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Hybrid re-engineering strategies for process improvement

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Abstract *Describes a set of re-engineering strategies that critically examine current business policies, practices and procedures (3Ps), rethink these 3Ps and then redesign some mission-critical "products, processes, and services." The term process improvement implies that the change or effort is directed towards an array of re-engineering strategies. Process improvement efforts are categorized into four primary re-engineering strategies: a set of continuous process improvement (CPI) tactics, a set of restructuring tactics, a set of organizational traits, and a set of renovation tactics. Discusses how these four re-engineering strategies can be logically combined in a concurrent fashion to achieve significant process improvements. Introduces two new hybrid re-engineering strategies for process improvements that have been found quite useful at Electronic Data Systems (EDS) Accounts.*

1. Introduction

For many manufacturing companies, still today, product development is characterized by long lead times (Clark and Fujimoto, 1989), a large number of engineering changes, manufacturing complications (Clark and Fujimoto, 1991), and, ultimately, excessive costs to satisfy the customer requirements (Bhote, 1996). One area that is given more attention, recently, to regaining the company's competitive position, is the "product improvement" area (Magrab, 1997). Product improvement, in this case, means improving product performances – adding more competitive features (including bells and whistles) so that when products come out in the market, they are attractive to the customers (Kamath and Liker, 1994). The effectiveness and efficiency of the engineering, manufacturing and/or business processes that support development and delivery of the products or services are given less importance (Prasad, 1996). Lack of competitiveness situations in those companies is often not due to product or technology related problems (Liker *et al.*, 1995). It is often due to the process – the way the companies carry out their day's work – the way their teams spend their resources (Martin *et al.*, 1995). For example, technology might have become updated but the affected engineers may have not changed the corresponding process or the work habits accordingly (Himmelfarb, 1992). Process in this context means how a set of work-tasks or job-functions is performed by the product development teams (PDTs) (Dong, 1995). Prasad defines a process as a set of 7Ts (talents, tasks, teams, techniques, technology, time, tools) arranged in a particular manner so as to transform a set of inputs into a specified set of outputs (goods or services)

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(Prasad, 1996). Since teams and tasks can be arranged in many different ways, there can be many "process possibilities" of performing a set of 7Ts (Prasad, 1996). Some possibilities could be more efficient or effective than others (Hammer and Champy, 1993).

Many progressive companies are interested in maintaining a competitive edge in the world marketplace and in producing high quality products or services (Liker *et al.,* 1995). They would like to do all of the above at a lower net cost of production than their competitors (Bhote, 1996). One easy way to increase a company's productivity or efficiency is to squeeze more out of its current system (Ezop *et al.,* 1989). This often boils down to a management asking their employees to work harder (e.g. putting in more hours than before), work lean, or to automate some of the manual tasks (Hammer, 1990) through advanced technologies, such as computer-aided design (CAD), design for manufacturability (DFM), and simulations (Anderson, 1990). Most companies pay less attention to doing things differently (Arai, 1997). "Automation of tasks" to some may also mean repeating the same mistakes but doing it more often and more quickly than before (Prasad, 1996). Many companies are finding that true increase in productivity and efficiency begins with such factors as clean and efficient process, good communication infrastructure, teamwork (Clark and Fujimoto, 1991), empowerment (Carroll, 1997), and a constancy of shared vision and purpose (Deming, 1993). The challenge is not simply to crank-up the speed of the machines so that their outputs (per unit of time) are increased or doubled (King, 1987), but to change the basic machinery or the process (e.g. 7Ts) that produces the outputs (Hoffherr *et al.,* 1994). To accomplish the latter goals, today many organizations are applying concurrent engineering (CE) principles through benchmarking (Freeze and Aaron, 1990), data management (Donlin, 1991), CPI (for example, Ezop *et al.,* 1989), organizational restructuring (e.g. Dong, 1995; Juran and Gryna, 1993), "Ts" renovation (e.g. Prasad, 1996), and business process re-engineering (e.g. Hammer, 1990; Hammer and Champy, 1993; Roberts, 1994). Today, there is a vast amount of CE literature that deals with these topics (Zhang and Zhang, 1995) related to manufacturing engineering. The walls between various groups and departments, that existed few years ago in manufacturing, are crumbling (Magrab, 1997). Today, it is becoming more important to get inputs from all facets of an organization (Luther, 1997), since no single group, supplier or a department is expected to know or do everything (McMillan, 1990). An organization is constantly looking at how to run its business more effectively and determine if it can be improved in some way (Kearney, 1997). One issue that is becoming important is that not only everyone in an organization should know what activity he or she is performing or engaged in, but the rest of the product development team, including the supply-chain should also know how their activities add to the big picture (Liker *et al.,* 1995). There are six parts to winning this competitiveness battle (see Figure 1):

(1) What to change (inputs, outputs, and process steps (tasks) including measures and decision points).

