

AN ABSTRACT OF THE THESIS OF

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presented on November 30, 1989.

Title: An Analytic Model for Implementation of Participatory Process Control

Abstract approved: *Redacted for Privacy*  
Tom E. Gingsby /

An analytic model for implementation of participatory process control was designed from a literature review of management theory, organizational development, statistical process control and base study methodology. A fieldwork research plan was developed using case study methods to explain the functional flow of the model. The research data on a major manufacturing company in Oregon were organized according to an eight step functional flow model for participatory process control.

The model provided an effective framework to measure process control in a manufacturing facility. Measures of quality and productivity, including: scrap and rework, lost time production, sales dollars from manufacturing and the percentage of labor dollars expended to sales dollars produced increased dramatically during the PPC program. Related issues identified for further research were examination of PPC on a longitudinal basis, collaborative efforts between Product Development and PPC, and simulation of variability.

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**An Analytic Model for Implementation  
of Participatory Process Control**

by

**Larry Jamison Schuetz**

**A THESIS**

submitted to

**Oregon State University**

in partial fulfillment of  
the requirements for the  
degree of

**Doctor of Philosophy**

**Completed November 30, 1989**

**Commencement June 1990**

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## ACKNOWLEDGEMENTS

I wish to thank the members of my doctoral committee at Oregon State University for their assistance in my doctoral program: Dr. Pat Wells, Dr. Tom Grigsby, Dr. Ruth Stiehl, Dr. Michael Shaughnessey, and Dr. Russ Maddox.

This work is dedicated to my father, Richard Lee Schuetz.

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# AN ANALYTIC MODEL FOR IMPLEMENTATION OF PARTICIPATORY PROCESS CONTROL

## CHAPTER I

### PROCESS CONTROL

#### Introduction

Peters (1987) argues in his book *Thriving on Chaos: Handbook for a Management Revolution* that we need not look far to find cause for alarm in America. According to Peters "almost all leading indicators--e.g., productivity, growth, competitive assessments of leading industries such as financial services and semi-conductors, the trade balances with almost any other industrialized nation--clearly show that our post World War II economic hegemony is at an end."

Two specific examples related to this manufacturing and economic decline are presented by Wilcox in the October 1987 edition of the *Training and Development Journal*. Wilcox found that "between 1979 and 1982, the rate of failure for manufacturing firms in the United States increased by more than 130 percent." Wilcox further stated that "more than two and half million manufacturing workers lost their jobs between 1979 and 1984. Outdated process technology and obsolete worker skills were partly to blame" (Wilcox, 1987). Training in specific process technology as well as education in participative management will be required for all successful manufacturing operations.

Another underlying source of our problematic economic performance is a cataclysmic change in worldwide competitive conditions. According to Peters (1987) "the role of labor has been traditionally minimized in American industry and most experts agree that this philosophy is a major contributor, if not the major contributor to our economic and productivity decline."

Minimization of labors' role in American industry has been discussed for a number of years. The "rabble hypothesis" developed by Mayo (1928) suggested that work in American industry meant humiliation. A later example of this hypothesis was reflected by Gooding (1971) as he tells the story of one young former executive who quit his job with a major corporation: "You felt like a small cog. Working there was dehumanizing and the struggle to get to the top didn't seem worth it. They made no effort to encourage your participation. The decisions were made in those with closed doors."

As management theorists converge to explain the decline of productivity and competitiveness in United States industry several successful strategies that employ statistical process control as a basic premise are emerging. Quality control experts, such as Dr. H. Edwards Deming (1982) suggest that statistical process control, if used as both a quantitative and qualitative organizational change method, can directly influence an American economic and productivity comeback.

Statistical process control (SPC), is a tool developed in the United States during the 1930s and 1940s. SPC is designed to give industry easy, logical controls for achieving effective and economical production levels. The development of SPC is generally traced to Dr. Deming, a one-time United States government statistician who lectured in post World War II Japan about statistical methods for quality control. Deming stressed new statistical methods combined with a philosophy of management designed to move decision making to the lowest level possible in an orga-

nization. Wilcox (1987) reflects on the differences between traditional manufacturing and manufacturing based in SPC:

Traditional manufacturers run nonstop production lines, churning out unit after unit until they meet quota. The line only stops when the manufacturing process fails--when some problem interferes with the smooth flow of raw materials, sub-assemblies, partially completed units, and finished products. When that happens, the process comes to a screeching halt. Quality control and maintenance personnel swoop down on the production line to find the problem, solve it, and get things moving again as quickly as possible. But no matter how quick the fix, these breakdowns exact a cost in downtime, lowered productivity, rework of the bad product, and lost sales. The difference between the traditional and SPC is that instead of focusing on the final product, we're channeling that focus to the process--the source of the problem.

Statistical process control uses a system of sampling on the assembly line that allows workers to measure a representative sampling of their own output. The same basic statistical concepts of inspection are used but the process occurs while the manufacturing is underway, not after the fact. The SPC system places responsibility for the sampling in the hands of the workers who make the product, not in the hands of quality control experts. Wilcox (1987), in his discussion on the value of SPC suggests that "it's the difference between a firefighter and a fire preventer."

Workers must be trained in basic statistical concepts in order for the system to work. They must be able to follow a pre-set trouble shooting process if several quality checks produce unacceptable variation in the manufacturing process. Manufacturing workers traditionally perform only manual labor tasks that require little or no mathematical skills. These new skills require a considerable amount of training as well as education in the management thought behind SPC. In his book *Quality, Productivity and Competitive Position*, (1982), Dr. H. Edwards Deming states that "no resource in any company is scarcer than statistical knowledge and no source of knowledge can contribute more to quality, productivity and competitive position."

Although statistical process control is a fundamental process management tool, it requires a basic amount of statistical knowledge and competence. The United States work force in general has not yet reached this level of understanding. Proper implementation of SPC may lead to a restructuring of the workforce in the manufacturing sector of our economy. This restructuring may improve the quality and productivity in American industry while helping to regain lost market share and competitive positioning in the domestic as well as international markets. Two questions then arise: (a) can training in specific SPC techniques and education in participative management processes bring about restructuring of the workforce in a manufacturing organization? and, (b) what is the impact of SPC on the ability of a manufacturing organizations' attempt to improve quality and productivity?

### Purpose Statement

The purpose of this study was to examine the impact of SPC on the ability of a selected Oregon manufacturing company to restructure its workforce as a method to improve quality and productivity. The objectives of this research were:

- 1) To review relevant literature in management theory, organizational development, statistical process control, and case study methods;
- 2) To propose an analytical model for examining industrial process control that might be generalized to similar industrial settings;
- 3) To develop and field test a plan designed to analyze process control within a small Oregon manufacturing company; and
- 4) To use the data collected in the case study method to examine the effectiveness of company process control.

## Significance of the Study

Although proponents of a quality based transformation of American industry seem to agree on certain fundamental points their methods differ markedly. These quality experts (Wilcox, 1986) believe that until top management gets permanently involved in quality, nothing will work.

Jeremy Main points out in *Fortune* that these experts set little store by robots, automation, and other gadgetry. They have little use for quality circles except as an adjunct to other statistical methods (Main, 1986).

The majority of quality related research since World War II has been dominated by five experts: Deming, Duran, Crosby, Feigenbaum, and Taguchi.

Taguchi's approach centers on a statistical quantitative method that targets the variations in a product that distinguish the defective parts from the acceptable. Taguchi's techniques are designed to eliminate endless testing for all possible defects.

Feigenbaum promotes a total quality control program that addresses self help in the creation of a quality system. Feigenbaum suggests that the same statistical and engineering methods applied to production can be used throughout a company.

Crosby has been the largest commercial success in the field of quality control. Crosby is best known for his motivational antics and slogans. Crosby approaches the productivity issue from a pure motivational approach. He asks workers to achieve zero defects through inspirational programs. The main criticism of Crosby from his rival quality experts is his lack of attention to the poorly designed manufacturing systems that workers can not change.

Juran teaches an incremental change process that involves both statistical and motivational change agents. Specific annual goals and projects are selected and concrete results are delivered. Juran differs directly with Deming in the qualitative realm of management philosophy. Juran believes, and Deming disagrees, that fear can bring out the best in people.

In post World War II Japan quality control processes became a critical element in the effort to restructure the economy and production effort. Government and industry leaders quickly embraced the system that trusted operators to perform their own quality checks while ushering in new participative management principles. Marks (1986) reported that "American productivity stagnated during the 1970s and Lockheed Corporation in 1973 became the first United States company to begin investigating the Japanese approach. In addition only five United States companies had SPC quality control programs in 1977."

The recession of the early 1980s forced more American industries towards quality control efforts. By 1990 it is estimated that over one-half of all U.S. companies with more than 500 employees will have quality control programs based in SPC.

An investigation into the process of statistical quality control in a selected Oregon industrial setting may shed light on how the effort may be successfully expanded to other organizations.

Implementation, training and technical problems may be uncovered. Analysis of these problems from both a technical and organizational development point of view may increase the probability of success for those companies who wish to implement SPC.

## Research Design

### Method

The method chosen for this study was an explanatory single-case design with an analytic structure.

### Rationale for Selection of Method

The technical definition of a case study as a qualitative research method is provided by Yin (1981) as: "an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident."

The case study distinguishes itself from a qualitative or quantitative experiment through separation of the phenomenon from its context. In addition, Schramm (1971) describes the essence of a case study as "an attempt to illuminate a decision or set of decisions; why they were taken, how they were implemented, and with what result."

Further rationale for a single case design is provided by Yin (1984) in *Case Study Research, Design and Methods*:

The single-case design represents the critical test of a significant theory. The model specifies a clear set of propositions as well as the circumstances within which the propositions are believed to be true. The single-case can represent a significant contribution to knowledge and theory building. Such a study can even help to refocus future investigations in an entire field.

### Population and Data Collection

The data were collected from a single manufacturing company located in Oregon. A field work plan was constructed and interviews were conducted within the organization. Data were gathered from all affected levels of the organization.

### Instruments

The data collection instruments were constructed using the guidelines provided in *Quality, Productivity and Competitive Position* by Deming (1982).

### Data Analysis

The data were analyzed through a procedure of pattern-making logic. Yin (1984) found that:

for case study analysis, one of the most desirable structures is the use of a pattern-making logic. Such a logic compares an empirically based pattern with a predicted one. If the patterns coincide, the results can help a case study to strengthen its internal validity.

In the explanatory case study method these patterns may be related to the dependent or independent variables of the research. Cook and Campbell (1979) suggest that the dependent variables be derived from a process of "non-equivalent, dependent variables design." This design allows for multiple dependent variables. Yin (1984) describes the validity of this method by suggesting "if for each outcome, the initially predicted values have been found, and at the same time the alternative of predicted values have not been found, strong causal inferences can be made."

### Independent and Dependent Variables

The major proposition of this study was, because process control is implemented a certain restructuring of organizational design and behavior will be pro-

duced. The independent variable was defined as the implementation of Process Control. The dependent variables, or predicted outcomes were as follows:

- 1) Productivity will increase over the levels prior to the implementation of process control;
- 2) Quality will increase over the levels prior to the implementation of process control; and
- 3) Employees will create new applications for process control, and these applications will be unique to each work unit in the organization.

#### Limitations of the Study

This study is limited in the following ways which may affect the ability to generalize these findings:

- 1) The selected industry for the study is located in Oregon. This company may not be organizationally and philosophically similar to industries of differing size or location.
- 2) The background and training of those interviewed may have been different from others throughout the United States.
- 3) The ability of the interviewer to be objective may have limited the readers' ability to generalize the findings to other institutions.

#### Delimitations of the Study

The study was delimited to one Oregon manufacturing setting. For reasons of confidentiality the true identity of the manufacturing facility will not be revealed.

## Definition of Terms

**Advanced Statistical Methods:** More sophisticated and less widely applicable techniques of statistical process analysis and control than included in Basic Statistical Methods; this can include more advanced control chart techniques, regression analysis, design of experiments, advanced problem-solving techniques, etc.

**Attributes Data:** Qualitative data that can be counted for recording and analysis. Examples include characteristics such as the presence of a required label, the installation of all required fasteners, the absence of errors on an expense report. Other examples are characteristics that are inherently measurable (i.e., could be treated as variables data), but where the results are recorded in a simple yes/no fashion, such as acceptability of a shaft diameter when measured on a go/no-go gage, or the presence of any engineering changes on a drawing. Attributes data are usually gathered in the form of non-conforming units or of nonconformities; they are analyzed by  $p$ ,  $np$ ,  $c$  and  $u$  control charts. (See also Variables Data.)

**Autocratic Style:** The manager tells the subordinates what to do and expects to be obeyed without question. May use forms of threats or force to lead the subordinates.

**Average:** The sum of values divided by the number (sample size) of values; designated by a bar over the symbol for the values being averaged: e.g.,  $\bar{x}$  ( $X$  bar) is the average of the  $x$  values within a subgroup;  $\bar{X}$  ( $X$  double bar) is the average of subgroup averages;  $(\bar{X})$  ( $X$  tilde-bar) is the average of sub-group medians;  $\bar{p}$  ( $p$  bar) is the average of  $p$ 's from all the subgroups. (See also Mean.)

**Awareness:** Personal understanding of the interrelationship of quality and productivity, directing attention to the requirement for management commitment statistical thinking to achieve never-ending improvement.

**Basic Statistical Methods:** Applies the theory of variation through the use of basic problem-solving techniques and statistical process control; includes control chart construction and interpretation (for both variables and attributes data) and capability analysis.

**Capability:** (Can be determined only after the process is in statistical control.)

When the process average plus and minus the 3-sigma spread of the distribution of individuals ( $\bar{X} \pm 3\sigma$ ) is contained within the specification tolerance (variables data), or when at least 99.73% of individuals are within specification (attributes data), a process is said to be capable. Efforts to improve capability must continue, however, consistent with the operational philosophy of never-ending improvement in quality and productivity.

**Central Line:** The line on a control chart that represents the average or median value of the items being plotted.

**Change Agent:** The person who is responsible for ensuring that the planned change in organizational development is properly implemented.

**Characteristic:** A distinguishing feature of a process or its output on which variables or attributes data can be collected.

**Common Cause:** A source of variation that affects all the individual values of the process output being studied; in control chart analysis it appears as part of the random process variation.

**Consecutive:** Units of output produced in succession; a basis for selecting subgroup samples.

**Control Chart:** A graphic representation of a characteristic of a process, showing plotted values of some statistic gathered from that characteristic, a central line, and one or two control limits. It minimizes the net economic loss from Type I and Type II errors. It has two basic uses: as a judgement to determine if a process has been operating in statistical control, and as an operation to aid in maintaining statistical control.

**Control Limit:** A line (or lines) on a control chart used as a basis for judging the significance of the variation from subgroup to subgroup. Variation beyond a control limit is evidence that special causes are affecting the process. Control limits are calculated from the process data and are not to be confused with engineering specifications.

**Detection:** A past-oriented strategy that attempts to identify unacceptable output after it has been produced and then separate it from the good output. (See also Prevention.)

**Distribution:** A way of describing the output of a common-cause system of variation, in which individual values are not predictable but in which the outcomes as a group form a pattern that can be described in terms of its location, spread, and shape. Location is commonly expressed in terms of the standard deviation or the range of a sample; shape involved many characteristics such as symmetry and peakedness, but these are often summarized by using the name of a common distribution such as the normal binomial, or Poisson.

**Financial Margin:** Sales minus all expenses as a single amount. Frequently used to mean ratio of sales minus all operating expenses divided by sales.

**Formal Organization:** The arrangement of individuals and the functions they perform.

**Individual:** A single unit, or a single measurement of a characteristic.

**Informal Organization:** The set of evolving relationships and patterns of human interaction within an organization, which are not officially prescribed.

**Intervention Strategy:** Virtually every means of changing the structure or the processes of an organization, or the attitudes, values or behavior of its members.

**Leadership:** The act of obtaining voluntary compliance from others. Influencing others because they want to be influenced or because they believe and support the leader's perceived power.

**Location:** A general concept for the typical values or central tendency of a distribution.

**Management Style:** The style in which a manager generally functions. Examples are Autocratic, Participative, Democratic, and Laissez Faire.

**Marketing Mix:** The controlled variables which the company puts together to satisfy a target market.

**Mean:** The average of values in a group of measurements.

**Median:** The middle value in a group of measurements, when arranged from the lowest to highest; if the number of values is even, by convention the average of the middle two values is used as the median. Subgroup medians form the basis for a simple control chart for process location. Medians are designated by tilde ( $\sim$ ) over the symbol for the individual values:  $\tilde{X}$  is the median of a subgroup.

**Middle Management:** Managers above supervisory level but subordinate to the firm's most senior executives.

**Never-Ending Improvement in Quality and Productivity:** The operational philosophy that makes use of the talents within the Company to produce products of increasing quality for our customers in an increasingly efficient way that

protects the return on investment to stockholders. This is a dynamic strategy designed to enhance the strength of the Company in the face of present and future market conditions. It contrasts with any static strategy that accepts (explicitly or implicitly) some particular level of outgoing defects as inevitable.

**Nonconforming Units:** Units which do not conform to a specification or other inspection standard; sometimes called discrepant or defective units.  $p$  and  $np$  control charts are used to analyze systems producing nonconforming units.

**Nonconformities:** Specific occurrences of a condition which does not conform to specifications or other inspection standards; sometimes called discrepancies or defects. An individual nonconforming unit can have the potential for more than one nonconformity (e.g., a door could have several dents and dings; a functional check of a carburetor could reveal any number of potential discrepancies).  $c$  and  $u$  control charts are used to analyze systems producing nonconformities.

**Normal Distribution:** A continuous, symmetrical, bell-shaped frequency distribution for variables data that underlies the control chart for variables. When measurements have a normal distribution, about 68.26% of all individuals lie within plus or minus one standard deviation unit of the mean, about 95.44% lie within plus and minus two standard deviation units of the mean, and about 99.73% lie within plus and minus three standard deviation units of the mean. These percentages are the basis for control limits and control chart analysis (since subgroup averages are normally distributed even if the output as a whole is not), and for many capability decisions (since the output of many industrial processes follows the normal distribution).

**Operational Definition:** A means of clearly communicating quality expectations and performance; it consists of (1) a criterion to be applied to an object or to a group, (2) a test of the object or of the group, (3) a decision: yes or no, the object or the group did or did not meet the criterion.

**Organization Chart:** A tool used to outline the relationships of employees and positions within the organization.

**Organizational Behavior:** The study of individual and group behavior within organizations and the application of the resulting knowledge.

**Organizational Development:** A planned and systematic attempt to change the organization, typically to a more behavioral environment.

**Pareto Chart:** A simple tool for problem-solving that involves ranking all potential areas or sources of variation according to their contribution to cost or to total variation. Typically, a few causes account for most of the cost (or variation), so problem-solving efforts are best prioritized to concentrate on the "vital few" causes, temporarily ignoring the "trivial many."

**Participative Style:** The manager involves subordinates in the decision making process but may retain final authority.

**Poisson Distribution:** A discrete probability distribution for attributes data that applies to nonconformities and underlies the c and u control charts.

**Power:** The degree of influence an individual has over another individual or group.

**Prevention:** A future-oriented strategy that improves quality and productivity by directing analysis and action toward correcting the process itself. Prevention is consistent with a philosophy of never-ending improvement. (See also Detection).

**Problem-Solving:** The process of moving from symptoms to causes (special or common) to actions that improve performance. Among the techniques that

can be used are Pareto charts, cause-and-effect diagrams and statistical process control techniques.

**Process Average:** The location of the distribution of measured values of a particular process characteristic, usually designated as an overall average,  $\bar{X}$ .

**Process Control:** See Statistical Process Control.

**Process Spread:** The extent to which the distribution of individual values of the process characteristic vary; often shown as the process average plus or minus some number of standard deviations (e.g.,  $\bar{X} + 3\sigma$ ).

**Process:** The combination of people, equipment, materials, methods, and environment that produce output - a given product or service. A process can involve any aspect of our business. A key tool for managing processes is statistical process control.

**Quality Control:** The system of methods, procedures, and policies used to maintain acceptable and dependable levels of quality in a company's output of goods and services as well as its purchases.

**Quality:** The degree of excellence of a product or service.

**Randomness:** A condition in which individual values are not predictable, although they may come from a definable distribution.

**Range:** The difference between the highest and lowest values in a subgroup. The expected range increases both with the sample size and with the standard deviation.

**Run Chart:** A simple graphic representation of a characteristic of a process, showing plotted values of some statistic gathered from the process (often individual values) and a central line (often the median of the values), which can be analyzed for runs. (See also Control chart).

- Run:** A consecutive number of points consistently increasing or decreasing, or above or below the central line. Can be evidence of the existence of special causes of variation.
- Sample:** In process control applications, a synonym with Subgroup; this use is totally different from the purpose of providing an estimate of a larger group of people, items, etc.
- Shape:** A general concept for the overall pattern formed by a distribution of values.
- Sigma ( $\sigma$ ):** The Greek letter used to designate a standard deviation.
- Situational Leadership:** Leadership based on situational factors such as: personal characteristics of subordinates, environmental pressures and the demands with which the subordinates must cope to accomplish goals and satisfy personal needs.
- Special Cause:** A source of variation that is intermittent, unpredictable, unstable; sometimes called an assignable cause. It is signaled by a point beyond the control limits or a run or other non-random pattern of points within the control limits.
- Specification:** The engineering requirement for judging acceptability of a particular characteristic. A specification is never to be confused with a control limit.
- Spread:** A general concept for the extent by which values in a distribution differ from one another; dispersion.
- Stability:** The absence of special causes of variation; the property of being in statistical control.
- Stable Process:** A process that is in statistical control.
- Standard Deviation:** A measure of the spread of the process output or the spread of a sampling statistic from the process (e.g., of subgroup averages); denoted by the Greek letter  $\sigma$  (sigma).

**Statistic:** A value calculated from or based upon sample data (e.g., a subgroup average or range), used to make inferences about the process that produced the output from which the sample came.

**Statistical Control:** The condition describing a process from which all special causes of variation have been eliminated and only common causes remain; evidenced on a control chart by the absence of points beyond the control limits and by the absence of non-random patterns or trends within the control limits.

**Statistical Process Control:** The use of statistical techniques such as control charts to analyze a process or its outputs so as to take appropriate actions to achieve and maintain a state of statistical control and to improve the process capability.

**Subgroup:** One or more events or measurements used to analyze the performance of a process. Rational subgroups are usually chosen so that the variation represented within each subgroup is as small as feasible for the process (representing the variation from common causes), and so that any changes in the process performance (i.e., special causes) will appear as differences between subgroups. Rational subgroups are typically made up of consecutive pieces, although random samples are sometimes used.

