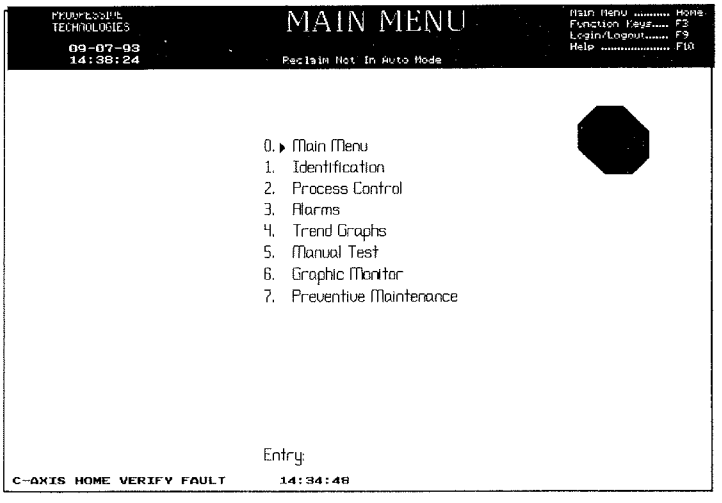
The computer hardware, along with a color VGA monitor, is mounted inside a NEMA-12 enclosure, which is air conditioned. This provides a rugged system, which is truly at ease on the factory floor. Our processes demand this level of protection.

PRIMS™ SYSTEM SOFTWARE

Introduction

The PRIMS™ software was written in-house at our facility in the "C" language, which was chosen for its high speed and full-featured programming environment. From the onset, our goal was to write a program that was "configurable" by our users and engineers WITHOUT changing the source code of the software. The end product exceeded our expectations! This has allowed us to easily support the software, offer upgrades to existing users, and permits our users to change screens, help messages, etc., without the high costs of custom software. The following screens are descriptions of our standard package, but are not intended to limit your imagination. We can easily configure special screens for unique requirements.

Main Menu Screen



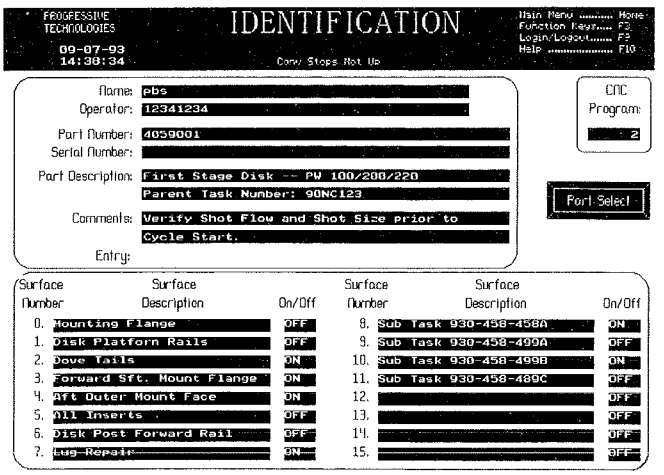
The first screen is a table of contents for the system, listing all the other screens. It shares three pop-up boxes with all the others:

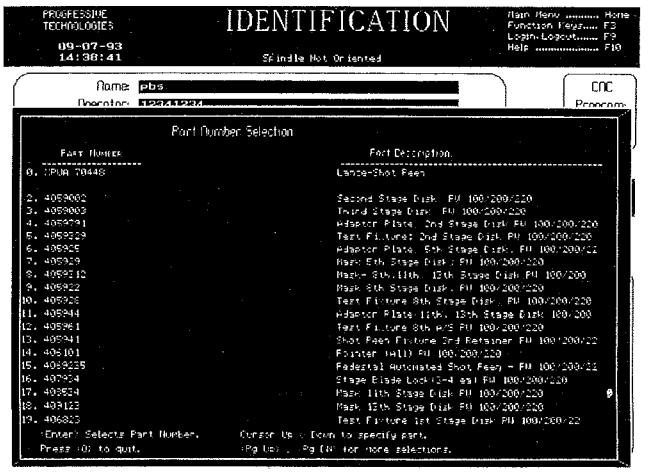
Security - Four levels of passwords are used to enable the user to maintain control over the operation of PRIMS™. The pop-up box allows users to log in with their password. Four levels of password protection are available.

Function Key Help - This pop-up lists all the function keys and what they do.

Context Sensitive Help - Every item displayed on the screen as well as all alarm messages have context sensitive help messages associated with them. One keystroke provides specific help information, allowing even first time users to master the system quickly. Also, like almost everything in PRIMS™, the help messages can be edited by the users after the system is in operation.