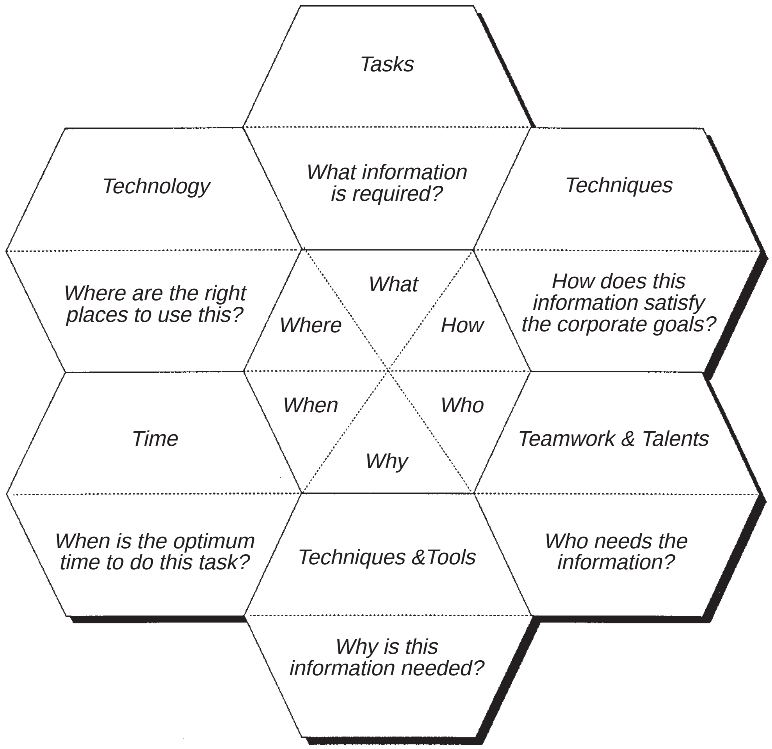

Figure 1.
Questions assessing the operational improvement needs

(2) How to change (techniques, tools, process boundaries and process flow).

(3) Whom to change (talents, teamwork, customers and supply chain).

(4) Why to change (techniques, process, purpose, function, and rationale for decision making).

(5) When to change (time, process order and structure).

(6) Where to change (technology gaps, process relationship and its context to the whole).

Knowing what information is required or what task to perform is one sixth of this battle. How this information or task satisfies the corporate goals is the second one-sixth piece. The examples of such pieces are (Prasad, 1996):

- What information is required?
- How this information satisfies the corporate goals?
- Who makes up the team? Who needs the information?
- Why is this information needed? Why will this technique or process not work?
- When is the optimum time to do this task? and
- Where will this information be used? Where are the right places to use this?

Though in Figure 1, sectors (being sides of a hexagon) are equally divided, in practice some pieces may be more important than others. "Who needs it" facilitates smooth communication and "why this information is needed" determines how valuable it is to a person, a team or to an organization. "Where this information will be used" determines the right place, "When to do" denotes the right time and this is also the contributing factor to meeting fast-to-market or concurrency goals. By knowing "what we do" today and "how we do it", a company will be in a better position to identify bottlenecks and barriers in the current system and possibly improve and revolutionize product development operations, if opportunities arise (Wheelwright and Clark, 1992).

Process improvement is a concept often used to accomplish many "lean" (Ohno, 1988) and "agile" (Gadient *et al.,* 1997) production goals (Roberts, 1994). In some organizations, "Process improvement (PI)" is often perceived as an after-thought – a functional service to be called on periodically for productivity improvement (Prasad and Strand, 1993). In such companies, process is viewed closely with "workforce productivity improvement (continuous process improvement) or organizational restructuring (fitting or reordering of teams and tasks)" (Himmelfarb, 1992). Others who have paid little more attention have concerned themselves with "process restructuring".