**Supervisory Management:** Persons who directly oversee the efforts of those who actually perform the work.

**Top Management:** The organization's most senior executives.

**Type I Error:** Rejecting an assumption that is true; e.g., taking action appropriate for a special cause when in fact the process has not changed; overcontrol.

**Type II Error:** Failing to reject an assumption that is false; e.g., not taking appropriate action when in fact the process is affected by special causes; under-control.

**Variables Data:** Quantitative data, where measurements are used for analysis. Examples include the diameter of a bearing journal in millimeters, the closing effort of a door in kilograms, the concentration of electrolyte in percent, or the torque of a fastener in newton-meters.  $\bar{X}$  and R,  $\bar{X}$  and s, median and individual control charts are used for variables data. (See also Attributes Data).

**Variation:** The inevitable differences among individual outputs of a process; the sources of variation can be grouped into two major classes: Common Causes and Special Causes.

## CHAPTER II

### A BRIEF HISTORY OF ORGANIZATIONAL DEVELOPMENT AND COLLABORATIVE MANAGEMENT PROCESS MODELS

This literature review will focus on three areas:

- 1) Organizational development and collaborative management processes (historical and current);
- 2) Current quality control models; and
- 3) Case study qualitative research methodology.

A critical element in the transformation of American industry through SPC is the concept of collaborative management. The systematic development of collaborative management has its roots in the field of organizational development.

French and Bell (1972) define collaborative management as

a shared kind of management--not a hierarchically imposed kind. Management of group culture must be owned as much by the subordinates as it is by the formal leader. Our definition recognizes that the key unit in organizational development activities is the ongoing work team, including both superior and subordinates.

As collaborative management is an important element in the SPC process it is important to trace the roots of organizational development. The field of organizational development is based in behavioral science. According to French and Bell (1978): "systematic organizational development activities have two major historical bases: (a) innovations in the application of laboratory-training insights to industrial organizations, and (b) survey research and feedback methodology."

## Laboratory Training in Industrial Organizations

In 1947 the National Training Laboratory in Group Development was organized by Lewin, Benne, Bradford, and Lippitt. This laboratory was sponsored by the Massachusetts Institute of Technology, Columbia University, The University of California at Los Angeles, Springfield College, Cornell University, the National Education Association and the United States Office of Naval Research. The initial work at the lab evolved into what was known as basic T-group or sensitivity training.

The early organizational development pioneers experienced frustration with attempting to transfer laboratory behavioral skills geared towards individuals into the problem solving process of complex organizations. In the late 1950s the focus began to shift from the training of individuals towards the training of teams from the same organization. Allport (1955) suggested that "McGregor, working with Union Carbide, was one of the first behavioral scientists to begin to solve the transfer problem and to talk systematically about and to help implement the application of laboratory-training skills to a complex organization." A small internal work group was formed at Union Carbide which used behavioral science practices to help line managers. This group was later called an "organizational development group" (French & Bell, 1978).

The Esso Standard Oil (now Exxon) experiments in 1958 and 1959 involved Shepard, Blake, and Mouton. These behavioral scientists utilized an instrumental laboratory that stressed the use of feedback on scales and measurements of group and individual behavior during research sessions. These instruments were later transformed into the managerial grid approach to organizational development. Although the Esso experiments produced inroads into the study of team development, consultation and inter-group conflict resolution efforts to involve top management

failed. Two lessons learned from this early organizational development failure can be applied to modern SPC programs: (a) any successful program of change requires active involvement in and leadership from the top management; and (b) on-the-job application is critical for success in any change related program.

French and Bell (1978) suggest that "it is not entirely clear who coined the term organizational development, but in all probability it was Blake, Shepard, and Mouton." Further, Kolb (1960) views the inclusion of employee relations departments in both the Esso and Union Carbide experiments as "significant." French and Bell (1978) summarize this laboratory training period of organizational development: "In the history of organizational development we see both external consultants and internal staff departments relinquishing their traditional roles and collaborating in quite a new approach to organizational improvement."

### Survey, Research and Feedback

The second historical thrust of organizational development as it relates to collaborative management processes and ultimately SPC is a form of action research called "survey research and feedback" (Likert, 1971). The Survey Research Center of the University of Michigan is primarily responsible for the development of survey methodology in organizational development. French and Bell (1978) suggest that "Likert pioneered in the construction of questionnaires, the use of rigorous probability samples, the use of carefully controlled coding procedures, and the evolution of feedback methodology." In the 1947 Detroit Edison Company experiments Likert uncovered a key aspect of organizational development that may provide an insight into successful SPC implementation. Baumgartel (1959) draws the following conclusions from the Detroit Edison Experiments:

The results of this experimental study lend support to the idea that an intensive, group discussion procedure for utilizing the results of an employee questionnaire survey can be an effective tool for introducing positive change in a business or organization. It may be that the effectiveness of this method, in comparison to traditional training courses, is that it deals with the system of human relationships as a whole (superior and subordinate can change together) and it deals with each manager, supervisor, and employee in the context of his own job, his own problems, and his own work relationships.

## Organizational Development and Current Theories of Collaborative Management Processes

French and Bell (1978) suggest that "organizational development has emerged from applied behavioral science and social psychology and from subsequent efforts to apply laboratory training and survey feedback insights to total systems." These organizational development efforts are at work over a wide and expanding range of organizations on a world wide basis. In terms of the development of current theories of collaborative management processes that are based in organizational development, it is important to examine the underlying assumptions about people as individuals, people in groups, and people in organizational systems. These assumptions were developed by French (1969) and reflect the work of Mayo, Roethlisberger, Dickson, Rogers, Maslow, McGregor, Likert, Mann, Argyris, Herzberg, Schein, Bennis, Beene and Sheats.

### Assumptions About People as Individuals

Organizational development efforts that include collaborative processes have a basic set of assumptions about human behavior. Understanding of these assumptions can lead to a higher probability of success in any SPC change related program. French (1969) feels that managers "can view people as fixed entities, or

as potentially in process or in the process of becoming." Further, French (1969) states these assumptions about people as individuals:

(a) most individuals have drives towards personal growth and development if provided an environment that is both supportive and challenging, and (b) most people desire to make, and are capable of making, a higher level of contributions to the attainment of organizational goals than most organizational environments will permit.

### Assumptions About People in Groups

The work of Mayo in the Hawthorne studies of the late 1920s provided the foundation for organizational development assumptions concerning people in groups. French and Bell (1978) found in laboratory-training experiments that:

(a) One of the most psychologically relevant reference groups for most people is the work group; (b) most people wish to be accepted and to interact cooperatively with at least one small reference group; (c) for a group to optimize its effectiveness, the formal leader cannot perform all the leadership and maintenance functions in all circumstances at all times; (d) suppressed feelings and attitudes adversely affect problem solving, personal growth, and job satisfaction; (e) the level of trust, support and cooperation is much lower in most groups and organizations than is either necessary or desirable; and (f) the solutions to most attitudinal and motivational problems in organizations are transactional.

### Assumptions About People in Organizational Systems

Likert (1961), in his book *New Patterns of Management*, presented the "linking pin" theory. According to Likert: "A manager is a member of at least two work teams--as the superior in one and as a subordinate and peer in another." French (1969) believes that the linking pin theory leads to a key assumption about people in organizational systems: the interplay of the dynamics of these work teams, as conveyed by the linking pin incumbents has a powerful effect on the attitudes and behavior of people in both groups. In particular, the leadership style and climate of the higher team tend to get transmitted to the lower team.

The literature review suggested that it is important to understand the various power bases and assumptions that tend to influence an individual or group of people. Blanchard (1982) suggests that "if you understand what power bases tend to influence a group of people, you have some insight into whom should be given a particular project or assignment."

Power bases can be identified in a company through a classification framework developed by French (1975). These seven bases of power, identified as a potential means of successfully influencing the behavior of others, are defined as follows (French, 1959):

**Coercive Power** is based on fear. A leader high in coercive power is seen as inducing compliance because failure to obey will lead to punishment such as undesirable work assignments, reprimands, or dismissal.

**Legitimate Power** is based on the position held by the leader. Normally, the higher the position, the higher the legitimate power tends to be. A leader high in legitimate power induces compliance or influences others because they feel that this person has the right, by virtue of position in the organization, to expect that suggestions will be followed.

**Expert Power** is based on the leaders' possession of expertise, skill and knowledge, which, through respect, influences others. A leader high in expert power is seen as possessing the expertise to facilitate the work behavior of others. This respect leads to compliance with the leaders' wishes.

**Reward Power** is based on the leaders' ability to provide rewards for other people who believe that compliance will lead to position incentives such as pay, promotion, or recognition.

**Referent Power** is based on the leaders' personal traits. A leader high in referent power is generally liked and admired by others because of personality. This liking for, admiration for, and identification with the leader influences others.

**Information Power** is based on the leaders' possession of, or access to, information that is perceived as valuable to others. This power base influences others because they need this information or want to be in on things.

**Connection Power** is based on the leaders' connections with influential or important persons inside or outside the organization. A leader high in connection power induces compliance from others because they aim at gaining the favor or avoiding the disfavor of the powerful connection.

Another important element dealing with the role of organizational work behavior is the measurement of leadership effectiveness. The leadership style of an individual is defined by Hersey and Blanchard (1982) as "the behavior pattern that a person exhibits when attempting to influence the activities of others." A person's leadership style involves some combination of either task or relationship behavior. The two types of behavior, task and relationship, are defined by Blanchard (1982) as:

Task Behavior-- The extent to which leaders are likely to organize and define the roles of the members of their group (followers); to explain what activities each is to do and when, where, and how tasks are to be accomplished; characterized by endeavoring to establish well-defined patterns of organization, channels of communication, and ways of getting jobs accomplished.

Relationship behavior--The extent to which leaders are likely to maintain personal relationships between themselves and members of their group (followers) by opening up channels of communication, providing socio-emotional support, psychological strokes, and facilitating behaviors.

Two specific research instruments were identified in the literature as reliable for the measurement of the dynamic interplay of organizational behavior work teams: The Leadership Effectiveness and Adaptability Descriptor (Hersey & Blanchard, 1982), and the Power Perception Profile (Hersey & Natemeyer, 1982).

### Current Quality Control Models

Organizational development is an important element in quality control and SPC models. The extent to which organizational development is used in current quality control models varies greatly. Three models of quality and statistical control will be examined: (a) Crosby's Zero Defects Model, also known as the 14 steps to quality improvement; (b) Taguchi's Model of Quality Control; and, (c) Deming's Statistical Process Control Model for the Transformation of American Industry.

These models will be examined as a prerequisite for the presentation of the research model in Chapter III.

### Crosby Zero Defects Model

Morgan (1987) states that "with the possible exception of Dr. Edwards Deming, no one is more closely identified with the quality issue than Philip B. Crosby, chairman and founder of Philip Crosby Associates (PCA)." In 1979, Crosby left ITT Corporation, where he had served as vice president and director of quality for 14 years. He then formed PCA and opened Quality College in Winter Park, Florida to teach his quality improvement philosophy to top management. Today PCA is widely regarded as one of the largest consulting firms in the quality field. With sales nearing the \$50 million mark, PCA has provided services to more than 200 of the Fortune 500 companies in the United States. A subsidiary, CAI Inc., has offices in England, Belgium, France, Germany, Puerto Rico, and Singapore.

Wilson (1987) suggests that

the Crosby school of thought leans heavily on the idea that top management must not only be committed to quality, but must set the tone and pace for implementation of quality throughout the company. Management must insist on conformance to requirements and provide the participation necessary for prevention to happen.

Conformance to requirements, by Crosby's standards is accomplished by producing things right the first time. Crosby suggests that prevention is the key to successful production. It is more expensive to continue running at unacceptable levels than to shut down, correct the shortcomings, and start up again at an acceptable level of quality output (Wilson, 1987). An example of the repercussions of Crosby's work was shown in the March 28, 1988 edition of *Fortune* magazine (Knowlton, 1988):

In 1979, Tennant Co. received two pieces of life-threatening news. Word arrived at Minneapolis headquarters that a potentially fatal defect had appeared in the motorized factory floor sweepers that it was exporting to Japan. The second piece of news was Toyota's announcement that it was

bringing out a competitive product. In an all-out effort to save its 40% North American market share, Tennant, the world's biggest manufacturer of floor maintenance equipment, embarked on an ambitious, Crosby recommended improvement program that over the next few years upgraded its product line. Today the company has 60% of the North American market and 40% of the world market; sales grew from \$98 million in 1979 to \$167 million in 1987.

Crosby presents in his book *Quality is Free* (1979) a viewpoint that leads to an effective quality improvement program:

Traditional quality control programs are negative and narrow, and it was no different at ITT. Primarily oriented towards product performance, they often turned off the management they were supposed to entice. To overcome this, we constructed numerous programs involving practical activities which could be implemented at the unit level.

Quality improvement through defect prevention, a 14-step program is the foundation for all Crosby quality programs.

1) Step 1: Management Commitment.

Purpose: To make it clear where management stands on quality. The first action that must take place in improvement is that the management of the company must take a moment to understand what is needed, and make the decision themselves that they indeed want to improve. This decision is made when they decide to adopt the attitude of defect prevention as their personal standard (Crosby, 1979).

Crosby insists that quality policy must be defined as a state of mind held by company personnel concerning how well they must do their jobs. He suggests that it is this policy, whether it has been stated or not, that determines in advance how successfully the next job will be done (Crosby, 1979).

2) Step 2: The Quality Improvement Team.

Purpose: To run the quality improvement program.

Crosby defines the quality improvement team as strictly part-time jobs for the members of the organization except for a chairperson. The responsibilities of the team members are: (1) lay out the entire quality improvement program; (2)

represent their department on the team; (3) represent the team to their department; (4) cause the decisions of the team to be executed in their department; and (5) contribute creatively to the implementation of the improvement activity (Crosby, 1979).

3) Step 3: Quality Measurement.

Purpose: To provide a display of current and potential nonconformance problems in a manner that permits objective evaluation and corrective action. Basic quality measurement data come from the inspection and test reports, which are broken down by operating areas of the plant. By comparing the rejection data with the input data, it is possible to know the rejection rates. These rates should be used to identify specific problems needing corrective action, and they should be reported by the quality department (Crosby, 1979).

4) Step 4: Measuring The Cost Of Quality.

Purpose: To define the ingredients of the cost of quality, and explain its use as a management tool.

The cost of quality is suggested by Crosby to be composed of the following:

Scrap	Purchase order changes
Rework	Software correction
Warranty	Consumer affairs
Service	Auditing
Quality control labor	Acceptance equipment costs
Engineering changes	

This total expense should represent no more than 2.5 percent of the company sales dollar (Crosby, 1979).

5) Step 5: Quality Awareness.

Purpose: To provide a method of raising the personal concern felt by all personnel in the company toward the conformance of the product or service and the quality reputation of the company.

Crosby (1979) stated that the idea of quality awareness is to show everyone the need for improvement and prepare them for eventual commitment to the Zero Defects program. He further suggests that quality awareness has two essential ingredients: (1) regular meetings, and (2) information about the quality program must be communicated through posters, articles, and special events.

6) Step 6: Corrective Action.

Purpose: To provide a systematic method of resolving forever the problems that are identified through previous action steps.

Crosby said that problems that are identified during the acceptance operation must be documented and then resolved formally. Crosby further recommends establishment of four levels of constant activity: (1) Hold daily meetings between the area supervisor and a quality engineer; (2) hold weekly meetings between the production general supervision and senior quality management; (3) monthly or special meetings held by general management; and (5) insuring that task teams consist of responsible members (Crosby, 1979).

7) Step 7: Zero Defects Planning.

Purpose: To examine the various activities that must be conducted in preparation for formally launching the Zero Defects program.

Crosby suggests that the quality improvement task team should list all the individual action steps that build up to Zero Defects day in order to make the most meaningful presentation of the concept and action plan to personnel of the company (Crosby, 1979).

8) Step 8: Supervisor Training.

Purpose: To define the type of training that supervisors need in order to actively carry out their part of the quality improvement program.

Crosby (1979) took the position that the supervisor, from the board chairman down, is the key to achieving improvement goals. The supervisor gives the individual employees their attitudes and work standards, whether in engineering, sales, computer programming, or wherever. Therefore the supervisor must be given primary consideration when laying out the program.

9) Step 9: Zero Defects Day.

Purpose: To create an event that will let all employees realize, through a personal experience, that there has been a change.

Crosby (1979) suggests that Zero Defects is a revelation to all involved that they are embarking on a new way of corporate life. Working under this discipline requires personal commitments and understanding. Therefore it is necessary that all members of the company participate in an experience that will make them aware of this change.

10) Step 10: Goal Setting.

Purpose: To turn pledges and commitments into action by encouraging individuals to establish improvement goals for themselves and their groups.

Crosby (1979) stated that about a week after Zero Defects day, the individual supervisors should ask their people what kind of goals they should set for themselves. Try to get two goals from each area that are specific and measurable.

11) Step 11: Error-cause Removal.

Purpose: To give the individual employee a method of communicating

to management the situations that make it difficult for the employee to meet the pledge to improve.

Crosby feels that one of the most difficult problems employees face is their inability to communicate problems to management. Error-cause removal is set up on the basis that the worker need only recognize the problem. When the worker has stated the problem, the proper department in the plant can look into it (Crosby, 1979). Simple one-page forms are supplied to each area, usually in wall boxes. When an employee feels that there is a problem, he or she completes the form and drops it in the box.

12) Step 12: Recognition.

Purpose: To appreciate those who participate.

Crosby (1979) took the position that recognition must be given for achieving specific goals worked out in advance, and the employees must have the opportunity to help select the goals. Crosby suggests that individuals must know that management seriously needs their help and sincerely appreciates it.

13) Step 13: Quality Councils.

Purpose: To bring together the quality councils for planned communication on a regular basis.

According to Crosby (1979) consistency of attitude and purpose is the essential personal characteristic of one who evaluates another's work. Crosby suggests bringing the quality control people together on a regular basis in a formal manner.

14) Step 14: Do It Over Again.

Purpose: To emphasize that the quality improvement program never ends.

Crosby (1979) states that there is always a great sigh of relief when goals are reached. To avoid the conclusion of the entire program it is necessary to construct a new team and to start the process over again.

### Taguchi Methods

The Allen-Bradley Corporation, a Rockwell International Corporation subsidiary is a confirmed user of Taguchi-based methods. According to the October 15, 1986 edition of *Electronic Business*, Hayashi reports that "some 80 Taguchi experiments have been conducted throughout all of Allen-Bradley's manufacturing facilities worldwide for a cost saving of more than \$1 million dollars." At an ITT manufacturing plant in Clint, Mass., previous to implementing the Taguchi methods only 5% of the plant's production was within specification limits. After implementation of the Taguchi method virtually 100% of the plant's production met the required specifications.

Kirkland (1988) reports in the February 1988 edition of *Plastics World*:

Fast and substantial improvements in costs and quality through optimization of product designs and existing manufacturing processes can be achieved using the Taguchi methods, a quality engineering technology that combines engineering and statistical disciplines. Japanese manufacturing companies, such as Toyota and Sony have been practicing Taguchi methods since the early 1960s. United States firms such as Ford, ITT, AT&T, Sheller-Glode, Flex Technologies, Mobay Corporation, and Xerox have begun to implement Taguchi Methods only in this decade.

Port (1987) reports in the June 8 edition of *Business Week* that "one unit of ITT Corporation has used Taguchi methods to slash defects by more than half, saving \$60 million since 1985."

Taguchi methods redefine the meaning of quality for traditional United States business operations. Taguchi methods aim to increase quality and reduce cost. Quality improvement is measured by annual cost savings, and quality is achieved by reducing variability around target specification values. According to

Kirkland (1988), "in the Taguchi definition of quality, any product characteristic deviating from a target value results in a loss in dollars after the product is shipped."

Taguchi methods support design methods and manufacturing processes that optimize in a manner that make them insensitive to factors beyond the manufacturer's direct control. An important dimension of the Taguchi approach to quality of a manufactured product is the total loss generated by that product to society. Kackar (1989) explains the Taguchi philosophy:

The societal view of quality is a profound concept. According to this concept, the aim of quality control is to reduce the total societal cost, and the function of quality control is to discover and implement innovative techniques that produce net savings to society. An effective quality control program saves society more than it costs and it benefits everybody.

The total societal loss concept is a new way of thinking about long term investment in quality improvement projects in American manufacturing endeavors. Investment in a project to improve quality is justified as long as the resulting savings to customers are more than the cost of improvements. Taguchi suggests that all societal losses due to poor performance of a product should be attributed to the quality of the product.

Kackar (1989) presents seven points that explain the basic elements of Taguchi's quality philosophy:

- 1) An important dimension of the quality of a manufactured product is the total loss generated by that product to society.
- 2) In a competitive economy, continuous quality improvement and cost reduction are necessary for staying in business.
- 3) A continuous quality improvement program includes incessant reduction in the variation of product performance about their target values.

- 4) The customer's loss due to a product's performance is often approximately proportional to the square of the deviation of the performance characteristic from its target value.
- 5) The final quality and cost of a manufactured product are determined to a large extent by the engineering designs of the product and its manufacturing process.
- 6) A product's (or process') performance variation can be reduced by exploiting the nonlinear effects of the product (or process) parameters on the performance characteristics.
- 7) Statistically planned experiments can be used to identify the settings of product (and process) parameters that reduce performance variation.

### Statistical Process Control (History And Models)

Dr. W. Edwards Deming is considered to be the father of statistical process control based quality programs. Deming worked with the Japanese following World War II in an attempt to rebuild their industrial capacity. Deming suggests that the key to quality control is the use of statistics, control charts, a minimal number of suppliers, and a management philosophy grounded in participative processes. Recent articles in many publications, including *U.S. News and World Report*, have presented the Deming philosophy as a "guiding light to quality" (1988). Many authors have jumped on the bandwagon as if the Deming ideas are new, revolutionary concepts. These assumptions simply are not true. Patricia Langan, a research associate for *Fortune* magazine explains:

It was Deming who first talked to the Japanese--in 1950--about how to build quality into products. For his contribution to Japan's postwar recovery, the Emperor gave him a medal, and a prestigious prize was named after him. Thirty years after the Japanese started to learn from Deming, America began to listen. Now he is inundated with pleas for help from companies such as Ford and AT&T.

Dr. Deming believes that 95% of the quality failures in American industry are caused not by workers but by the system (management). Deming suggests that exhorting workers to improve quality is senseless because most of the elements of quality are not in the hands of the workers such as the right tools, the right materials, good training and a workable production process. This philosophy differs greatly from that of the Crosby Zero Defects model for quality control. Deming insists that clients adopt his fourteen points of management for proper quality control. Langan (1984) also points out in *Fortune* that:

Deming suggests that the classical method of achieving quality control by inspecting finished products is "criminal." Getting rid of defective products costs money and doesn't improve the process. Quit mass inspections, he urges, and instead control and improve the process so that each item comes out right the first time.

