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QUALITY CONTROL CIRCLES; TOWARDS A COMPUTERIZED SIMULATION

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ABSTRACT

Japanese industry implemented Edward Demings ideas for quality production in the 1950's. This helped to transform their products from one considered to be poor in quality to one of high quality. This drastic change has been noted in American industry and attempts to emulate their successful techniques have occurred. One of these techniques is the concept of Quality Circles. The results of Quality Circle implementation in the United States has led some to conclude that they are only fads, really a beginning step toward some form of participatory management. However, many of the failures of Quality Circles can be traced to an incorrect implementation and/or incorrect usage of the technique. This paper develops a model which will allow students to learn (1) the correct procedure for implementing Quality Circles and other aspects of Demings quality approach; and (2) both the benefits and negative aspects of using Quality Circles in an ongoing business concern.

INTRODUCTION

Japanese industry has radically changed the world's view of their products. In the 1940's and 1950's, Japanese products were considered (in general) to be of poor quality. However, now, the reverse is true and Japanese products are highly regarded throughout the world. This change has resulted from the implementation of Edward Deming's quality oriented approach to production by the Japanese. This approach to production has been put into 14 points by Deming. These points all point toward the concept of "Never-Ending_ Improvement" (NEI) production, i.e., constantly improving the quality level of production.

These 14 points include several statistical analysis tools that are an integral part of NEI Another very important point of this approach is the correct implementation of the concept of Quality Circles (QCs). One definition of a Quality Circle is

> "…a small group of employees and their supervisor from the same work area, who voluntarily meet on a regular basis to study quality control and productivity improvement techniques, to apply these techniques to identify and solve work-related problems, to present their solutions to management f or approval, and to monitor the implementation of these solution to ensure that, they work." (Thompson, p. 3]

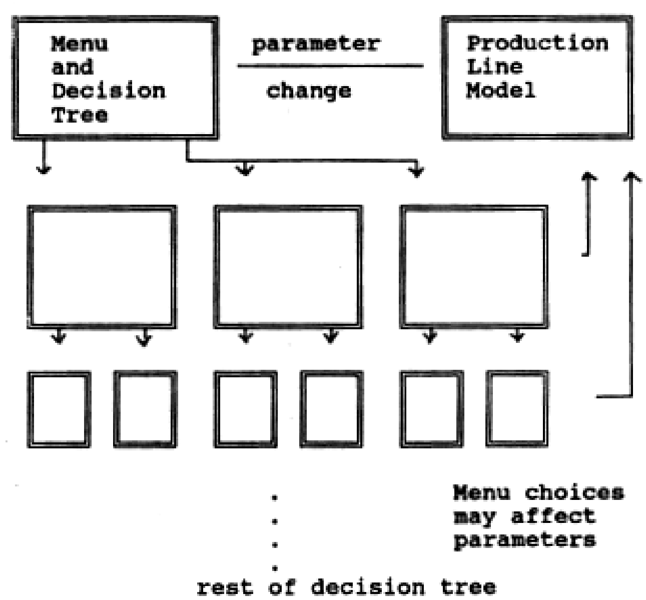
QC's are a structured approach to enhance quality in a firms production. Implemented and applied correctly, they should always provided beneficial results to the firm and the firm's workers. However, in actual practice, they are often implemented and operated incorrectly. Cole (1983), Lawler and Mohrman (1985) and Marks (1986) illustrate the discussion surrounding the usage of QC's. This paper describes an attempt to simulation a firm so that students will learn the essentials of effective QC techniques and of Deming's 14 points. The emphasis will be upon the teaching of the techniques for implementation and usage of QC's.

One of the structured techniques used in QC's is brainstorming. There are already some programs developed which help individuals and groups develop ideas (see Proctor, 1986). The model described here considers the entire QC process rather than just a specific portion of it.

THE MODEL

The simulation model used in this study is composed of two different parts. The first is a basic production line model and is the core of the simulation. The second part is a decision tree structure that displays a menu of choices to the user, causes parameters in the production line model to be adjusted depending upon the user's input, and directs movement along the rest of the decision tree. This is illustrated in Figure 1.

FIGURE 1
OVERALL VIEW OF THE QC MODEL



In Figure 1, the decision tree defines the paths the user can take in the model. These paths are explicitly shown in the menus displayed on the screen. For example, one screen may display the following:

1 - Add a new technologically advanced machine to the production line, reducing the total amount of time to produce goods
2 - Rearrange the path through the production line for a good
3 - Call in a consultant
4 - Use statistical tools
5 - Retrain and/or train employees
6 - Change vendors of raw materials

Make your choice and input the appropriate number >.

Depending upon the user's input a submenu may be displayed to allow further input of information. Each of these choices is presented to management in the form of recommendations and may or may not be accepted. Even if accepted, there may be a time lag involved in the implementation of the recommendation.

If accepted and implemented then the current parameters of the production line model would be affected. For example, if choice 1 above is taken, then the amount of time and perhaps other resources would be decreased, increasing efficiency (actual numerical values for this decrease must obviously be supplied and tested). However, there would be an additional cost which also must be weighed against the increase in efficiency. The cost of the new machine would be given in a submenu display. The numerical changes in the parameters of the model would not be displayed to the user. Thus, they must use common sense and Deming's fourteen points to guide them to the best alternative in any given situation.

Choice 2 may cause an increase in efficiency. This is one that must be tried to determine its true effect. There should be a good reason to make this choice since again there is an associated cost to re-routing particular goods. Clearly, if this produces a lower efficiency rating, then the routing would be changed to its original state (with another associated cost). This is necessary since even with good justification plans that should work often don't.