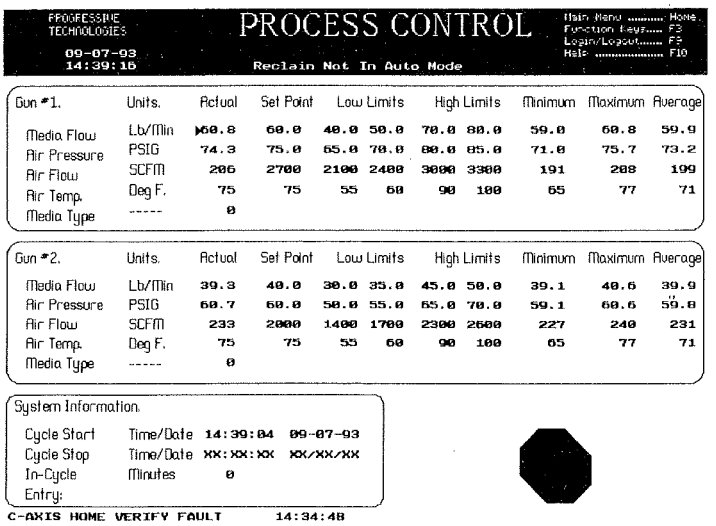
Identification Screen





Here the user selects the part number to be processed, and enters the serial number. Parts are made easy-to-select with our pop-up parts list. A "Surface Select" feature allows the operator to pick certain areas on the part to be processed, while skipping others, minimizing total program time by running only the applicable sections.

Process Control Screen

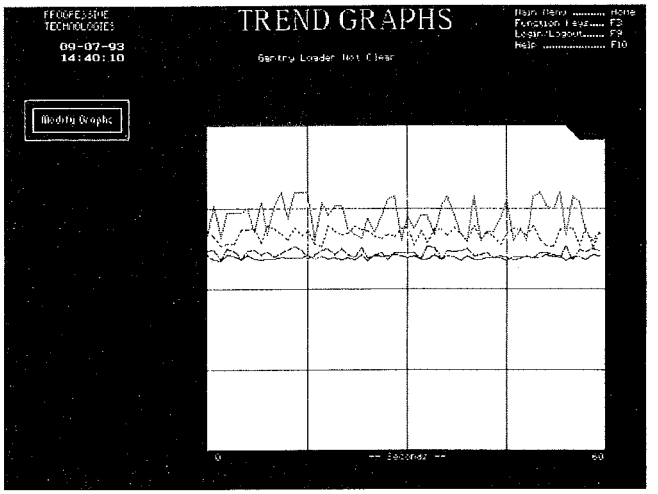


All process parameters are displayed and updated continuously. Measured variables, current setpoint and alarm and shutdown limits are all displayed on this screen. It also shows the minimum, maximum, and average values for each measured variable. Examples would be shot flow, air pressure, and air flow. As the system is running, these values are being stored by the data loggers. The alarm, and shutdown limits are continually compared against the actual values for fault annunciation. PRIMS™ becomes an integral part of the machine cycle control, as it interrupts the cycle if parameters exceed shutdown limits.

Alarm Screen

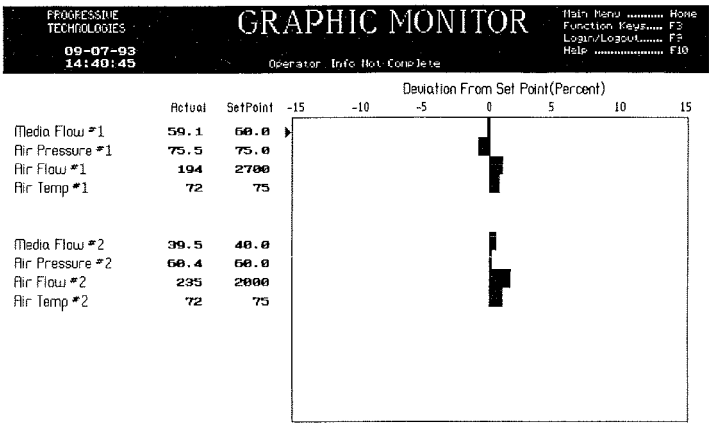
Alarms are displayed, along with a time stamp on this screen, and then stored on disk file. Expanded help messages for each alarm are available by pressing the help key.