The basis for Deming's method for high quality production is statistical process control. Deming suggests that every process has variations from the ideal. Langan reports that:

Deming shows clients a systematic method for measuring variations, finding out what causes them, reducing them, and steadily improving the process and thereby the product. Deming divides these variations into special causes, which result in 6% of failures, and common causes, which account for the rest. A special cause--a bad batch of parts or a careless worker--creates erratic, unpredictable variations. Common causes are the rhythmic variations in the system--such as the slight differences in the dimensions of a bore produced by the same tool. Deming gets clients first to bring the manufacturing process under statistical control by eliminating the chaos of special causes, then has them work on the common causes by tinkering with the system and consistently measuring the effects.

The Ford Motor Company began using Deming principles in December of 1980. The company's Body and Assembly Operations conducted a very detailed analysis of supplier faults with incoming material which included extensive follow-up to determine corrective action. According to Robert Irving (1983) of *Iron Age*:

FORD reported the 30% of the faults were corrected through the process improvements and 70% through inspection actions. FORD decided to de-

velop an extensive statistical training program for all suppliers. FORD is convinced that statistical process control will replace inspection in American industry and that the result will be greatly improved quality and lower manufacturing costs.

One quick look at the September 1988 *Value Line* shows the result of SPC at Ford. All areas of quality and profitability have dramatically improved since the implementation of SPC at Ford in 1981.

<u>Category</u>	<u>1980</u>	<u>1989</u>
Sales per share	68.35	192.50
Earnings per share	.00	12.00
Book Value per share	15.77	61.30
Sales (millions)	37086	77000
Operating Margin	deficit	10.5%
Net Profit (millions)	deficit	4950
Long Term Debt (mil)	2709	1730
Net Worth (mil)	7362	24510

Another remarkable statistic is the Ford market share data from 1980 to 1989. The Ford market share has not increased dramatically. Ford simply began doing a better job of producing what they have always produced with no major changes in the product mix or marketing mix. As a method to improve quality and productivity SPC is based in collaborative management processes as well as statistical methods. Six questions related to the statistical development of SPC were developed in the Spring of 1980 by Ford Motor Company:

- 1) What is meant by a process control system?
- 2) How does variation affect process output?
- 3) How can statistical techniques tell whether a problem is local in nature or involves broader systems?
- 4) What is meant by a process being in statistical control?

- 5) What are control charts, and how are they used?
- 6) What benefits can be expected from using control charts?

According to Ford (1983) a process control system can be described as a "feedback system." Four elements of the system are presented by Ford (1983): "(a) the process; (b) information about performance; (c) action on the process; and (d) action on the output."

The process can be defined as the factors of production, the combination of human resources, equipment, input materials, methods, and environment that work together to produce output. Information about performance can be gathered by studying the process output. This output includes not only the products that are produced, but also any intermediate outputs that describe the operating state of the process. If the information is gathered and interpreted correctly, it can show whether action is necessary to correct the process or the just-produced output (Ford, 1983).

Langan also points out in Fortune (1984) that: It may not be coincidental that Ford seems to have achieved notable quality improvements. Deming has visited Ford, where he is sometimes referred to as "the guru," about once a month, talking to everyone from President Donald Peterson down to groups of hourly workers. His prescriptions range way beyond manufacturing methods. At Deming's urging, for example, Ford is now revising its management rating system and soliciting the views of employees about a new, non-numerical system. The Deming philosophy involves qualitative as well as statistical elements. Deming calls these elements his "fourteen points" for management. It is the combination of these statistical methods and new management philosophies that turned Ford around according to Langan (1988). Here are Deming's 14 points:

- 1) Create constancy of purpose to improve products and services, with the aim of becoming competitive, staying in business and providing jobs.
- 2) Adopt the new philosophy. We are in a new economic age, created by Japan. We no longer can live with the commonly accepted style of U.S. management, nor with commonly accepted levels of delays, mistakes, and defective products.
- 3) Cease dependence on inspection to achieve quality. Eliminate need for inspection on a mass basis by building quality into the product in the first place.
- 4) End the practice of awarding business on the basis of price tag. Instead, minimize total cost.
- 5) Continually improve the system of production and service, to improve quality and productivity and thus constantly decrease costs.
- 6) Institute on-the-job training.
- 7) Institute supervision that aims to help people, machines and gadgets to do a better job. Supervision of management as well as of production workers in need of overhaul.
- 8) Drive out fear, so that everyone may work effectively for the company. To accomplish this, fundamental changes--such as elimination of annual ratings and management by objectives--are required.
- 9) Break down barriers between departments. People in research, design, sales and production must work as a team to foresee production and usage problems.

- 10) Eliminate slogans, exhortations and targets for the work force, asking for zero defects and new levels of productivity without providing road maps.
- 11) Eliminate work standards that prescribe daily quotas.
- 12) Remove barriers between the hourly worker and his right to pride of workmanship. Supervisors' responsibility must be changed from sheer numbers to quality. The same statement holds for management.
- 13) Institute a vigorous program of education and retraining.
- 14) Take action to accomplish the transformation.

### Single Case Research Design--Background

Luthans and Davis in a 1982 *Academy of Management Review* article point out that single case experimental designs have a long history in experimental psychology. Pavlov developed single subject research designs and Skinner (1953) defended the use of single case design by stating that he would prefer a study with a thousand replications of a single subject than one study of a thousand subjects in order to understand human behavior.

Further, Luthans and Davis (1982) suggest that: Only recently have single case designs been developed for use in applied settings. The works of Sidman (1960), Allport (1962), Dukes (1965), Baer, Wolf, and Risley (1968), Bergin and Strupp (1970), Lazarus and Davison (1971), Kazdin (1973), and Barlow (1976) have added to the development of workable single case designs that can be applied to research of interactive organizational behavior.

### Single Case Design--Internal and External Validities

The main problem with single case research, as presented by Luthans (1982) is the weakness that this approach shares with most group comparison research: the problem of generalizing the findings to a given population. Most researchers in organizational behavior would agree that a sample of only one case makes any attempt to generalize the findings unreasonable. However, Edgington (1967) suggests that:

the belief that you cannot statistically generalize to a population of individuals on the basis of measurements from only one subject is certainly correct. However, it is also correct that you cannot statistically generalize to a population from which you have not taken a random sample, and this fact rules out statistical generalization to a population (at least to a population of some importance) for virtually all psychological experiments, those with large samples of small.

Other factors, as pointed out by Luthans (1982), such as demand characteristics, experimental effects, and expectations, are a potential problem in single case design, as they are, at least to some degree, in all research. Luthans (1982) also suggests that major solutions to the generalization problems related to demand characteristics, experimental effects, and expectations as Skinner (1953) first recognized and Hersen and Barlow (1976) have more recently emphasizes is replication. Replication allows researchers to generalize realistically from one setting to another with some degree of confidence. However, Kennedy (1979) also suggests that even without replication the judgement of generalizability can be shifted to the user of the case data rather than the researchers who produce the data. Luthans (1982) suggests that this is what is done in legal and clinical generalization. Luthans (1982) also states that "single case studies may prove to be more valuable to management

practitioners than statistically oriented group studies because group comparisons may not generalize to individual cases."

### Summary--An Integrated Approach to Process Control

The literature review addressed three areas related to process control: historical and current organizational development models, participative management processes, and, current quality control models. The review suggests that participative (collaborative) management processes are the key to successful programs of change in organizations. A historical look at laboratory training in industrial organizations provides two key elements for development of effective quality control programs: (1) a successful program of change requires active involvement in and leadership from top management; and, (2) on-the-job application is critical for success in any change related program.

Pioneers in survey research and feedback found another element that may be key to successful quality process control programs. That is, an intensive program of change is more effective when the change occurs as a function of human relationships as a whole. In addition, collaborative change was found to be lasting, long term, change in organizations. Organizational Development practitioners including French, Bell, Mayo, Maslow, McGregor, Herzberg, Argyris, and others have provided assumptions about individuals, groups, and organizations useful in planning a process control system.

Crosby's Zero Defects Model suggests that prevention must be integrated into the effective process control model. The Crosby Model also stresses other important factors to integrate including; measurement of quality, and its costs, planning and corrective action, supervisor training, goal setting, recognition and quality councils.

The Taguchi method provides several key elements to integrate into a process control model. An important dimension of this approach that optimizes engineering design methods is the ability to make processes insensitive to factors beyond the manufacturers direct control. Another important element of the Taguchi method useful for integration purposes is measurement of continual reduction in the variation of product performance about target values.

Deming provides both quantitative and qualitative elements of integration into the process control model. Statistical techniques of a descriptive (enumerative) nature are combined with management processes from analytic bases to form the Deming approach.

However, the literature review also suggests that Deming as well as Taguchi methods focus quality improvement programs in a direction dominated by statistical and engineering techniques. This is not to suggest that either program lacks a qualitative or participative element. However, the major criticism of both Deming and Taguchi is the stoic focus and scientific jargon. Even the words Statistical Process Control elicits fear in the minds of most Americans let alone the hourly operational work force.

On the other hand, critics of methods that focus too much on the qualitative aspects of quality improvement programs abound. Crosby techniques are continually criticized by competing quality control consultants as well as the press.

An integrated approach might be the answer to successful planning and evaluation of quality control programs. The research model, called Participatory Process Control (PPC), is an attempt to bridge the gap between quantitative and qualitative based quality control programs. The key element of this integrated approach is participatory (collaborative) management. The analytical PPC model is presented in Chapter III of this thesis. The analytical model was used for the stated

purpose and objectives of this study. A manufacturing firm from Oregon served as the case study for the analytical process.

## CHAPTER III

### DESIGN OF THE STUDY

#### Introduction

The design of the study included the methodology and procedure used in conducting the case study research on a manufacturing facility. This consists of a restatement of the problem, a population description, the collection of data, and a description of the research design.

#### Problem Restatement

The purpose of this study was to examine the impact of SPC on the ability of a selected Oregon manufacturing company to restructure its workforce as a method to improve quality and productivity. Following the stated objectives, a literature review was conducted in the area of management theory, organizational development, quality control models, and case study methodology.

Major components of a proposed model were identified from the selected areas of specialization in the review. An analytical framework was developed integrating process control with areas of organizational development, management theory, and statistics. The case study was developed to explain the functioning of the proposed process control model.

## Population Description

The case study used in this research design was a major manufacturer in the Willamette Valley of Oregon. Hereafter referred to as the Company.

## Collection of Data

The research design concentrated on analysis of the business in relation to the process control model developed. Three methods were used to gather data: (1) interviews, (2) archival data, and (3) observation. Interviews were conducted with employees at all levels of the organization including top management, middle management, supervisory management and operators.

An interview guide was used to make sure all key areas of examination were discussed. Personal focused interviews were held over a six week period of time. Several forms of archival data were used to supplement the interviews. These included financial reports, previous management marketing and production plans, personal notes by management and business periodical company reviews contained in local and regional publications.

The project also used observational data. This included observing the interaction of management with production as well as observations from the factory floor.

## Research Design

The thesis was concerned with the functioning of the Participatory Process Control model. A research format was selected (Pearson, 1987) using methodology

in the form of a case study to understand the application of the PPC model (see Figure 1).

The case study method was explained in the prospectus and literature review as an appropriate technique for the subject. The case study method used the following procedures:

- 1) Developed an interview guide to gather data;
- 2) described the case;
- 3) selected individuals to be interviewed;
- 4) elected other sources of information (financial reports, news articles, and historical documents);
- 5) followed the data through the PPC analytical structure; and
- 6) validated the framework and redefined the model, if necessary with the data (Pearson, 1987).

### Analysis of Data

There are two types of statistical studies: enumerative and analytic. This thesis is concerned with the analysis of data from an analytic framework. Nolan (1988), Deming (1975), and Provost (1989) have provided the basic principles of design and analysis of analytical studies. Deming defines enumerative and analytic studies as follows:

- 1) An enumerative study is one in which action will be taken on the universe; and
- 2) An analytic study is one in which action will be taken on a process to improve performance in the future.

In an analytic study the focus is on a process and how to improve it in the future. There is no identifiable universe as there is in an enumerative study. As the

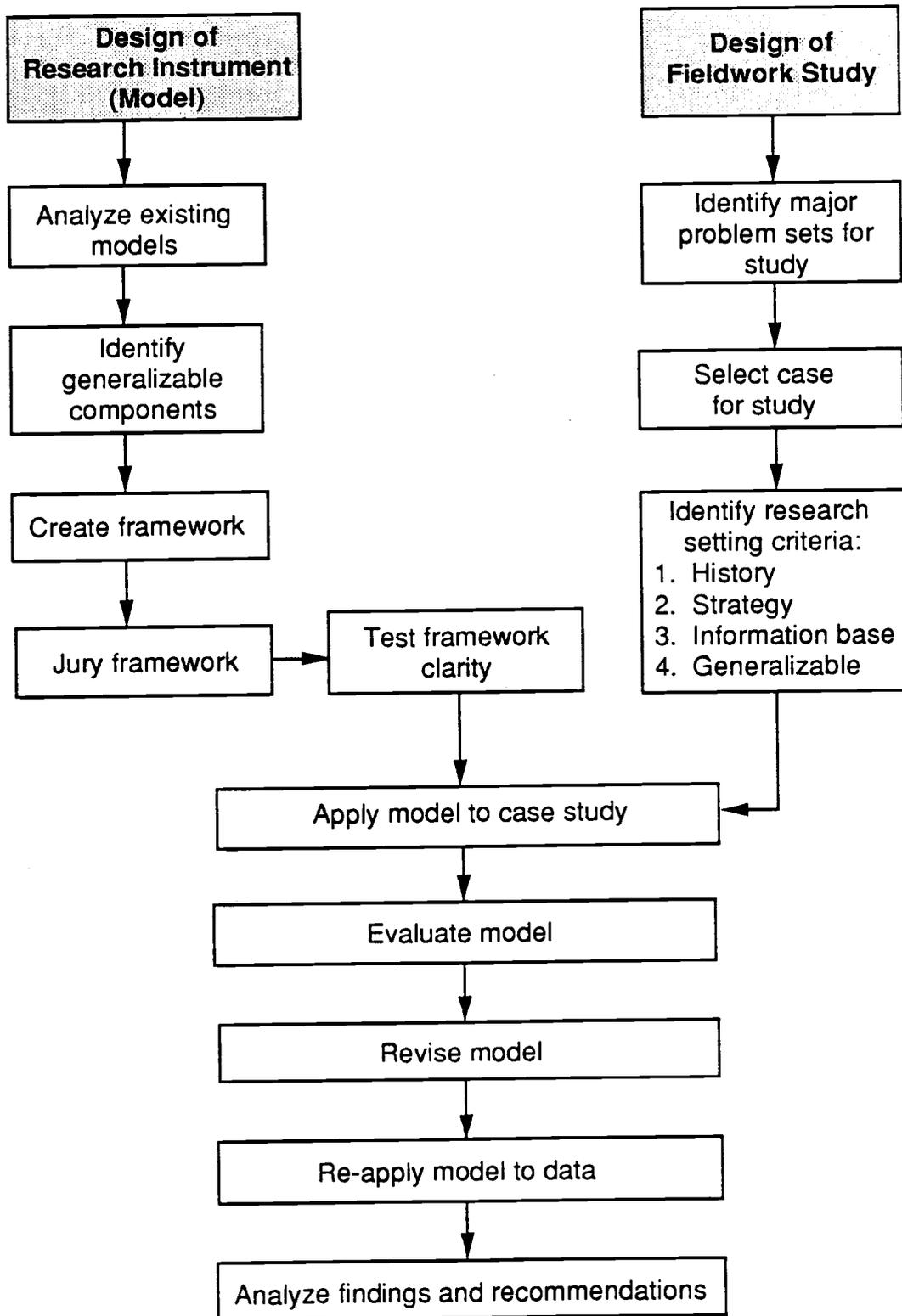


Figure 1. Research Design (Pearson, 1987).

purpose of an analytic study is to improve performance of the process in the future, the outcomes of interest have yet to be produced by the process. In some cases the process itself may not exist, but only laboratory or pilot models are available (Provost 1989).

Deming (1986) states: "Analysis of variance, t-tests, confidence intervals, and other statistical techniques are inappropriate for analytical studies because they provide no basis for prediction. In an enumerative study, the existence of a distribution for the characteristic of interest can be justified. Summary statistics such as a mean and standard deviation can be used to estimate parameters of the distribution. These estimates will have a quantifiable measure of uncertainty if the sample was properly selected. This type of analysis is usually an important step to accomplish the aim of an enumerative study. However, Provost (1989) suggests: The standard error of a statistic or the standard deviation of a process does not address the most important source of uncertainty in an analytic study: the uncertainty of predictions outside the conditions of the study. These measures of variation may sometimes be useful to assess the impact the common causes not under consideration in the study have on the results. However, these procedures are not generally recommended since it is unusual that the theoretical assumptions on which they are based are satisfied in an analytic study. This is due to circumstances such as the lack of stable processes, lack of appropriate randomization, interaction between the factors under study and the experimental conditions, and interaction between the factors and the experimental units. One basic principle (Provost, 1989) will be used in relation to the analysis of data for this study: The analysis of data, the interpretation of the results, and the actions that are taken as a result of the study will be closely connected to the current knowledge of experts in the relevant subject matter.

This principle relates to the important role that knowledge of the subject matter plays in the analysis and interpretation of data from analytic studies. This knowledge could be based in well accepted scientific principles or simply hunches based on past experiences. According to Deming (1986): "Building the knowledge necessary for improvement is an important use of analytic studies." During the study planning phase, predictions of how the results of the study will turn out were made by the researcher. This process of pattern matching was designed to bring current knowledge into focus before data was collected for the study. These predictions were suggested in Chapter I.

Now that the study is complete, the results of the analysis of data can be compared to the predictions made during the planning phase. The degree of belief that the study forms as basis for action is directly related to how well the predictions agree with the results of the study.

### Analysis of Procedural Steps in the Proposed PPC Structure

An analytical structure for participatory process control was developed from the integration of components reviewed in the literature. Functional Flow Level analysis, as suggested by Stiehl (1989) provided the procedural organization for the analytical model. A Model for Action Research (Figure 2) was used to formulate the graphical structure of the PPC model. The analytical model for implementation of participatory process control has two functional flow levels.

Functional Flow Level I, Figure 3, examines the organization from an overall, or macroenvironmental view. This general analytical flow level provides the researchers with initial organizational linkages and preliminary secondary information. Functional Flow Level I describes the model as systems based with eight steps:

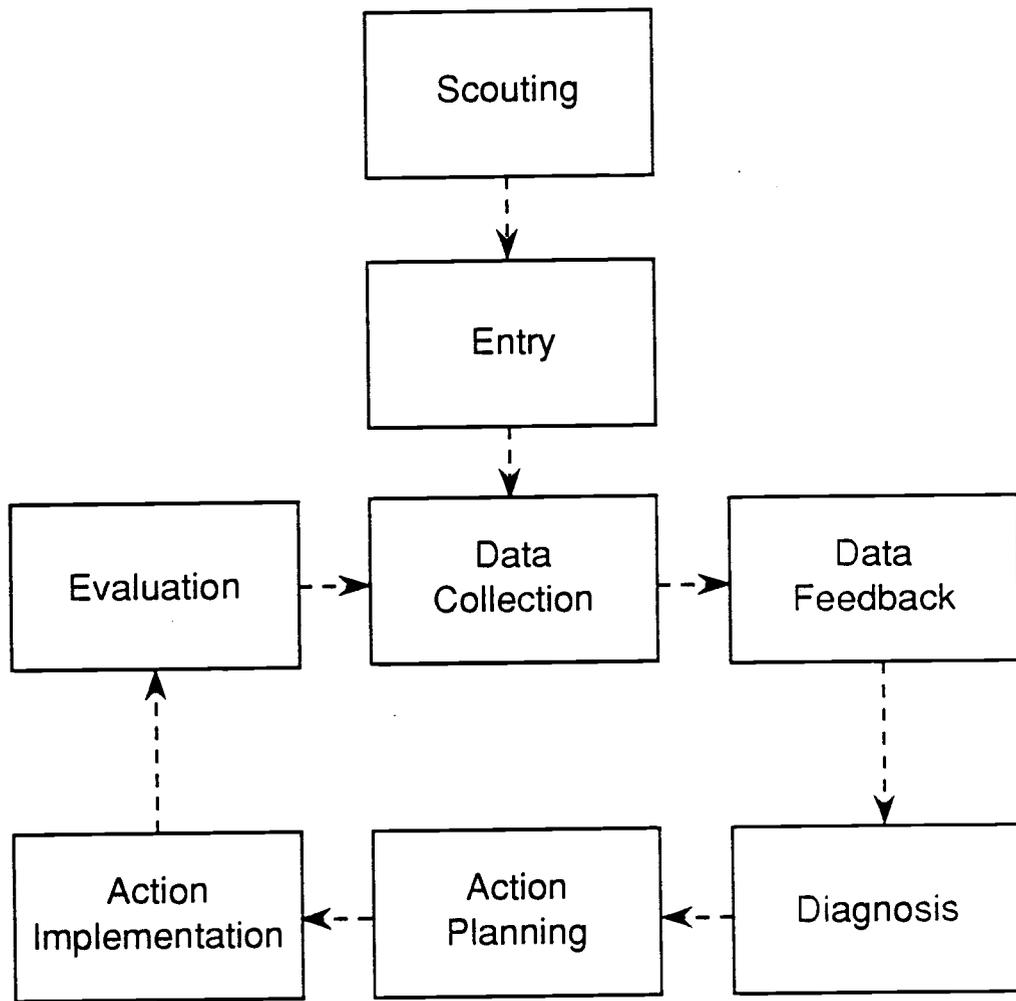


Figure 2. Model for Organizational Diagnosis.

