Quality control in network-based production environments

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A holistic, Internet-based approach to quality control integrates an information network, sensor data, decision support system, and a web-enabled production facility.

Lack of quality control is a major obstacle for information-based electronic manufacturing. In the future, critical functions associated with design, production, information storage, and business transactions will be Internet-based. Web-based gauging, measurement, inspection, and diagnostics have become important component issues in e-manufacturing systems and management.

Quality itself, more generally, constitutes a competitive strategy to avoid domestic job losses. In 2003 the Ford Motor Company claimed to have saved $1 billion through waste elimination after inaugurating a quality control effort in 2000. Improving product quality requires constant vigilance, state-of-the-art technologies including lean and high-tech manufacturing, various forms of automation, and other quality-enhancing techniques.

The Internet may be employed as an infrastructural component to integrate the various aspects of quality manufacturing, as shown in Figure 1. Constituents include networked sensors, web-controllable robots and machine vision systems, a high-speed computer numerical control (CNC) mill, server, and other switches and devices.

A holistic approach

The Internet-based quality control scheme we call E-Quality for manufacturing (EQM) refers to an approach to design that embeds efficient quality control in the context of network integrated manufacturing through the use of advanced sensor technology. The result is real-time, fully-automated quality inspection that is better suited to the contemporary production environment, with emphasis upon application of Internet-based technologies. The setup at Drexel University allows various ideas in EQM to be tested.

Figure 1. A quality control approach, called E-Quality for manufacturing (EQM), conceptualized within the framework of Internet-based manufacturing systems developed at Drexel University.

Progress to date

Currently, both Visual Basic code and the Java-based application programming interface (API) have been developed. Robot and vision systems are integrated into the network with individual IP addresses for easy access (see Figure 2). Inspection and quality control logics are embedded in the process server that connects the API, hardware, and decision functions related to quality inspection over the Web. Various image processing and analysis algorithms have been integrated for remote vision tracking of moving parts.

Newly-developed automated production and measuring instrumentation enables real-time inspection in which critical dimensions are constantly measured and verified while parts are being produced. This approach confers an immediate cost reduction advantage by terminating processing of defective parts.

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Figure 2. Snapshot of the application programming interface (API) developed for EQM.

parts at any stage of the manufacturing process. More importantly, remote accessibility and the ability to control equipment over the Internet or a local area network offer novel benefits. Designers at remote locations can carry out inspections and quality checks even as processes associated with both design and manufacturability evolve. Quality control and the process capability analysis can be tested and adjusted according to assembly and manufacturing specifications. Changes in product specifications and associated quality control routines can be instantly updated and verified, enhancing overall production efficiency. Critical to the future development of EQM will be integrating human decision-making and data from production lines streamed over network.

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