The Design for Real-Time Paper Perforation Quality Control

Hairulliza M. Judi, Noraidah Sahari and Kai F. Teoh

Abstract— **This paper discusses the process monitoring in producing perforated paper. Real-time quality control was conducted by using an integrated system. The proposed design are discussed in the paper, that unifies a close monitoring approach that features a helpful graphical user interface (GUI). With the data acquisition instrument that capture the analog signal of porosity reading and trigger alarming buzzer, the data were transferred directly to a client platform via universal serial bus (USB) or RS232 serial, it is dedicated to monitoring and controlling the perforation process with this real-time data collection.**

Index Terms— **Quality control, real-time, graphical user-interface.**

I. Introduction

Nowadays, companies are facing more stringent requirement from customers. Demand from customers to produce high quality products should be fulfilled if they want to ensure survival in global competition. The research is part of a consultancy of a medium-sized company in Malaysia that produces perforated papers. Continuous customer complaints and rejection of entire batch of bobbins have lead not only to financial lost, but also their moral and credibility.

The management was facing difficulties in responding to customer complaints since there is no systematic historical data as to which part of manufacturing process has caused to this problem. In particular, the serious quality problems are regarding three issues. First, poor perforation process monitoring. It is due to the fast speed of display reading, poor scale of plot on the control chart and no accurate porosity reading.

Second, loose control upon porosity test by ATEN machine. Upon completion its perforation, each bobbin will be tested by taking three readings at different locations at the end of bobbin randomly. Clear procedure was not available to support this activity such as tool to store the test or to supervise the judgment process. Third, lack of quality awareness in the organization.

II. REAL-TIME QUALITY CONTROL

Quality control emerges as an important topic during the industrial economy era. Quality can be defined as fulfilling specification or customer requirement, without any defect. A product is said to be high in quality if it is functioning as expected and reliable. Quality control is an activity to ensure that items are fulfilling these criteria.

There are wide available techniques to control product or process quality. Among the basic techniques is Statistical Process Control (SPC). SPC is a statistical approach for assisting operators, supervisors and managers to manage quality and to eliminate special causes of variability in a process [1]. SPC also plays an important role to actively identifying opportunities for process improvement [2].

Control chart is among powerful SPC tools that can be used to collect, organize and store information, calculate, and present results in easy to understand graphs. The control chart measures how consistently the process is performing, and compares the process performance to the customers' requirements [3].

With the ability of computers to accept information typed in manually, read from scanners or manufacturing machines, or imported from other computer databases, the resulting control charts can be examined in greater detail, incorporated into reports, or sent to users across the internet [4].

A computer collecting information in real time can detect very subtle changes in a process, and gives warning in time to prevent process errors before they occur. The implementation of a distributed quality information system requires gathering, processing, storage and the distribution of quality-related data among shop floors and central control office [5],[6]. Real-time quality control involves the processes, metrics, techniques, and systems appropriate to measure and manage the quality of a manufacturing process.

Real-time SPC would be a helpful solution for companies facing issues around lack of quality awareness, passive response. machine problem, unreliable incoming materials quality, tight customer schedule [4]. Effective utilization of IT in supporting operations especially in quality monitoring will be able to help quality assurance [7]. For example, the application of integrated quality assurance information system allow the company to achieve maximum effectiveness and full customer quality satisfaction [8].

Real-time quality control provides great efficiency to the management as it takes time to prepare manual control charts and the time allowed to perform meaningful data analysis is limited. Among the benefits are the ability of the production to provide all the charts they needed and responded flexibly to the demands of its employees, and the corporate staff in quality uses it to analyze monthly reports sent electronically by several divisions [4].

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III. DESIGN AND METHODOLOGY

The conceptual model in Fig. 1 depicts the conceptual model of the system that we proposed. It consists of several modules including real-time data collection module, graphical module and data storage module.