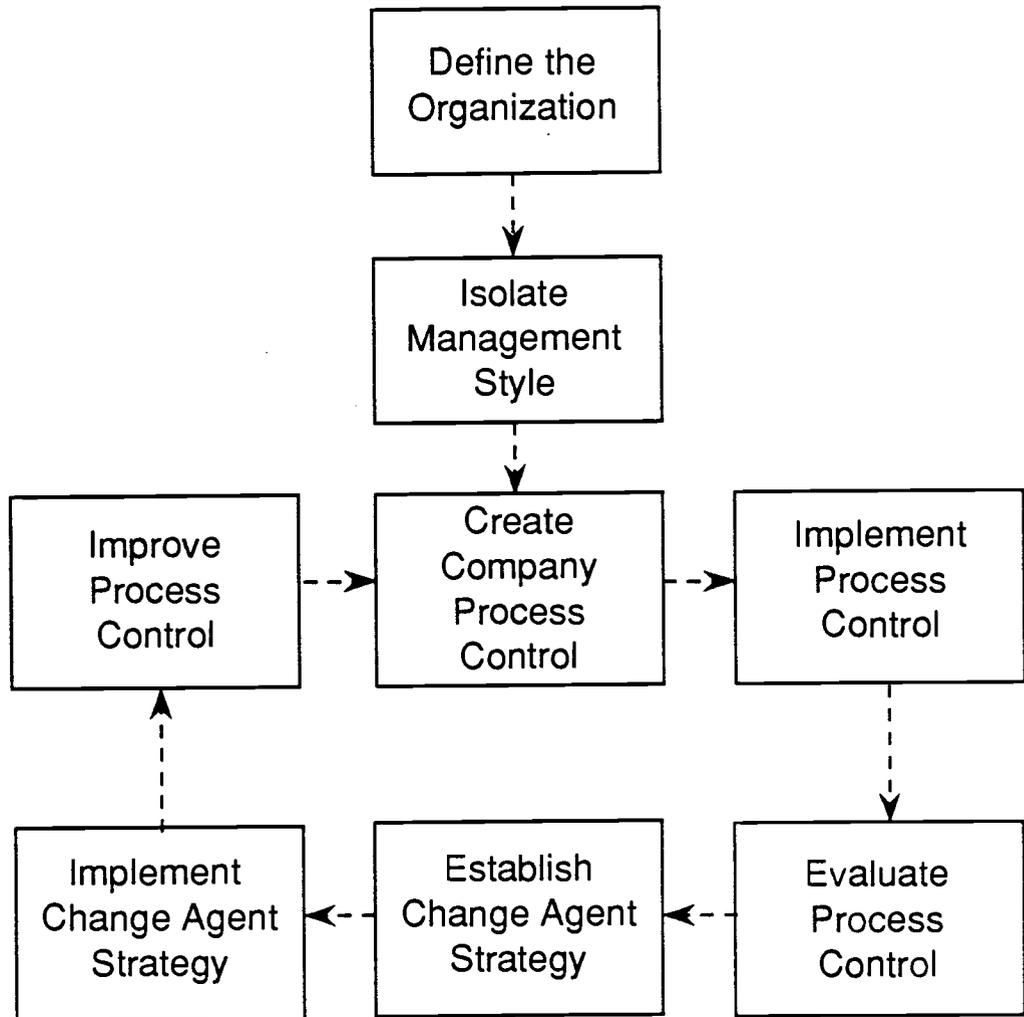


Figure 3. Analytical Model for Participatory Process Control--Functional Flow Level I.

- 1) Step 1: Define the organization;
- 2) Step 2: Isolate the clients management technique;
- 3) Step 3: Create the company PPC model;
- 4) Step 4: Implement PPC model;
- 5) Step 5: Implement the change agent strategy;
- 6) Step 6: Evaluate PPC implementation;
- 7) Step 7: Improve PPC model; and
- 8) Step 8: Maintain change in client.

Functional Flow Level II examined the organization from a microenvironmental view. Eight Functional Flow Level I steps were examined in detail from the company. Functional Flow Level II provided a template for successful process control. The microenvironmental point of view is presented with case information for each element in Chapter IV of this thesis.

## CHAPTER IV

### FINDINGS

#### Introduction

The data were collected and reported within the structure of the participatory process control model as presented in Chapters II and III. These Functional Flow Level II elements included: (1) Define the Organization; (2) Isolate the Client's Management Style; (3) Create Company Process Control; (4) Implement Company Process Control; (5) Evaluate Company Process Control; (6) Establish Change Agent Strategy; (7) Implement Change Agent Strategy; and (8) Improve Company Process Control.

#### Step 1--Define the Organization

Functional Flow Level II of the PPC Model examined the organization from a microenvironmental view. Step 1, Define the Organization, is shown in Figure 4. This initial step in the process has an internal structure, or sub-model, consisting of three elements: (1) Review of Organizational History; (2) Identify Organizational Hierarchy and Power Bases; and (3) Measure Change Conditions.

The data gathering instrument used for step one of the PPC model was developed by Deming (1986). These guideline questions, provided valuable background information on the Company. Answers were edited and combined with additional secondary source materials in an attempt to develop a formative evaluation of the Company for successful process control.

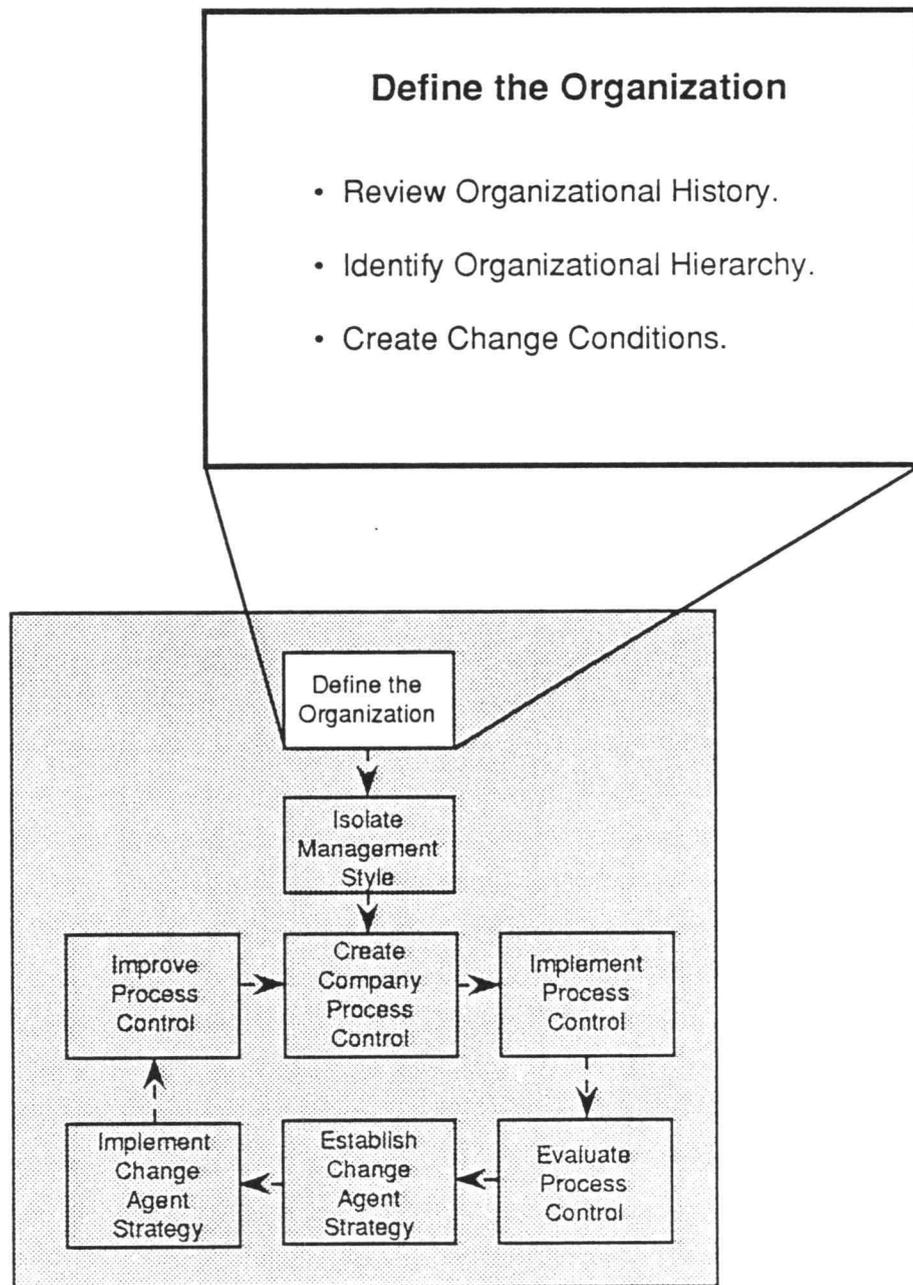


Figure 4. PCC Model--Functional Flow Level II, Step 1.

## Review Organizational History

As briefly stated in the population description section of Chapter III the case study used in this research design involved a major manufacturer in the Willamette Valley of Oregon. Certain facts, including financial margins and accounting practices, were changed to retain confidentiality for the business and its employees.

### Early Years--1978 to 1985

The case description focused on activities within the organization from the period of time 1978-1989. The early years of the company were characterized according to the production supervisor (1989), as a period of great corporate "confusion." Three major internal and external environmental conditions led to poor organizational health during this period of time. These conditions were (a) search for corporate identity; (b) lack of continuity in the top management position; and, (c) a centralized, autocratic management style in all levels of the organization.

The corporate identity was undefined during the period of 1978 to 1981. A major Fortune 500 Corporation owned the Company in 1978. Lack of corporate identity was reflected in lower sales, reduced net profits, high absenteeism, poor safety records, and labor problems that included poor worker morale. In 1978 another merger and acquisition added more pressure and organizational turmoil at all levels of the company.

According to the production supervisor (1989):

The corporate approach was short term oriented. They invested a large amount of money in capital equipment and expected a 25% market share increase. Unrealistic sales forecasts were established and it was clear that the corporate identity was unknown to the top management as well as the hourly work force.

From the period of 1978 to 1981 the company experienced five new chief executive officers. The organizational chaos and lack of direction was increased by

the continual shuffling of new chief executive officers from the corporate offices. The primary management style used by the chief executive officers during this period of time was considered to be highly autocratic. The corporate philosophy of high investment in capital equipment at the expense of labor continued during 1981. Corporate financial managers invested well over sixteen million dollars into the company for new equipment during 1981. This capital expansion vaulted the company into a position as the nations largest producer of related specialty products. However, the corporate capital expansion philosophy resulted in greater long term losses for the company.

The short term oriented management style did little to focus on the workers at the operation. Larger productive capacity added stress to the organizational structure and the supervisory rate grew out of proportion during the period of 1981 to 1985.

#### The New Era, 1985-1989

The company was put on the auction block by the parent corporation in late 1985. The operating losses simply were not covering the costs of the recent capital improvements. During 1986 negotiations took place regarding a purchase of the company by managers of the company. The purchase of the company by the current management was approved in the fall of 1986. Statistical Process Control and the new participatory management methods began in the production area during late 1986 and early 1987. The new management immediately reduced the layers of management from seven to four and approximately 150 operators, line supervisors and related support staff were displaced during this initial restructuring. Nine supervisory positions were immediately eliminated, 26 quality control specialists were also given the opportunity to become operators.

### Identify Organizational Hierarchy

The company organizational structure changed dramatically from 1985 to 1987. The formal nature of the company, as identified by the organizational charts, shown in Figures 5 and 6 reflect this structural change.

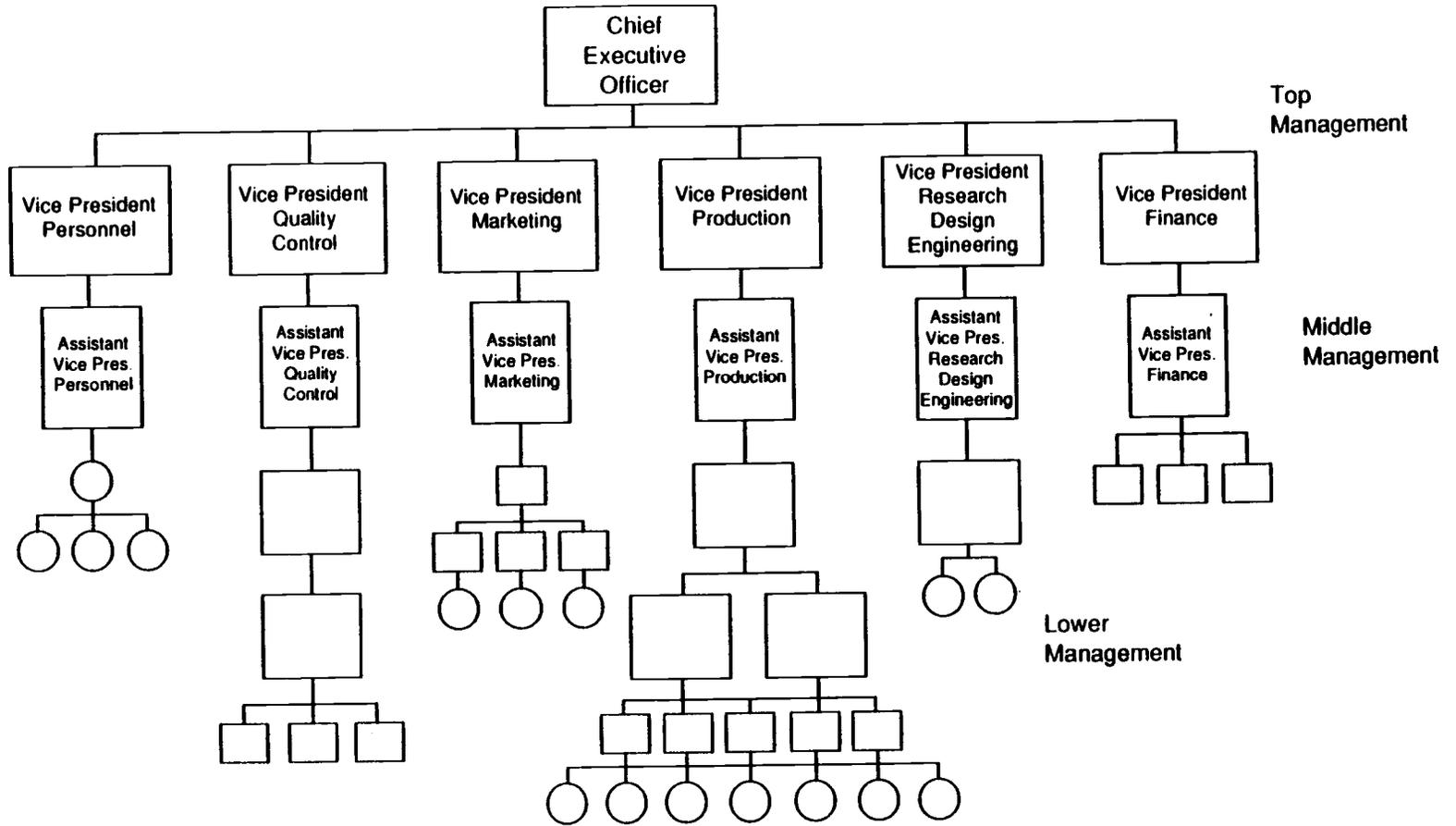
The literature review suggested that it is important to understand the various power bases and assumptions that tend to influence an individual or group of people. French (1975) suggests that "if you understand what power bases tend to influence a group of people, you have some insight into whom should be given a particular project or assignment."

French's research points towards the use of organizational charts as the basis for identification of the formal organizational hierarchy. We can increase the probability of success in the process control model if we understand the power bases and employees involved in the new methodology. Various power bases were identified in the company and classified in the framework developed by French (1975). These seven bases of power, identified as a potential means of successfully influencing the behavior of others, were defined in the literature review.

Nine top and mid-management personnel were asked to define the current (1989) and past (1985) power bases of each other and of the chief executive officer. The Power Perception Profile (Hersey & Natemeyer, 1982) was used to measure perception of power in the company.

The instruments were compiled and a dominant base was identified for each of the participants and for the chief executive officer. Identification of power bases in the organization led to proper utilization of resources and change agent strategies (step 6 in the PPC model). Initial restraining forces against new change-based

Figure 5. Management Structure, 1985.



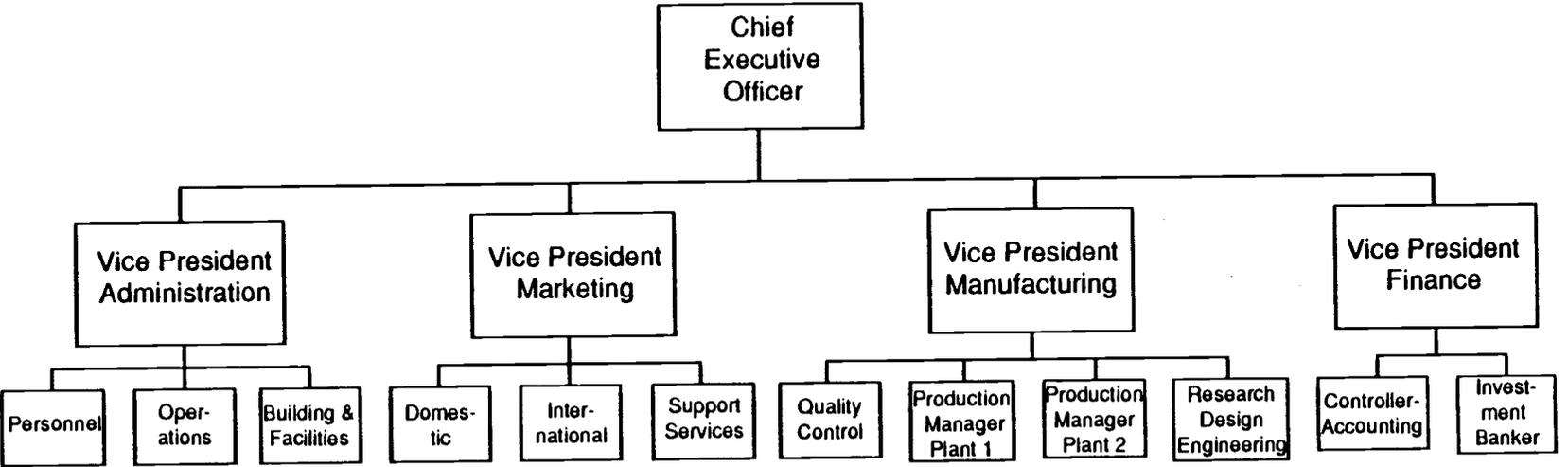


Figure 6. Management Structure, 1989.

methods were identified in top management, manufacturing, research and development, accounting, as well as production. These managers all held power in legitimate, coercive or connection bases identified as detrimental to organizational growth in times of rapid change.

Supporting forces were identified in the finance, marketing, and sales departments. However, critical to the success of the program, supporting power bases were found in the supervisory level of the company.

The chief executive officer was perceived to have retained legitimate power from 1985 to 1989. However, significant changes were found in the perception of other top management power bases during the same period of time. These changes were viewed as positive by the research participants. For example, the Vice President of Manufacturing was perceived to have a legitimate power base in 1985. This position power base led the research participants to feel that this vice president had inadequate knowledge of the organizational operations in 1985. As a result of the change processes underway in the company this power base was perceived as expert in 1989. A production supervisor remarked (1989):

This particular vice president was opposed to all attempts at organizational change in 1985. He reluctantly agreed to the implementation of process control in the production department. As morale and profit margins were low in 1985 he developed an attitude that was perceived as uncaring. However, once the process control experiments began to improve the quality, productivity and profit margins of the company this vice presidents' attitude changed. He became more involved in the process and eventually expanded the initial process control program to other areas of the company. This vice president is now perceived as an expert in the organization. This expertise is respected and is influential in the facilitation of work behavior in the company.

A summary of the Power Perception Profile results is shown below, followed by another example related to changing power bases within the company.

Power Perception Profile Results

<u>Title</u>	<u>1985</u>	<u>1989</u>
Chief Executive Officer	Legitimate	Legitimate
Vice President, Mfg.	Legitimate	Expert
Vice President, Finance	Expert	Expert
Vice President, R&D	Coercive	Expert
Vice President, Marketing	Information	Information
Production Manager I	Connection	Expert
Production Manager II	Connection	Information
Comptroller	Legitimate	Expert
Sales Manager	Connection	Referrent
Production Supervisor	Reward	Expert
Production Supervisor	Reward	Expert

Another example of perceptual change as measured with the Power Perception Profile was found in the research and design area. Perception of the Vice President of Research and Design power base also changed dramatically from 1985 to 1989. Viewed as coercive in 1985 this VP was well known for inducing compliance through force in the organization. A production manager (1989) suggested that:

this vice president was feared as an enforcer of punishment, a deliverer of dismissal orders from the C.E.O. Company personnel went out of their way to avoid him in their day-to-day work routine in 1985. But, as was the case with the VP of manufacturing, an attitude change occurred that coincided with profit margin changes and implementation of process control techniques in the company. In 1989 this VP is also viewed by workers as an expert in the company. It remains to be seen if the attitude change is real or just tied to increased profits in the company.

The perception of mid-management power bases also changed during the period of 1985 to 1989. The Power Perception Profile reflected movement towards expert and information power on the part of both company production managers.

One operator (1989) who remained with the company after the 1986 reorganization reflected:

those production managers were the spark plug for the whole effort towards process control. We wouldn't have followed them anywhere if we had to in the old days. But things surely changed after the management acquisition of the company. We were not sure, at first, if the change towards participatory management was real, but the bonus program convinced us quite rapidly of the change in these mid-managers.

### Summary of the Company Power Perception Profile

The development of these internal resources is an important, inherent feature of the PPC model. In the PPC model, the external change agent attempts to reduce the organizations reliance on the agent by developing internal resources with strong power bases.

Movement in employee attitudes and behavior are ultimately reflected in the Power Perception Profile. At all levels of management change occurred by focusing process control efforts towards those employees identified as possible change agents. Initial attempts at moving process control techniques out of the production area were focused on finance, marketing and sales as these managers were found to have power bases influential to positive change in the organization.

However, an interesting development addressed the power base and role of the chief executive officer. The perceived power base as measured by the Power Perception Profile showed no change from 1985 to 1989. A question then arises--is top management commitment and involvement necessary for successful organizational change programs? The data suggest that, in this case, top management commitment and involvement are not paramount for successful change oriented programs of process control.

### Measure Change Conditions

The literature review suggested that an intensive program of change is more effective when the change occurs as a function of human relationships as a whole. As the company goal for process control was identified to be lasting, long term change, the Kimberly and Nielsen (1975) model was selected to measure change in the organization.

Data were collected from the company regarding perception of organizational climate for change on two separate occasions, January 1987 and March 1988. The distribution of instruments to measure the organizational change climate included: two top managers, five mid-management personnel, and nine supervisory or operational employees at the company.

Administration of two instruments, suggested by Kimberly and Nielsen (1975), were used to measure the change climate. One instrument asked the participants to rate support, communication, objectives, conflict, process control, trust and environment.

The second questionnaire asked employees to rate their supervisors in areas of listening, problem solving, self-development and willingness to change. Participants were given basic instructions on the data collection instrument and were asked to return the questionnaire within a week.