Trend Graph Screen



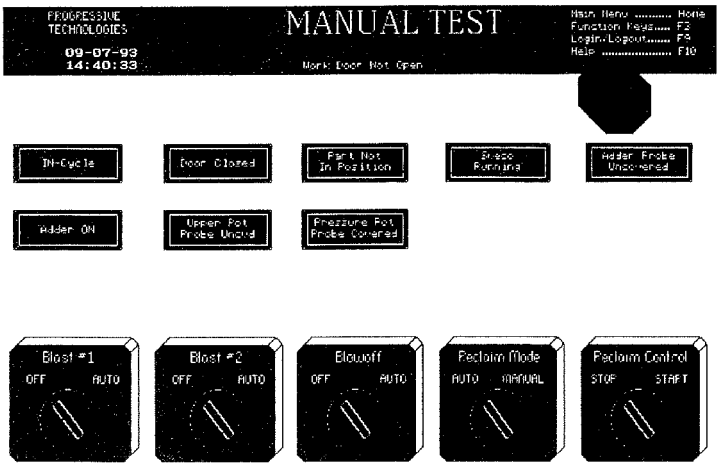
This acts as an on-screen chart recorder, graphing actual values on the screen as selected by the operator. Up to four "pens" can be selected for four simultaneous lines on the graph. The display can be "frozen" and stored to disk at any time to review.

Graphic Monitor Screen



Each process parameter is shown as an animated bar graph, with deviation from setpoint shown in green, yellow, and red colors.

Operator Push-button Screen



The Operator Push-button Screen displays simulated push-buttons, which enables the operator to manually control the sequence of operation for testing and troubleshooting. Since help is available for each key, it becomes an on-line training system for each button.

DATA COLLECTION

Data Logging

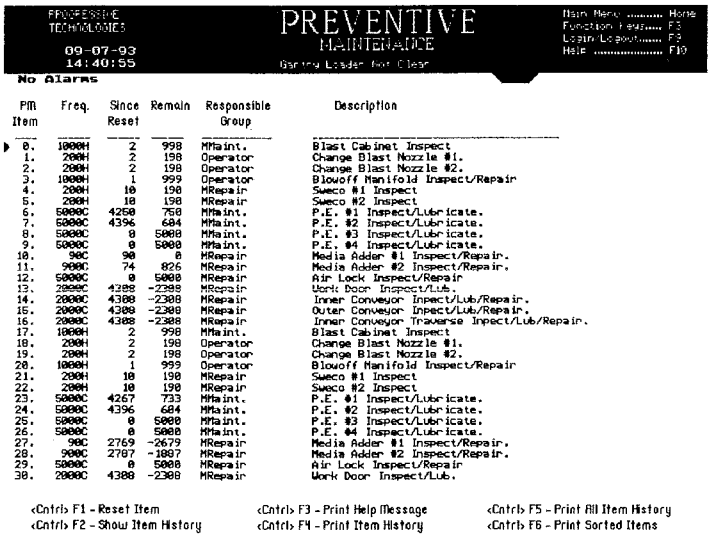
Any parameter displayed can be logged to disk. Factory supplied data logging setups can be modified by the user. Log files are compatible with Lotus 123, and printing macros are supplied. In some of our installations, network cards are installed in the PC, allowing the system to log directly to the user's host computer.

Reports

Start of Cycle, End of Cycle, Alarm Log, Flight Recorder, plus two user defined reports are available. The contents of all reports are configurable by the user.

PREVENTIVE MAINTENANCE

Preventive Maintenance Screen



PRIMS™ monitors up to 100 independent machine areas for time or cycles remaining until maintenance is required. The system tracks total hours/cycles, and hour/cycles remaining. A complete history of all maintenance tasks for each monitored component is kept on file. Maintenance Near and Due prompts as well as cycle inhibit commands for user defined Maintenance Stop conditions are provided. Systems come factory equipped with all required maintenance items, and new items can be added by the user. Also, each item has its own help message explaining the work to be done. These help messages can be printed, and are frequently used as "cheat sheets" by the maintenance person.

Preventive Maintenance (PM) Reports

PM History for a specific component, PM History for all items, and a Sorted list of PM items in order of when due are available from the PM system.

CONCLUSION

A system is presented which provides complete process monitoring and data logging for the shot peening process. The sensor technology and computer hardware used is not new, but is combined with a unique software package to create a totally integrated system for shot peening. There are many peening applications that would benefit from this technology, and it will go a long way towards converting shot peening from an "Art" into a "Science".

For more information on PRIMS™, please contact:

Progressive Technologies
4201 Patterson S.E.
Grand Rapids, Michigan 49512 USA
Tel: (616) 957-0871 • Fax: (616) 957-3484

D. Devos is the Chief Controls Engineer and W. Barker is a Sales Engineer at Progressive Technologies.