A Systematic Way of Achieving Total Continuous Process Improvement (TCPI) in an Industry

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ABSTRACT

This paper highlights the steps that are required to achieve total continuous process improvement in the production of products in a manufacturing industry. The importance of each step will be discussed and the strategies that need to be taken to achieve the objectives of each of the steps will be mentioned. The aim of this paper is to provide essential guidelines for operators, supervisors, engineers and managers so that they are aware of the various steps that need to be taken in achieving TCPI.

Keywords

Total continuous process improvement (TCPI); knowledge management; process capability; design of experiment; statistical process control

1.0 INTRODUCTION

Improvement should not be a one-time effort, it should be continuous. Constant improvement is the fifth of Deming's 14 points for continuous improvement (Deming, 1982). Everyone and every department in an organization must be involved in the process of continuous improvement. Houshmand and Lall (1999) study the implementation of continuous process improvement in the academic line while Werner and Rick (2000) discuss continuous quality improvement in the banking sector. A systematic approach that will serve as a guideline which allow us to organize and manage the available resources and utilize the best method for achieving continuous process improvement in an industry will be discussed in detail in the next section.

2.0 A TOTAL CONTINUOUS PROCESS IMPROVEMENT (TCPI) SYSTEM

An ideal TCPI system practice in an industry should comprise the following 10 steps which will be referred to as subsystems hereafter. Figure 1 gives a simple graphical illustration of this system.

2.1 Total Continuous Education (S1)

To introduce a TCPI system, first an education and training of the fundamentals related to the system is needed. This educational subsystem is designed in such a way that all the employees will receive important information and knowledge on a continuous basis to enable them to perform and complete their job

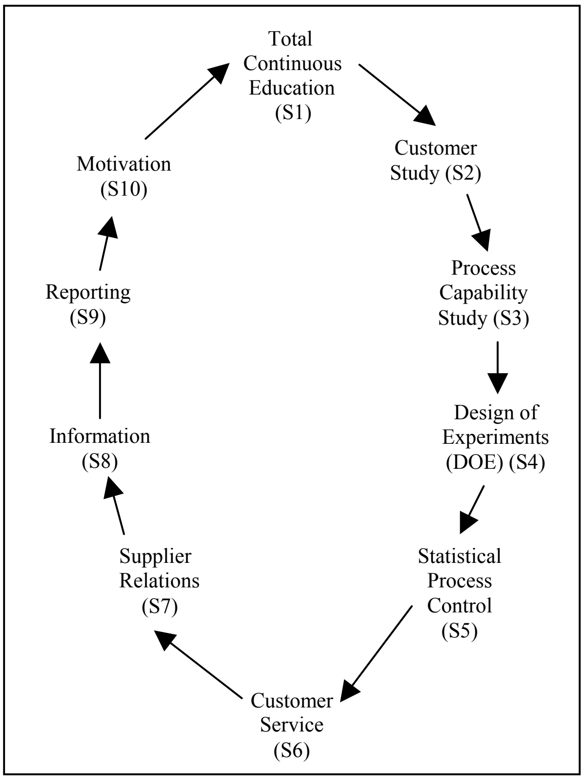

Figure 1. A TCPI System

successfully. This subsystem includes developing simple, yet effective educational methods and programs, planning and control, continuous consultation, motivation and stimulation.

2.2 Customer Study (S2)

It is important to study the needs of the customers so that an industry can design and produce its products based on such needs. It should be noted that these needs and expectations vary from one customer to another. The major elements in this subsystem are:

(i) Studying customers' requirements and translating those requirements into appropriate company requirements.
(ii) Searching for the industry's best practices and comparing them with the company's practices.
(iii) Developing long-term objectives and short-term targets.

(iv) Developing the company's strategies and tactics to achieve short and long term objectives and targets. Here, strategies developed should focus not only on just price, access to inventory, speed of shipping and other distribution issues but those that emphasize on producing sustained quality products over time so as to retain the existing customers and to attract new ones.