The instruments used Likert-type scales within a rating system structure. These rating scales used the number 1 as the minimum average score (least desirable value) and the number 5 as the maximum average score (most desirable value), scaled as follows: 1 = very poor; 2 = poor; 3 = neutral or average; 4 = good; and 5 = very good.

Measurement of Company Change Conditions

Organizational Climate, Mean Scores

<u>Item</u>	<u>January 1987</u>	<u>March 1988</u>	<u>Percent Change</u>
Trust	3.1	4.7	52
Support	2.9	4.1	41
Self-Direction	2.7	4.2	56
Handling Conflict	2.1	3.4	62
Open Communication	2.4	4.1	71
Commitment	3.1	4.4	42

Supervisory Behavior, Mean Scores

Expression of Ideas	2.1	3.7	76
Listening	2.4	4.3	79
Influence	2.3	4.	79
Decision Making	2.7	4.2	56
Relations with others	2.1	4.4	109
Task Orientation	3.5	3.9	11
Self Development	2.7	4.1	52
Problem Solving	3.4	4.2	24
Willingness to Change	2.2	4.4	100

Discussion of Organizational Climate and Supervisory Behavior Measurements

In January of 1987 the problems associated with the turmoil of reorganization were evident in all measures of organizational climate. Most measures received poor ratings, including support, self direction, open communication, and handling conflict. Only commitment and trust received fair ratings. Supervisory behavior measurements in January of 1987 also reflected mainly poor ratings. Ex-

pression of ideas, interpersonal relations, and willingness to change received that lowest ratings. Not surprisingly, task orientation received the highest rating.

The March 1988 measurements showed improvement in all areas of organizational climate and supervisory behavior. Open communication and handling conflict reflected the largest organizational climate changes showing 71% and 62% gains respectively. In addition, perception of supervisory behavior showed large increases in willingness to change (100%), and relations with others (109%).

Hersey and Blanchard (1982) suggest that "once individuals have become motivated to change, they are ready to be provided with new patterns of behavior." The organization climate results, showing upward trends in all measured areas, suggested that company personnel were motivated to change through internalization. Internalization occurred because the personnel were placed in situations where new behaviors were demanded of them in order to operate successfully. These new behavior patterns were learned for survival and identification needs.

However, in order to measure the true long term environmental change at the company the Kimberly and Nielsen instruments should be readministered and measured each year. Longitudinal research methods combined with the Likert scale instruments are needed in future examinations of change in the company. As stated in the literature review, replication can help in determining the content validity of the method in terms of true organizational change.

### Step 2--Isolate the Client Management Style

The second step of the PPC model contains three non-mutually exclusive steps: (1) Administer leadership effectiveness instruments; (2) identify restraining forces for change in the organization; and (3) identify driving forces for change in the company (see Figure 7).

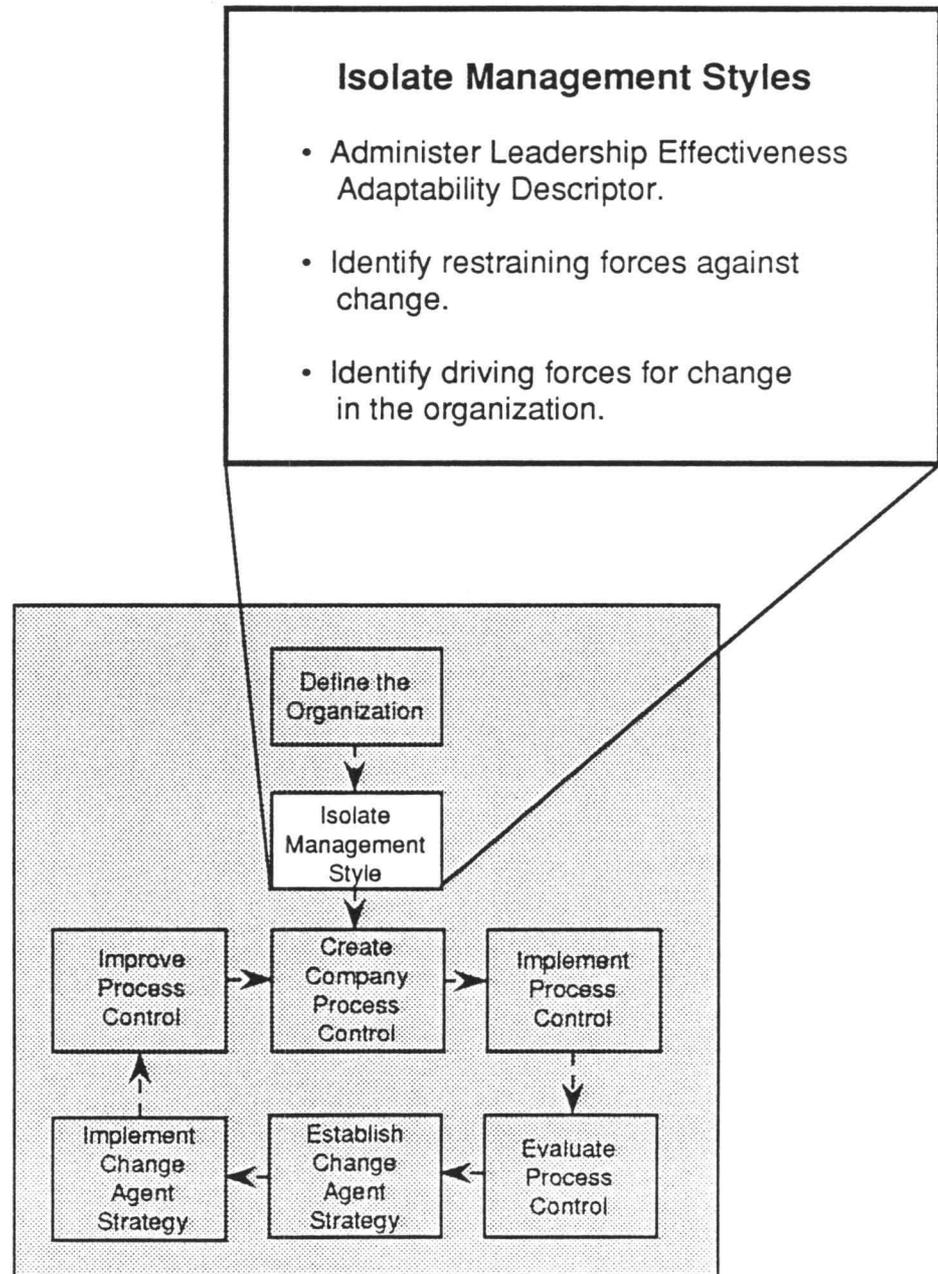


Figure 7. PCC Model--Functional Flow Level II, Step 2.

### Administer Leadership Effectiveness Instruments

As noted in the literature review specific research instruments were identified as reliable for the measurement of the dynamic interplay of organizational work teams. The Leadership Effectiveness and Adaptability Descriptor (LEAD) was used to measure three aspects of leader behavior at the company including style, range, and adaptability. LEAD instrumentation was administered to thirteen management personnel over a three week period of time. The LEAD instruments provided each participant with leadership simulations for analysis. Management personnel at the company responded to LEAD instrumentation describing their own behavior as well as their perception of other company manager behaviors.

Each respondent was given the LEAD materials and a one week deadline to complete the instrument. After scoring the instrument results were discussed with each individual and again as a team during quality review and follow-up meetings. This process allowed for in-depth evaluation of key management perceptions in the company. The instruments were scored according to LEAD guidelines and two specific dimensions of leadership behavior were measured: (1) style typology and (2) effectiveness. Style and range are determined by four scores, and adaptability (effectiveness) is determined by one normative score. The LEAD instrument contains twelve leadership situations in which respondents are asked to select from four alternative actions. These alternative actions reflect a continuum of management profiles--a high task/low relationship behavior, a high task/high relationship behavior, a low relationship/low task behavior, and a high relationship/low task behavior.

Reddin (1970) developed an effectiveness measurement from these continuum of management profiles. Hersey and Blanchard (1982) suggest that if the ef-

fectiveness of a leader behavior style depends on the situation in which it is used, it follows that any of the basic styles may be effective or ineffective depending on the situation. Hersey (1982) provides more information on the effective/ineffective dimension of the LEAD instrument: The difference between the effective and ineffective styles is often not the actual behavior of the leader but the appropriateness of this behavior to the environment in which it is used. In reality, the third dimension is the environment. It is the interaction of the basis style with the environment that results in a degree of effectiveness or ineffectiveness. One might think of the leader's basic style as a particular stimulus, and it is the response to this stimulus that can be considered effective or ineffective. Effectiveness, is, therefore a matter of degree and any given style in a particular situation could fall somewhere on this continuum from extremely effective to extremely ineffective.

Key LEAD (Other) ratings for the company are shown below:

<u>Employee</u>	<u>Department</u>	<u>Dominant Style</u>	<u>I/E Rating</u>
CEO	Top Mgt.	1 (HT, LR)	-4
VP Manuf.	Top Mgt.	1 (HT, LR)	-7
VP Finance	Top Mgt.	3 (HR, LT)	+2
VP R&D	Top Mgt.	1 (HT, LR)	-8
VP Marketing	Top Mgt.	2 (HT, HR)	+7
Production Mgr.	Mid Mgt.	2 (HT, HR)	+13
Production Mgr.	Mid Mgt.	2 (HT, HR)	+11
Comptroller	Mid Mgt.	4 (LR, LT)	-3
Sales Associate	Low Mgt.	2 (HT, HR)	+11
Production Super.	Low Mgt.	2 (HT, HR)	+9
Production Super.	Low Mgt.	4 (HT, HR)	+2
Operator	Line	2 (HT, HR)	+12
Operator	Line	3 (HR, LT)	+2

### Identify Restraining Forces for Change in the Organization

The LEAD instrument results were used to determine restraining forces for change in the company. Conflicting styles were identified in all three management levels of the organization. Autocratic styles dominate the top layer of management in the company. These styles are seen as possible restraining forces for change in the organization. The Chief Executive Officer, as perceived by others in the organization displayed a dominant style of 1 on the LEAD instrument. This C.E.O. was perceived as viewing some employees as lazy and irresponsible while viewing others as positive and creative. This leader was found to usually label managers and workers and found to be very supportive when he saw employees buying into his goals. The C.E.O. was also perceived to be very controlling when he viewed any employees as against him in the organization. The C.E.O. was perceived to have an effectiveness rating of -4. The Vice President of Manufacturing was also perceived to exhibit a dominant style of 1, with an effectiveness rating of -7. In addition, the Vice President of research and Development was also perceived to have a dominant style of 1, with an effectiveness rating of -8. These three individuals were viewed as providing the strongest restraining forces against change in the organization.

### Identify Driving Forces for Change in the Company

The LEAD instrumentation was also used to identify the strongest driving forces for change in the company. Mid-management provided the strongest support for change in the organization. The production managers were identified as having dominant style 2. Style 2 leaders are the most frequently identified style in successful change based programs in the United States. Both production managers were viewed by others as being very effective and supportive. Effectiveness ratings

of +13, and +11 indicate strong co-worker and subordinate support as both show a dominant high task and high relationship profile. Production supervisors in the company also were perceived as supportive for organizational change. Dominant styles of 3 and 4 were found with exceptional effectiveness ratings ranging for +9 to +13 at the supervisory level. These styles indicate effective management whose staff needs very little direction from the top layers of management. This may indicate one reason why the program proved successful at the company. These same production supervisors received very little, if any, direction from top management during the process control efforts.

### Discussion and Implications from Step 2 of the PPD Model

Management theorists have purported for decades that top management commitment is critical to the successful implementation of any organizational development based change program. The literature review traced the development of these assumptions from the Esso experiments to the Detroit Edison discoveries.

The company data revealed that these assumptions may be subject to review. In this case study the company C.E.O. leadership style and behavior remained constant during the entire organizational development based quality control program. The C.E.O. and a few other top managers in the company remained non-involved throughout the program. Productivity measures and profitability margins improved dramatically without the top management commitment and involvement in the process.

Employee perception of the C.E.O. role and behavior did not change as measured by both the Power Perception Profile and the LEAD instruments. The autocratic style of the C.E.O. as perceived by other managers reflected as focus on task at the expense of a more humanistic approach. An implication of this data

presents an interesting dichotomy. If profit margins fall, or productivity declines in the organization, would the PPC model survive?

### Step 3--Create the Organization Process Control

Step 3 of the PPC model contains two elements: (1) perform a quality audit; and (2) identify key process variables (see Figure 8).

#### Quality Audit

Brache and Rummler (1988) provided the base materials for the quality audit with supporting materials provided by Deming (1982). The focus of quality at the company was examined on three levels to determine the key variables for process control: organization, process, and individual.

Two quality teams were established in late 1986 in the company. One top manager, three mid-management personnel, and four operators or supervisors served on each team. Meetings were held at times determined to be ideal for the operators to minimize down time in the organization.

These quality teams rotated membership at three month intervals and met at least on a weekly basis. Quality and process control materials were reviewed by the quality teams including background information on the Deming methods. Organization quality issues were established during the initial team sessions. The answers to this quality audit were continually reviewed in the company and provided the company with the role that quality should play in the organization. Current opportunities for improving organization, process and individual quality were reviewed on a weekly basis. It was felt that the company could substantially increase the odds of solving quality problems through the audit and the initial key variables were defined upon completion of the questions shown below.

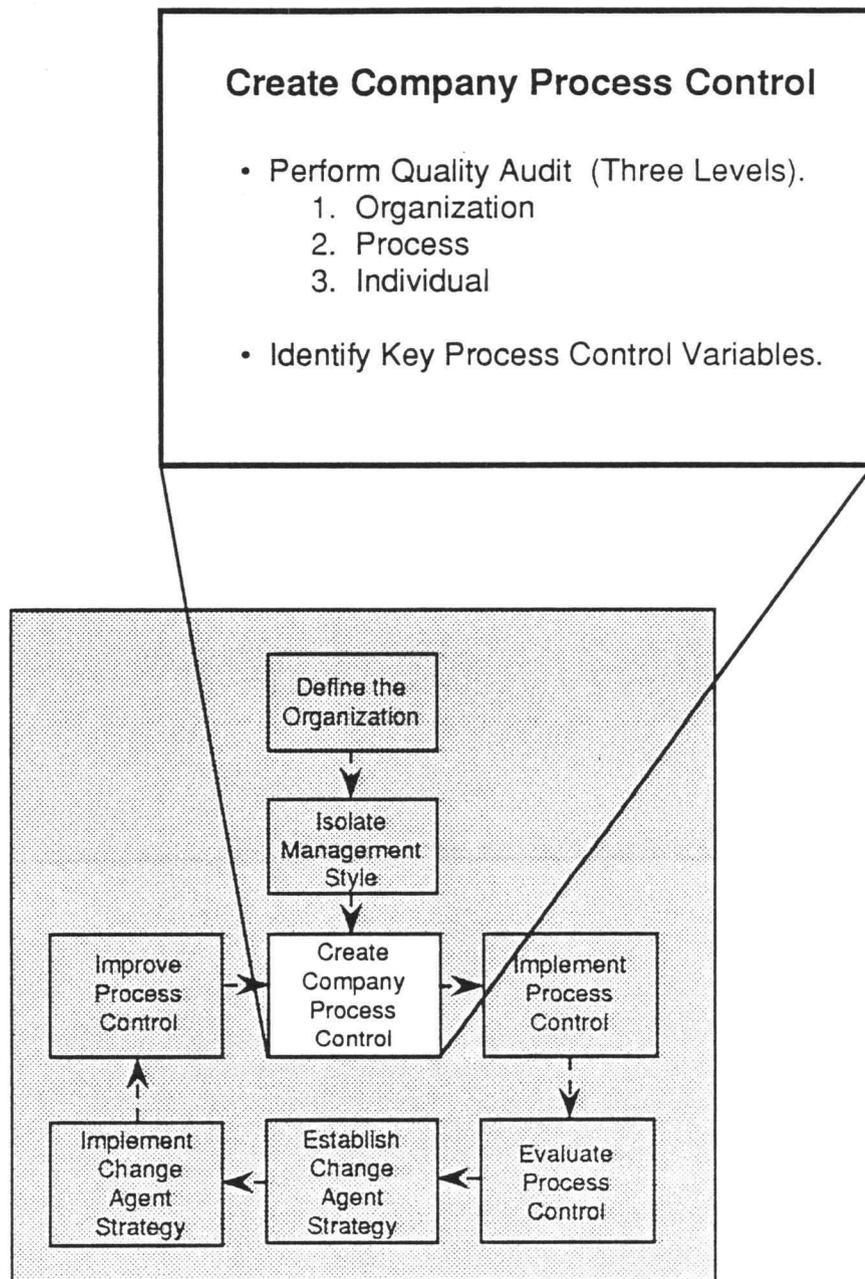


Figure 8. PPC Model--Functional Flow Level II, Step 3.

1) Organization (Level 1).

- What is our company strategy?
- What, specifically, are the aspects of quality that differentiate us from our competition?
- How is the quality of our strategy measured?
- Where are the gaps between our quality vision and reality?
- How can we define our organization so that it supports our quality strategy?
- What are the systemwide measures against which we should assess our performance?
- Where are the gaps in our systemwide quality performance?
- How can we best ensure that organization-wide performance is assessed regularly in terms of these measures?

2) Process (Level 2).

- What are the key cross-functional processes that affect customer quality?
- What is the most effective design for these processes?
- What are the most useful measures of overall process quality and of quality at each key process step?
- Where are the gaps in our process quality performance?
- How will we ensure that we manage these processes and the functions through which they flow?

3) Individual (Level 3).

- What are the appropriate individual quality measures, based on the organization and process measures?
- Where are the gaps in individual quality performance?

- How can we ensure that these measures serve as the foundation of human performance management?

### Identification of Initial Key Process Control Variables

Key project variables were defined in the fall of 1986 from the quality audit. The key primary quantitative process control objectives for the company were defined as follows:

- 1) Reduce lost time injury hours by a minimum of 5% for each quarter of 1987;
- 2) Reduce lost time absenteeism hours by a minimum of 10% for each quarter of 1987;
- 3) Reduce scrap and rework by a minimum of 5% for each quarter of 1987;
- 4) Increase sales dollars produced from manufacturing by a minimum of five thousand per production employee, per quarter for each fiscal quarter of 1987; and
- 5) Reduce the percentage of labor dollars expended to sales dollars produced by a minimum of 10% for each quarter of 1987.

### Step 4--Implementation of Company Process Control

Kleinert (1988) and Deming (1982) provided the basis for the implementation of process control in the company. This step of the PPC model contains six elements (see Figure 9):

- 1) Careful selection of items for application of process control;
- 2) Determination of the accuracy, repeatability, reproducibility, and variation of the measuring system;

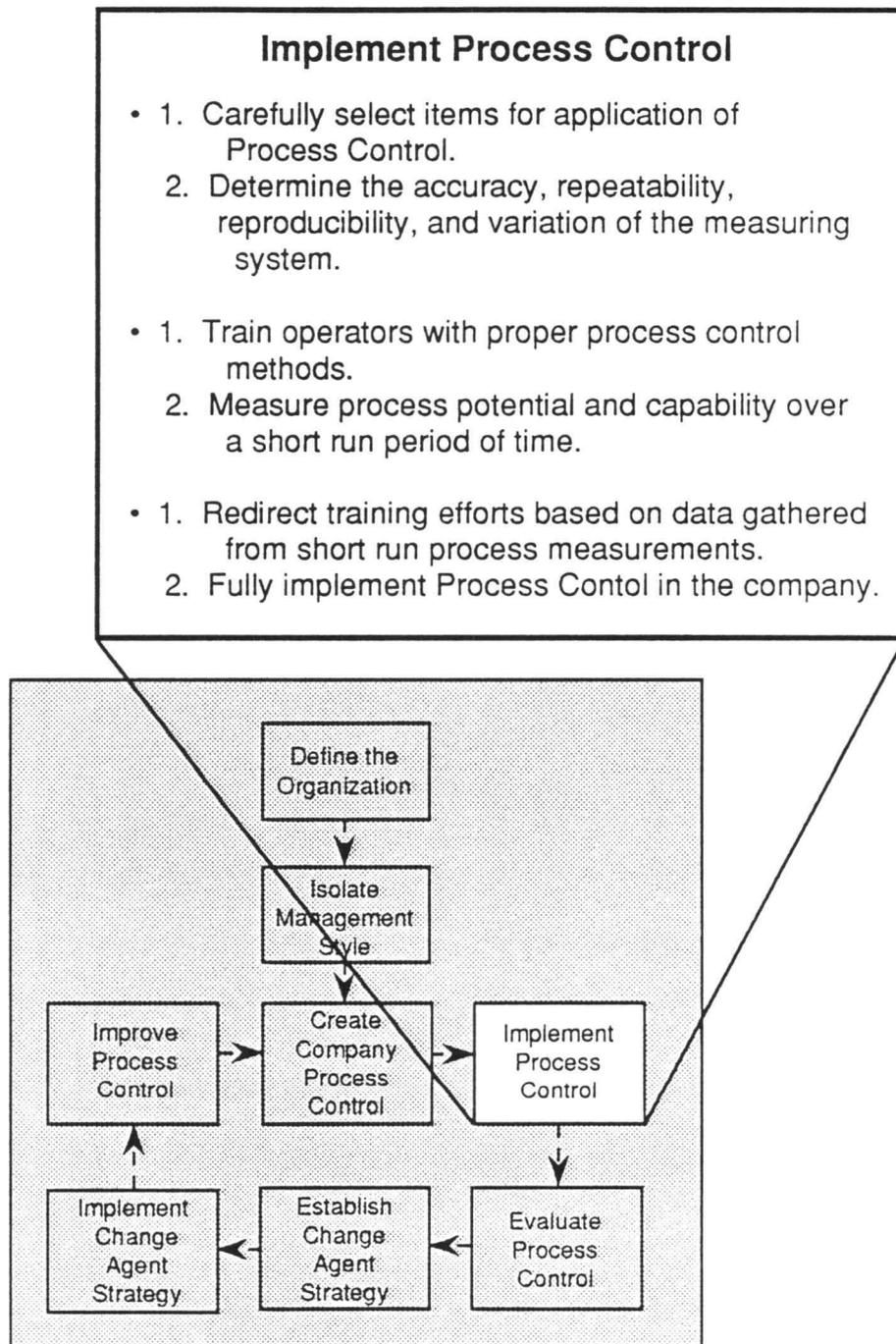


Figure 9. PPC Model--Functional Flow Level II, Step 4.

- 3) Orientation and training operators with proper methods;
- 4) Measurement of process potential and capability over a short run period of time;
- 5) Redirect training efforts based on data gathered from the short run process measurements; and
- 6) Full implementation of PPC for the company.