- Real-time data collection module: A personal computer (client) was connected to a real time data collector (hardware interfacing) and data acquisition instrument for data collection.
- Graphical module: A computer system that presents the information using a graphical user interface (GUI) that was designed and developed using Visual Basic programming to allow users to interact with the control chart that computed and generated in client) and online printer (a printing device to print the control charts and reports for further analysis).
- Data storage module: It consists of a file server station with a database (a dynamical design Access file format database) for system setting information, data storing and data retrieving

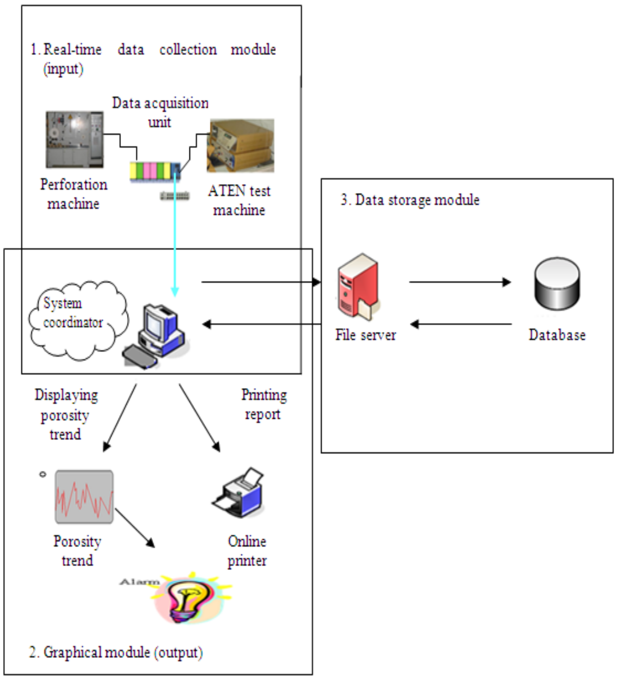

Fig. 1: Conceptual model of the system

Fig. 2 depicts the flow of the quality control procedure in perforation process. It involves porosity setup and running the production process. The porosity setup configures the perforation machine until it is conformed to produce the required porosity specification. For instance, a customer will order a batch of bobbins with different product specification: 30 bobbins of 2364LP2105-226, 50 bobbins of 2372LP1080-230.

In this case, the operator will split the order into two jobs. Before the operator can really start producing the bobbin for the jobs, he/she must configure the machine. This process will take an iteration of machine setup, test run and ATEN confirmation activities for some time (may range from 20 minutes to 2 hours).

After the completion of Machine Run Test, then the actual production can only be started. A new paper bobbin is loaded into perforation machine. With the previous porosity setup, observation will be made on the output reading on machine LED and trend pattern on control chart along the process. ATEN Confirmation Test is then conducted, if the porosity measurements are approved, the production proceeds to the next bobbin.

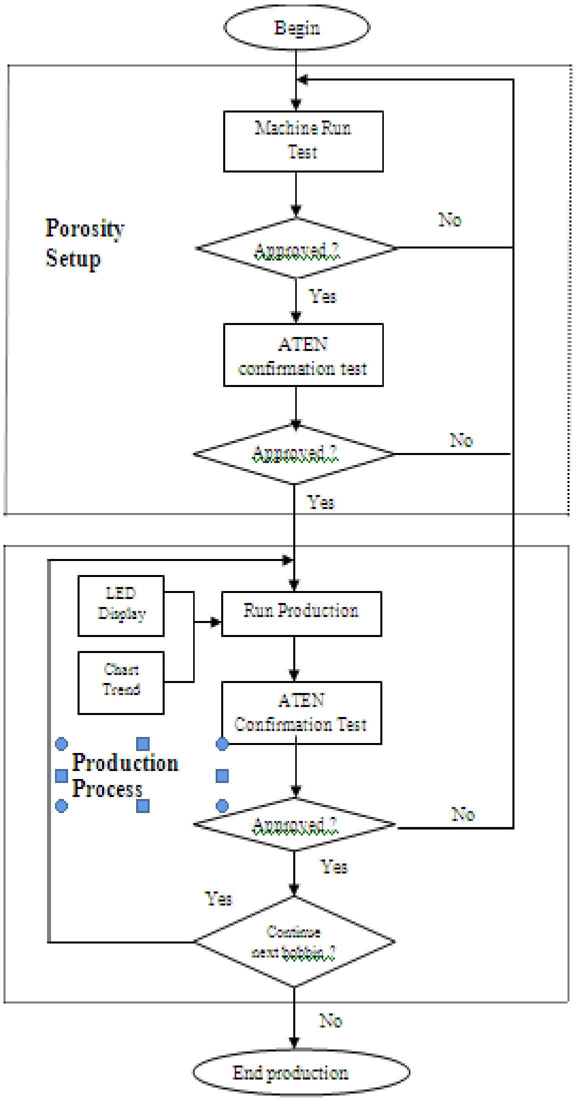

Fig. 2: Flowchart of the real-time quality control system

IV. EXECUTION

To validate our proposed model, the algorithm was coded to apply to a real world problem. Some of the modules in the prototype system are presented here. Fig. 3 illustrates the graphical module in production running. Fig. 4 and 5 depict the support for decision making to reject and accept the completed bobbin, respectively.

