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An integrated approach to process control

Werner A.J. Schippers*

Eindhoven University of Technology, Faculty of Technology Management, P.O. Box 513, Pav. C12, 5600 MB Eindhoven, Netherlands

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Abstract

The control of production processes is the subject of several disciplines, such as statistical process control (SPC), total productive maintenance (TPM), and automated process control (APC). Although these disciplines are traditionally separated (both in science and in business practice), their goals have a great deal of overlap. Their common goal is to achieve optimal product quality, little downtime, and cost reduction, by controlling variations in the process. However, single or separated parallel applications may be not fully effective. This implies the need for an integrated approach to define, describe and improve the control of production processes. This paper discusses how controls from disciplines such as SPC, TPM and APC can be seen as a coherent set of efforts directed to the technical control of production processes. To achieve this, an integrated process control (IPC) model is introduced. The model provides a structure to get an overview of the functions of controls and their interrelations. It shows that there is no one best way to control a process: the optimal set of controls depends on the situation. The main contingencies are briefly addressed. The possibilities to use the model for prescribing, describing and improving control are illustrated. Finally, implications for business practice are discussed.

Keywords: Process control; Integration; Framework; Contigencies; SPC; APC; TPM

1. Introduction

The work described in this paper is part of a research that is focussed on structuring the tools of statistical process control and studying the possibilities to apply them in different situations [1]. Statistical process control traditionally uses output measurements to control the stability of a process and to detect causes of non-stability (out of control situations) [2,3]. However, as a result of the trend to strive for prevention instead of detection, SPC is shifting from controlling product characteristics to controlling process input and process factors. The goal of this shift is to detect and resolve problems in the process before they can lead to (in-stable) variation in the product. It shows that in some cases statistical tools such as control charts can be used to monitor process factors (such as furnace temperatures), but in many cases, other tools, such as maintenance and automated controls that are part of other disciplines than SPC, are used to achieve process control.

* Tel.: + 9 31 40 247 2716; fax: + 9 31 40 243 6492
E-mail address: w.a.j.schippers@tm.tue.nl. (W.A.J. Schippers).

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Thus, the control of production processes is the subject of statistical process control (SPC) but also of several other disciplines, such as total productive maintenance (TPM) [4], and automated process control (APC) [5]. In this paper we will focus on SPC, TPM and APC, because they are three well known and frequently used examples of disciplines directed to process control. However, one could think of other related "disciplines" that are directed to the control of production processes, such as source inspection and Poka Yoke [6]. Although each discipline has a specific approach to process control, there is a great deal of overlap between these disciplines because of their common goal: to achieve optimal process performance in terms of product quality, downtime, and costs, by controlling variations in the process.

Despite this overlap, these disciplines are traditionally separated, both in science and in business practice. In practice each discipline is often initiated by separate departments: SPC by the quality department and production; TPM by the maintenance department; APC by the engineering department. In these cases efforts to improve control tend to be limited to tools from one of these this disciplines, or in case controls from different disciplines are used, they are often not related to each other. This may result in single, or separated parallel mono-disciplinar applications. Since the tools from various disciplines are partly additional, but also partly overlapping alternatives, this situation may be not fully effective.

Also in literature the overlap of process controls did not result in an integrated approach to process control. Although literature from the separate disciplines partly claim the same area, most of the referred publications from these disciplines hardly mention each other. Instead they tend to refine and expand their particular field to the level of control programs, thus implicitly claiming a larger part of the working areas of other disciplines. If tools from other disciplines are mentioned they are often depicted as part of or supporting to the one described. Some papers discuss the integration of SPC and APC, but mainly focus on the mathematical aspects of integration [7–9]. Other papers discuss the integration of SPC-related techniques and TPM [10,11], but limit the discussion to management aspects. This paper however, presents a generic approach that also integrates process control tools outside the fields of SPC, TPM and APC, and addresses technical operation aspects of integration.

The first goal of this paper is to show the relations and overlap of controls from different disciplines, and thus the need for an integrated approach to process control. After a discussion of the working areas and overlap of SPC, TPM and APC, the need for an integrated approach is addressed. The second goal of this paper is to present a model that supports an integrated approach to process control, by providing a structure to describe and systematize the controls of a process. This model, the IPC model, is introduced and the possibilities to use the model for business practice and scientific purposes are discussed. Finally, conclusions and directions of further research are addressed.

2. Working area and overlap of SPC-, TPM- and APC process controls

The common goal of SPC, TPM and APC is to reduce and to control the variation in a process. To achieve this, they rely for a great deal on defining activities to monitor production processes. These activities will be defined as controls. In this paper, we will concentrate on these controls and their application in discrete production processes. We consider discrete production processes, because in this type of production, the overlap of different disciplines is clearly visible. To illustrate this overlap between the different process control disciplines, below we will give a brief description of the working areas claimed by SPC, TPM and APC. After this, we will indicate their interrelations by discussing examples of what can cause the need to consider controls from different fields as an alternative or combination.

2.1. Working area of SPC

The main goal of SPC controls is to achieve product quality by monitoring the stability of the