Statistical process control efforts began in the company in early 1987 following the management buyout and restructuring. The operators orientation efforts were led by the production manager, assisted by two production supervisors and coordinated by the established quality teams.

The company plants operate around the clock, using a four-crew, rotating shift arrangement. Two hour initial orientation seminars were held for entire crews prior to the last working day of each week. This enabled the crew to begin plotting control charts immediately. Control charts, primarily sample mean and deviation charts with limits, were easily explained without statistical jargon. The assumption was that while the operators needed to know how to use the charts they didn't need to learn all the theory and mathematics that go into developing the control charts. Deming suggests that an important secondary goal of SPC training is to reduce the operators fear of statistics.

At the beginning of the process, only the trained crews plotted control charts and these charts were left for display in the production area with copies in the lunchroom. Deming videos were shown at various times during the training to reinforce the trainers delivery and to add to discussion for all concerned.

Operators were introduced to how the control charts would be used in the company through process capability exercises using actual data from production lines. The operators were trained to collect data from each process, plot statistical

patterns, how to interpret the patterns, and how to correct the process until the capability was reached. The Parker (1988) methods of demonstration, repetition, and participation were employed for the continued training in SPC at the company. Demonstrations of how control charts directly added to the profit margins were shown at followup meetings with each work crew. All financial margins and production figures were exhibited in the lunchroom for the employees. Special control chart boards, production quota records, message spaces and recognition areas were coordinated by the production management into the lunchroom for all employees. This open display enabled each operator to assume a vested interest in the production unit and the organization as a whole.

Three weeks into the training all crews had accepted the control charts and new management philosophies. Most had realized that the primary tool for statistical process control was the control chart that is plotted by operators. Industry standards of two years for results to show from SPC training were easily broken in the company. Within three months after implementation of the program all measures of quality and productivity in the production area had improved.

The specific training of operators was a systematic process that followed a Deming format modified for the company. The process involved three steps: data collection, calculation of control limits, and measuring capability. Process improvement using control charts is an iterative procedure, repeating these fundamental phases.

- 1) Collection.

The process was run, and data for the characteristics being studied were gathered and converted to forms that were plotted on process control charts (see Figure 10).

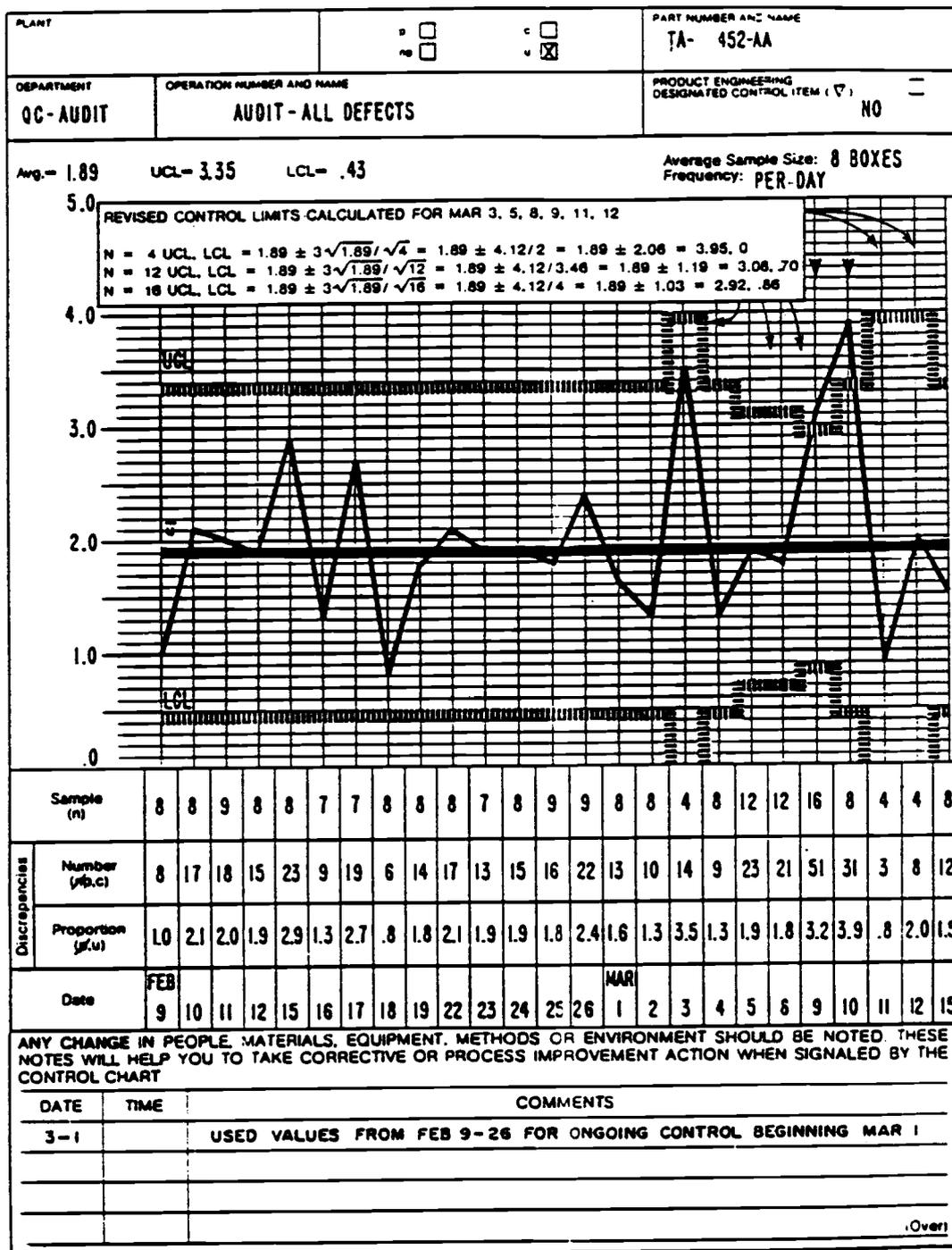


Figure 10. Control Chart for Attribute Data.

An X and R chart, as a pair, were developed from measurements of a particular characteristic of the process output. These data were reported in small subgroups of constant size with samples taken periodically. A data gathering plan was developed and used as the basis for collecting, recording and plotting the data on charts. The collection step also included selecting scales for the control charts and plotting averages and ranges on the control charts.

2) Calculate control limits.

Control limits for the range chart were developed first, then those for the chart for averages. These control limits were calculated to show the extent by which the subgroup averages and ranges would vary if only common causes of variation were present.

3) Interpret for process control.

The analysis of data plots on the range chart indicated the primary evidence of non-control. Any point beyond a control limit was the signal for immediate analysis of the operation for the special cause of variation.

Scrap and rework values were established to measure the process potential and capability over a short run period. Each shift plotted data on master control charts in the company lunchroom. Immediate improvement in scrap and rework values enabled the process control effort to be expanded throughout the production department. The effort was monitored on a weekly basis by the quality teams and re-directive action was taken as necessary to insure continual improvement. Full implementation efforts in process control began in early 1987 and continued throughout 1988 and 1989.

### Step 5--Evaluation of Company Process Control

Evaluation of the company process control effort has four systematic steps: (1) review elements of the measuring system and key variable goals; (2) measure the process potential and capability over the long term; (3) confirm the model predictiveness; and, (4) redirect if necessary (see Figure 11).

1) Review elements of the measuring system.

Five elements, quantitative in nature, were established to measure the effectiveness of the PPC model:

- lost time injury hours in the production department,
- lost time absenteeism in the production department,
- sales dollars produced from manufacturing,
- scrap and rework, and
- the percentage of labor dollars expended to sales dollars produced.

2) Measure process potential and capability (long term).

The process potential and capability was measured for thirty-one months. Measurements were collected and recorded by the production operators, interpreted by the management and comptroller and displayed for all employees in the company lunchroom. The long term measurements reflected implementation and redirection of the PPC model at the company.

3) Confirm model predictiveness.

Key variable goals were established in the creation and implementation phases of the company PPC model.

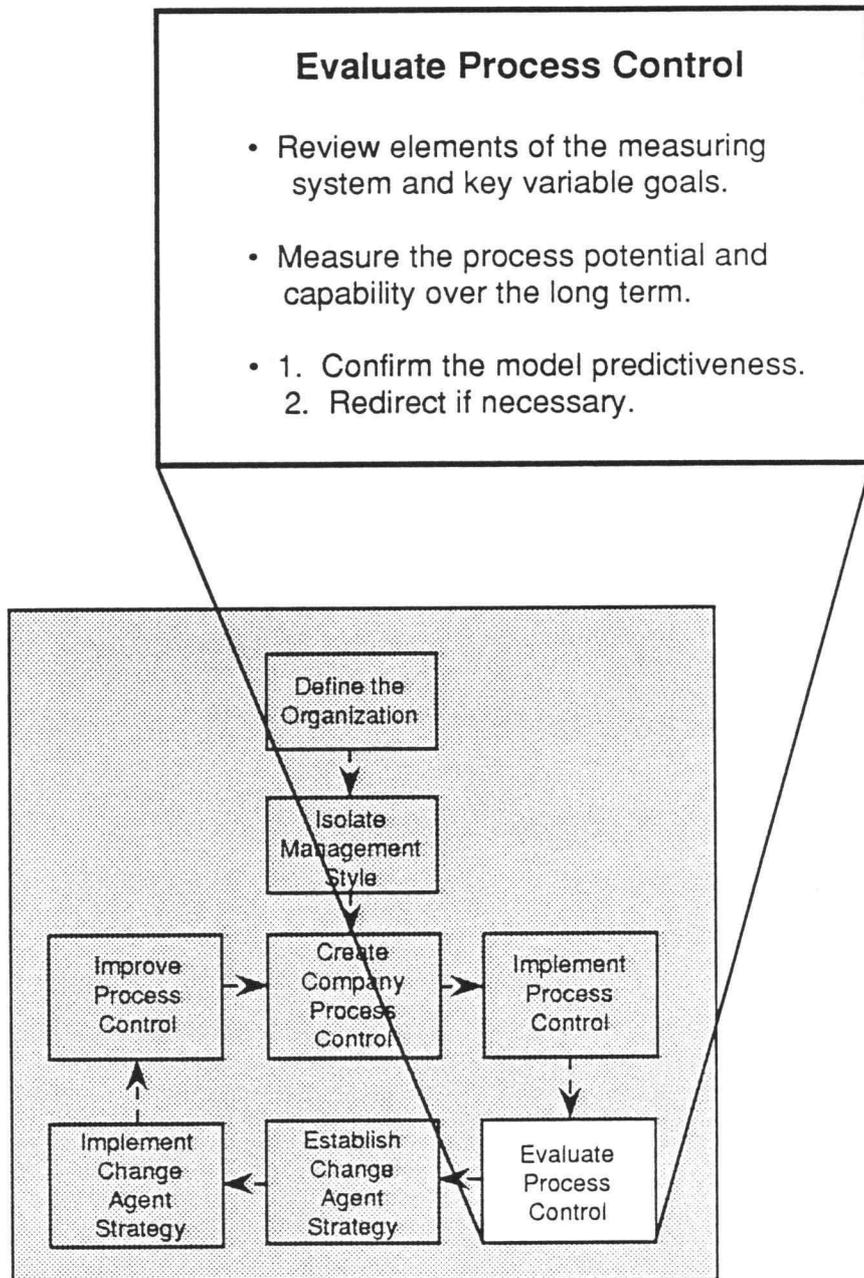


Figure 11. PPC Model--Functional Flow Level II, Step 5.

### Lost Time Injury Hours

The safety related measurement variable goal was established as a 5% reduction for each quarter of 1987. This goal was easily reached as injury hours dropped from 141 in January to 39 in December of 1987. This resulted in a 73% reduction as compared to the goal of 20% for all of 1987. Lost time injury hours continued to decline in 1988 until May. Large increases in May and June were viewed as problem indicators and were a strong factor leading to the organizational development strategy employed at the company. As a result of the intervention, injury hours once again declined steadily to a low of 23 in March of 1989. The overall percentage decline in lost time injury hours from January of 1987 to March of 1989 was 84% (see Figure 12).

### Lost Time Production Absenteeism

The measurement goal for absenteeism was established as a reduction of 10% for each quarter of 1987. In January of 1987 absent hours were measured at 69. In December the lost time hours due to absent full time employees was 19. This resulted in a decline of 72% for 1987 compared to the goal of 40%. As with injury hours, absent hours continued to decline during 1988, until the production problems surfaced in mid year. The intervention strategy was employed and absent hours immediately improved throughout the rest of 1988 and into 1989. The total reduction in absent hours from January of 1987 to March of 1989 was 84% (Figure 12).

### Lost Time Production (Production Employees Only) 9/86 to 3/89

Year	Month	Injury Hours	Absent Hours	Year	Month	Injury Hours	Absent Hours
1986	Sept.	146	81	1988	Jan.	34	19
	Oct.	148	83		Feb.	27	16
	Nov.	155	79		Mar.	23	18
	Dec.	149	76		Apr.	31	17
1987	Jan.	141	69		May	62	36
	Feb.	134	52		June	71	50
	Mar.	129	47		July	69	52
	Apr.	121	31		Aug.	62	24
	May	110	30		Sept.	54	19
	June	87	29		Oct.	49	15
	July	82	30		Nov.	41	11
	Aug.	76	31		Dec.	34	12
	Sept.	63	28	1989	Jan.	31	10
	Oct.	52	24		Feb.	26	14
	Nov.	45	20		Mar.	23	11
	Dec.	39	19				

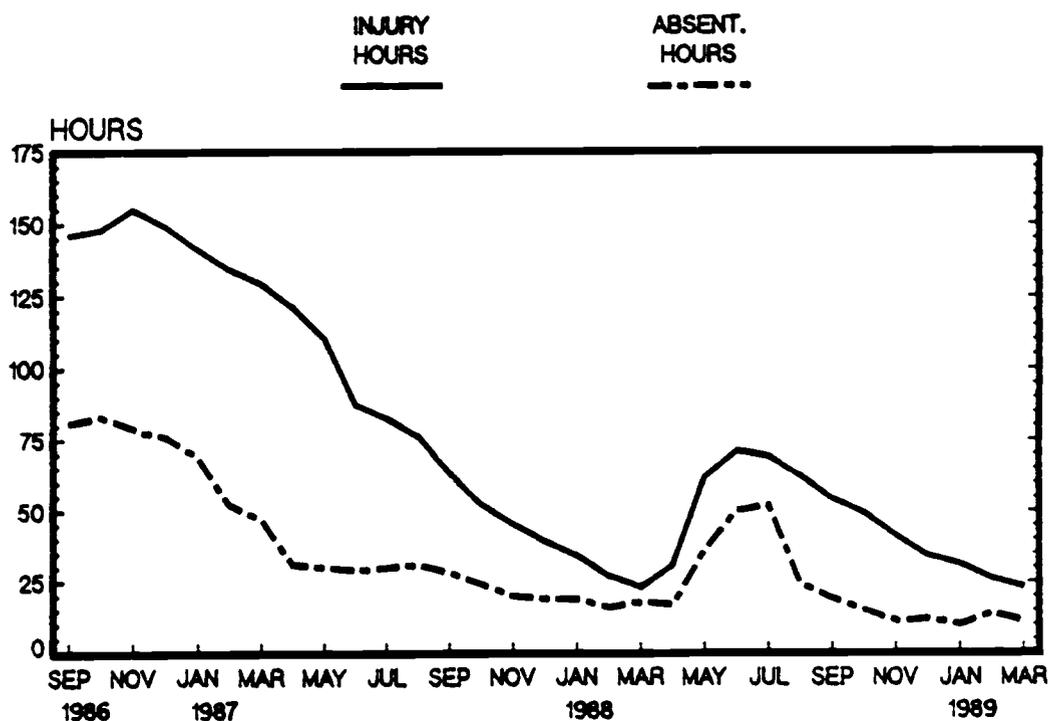


Figure 12. Lost-Time Production (Production Employees Only), September 1986 to March 1989.

### Scrap and Rework

The percentage of scrap and rework to total units produced was established as a measure of productivity in the creation and implementation phases of the company PPC model. The key variable goal was established as a minimum reduction of 5% for each quarter of 1987. During 1987 scrap and rework for all lines declined 34%, far surpassing the stated goal of 20% for the year. Scrap and rework continued to decline during 1988 until the labor problems surfaced in mid-year. The intervention strategy employed resulted in a reversal of this trend and as a result scrap and rework continued downward to a low of 1.8% in March of 1989. Scrap and rework declined 44% in total since the process control implementation in January of 1987 (Figure 13).

### Sales Dollars Produced (Per Month, Per Employee) From Manufacturing

The primary quantitative process control objective was defined as increasing sales dollars produced from manufacturing by a minimum of five thousand dollars per production employee, per quarter for each fiscal quarter of 1987. These goals were achieved in 1987 and the upward trend continued into 1988. Late 1988 and early 1989 figures reflect the intervention strategy employed in mid 1988. Over all sales dollars produced have increased 202,000 per employee since the process control implementation, a 134% increase in two years (Figure 14).

### Percentage of Labor Dollars Expended to Sales Dollars Produced

This measurement was established as a key variable during the creation and implementation phases of the company model. As a measure of productivity and profitability the goal was established to reduce by 10% for 1987 the percentage of

**Percentage of Scrap and Rework  
To Total Units Produced (All Lines) 9/86 to 3/89**

Year	Month	Percentage	Year	Month	Percentage
1986	Sept.	60.2%	1988	Jan.	9.8%
	Oct.	60.4%		Feb.	10.1%
	Nov.	59.8%		Mar.	9.4%
	Dec.	55.4%		Apr.	9.3%
1987	Jan.	46.0%		May	31.4%
	Feb.	42.1%		June	30.2%
	Mar.	34.6%		July	13.7%
	Apr.	24.8%		Aug.	12.9%
	May	19.7%		Sept.	9.8%
	June	20.3%		Oct.	5.4%
	July	18.9%		Nov.	5.1%
	Aug.	19.1%		Dec.	4.3%
	Sept.	17.4%	1989	Jan.	2.7%
	Oct.	17.3%		Feb.	2.0%
	Nov.	16.9%		Mar.	1.8%
	Dec.	12.2%			

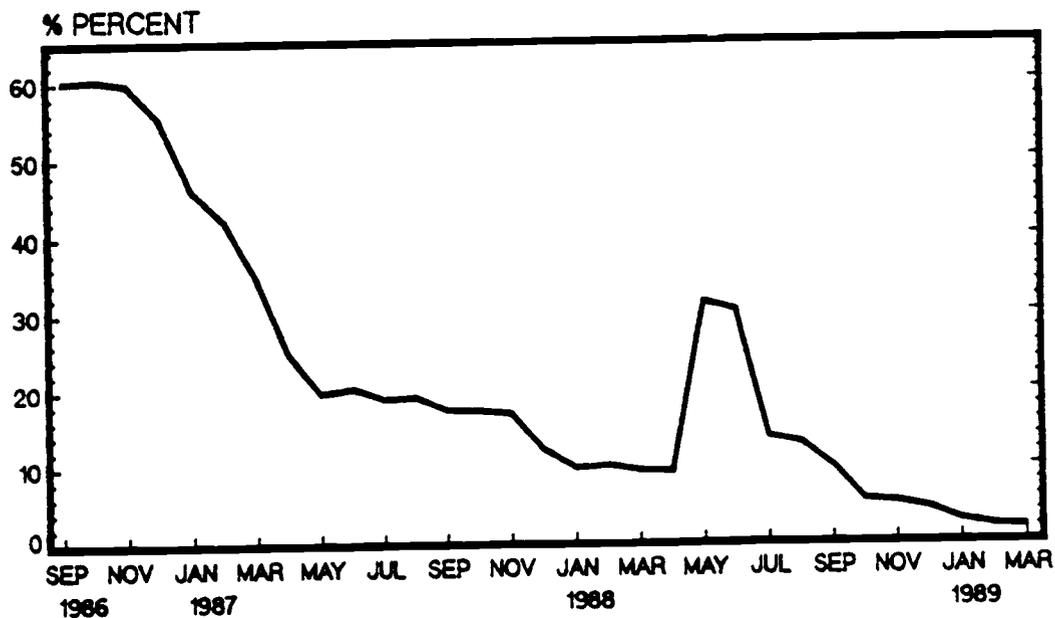


Figure 13. Percentage of Scrap and Rework to Total Units Produced (All Lines), September 1986 to March 1989.

**Sales Dollars Produced (per Month per Employee)  
From Manufacturing (Not Warehouse Inventory), 9/86-3/89**

Year	Month	Rounded Dollar Amt	Year	Month	Rounded Dollar Amt
1986	Sept.	143	1988	Jan.	234
	Oct.	141		Feb.	251
	Nov.	143		Mar.	253
	Dec.	146		Apr.	258
1987	Jan.	151		May	271
	Feb.	169		June	280
	Mar.	168		July	286
	Apr.	174		Aug.	293
	May	176		Sept.	246
	June	179		Oct.	217
	July	184		Nov.	237
	Aug.	187		Dec.	266
	Sept.	196	1989	Jan.	307
	Oct.	211		Feb.	349
	Nov.	215		Mar.	353
	Dec.	231			

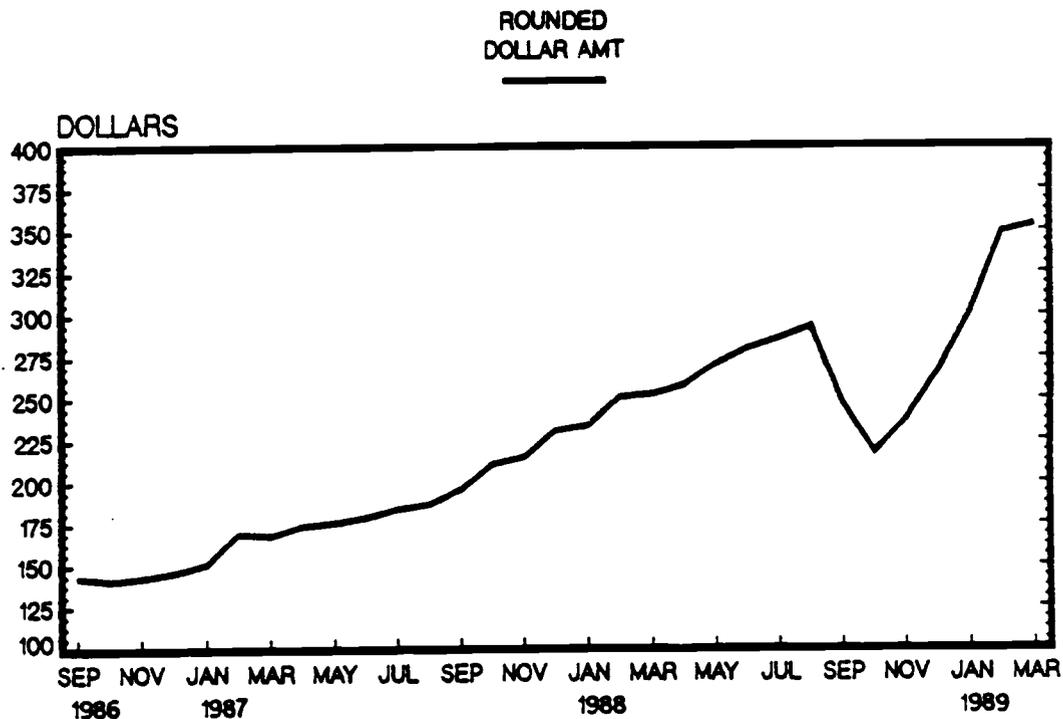


Figure 14. Sales Dollars Produced (Per Month Per Employee) from Manufacturing (Not Warehouse Inventory), September 1986 to March 1989.

labor dollars expended to sales dollars produced. In 1987 the percentage decreased from 27.9% to 13.4% for a 14.5% reduction. This trend continued into 1988 until the mid-year labor problems. Upon completion of the intervention strategy the decline continued to a low of 8.4% in March of 1989. A total reduction of approximately 20% was achieved since PPC program implementation at the company (Figure 15).