(v) Planning and scheduling of improvement activities and feedback analysis of accomplishments.

2.3 Process Capability Study (S3)

After translating customer requirements into operational needs, it is important to determine the capability of a process to see what should be done to make the company capable of meeting the set targets and objectives. A typical way of expressing process capability is in terms of the process capability ratio given by the formula (Montgomery, 2001a)

$$C_p = \frac{\text{USL - LSL}}{6\sigma}, \quad (1)$$

where USL and LSL are the upper and lower specification limits of the measurement of interest while σ is the measurement's standard deviation. Table 1 gives the recommended process capability ratio based on eq. (1).

Table 1. Recommended Minimum Values of the Process Capability Ratio

Criteria	C_p
- Existing processes	1.33
- New processes	1.50
- Safety, strength or critical parameter for existing process	1.50
- Safety, strength or critical parameter for new process	1.67

Heuvel and Roxana (2003), Montgomery (2001a), Kotz and Lovelace (1998) and Somerville and Montgomery (1996) provide excellent discussions for performing a process capability analysis. Process capability studies are performed on a continuous basis because the process elements such as material, people, machines, methods, product and environment are also continually changing.

2.4 Design of Experiment (DOE) (S4)

In subsystem 3, the process is brought into a state of control (stable). The importance of a stable process is that acceptable products can be produced for relatively long periods of time (Montgomery, 2001a). By bringing the process into control, we usually reduce the process variability and increase the process output. However, this type of improvement has limits that are related to the process potential, i.e., when a process is brought into a state of control, the best that one can expect from it is performance on its potential level. However, the problem is when this level is not good enough. Here, we need to employ the DOE methodology to change the system of causes. A DOE is a series of tests where the input variables of a process are purposely changed so that we may observe and identify corresponding changes in the output response. Figure 2 illustrates a process that consists of some combination of machines, methods and people that transforms an input material into an output product.

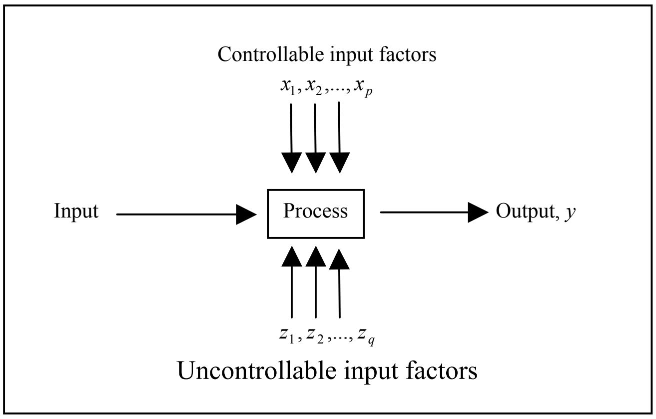

Figure 2. General Model of a Process (Montgomery, 2001b)

Some of the process variables $x_1, x_2, ..., x_p$, are controllable while others $z_1, z_2, ..., z_q$ are uncontrollable. The objectives of DOE are:

(i) Determining which variables are most influential on the output, *y*.

(ii) Determining where to set the influential *x*'s so that *y* is near the nominal requirements (target values).

(iii) Determining where to set the influential *x*'s so that the variability in *y* is small.

(iv) Determining where to set the influential *x*'s so that the effects of the uncontrollable variables *z* are minimized.

DOE allows us to work on continuous reduction of the process variability, determining methods for yield improvement and process optimization. A detailed discussion on this topic is given in Montgomery (2001b). Recent works on DOE include Ye and Hamada (2000), Montgomery (1999), Montgomery and Runger (1996) and Nelson (1995).