V. CONCLUSION AND FUTURE WORKS

The system provides more reliable quality control as porosity data could be checked automatically comparing to through operator's eyesight. Operator gets more satisfaction and confident by working together with a monitoring PC which is able to reflect the entire perforation process by reading the trend display on the monitor.

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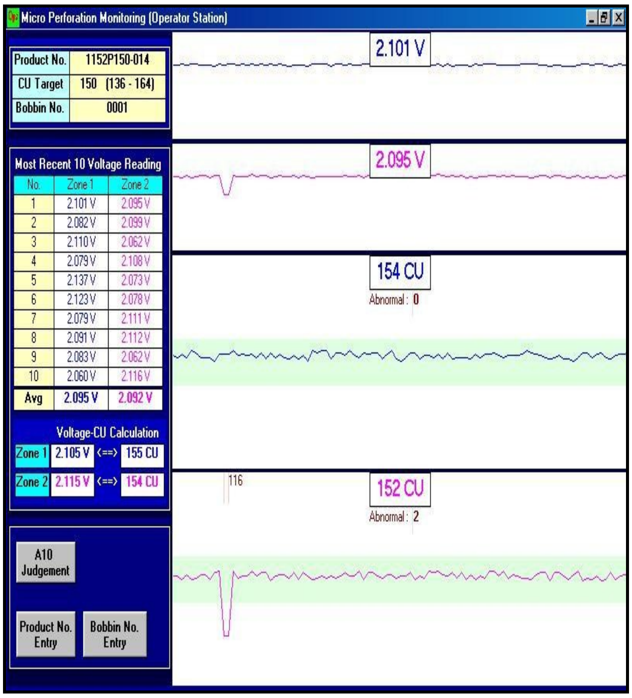

Fig. 3: : Lower limit error in production running

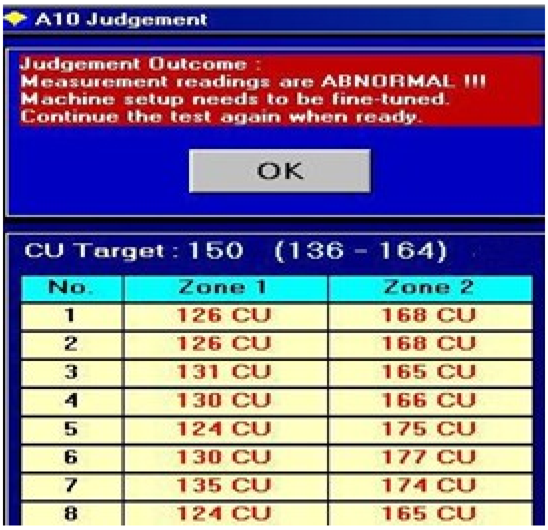

Fig. 4: Alert from ATEN Test

Fig. 5: Normal result from ATEN Test

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Real-time quality control is a stepping stone for this company to overcome the high rejection of its bobbin. In a long term plan, this company should consider other SPC tools to improve the process, such as analyzing important factors in porosity setup by using fish bone diagram and conducting process capability study as the process capability index could give guidance for accurate direction for quality improvement [3].

The tools serve not only in their technical aspects, but build an environment in an organization in which all individuals seek continuous improvement in quality and productivity [4]. This environment is best developed when management becomes involved in the process. Soon, the routine application of SPC becomes part of the norm, and the organization is well on its way to achieving its quality improvement objectives.

Workers acceptance to improvement programs is vital to the whole success of the company. Effective communication about quality awareness and enough technical training are required to develop the right environment [9]. The worker learning process will be able to harness their skills and knowledge to improve quality and productivity level as it creates atmosphere of trust [10], [11]. The emphasize given by the company to its people enable the workers to give invaluable contribution and participation to the company.

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