#### 4) Redirection.

The evaluation of the company process control effort remained in the control of the quality teams established during the initial phases of the program. Redirection was undertaken as a function of this continuing review process by the quality teams of the company.

### Step 6--Establish the Change Agent Strategy

Step 6 of the PPC model contains two steps: (1) identify change strategies of intervention from organizational development models; and, (2) select a change agent strategy fit for the situation (see Figure 16).

The literature review described the nature of organizational development, the characteristics and scope of assumptions about human nature. Many of these same characteristics ascribed to organizational development also were present in the establishment of a change agent strategy for the company. Many classifications of intervention strategies and change agent processes are presented in organizational development theory. French and Bell (1982) define organizational development interventions as a range of planned programmatic activities that clients and consultants participate in that are designed to improve the organizations functioning. Interventions are sets of structural activities in which selected target groups

**Percentage of Labor Dollars Expended  
To Sales Dollars Produced, 9/86 to 3/89**

Year	Month	Percentage	Year	Month	Percentage
1986	Sept.	31.7%	1988	Jan.	11.8%
	Oct.	31.8%		Feb.	10.9%
	Nov.	32.1%		Mar.	11.3%
	Dec.	30.8%		Apr.	10.7%
1987	Jan.	27.9%		May	17.8%
	Feb.	26.5%		June	18.1%
	Mar.	24.7%		July	13.6%
	Apr.	24.6%		Aug.	11.4%
	May	25.1%		Sept.	11.3%
	June	23.9%		Oct.	10.8%
	July	21.8%		Nov.	9.7%
	Aug.	21.4%		Dec.	10.1%
	Sept.	20.3%	1989	Jan.	9.6%
	Oct.	16.9%		Feb.	8.8%
	Nov.	15.8%		Mar.	8.4%
	Dec.	13.4%			

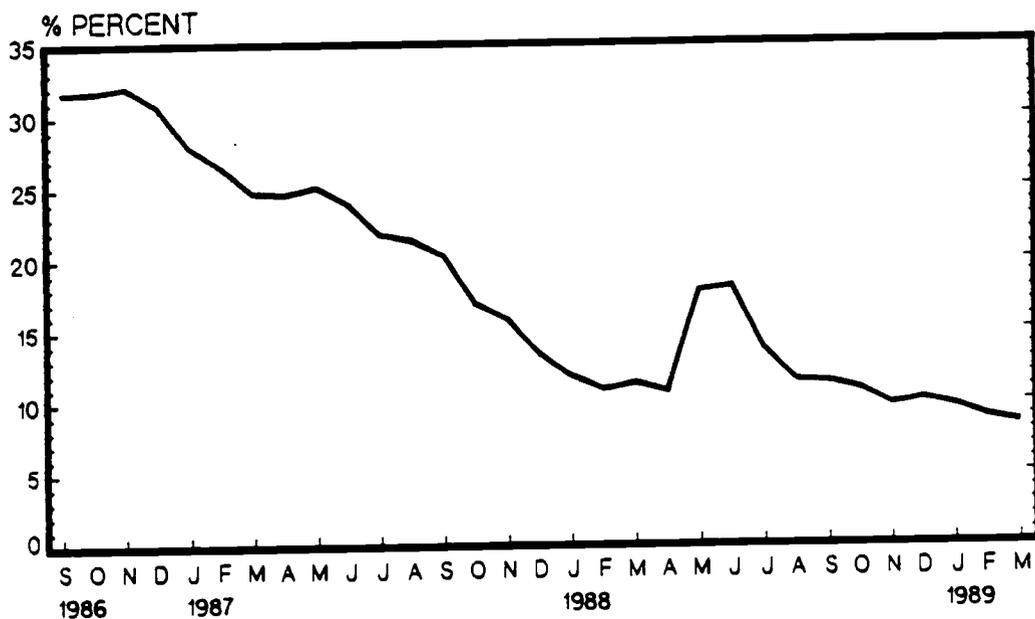


Figure 15. Percentage of Labor Dollars Expended to Sales Dollars Produced, September 1986 to March 1989.

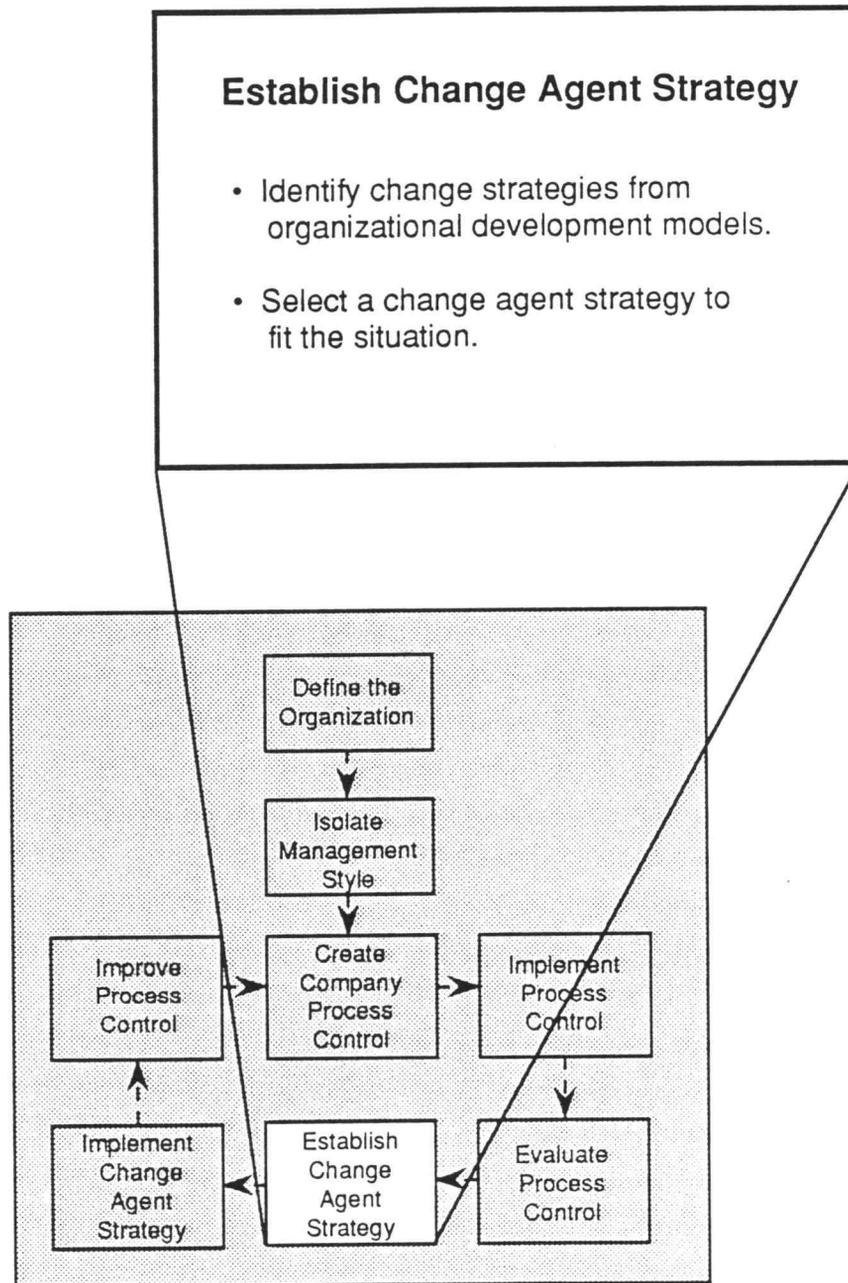


Figure 16. PPC Model--Functional Flow Level II, Step 6.

engage with a task or sequence of tasks where the task goals are directly beneficial to organization health.

However, a typology of interventions presented by French and Bell (1978) was used for the company research. This typology is presented in Figure 17. The typology used, as determinant factors two simple questions: (1) is the intervention directed toward individual learning, insight, and skill building or toward group learning?, and (2) does the intervention focus on task or process issues?

In March of 1989, after two years of successful process control major problems were identified through quantitative measures in the production department. Throughout 1987 and 1988 the key quantitative and qualitative variables identified had steadily improved. The percentage of labor dollars to sales dollars produced, down time safety problems, and absenteeism had declined. However, in March of 1989 significant increases in these variables were noticed. Researcher meetings with the company production management indicated that an organizational development intervention was needed to diagnose and treat the problem. Initial meetings with affected managers and operators indicated that the focus for the intervention, according to the French and Bell typology, was group oriented with a focus on task issues.

The initial interviews provided valuable background information for the selection of an appropriate intervention strategy. Productivity measurements were down in all areas including scrap/rework, and lost time production. The April 1988 S/R figures were at an all time low of 9.3%. This same measure of quality and productivity jumped to 31.4% in May of 1988. Lost time production also jumped dramatically during April, May, and June of 1988.

The initial meeting focused on a series of questions that provided direction in the identification of a possible intervention strategy. It was determined that the

## Individual vs. Group Dimension

		Focus on the Individual	Focus on the Group
Task vs. Process Dimension	Focus on Task Issues	Role analysis technique  Education: Technical skills; also decision-making, problem solving, goal setting, and planning.  Career planning  Grid OD phase 1 (see also below)  Some forms of job enrichment and Management by Objectives (MBO)	Technostructural Changes  Survey feedback (see also below)  Confrontation meeting  Team-building sessions  Intergroup activities  Grid OD phases 2,3 (see also below)  Some forms of socio-technical systems
	Focus on Process Issues	Life Planning  Process consultation with coaching and counseling of individuals  Education: group dynamics, planned change  Stranger T-groups  Third-party peacemaking  Grid OD phase 1  Transactional analysis	Survey feedback  Team-building sessions  Intergroup activities  Process consultation  Family T-group  Grid OD phases 2,3  Gestalt OD

Figure 17. Organizational Development Interventions Classified by Two Independent Dimensions--Individual/Group and Task/Process (French & Bell, 1975).

particular problem was a group phenomena that could be translated to individuals within the company if intervention did not occur on an immediate basis. The issues were determined to be task oriented and were most likely related to new scheduling problems adopted recently at the company. The French and Bell typologies presented six possible strategies for intervention: (1) techno-structural changes; (2) survey feedback; (3) confrontation meeting; (4) team-building sessions; (5) inter-group activities; and (6) grid organizational development. These initial diagnostic activities suggested that the intervention strategy of confrontation would be most applicable to the situation. This term refers to surfacing and addressing differences in beliefs, feelings, attitudes, values or norms to remove obstacles to effective interaction. Confrontation is a process that actively seeks to discern real differences that are getting in the way, surface those issues, and work on the issues in a constructive way.

The assumption behind this intervention strategy was that many obstacles to growth and learning exist and they continue to exist when they are not actively examined and addressed.

### Step 7--Implement Change Agent Strategy

Step 7 of the PPC model includes two steps: (1) initiate the intervention strategy; and, (2) develop criteria for success for the intervention strategy (see Figure 18).

The confrontation meeting, selected as an intervention strategy from the French and Bell typology was modified to include more participation by members of the entire company. The confrontation meeting used a one-day meeting of the entire management of the company and selected operational staff with strong power bases in the organization. In a series of events the group generated informa

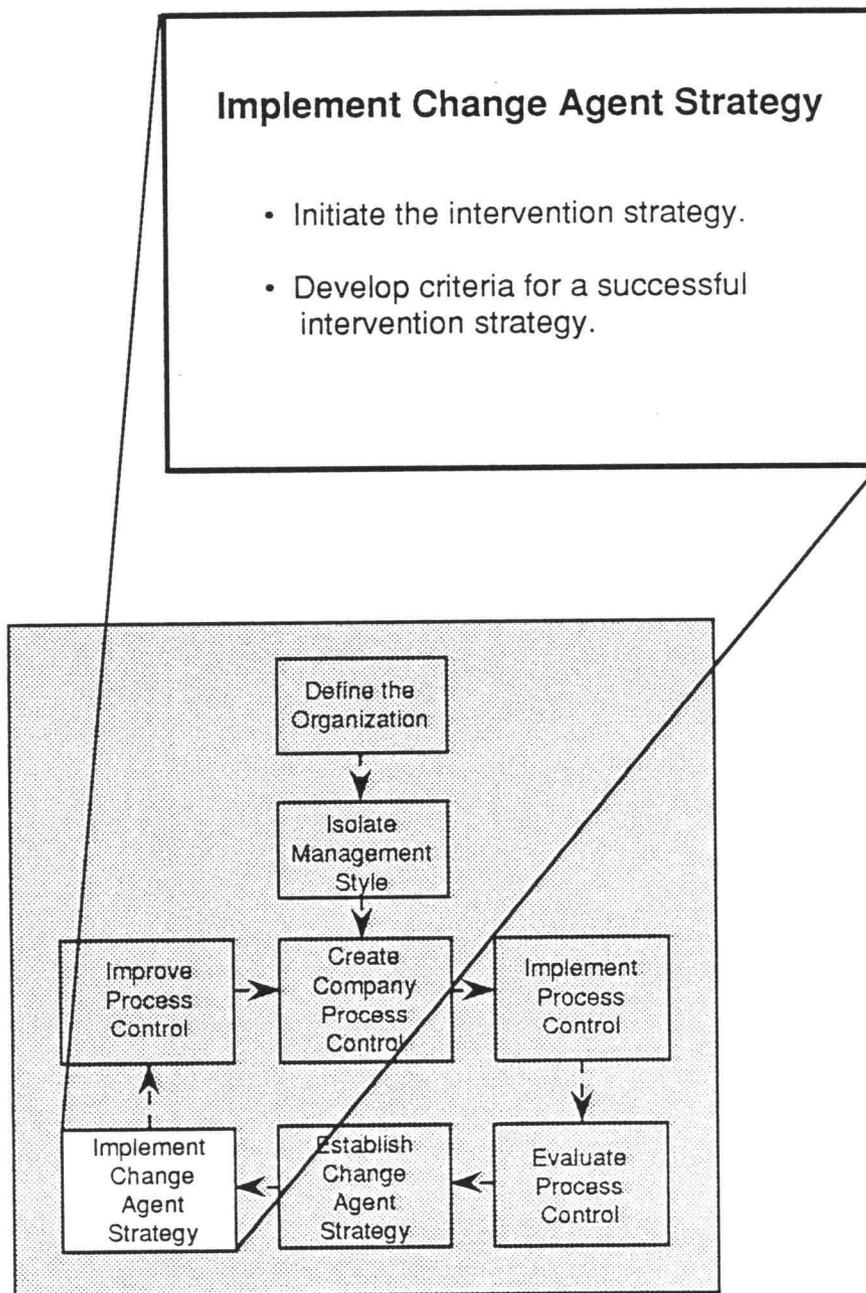


Figure 18. PPC Model--Functional Flow Level II, Step 7.

tion about problem areas, analyzed underlying causes, developed action plans for correction and set a schedule for completion of needed work.

Developed by Beckhard (1967) the confrontation meeting was a quick, simple, and reliable way to generate data about an organization. The confrontation strategy was selected according to the guidelines provided by Beckhard (1967). The method was identified as appropriate because:

- there was a need for the total management group and selected operators to examine its own workings,
- very limited time was available for the activity,
- there was enough cohesion in the team to insure followup,
- there was real commitment to resolving issues on the part of top management, and
- the organization was experiencing major change.

The confrontation meeting was held at the company in the Spring of 1989.

The steps involved in the process were:

1) Climate Setting.

The top manager from production spent the first part of the meeting stating goals for the session. He also cited the need for open discussion and clearing the way for free flowing communication. This researcher then provided input about the importance of clear communication, the applicability of company problem solving, and the usefulness of solving company problems.

2) Information Collection (one hour).

Small, cross-sectional groups of six members were formed. Cross sectional organization was used in the session to insure a maximum mixture of people from different functional areas and working situations on each team. Supervisors and subordinates were not placed on the same team and the top managers met as a

separate group. The task assigned to all groups was given in the Beckhard (1967) format:

Think of yourself as an individual with needs and goals. Also

think as a person concerned about the total organization. What are the obstacles, demotivators, poor procedures or policies, unclear goals, or poor attitudes that exist today?

What different conditions, if any, would make the organization more effective and make life in the organization better?

The groups worked on this task for an hour while recorders listed the results of the discussion.

### 3) Information Sharing (one hour).

Recorders from each small group reported the groups findings to the total group and these were placed on meeting room wall charts. Items were categorized based on the type of problem, relationship, or area of involvement in the company. Lunch was catered while the lists were duplicated for distribution to everyone.

### 4) Priority Setting and Group Action Planning (two hours).

Upon completion of the lunch session, which included a marketing department preview of a major fall season item, the participants formed into functional, natural work teams. In a ten minute general session the confrontation meeting leader asked the groups to respond to three tasks: (1) Identify and discuss the issues and problems related to their area, decide on the priorities of these problems of these problems, and determine early action procedures to address the problems; (2) Identify the problems they think should be priority issues for top management; and (3) Determine how they will communicate the results of the confrontation meeting to their subordinates.

The confrontation meeting then ended for all but the top management group.

### 5) Immediate Follow-Up by the Top Management Team (three hours).

The top management team met for the rest of the day, and into the evening, to plan follow-up action steps and to decide what actions were taken on the basis of what they had learned during the day. These action plans were communicated to the rest of the management group with twelve hours.

6) Progress review (three hours).

Follow-up meetings with the total management group were held at three-week intervals to report progress and review the plans resulting from the confrontation meeting. The confrontation meeting achieved quick results leading to improvement in all areas of the organization. The confrontation was, in no way, a substitute for long term organizational development efforts. However, the confrontation meeting provided an effective and accurate means for diagnosing problems, enhancing communication and problem solving skills, increased involvement and Commitment to action in the entire work group. Measures of quality and productivity increased dramatically upon completion of the confrontation meeting and continued to improve during the second fiscal quarter of 1989.

### Step 8--Improve the Process Control Model

Improvement in the company model followed a three step, continual process: (1) Identify ideal states of process control; (2) compare current situation with ideal states; and, (3) redirect resources as necessary (see Figure 19).

A typology of ideal states of nature was established for improvement of the PPC model. Each area is presented with an ideal equilibrium state. Examples of successful improvement of the PPC are found throughout the organization. Two superior examples are presented from the production area involving professional development of operators and a seed program established with the local community college.

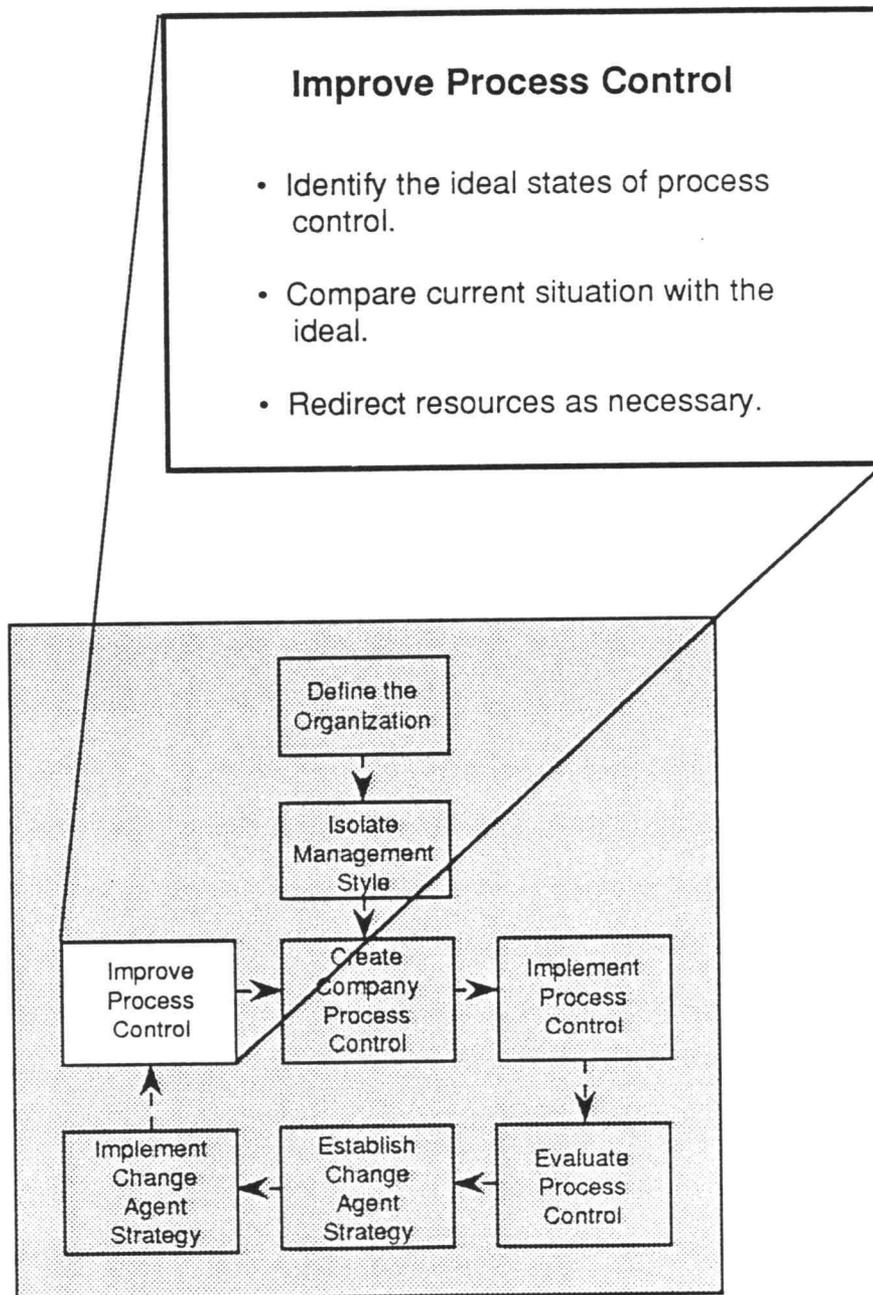


Figure 19. PPC Model--Functional Flow Level II, Step 8.