Choice 3 is a kind of HELP facility. A large cost would have to be incurred and there is no guarantee that good advice will be forthcoming.

Choice 4 brings up a submenu of available statistical tools and company information available to the OC. Any of the available tools may be used on the available information (data). Any other information needed must be explicitly requested from management on another menu and may or may not be honored.

Choices 5 and 6 explicitly incorporate some of Deming's fourteen points toward Quality Production. These should not always be chosen.

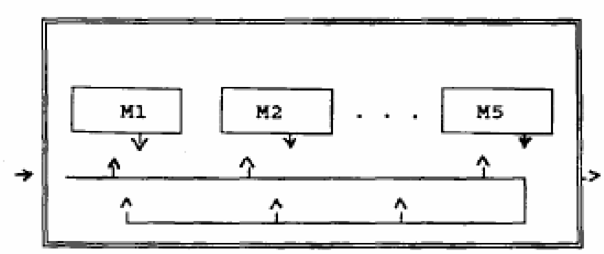
They are appropriate at certain points in the simulation and not appropriate at others. The determining factors of appropriateness is the current situation of the firm, i.e., the parameters of the production line model (and the overall position of the firm with regard to the economy and its competition, etc.).

The Production Model

This section describes the production line portion of the simulation. The path raw materials and products take through the production line is described first. Machines that process the raw materials and labor that interacts with these machines are discussed next. Consequences of defective raw materials and output from a process in the production line are also considered. Finally, the time frame of the simulation is discussed.

The production portion of this simulation is illustrated in Figure 2. Between one and three raw materials are combined with the work of one to five machines and appropriate labor requirements to produce one to four final products. The actual ordering of the needed raw materials is done by parties other than the OC, but if the orders are late or defective, the production line and QC would be affected. In fact, one recommendation of the OC may be to change suppliers of the raw materials due to a high percentage of defective items or lateness in raw material shipments. On the other hand, another recommendation might be to develop a long-term relationship with the vendor, helping them to correct any deficiencies in their services (this is a Deming's recommendation).

FIGURE 2
PRODUCTION LINE MODEL PATH



Production Line

In Figure 2, raw material(s) enter the production line and are transformed into the product being manufactured by the appropriate machines and labor. The required machines needed to perform this task denote the path in the production line. Thus, the input may enter the line and be processed by machine 1 (M1) or be processed by some other machine in the line. After being processed by machine 1 (for example) the result may next need to be processed by machine 4. In addition, the result of any operation may be discarded or put back into the production line at any point for reworking.

The number of raw materials and machines may be changed as the simulation progresses. Of course, these are parameters that may be changed by management accepting and implementing recommendations of the OC.

Machines in the Production Lane

Each machine is assigned an efficiency rating, which is measured by the amount of service time required for the machine to complete its task (in conjunction with labor and raw materials or output from a previous machine). This service time includes any required setup time, cleaning or other time associated with the machine output. Random variation in a machine's service time will take into account such things as a slow worker, or one who takes a break, or any other random time elements.

In addition, a given machine may be working at less than optimal efficiency, or be broken down, affecting overall output for the simulated time period. Breakdown rates on each machine are determined by random numbers. As each machine grows older and only receives normal maintenance, the service times tend to get longer. However, a machine can be overhauled, replaced, or supplemented with another machine to reduce that area of productions overall service time.

Defective Materials

Another part of this model allows for defective raw materials. These materials may be thrown away or reworked. Both of these actions have costs and benefits associated with them. Part of the exercise is for the participants to see that application of Deming's points will indicate one action or the other depending upon the situation of the firm (and production line).

A further complication is that a previous workstation may produce less than optimal output. This output may go into another workstation as input. This defective input may be discarded or reworked or the material may be sent back through the production line. Reworking the material adds to the current work stations service time. Again, these actions can be affected by the recommendations of the OC. For example, it would be very important for the QC to determine why one workstation was making so many defective parts. If they discover the true problem, then they are in a position to recommend to management a change, which will correct the problem.

Labor is an integral part of production of this firm, but is not really a concern of most QCs. Because of this, labor is assigned an efficiency rating, which is used in the calculation of production levels. Worker morale is always an important consideration in production and will be measured by the consensus level of the participants at each decision level.

Simulation Time Frame

The simulation runs for five one-day periods to allow for machines to be broken (or in good working order) and then repaired (or broken) in the same simulation period. These average weekly results are aggregated into monthly and quarterly information. This data together with other company information provides the quarterly results displayed to the OC participants. This approach allows the simulation to be run for extended periods, which is necessary to see the full benefits of OC.

Testing of the Model

The model will be tested to ensure that the parameter changes occurring along the decision tree are realistic and enhance the teaching of the principles behind QC's and Deming's approach. This validity test is important to all simulation games (Davis and Grove, 1986), but is especially important in this simulation. This is true since, if the model is not correct, students will learn to use specific techniques in an incorrect manner.

The simulation program itself is written in TURBO PASCAL. Although there are many languages designed specifically for writing simulations, and there are even languages written to simulate production lines, the requirement of making QC’s and Deming's approach part of the model requires the writing of the program from scratch.

SUMMARY

The model presented in this paper will be useful in teaching students the techniques necessary to enhance productivity and the quality of a product. Further, both problems and benefits associated with implementation and usage of OC's can be explored and understood before actual real world implementation. This will reduce significantly the number of failures of QCs reported in the literature.

In addition, to these results, this model shows how some non-traditional simulation problems can be implemented. In this simulation, the participants must input their ideas and recommendations in a particular situation. At the present state of the art of the machines' understanding, these ideas must be limited without affecting the overall results. This is best done via the implemented menu structure, tying parameter changes in the production line to the path chosen by the participants.

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