Process restructuring is often targeted towards causing piece-wise or one-at-a-time improvements due to an incremental or an add-on approach of continuous improvement in manufacturing process, product quality, etc. However, the perception is clearly different in companies following total quality management (TQM) (Hoffherr *et al.,* 1994), lean and agile production principles (Bhote, 1996). In those companies, process improvement is seen as a pervasive set of renovation activities that form the life-blood of a company's regenerating profit potential. "Process renovation" is a re-engineering strategy that critically examines those six pieces of the battle, rethinks them through and then redesigns the mission-critical "products, processes, and services" within an organization (Prasad, 1997). In this paper, process improvement efforts are categorized into four primary re-engineering strategies: a set of continuous process improvement (CPI) tactics (e.g. consistent or common environment), a set of restructuring tactics (e.g. common best corporate system), a set of organizational traits (e.g. agile and virtual organizational traits), and a set of renovation tactics (e.g. best industry practices, innovative and unmatched practices).

Re-engineering in this paper is used to mean one or more of the above improvement strategies. In applying a re-engineering strategy (RS) for process improvement (PI), a product development team (PDT) collectively comes up with a process that takes into consideration the needs of all the individuals and groups, and above all, the needs of the company as a whole. The choice of the term "process" in PI speaks loudly that the focus is on "processes" as opposed to "products". The term "re-engineering" implies that the change or effort is directed towards an array of process modification strategies. Less frequently re-engineering implies starting with a clean slate (a new process, e.g. 7Ts) and radically overhauling – meaning replacing the old processes with new ones.

The paper describes how the four re-engineering strategies (RSs) can be logically combined in a concurrent fashion to achieve significant process improvements. Towards this end, the paper introduces two new hybrid re-engineering strategies for process improvements (PI) that have been found quite useful at electronic data systems (EDS) accounts. The first hybrid re-engineering strategy is obtained by combining "CPI" with "restructuring" traits and the second hybrid is by combining "restructuring traits" with "organizational" traits. During a typical implementation of a hybrid RS, it is assumed that:

- an organization is in constant touch with new technological advances in all related fields such as engineering, process, computers and systems;
- the product development team (PDT) examines regularly those latest advances in the fields, benchmarks and then reviews some key candidates for improvements in the product life cycle; and
- an enterprise strategically inserts those technological advances, if sound, appropriate or applicable, as a part of overhauling the process wagon to improve its efficiency, productivity or performance. In actual practice, however, these are difficult goals.

The paper also discusses where those re-engineering and hybrid strategies were found useful in giving companies flexibility and opportunities to do things differently during a process improvement. The paper also describes with RS how companies could become creative in making strategic technology insertion decisions during product development.

1.1 Understanding and managing change

Changes are an essential part of any improvement. Whatever new steps or new tools we introduce require a change. With the new tools, if we do not make the corresponding changes in the processes or work-habits, we would be making the same mistakes but perhaps more often with the new tools. In other words we may be computerizing or automating a bad process. So the question is how do we successfully introduce and manage change?

1.1.1 Understand the change process. The first step before we introduce a change is to understand the change process. In computer-aided design (CAD) system for example, each change generates and stores a new version number of the design files, so that the designer can backtrack if required. Understanding the change process requires knowing:

- what to change
- how to change
- whom to change
- why to change
- when to change
- where to change

Understanding the change process =

$$f[\{\text{What}\}, \{\text{How}\}, \{\text{Whom}\}, \{\text{Why}\}, \{\text{When}\}, \{\text{Where}\}] \quad (1)$$

For example, "how to change" may imply promoting change techniques so that the improvement cycle repeats. Sometimes "where to change and what to change" has involved performing strategic review, which is an expansive term for a well-known competitiveness analysis process called SWOT. SWOT stands for strengths, weaknesses, opportunities and threats. Market analysis provides the points towards each of the four SWOT groups. They are listed in four quadrants of an axis-diagram as shown in Figure 2.

1.1.2 Manage the change process. The second step is to manage the change. Corresponding to the six steps of "understanding change" there are also six steps to "managing change". These are:

(1) leading the change process;
(2) setting the direction;
(3) creating the environment for change;
(4) challenging past practices and excuses;
(5) removing the barriers and roadblocks; and
(6) rewarding the right things, so that change continues to evolve.