## Ideal States of Process Control

- 1) **Management:**
  - Quality is an economic imperative and superordinate value.
  - Devotion of resources to prevention and continual improvement of processes.
- 2) **Organization:**
  - Problem solving teams.
  - Focused factories
  - All employees responsible for quality.
- 3) **System Measurement:**
  - Participatory Process Control implemented and audited.
  - Intangible quality costs measured.
  - Continuous improvement in all processes.
  - Participatory process control included in product concept and design phases.
- 4) **Customers:**
  - Customer satisfaction is the main measure of quality.
  - The customer orientation pervades the entire organization.
- 5) **Design:**
  - Design for zero variation and failures.
  - Participatory Process Control teams for new product development.
- 6) **Suppliers:**
  - Suppliers serve as an extension of the company.
  - Suppliers are self-certified.

- One supplier is used for most needs.
- 7) Process/Manufacturing:
- Scrap is eliminated.
  - Inspection and testing eliminated.
  - 100 percent yield on all products.
- 8) Service:
- Built in diagnostics in the system.
  - Flexibility and responsiveness also built into the system.
- 9) Training/Employees:
- Every employee works as a manager.
  - Managers serve as internal consultants.
  - Implementation of PPC with results.
  - Operators are involved in all phases of design and production.
  - Training is focused and implemented.

### Movement Towards the Ideal States in Process Control at the Company

An example movement towards the ideal state of participatory process control in the areas of organization and training began at the company in April of 1989. This program, coordinated between the company and the local community college, is a prime example of improvement in the PPC model. The program, entitled "Intern Operators," is also a reflection of the dependent variable stated in Chapter One of this thesis. Employees as well as management sought out other applications of SPC in the company.

The purpose of this program was to "seed" individuals into the training and education required for successful process control. The specific process control skills are learned from an approach of on-the-job training combined with commu-

nity college classroom instruction. Basic statistical methods and general Deming management process control principles are instructed at the college sophomore level. The "intern operator" then applies these techniques on the job under the supervision of a permanent full time mentor operator from the company. Twenty initial "interns" were placed with the company in May and June of 1989. Dr. Deming visited the company in June of 1989 and reacted favorably to the innovative program.

### Intern Procedure

The "intern operator" program procedure had five steps: (1) Prerequisites; (2) Application; (3) Orientation; (4) Continuing improvement; and, (5) Graduate phase.

- 1) Prerequisites:
  - Sophomore standing at a community college or university.
  - Completion of community college general education requirements.
  - Completion of a basic statistics class.
  - General management background in Deming methods or a similar process control technique.
- 2) Application:
  - Interviews with three levels of company management.
  - References required from instructors and former employers.
- 3) Orientation Period:
  - Prefer students who can start in the summer.
  - Assignment of Operator Mentor.
  - Follow usual new hire orientation.

- Work full time with mentor upon completion of usual new hire orientation.
- 4) Continuing Improvement Period:
    - Work twenty hours per week plus holidays while continuing training in the community college or university.
  - 5) Graduation Phase:
    - Option for intern to secure full time supervisory level management position upon graduation from community college or university.

A second innovative program at the company gave direction towards the ideal state of PPC. An outgrowth of the confrontation intervention strategy was employee participation in a professional development plan for all production workers in the company. This plan links the company to the local community college in that individual employee evaluation includes elements of basic general education skills and specific management development courses for advancement in the organization. Knowledge, behavior, and productivity were defined as evaluation areas added to the performance review system. In addition to the usual attendance, safety, sanitation, quality, and base operator phases of the performance review the team added requirements in writing, algebra, statistics and general management theory.

Global economies of scale influenced by corporate change are now directly influencing policy, mission, and curriculum in community college systems. Feldman (1984) points out in his article on "Establishing Linkages" that the most dramatic growth area in community colleges should be in the educational effort of business and industry. Cross (1984) also mentioned that the rising interest of business and industry in Human Resource Development makes corporate education the most actively growing educational activity in the nation. Parnell (1982) suggests that a spe-

cial response is needed to establish cooperative educational ventures with the private sector.

These two innovative programs of "intern operators" and professional development plans for all production employees are examples of efforts that can lead companies towards the ideal state of participatory process control while establishing healthy linkages with local community colleges.

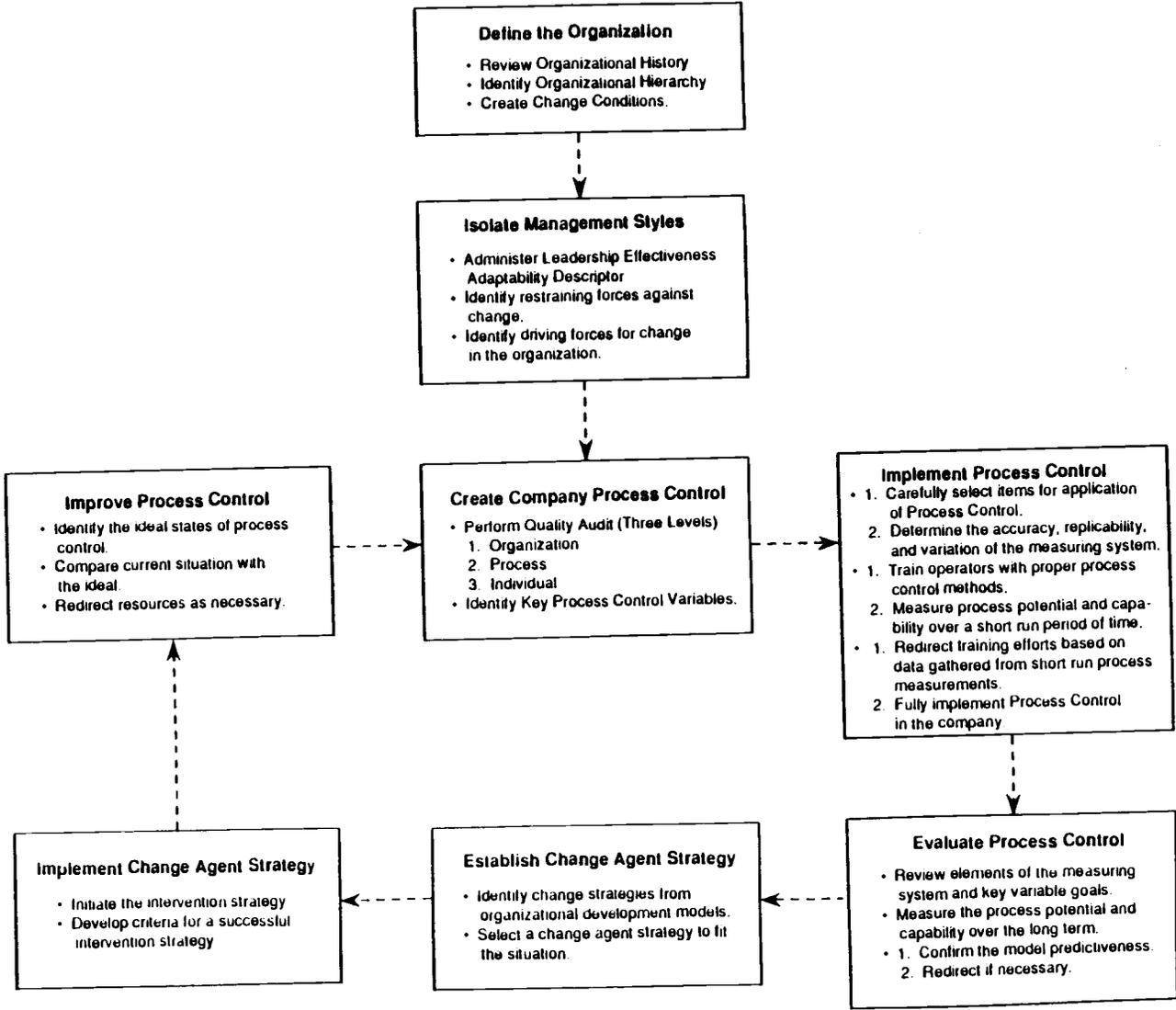
These linkages are working to bring business and education together to insure upward mobility for citizens while increasing quality and productivity in the workforce. The PPC model, step eight, has revealed that participatory process control can also assist the local community college systems to adopt an integrated focus towards planning and curriculum development in the future.

The complete Participatory Process Control model, with the addition of Functional Flow Level II, is shown in Figure 20. This integrated model provided a template for successful company process control. The analytical elements of the model also provided the primary information for conclusions and implications shown in Chapter V.

Although PPC integrates elements from other quality based program the model has distinct advantages over existing methods. The PPC model contains direct elements and assumptions from the fields of organizational development and the applied psychology of work behavior.

As noted in the literature review a major criticism of Taguchi, Juran and other engineering based quality control programs is the stoic focus upon statistical techniques. These engineering related methods have proven to be quite successful in organizations where the statistical competence of production employees is strong. However, these same methods may fail in organizations where operators are not well versed in engineering or statistical methods. The main reason for

Figure 20. PPC Model, Complete Functional Flow Level II.



potential failure of these engineering based methods is the lack of an implementation strategy based in the humanistic approach to change in organizational behavior.

The PPC model attempts to bridge this implementation gap by reliance upon sound, existing statistical techniques that can successfully implement through the use of methods designed to encourage participation and involvement in the organization. This collaborative based change method, PPC, can lead to long term change. PPC uses training in statistical techniques, as in the Taguchi and Juran methods, but also focuses on educating the work force to face long term, lasting change in the organization.

Deming methods also focus on statistical and humanistic training techniques. The value of Deming's fourteen points of management is well documented through success at Ford Motor and other domestic, as well as international, corporations. However, most institutions, when faced with development of Deming methods, must rely upon internal processes for implementation. These internal implementation strategies may or may not include assumptions from the world of social psychology and work behavior. Deming methods draw upon humanistic approaches to the management of work behavior while developing training in statistical process control. However, the PPC model responds to criticism of Deming methods by focusing on analysis and preparation of the organizational culture to insure proper implementation of process control techniques.

The PPC model, in examining management styles, power bases, organizational hierarchies and supervisory behavior prior to implementation of process control can identify driving and restraining forces of change in the organization. This formative evaluation is the major difference between PPC and other existing process control models. This case study suggests that proper formative evaluation

combined with proven process control techniques and continued re-fostering of the participative culture of the organization may lead to increased quality, productivity, and profit margins.

## CHAPTER V

### CONCLUSIONS AND IMPLICATIONS

#### Summary

The purpose of this study was to examine the impact of process control on the ability of a selected Oregon manufacturing company to restructure its workforce as a method to improve quality and productivity. An analytical model for implementation of participatory process control was designed from a literature review of management theory, organizational development, statistical process control and case study methodology. A fieldwork research plan was developed using case study methods to explain the functional flow of the model.

The research data on a major manufacturing company in Oregon was organized according to the eight step functional flow model for participatory process control. The case study model provided an effective way to analyze process control in a small manufacturing facility. Quality and productivity increased upon company implementation of the process control method and profits have continued to rise throughout 1989.

Related issues identified for further research were: Examination of participatory process control on a longitudinal basis; refinement of the model by simulation of variability; collaborative efforts between product development quality control (PDQC) and participatory process control (PPC); and service sector application of the model.

## Objectives of the Study

Objective 1: To review relevant literature in management theory, organizational development, statistical process control, and case study methods.

The literature review suggested that participative management processes are the key to successful programs of change in organizations. An historical look at Laboratory Training in Industrial Organizations provided two key elements for development of the company quality control program: (1) measurement of the climate for change and management commitment; and (2) on-the-job-training is critical for success in any change related program.

Pioneers in Survey Research and Feedback were reviewed. Organizational Development practitioners, including French, Bell, Mayo, McGregor, Herzberg, Argyris and others, provided basic assumptions for the PPC model.

The Crosby Zero Defects model provided measurements of quality, supervisor training, and prevention into the PPC model. Taguchi methods provided elements useful for integration purposes in measurements of continual reduction in the variation of product performance. Deming provided both quantitative and qualitative elements of integration into the PPC model. Statistical techniques of a descriptive nature were combined with management processes from analytic bases to form the process control approach.

Weaknesses were identified in the various models and resulting literature. The literature review suggested that the missing link in quality control was a model that integrated analytical and enumerative bases. The review also suggested that case study methodology would be the best vehicle for testing the PPC model.

The PPC model was developed in response to this identified research gap. This analytical model was used for the stated purpose and objectives of the study.

**Objective 2: To propose an analytical model for examining industrial process control that may be generalized to similar industrial settings.**

Major components of the PPC model were identified from the selected areas of specialization in the literature review. An analytical framework was developed integrating process control with areas of organizational development, management theory, and statistics.

Functional flow level analysis provided the procedural organization for the company analytic model. The model had two functional flow levels.

Functional Flow Level I examined the company from a macroenvironmental view. This general analytic flow level identified initial organizational linkages in the company. It also provided preliminary secondary information critical to the success of the program.

Functional Flow Level II examined the company from a microenvironmental view. Eight steps were examined in detail with examples from the successful process control effort at the company.

**Objective 3: Develop and field test a plan designed to analyze process control within a small Oregon manufacturing company.**

The goal of the research design was to explain the functioning of the PPC model. A research format was selected (Pearson, 1987) using case study methodology to understand the application of the PPC model. The case study field test: (1) developed an interview guide to gather data; (2) described the case; (3) selected individuals for interview; (4) examined secondary sources of information; (5) followed the data through the PPC analytical structure; and (6) validated the framework of the model.

Objective 4: Use the data collected in the case study to examine the effectiveness of company process control.

Functional flow level analysis was used to identify eight final steps of the PPC model. The analytic framework provided measures of PPC effectiveness on both the qualitative and quantitative levels. Profitability measures and measures of quality and productivity have shown significant increases since the process control implementation. The predicted outcome measures identified prior to the research have been validated as a result of the PPC process:

- 1) Productivity increased over the levels prior to PPC;
- 2) Quality increased over the levels prior to implementation of process control; and
- 3) Employees created new applications for process control and these applications were unique to each work unit in the organization.

#### Discussion of Predicted Outcomes

Four quantitative measures of effectiveness were defined and monitored for thirty one months: Scrap and Rework; Lost Time Production; Sales from Manufacturing; and, Labor Dollars Expended to Sales Dollars Produced.

Productivity increased over the levels prior to PPC as measured by Sales from Manufacturing and Labor Dollars Expended to Sale Dollars Produced. Sales dollars produced from manufacturing increased 134% in 2 years. This increase far exceeded the stated goal of 20% for the same period of time. The percentage of labor dollars expended to sales dollars produced dropped by 20% compared with a goal of 10% for the same period of time. These increases, directly related to quality and productivity, have translated into increased financial margins for the company.

The major measure of effectiveness related to quality was defined at the company as Scrap and Rework. Reductions in scrap and rework indicate quality improvements in all production lines. Scrap and rework declined a total of 44% during the study, far exceeding the stated goals for the project. These quality measurements translated directly into financial margin increases at the company. Another measure of productivity was defined as lost time production hours in manufacturing. Organizational climate improvements were translated into increased productivity and declines in lost time production hours. Lost time injury hours declined 84% during the measured period of time. Lost time absenteeism also declined 84% during the same time period.

These organizational climate improvements can be directly attributed to the participatory process control environment at the company. The Power Perception Profile, Leadership Effectiveness and Adaptability Descriptor, and Kimberly/Nielson Model all measured change in the organizational climate of the company. Measured on two specific occasions, these qualitative variables show dramatic improvements in organizational climate and supervisory behavior at the company during the PPC program. The largest increases were found in: open communication (71%); human relations with others (109%); willingness to change (100%); listening (79%); and trust (52%).

New applications for process control related ideas occurred in both the human relations and production areas of the company. As a direct result of the PPC process the intern operator program was initiated in the company. In addition, a professional development plan was established for operators in the company. These examples of increased productivity, quality, and new applications of process control are presented to validate the predicted outcomes of the research.

Three implications that may have a direct impact on future process control efforts were identified:

- 1) A participative company environment, that includes an integrated, analytical approach to process control can lead to increased productivity, higher quality, lower operating costs, and higher profit margins.

The literature review presented the need for collaborative efforts in any change related program. The case study results also clearly showed the effects of a participatory environment on quality, productivity and profit margins. Increased productivity was shown through improved sales dollars from manufacturing and lowered labor costs as they related to sales dollars produced. Higher quality was reflected in dramatic lost time production hours from injury and absenteeism. These measures of higher quality and increased productivity with lower scrap and rework led to lower operating costs and increased profit margins at the company.

The workforce was restructured prior to and following the implementation of process control. Structural change allowed for the creation of an environment conducive to the process control efforts. The intervention strategies employed, including the confrontation meetings, were successful primarily due to the participative environment established prior to process control implementation.

- 2) Participative environments must be continually renewed and measured to reduce loss of autonomy in process control programs.

The participative process control model aimed to increase employee involvement, self-management, and quality control efforts throughout the company. Klein presents an interesting related article in the April 1989 *Harvard Business Review* entitled "The Human Costs of Manufacturing" (Klein, 1989). Klein suggests that statistical process control type programs may actually reduce team and individual autonomy. This focus of continual improvement on the manufacturing line may

reduce the chance of employees exercising genuine autonomy in the sense of independent self-management. The SPC focus on elimination of waste means more structure on workers time and action.

The company reorganization, including reducing the layers of management from seven to four, helped foster a participative environment based on growth, trust, quality, and an adequate reward system. Quality teams, including production operators, determine schedules and design work space in the company. These participatory measures have helped improve quality and productivity in the company.

As more stringent process control techniques are introduced into the company the participative environment must continually be renewed. Klein (1989) points out the need for "greater collaboration" between quality teams. Specific suggestions designed to mitigate the harsh effects of process control primarily focus on task design and flexibility in execution.

- 3) Participative environments may not need top management commitment or involvement in order to achieve quality and productivity measures of success.

The issue of management control over change based programs was viewed in the literature review as a critical element in the success of any organizational development program. The assumption presented in the literature review suggested that top management support is necessary for program success.

However, the issue of top management support and commitment at the company was not found to be a critical factor in the success or failure of the PPC model. In addition, it may be that the internal corporate culture was more important in achieving change than any specific organizational development intervention strategy.

O'Reilly (1989), in a recent *California Management Review* article entitled "Corporations, Culture, and Commitment: Motivation and Social Control in Organizations," reported financial margin turnarounds in well known firms such as 3M, Johnson and Johnson and Apple. O'Reilly suggests that these turnarounds are due primarily to changing the management philosophy and culture. O'Reilly reports that "at the systems' core is a culture in which the assembly line workers maintain their machines, ensure the quality of their work, and improve the production process."

However, O'Reilly also points out that "culture is not always a positive force." O'Reilly suggests that an organizational culture can be analyzed and managed. The company culture can also be thought of as a potential social control system. O'Reilly suggests that culture can be developed and maintained and cites examples of a competitive environment at Pepsi and an innovative culture at 3M.

As the company data suggested top management commitment to the process control model was not a critical factor in the success of the program. Additional attention must be given to the study of cultural processes within the organization.

The case study presented measures of increased productivity and quality in the company from late 1986 to early 1989. These measures may or may not be directly related to the implementation of PPC. As presented in Chapter Two of this study, a restructuring of the formal organization occurred in late 1986. These structural changes, which included the reduction of the layers of management from seven to four, could in itself be responsible for the accelerated increases in productivity and quality in the company.

It is clear that changes in corporate culture occurred during the period of 1986 to 1989. However, it must be noted that these cultural changes may be a function of the structural organizational change and not a direct result of PPC.

The real reason behind the dramatic swing in measures of productivity and quality at the company may be found in the combination of PPC and structural change. Further research may focus on the management of corporate culture and the role of top management in restructuring organizations. Additional research, hopefully of a replicative and longitudinal nature, may provide insight into PPC implementation in stable organizational structures as well as those companies undergoing formal restructuring.

### Further Research

On the basis of this case study and in the interest of future improvement efforts, three specific areas are recommended for further research: (1) refinement of the PPC model; (2) collaborative efforts between PPC and PDQC; and (3) examination of the role of corporate culture and top management in process control efforts.

#### 1. Refinement of the Participatory Process Control Model.

Simulation of variability, development of effectiveness measures and longitudinal research are recommended as areas of focus for further research in the process control field. The literature review showed the importance of variability in process control programs. Variability in process control is a determining factor in the quality equation. Highly regarded as the key for continuing improvement philosophies of quality control, variability is also a factor in which the process of estimation can deliver questionable statistics. Development of a model to simulate the variability in PPC is recommended for further research. The literature review

also suggested that validation of case study research as a method is improved through longitudinal study of the system in question. Further research in PPC with measures of effectiveness that are quantifiable would also greatly refine the model.

## 2. Collaborative Efforts Between PPC and PDQC.

Statistical process control and the work of Deming (1986), Juran (1988) and others have enabled many American companies to improve quality and productivity. However, will SPC and PPC be adequate models for future efforts of quality control as we enter the twenty-first century? Experts feel that these methods alone won't be enough for American companies to remain competitive in the international arena. Many companies are now moving from manufacturing process control to product development quality control (PDQC). First used by Japanese companies in the 1970s the system has been used by non-manufacturers as well as process manufacturers. Literature reflecting product development quality control use in American companies is minimal. However, there is adequate usage to warrant further investigation in the field.

PDQC is customer driven and aims to detect and solve quality problems in the design phase as opposed to the process stage as is the case with SPC. It is felt by some authors that design optimization during the product design stage can significantly reduce manufacturing variations. PDQC is defined (*Fortune*, 1988) as a systematic way to ensure marketplace demands are accurately translated into relevant technical requirements and actions throughout each stage of product development. PDQC can take a clear path from the customer requirements at the start of product planning down to the most detailed instructions at the operating level. Further research is needed on PDQC and a possible collaborative effort with PPC for the total quality control effort of the future.

### **3. Examination of the Role of Corporate Culture and Top Management in Process and Quality Control Change Programs.**

Assumptions regarding the role of top management in quality control or other change based programs need to be examined through additional research. In addition, the data from this case study suggest that the management of corporate culture may be essential to successful change based programs in organizations. Integration of PPC concepts with corporate culture based change strategies could improve organizational performance in the workplace of the twenty-first century.

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