2.5 Statistical Process Control (S5)

This subsystem involves the operators who control the process by using control charts, engineers and technicians who develop the charts and take corrective actions on the process if the operator needs help, and supervisors and managers who use the charts' information for decision making. The most important element here is to identify the correct chart to use by determining whether to monitor the process mean or variance (or both of them). A common control chart that is widely used for the process mean in manufacturing industries is the $\overline{X}$ chart. Similarly, charts that are popularly used in industries for the process variance are the *R* and *S* charts. Besides these classical charts, more robust charts such as the EWMA, CUSUM and moving average charts are sometimes used if we are concern with quick detection of small shifts. Robust control charts which do not require the assumptions of the traditional charts are suggested by Abu-Shawiesh and Mokhtar (1999) and Chun (2000). A typical control chart is shown in Figure 3. Here, the chart has a center line (CL) and upper and lower control limits. An out-of-control (o.o.c.) situation is signalled when a point plots beyond the UCL/LCL limits. Here, the o.o.c. signal indicates an off-target process where actions are required to identify and remove the assignable causes so that the process will return into a state of control.

Figure 3. A Typical Control Chart

2.6 Customer Service (S6)

The importance of this subsystem is to identify the best approaches and methods and the types of services provided to the customer. This subsystem involves activities related with the just-in-time approach (JIT), total cycle time (TCT) and customer complaints and returns (CCR). Among the activities which are usually carried out are cycle time study, line balancing, optimal lot size determination, inventory control, downtime analysis and return analysis. The aim of this subsystem is to achieve customer satisfaction.

2.7 Supplier Relations (S7)

Industries need to work together with their suppliers to achieve mutual beneficial goals. Thus, this subsystem involves all the activities that are related with improving suppliers' performance which include supplier selection and approval, material analysis and approval, supplier auditing, supplier comparison experiments, specification activities, on-time delivery control, direct-to-stock activities and technical and educational assistance.

2.8 Improvement (S8)

Many manufacturing industries have plants that are set up outside their parent companies. For example, Intel, AMD, Hewlett Packard and Dell have branches which are located in different countries all over the world. To share the experiences and results from process improvement, this subsystem includes the following elements and activities:

(i) Periodic publication of focus magazines which reflect the experiences and results from process improvements in all locations.
(ii) Periodically conducting international conferences and symposiums where presentations on process improvement are made.
(iii) E-learning by putting in all the relevant information in the internet and giving passwords to authorized personnel to access them.

2.9 Reporting (S9)

Special format of reporting the process improvement activities and achievements can be developed for each industry. Examples are capability status report and educational status report. A capability status report shows how good a process conforms to its specifications which are set based on external factors such as customer requirements. Educational status report shows how well the employees are able to follow, learn and understand the quality improvement programs that are introduced to them.

2.10 Motivation (S10)

Motivation is an important factor to get employees more interested, serious and committed in their work in striving for process improvement. A number of different incentives can be introduced and given to employees as means of motivation:
(i) Awards for the "engineer of the year".
(ii) Awards for the "operator of the year".
(iii) Awards for the "best conference presentation".
(iv) Awards for the "best projects of the year".
It should be noted that all the activities mentioned in the previous subsystems also work as motivators. For example, control charts motivate operators to do better jobs because their improvement is visible. The presentation made by an engineer during meetings, seminars and conferences are motivating elements because of the visibility and recognition. Thus, the process improvement activities are actually important elements of motivation.

3.0 CONCLUSION

This paper discusses a systematic approach of achieving total continuous process improvement (TCPI) in an industry. The 10 subsystems mentioned in Section 2 serve as important guidelines for industrial practitioners to follow so that the ultimate aim of an industry in producing better quality products can be attained easier. Industrial practitioners dealing with process improvement may find these 10 steps useful and beneficial in their job functions. The sequence of these steps are guidelines for practitioners to follow in achieving process improvement. The importance and expectations of each subsystem are explained clearly and in a simplified manner so that all levels of employees in an industry can have good understanding of a TCPI system. A well managed and organized way of educating and equipping practitioners with knowledge on a TCPI system will surely help an industry to achieve process improvement faster and with a higher success rate. The TCPI system discussed in this paper is suitable for most manufacturing industries.

4.0 ACKNOWLEDGEMENT

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