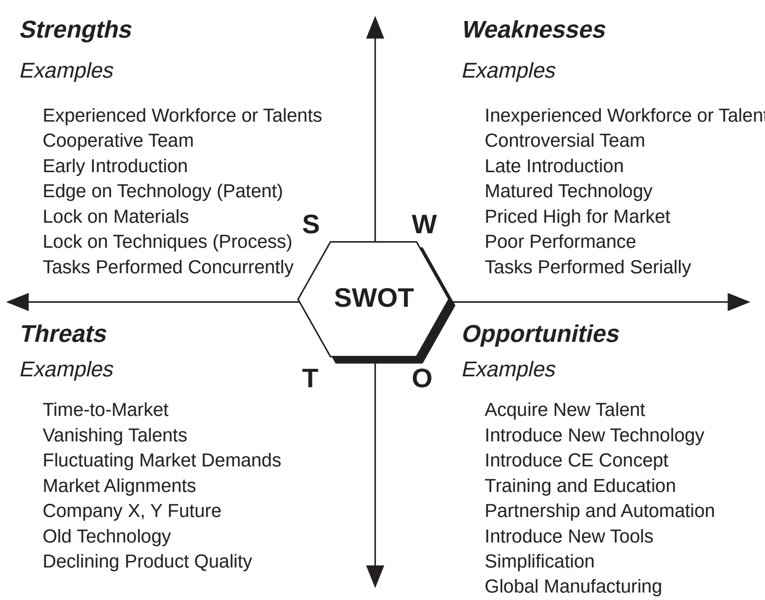

Figure 2.
SWOT analysis

These six steps are shown in Figure 3 by an outer ring.

$$\text{Managing the change process} = f\,[\text{Leading the change process, Setting the direction, Creating the environment for change, Challenging past practices and excuses, Removing the barriers and roadblocks, and Rewarding the right things.}] \quad (2)$$

These two steps are schematically shown in Figure 3 by two annular rings. Managing the change process is also referred to as LSC^2R, where, the abbreviated word represents the first letter of the steps involved. Setting the direction involves method of data collection, determining the change frequency and determining the change complexity. Collection of data that measure the number and magnitude of changes is important. The estimation of the frequency of changes (number of changes per unit of time) is usually made by monitoring the CAD files of the product designers. The way to determine the change complexity is to examine the CAD file progression, and to look for change notes, file numbers, parts creation dates and times. Challenging past

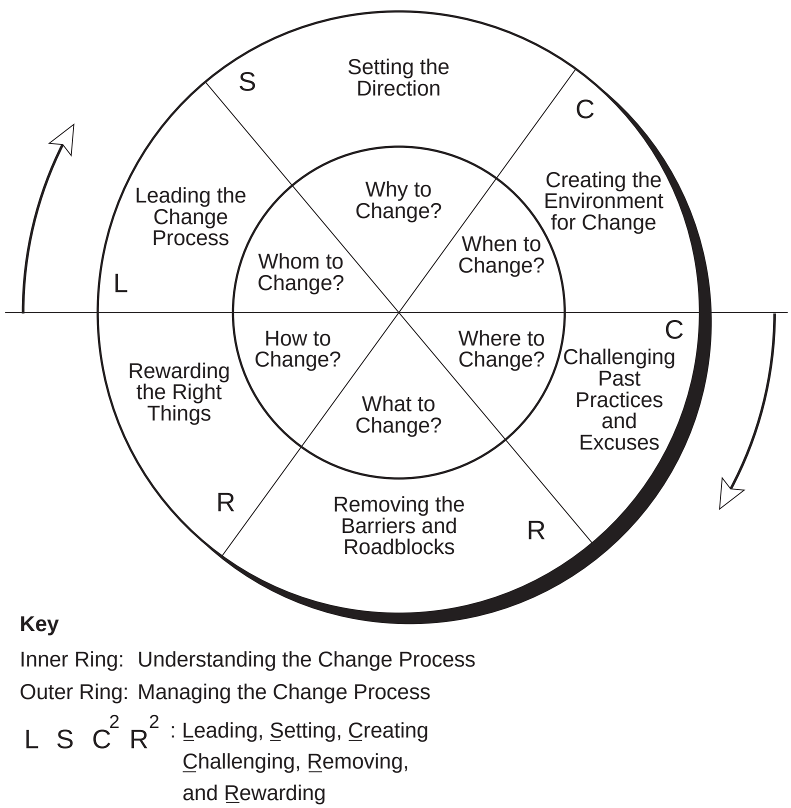

Figure 3.
Understanding and managing the change process

practices and excuses involves to a large extent understanding the sources of waste. Waste exists in all work activities, all process tasks and at all levels in an organization. Taiichi Ohno has reported seven types of waste commonly found in a manufacturing work-site (Ohno, 1988):

(1) waste of overproduction;

(2) waste of correction;

(3) waste of material movement;

(4) waste of processing;

(5) waste of inventory;

(6) waste of waiting; and

(7) waste of motion.

The one type of waste that is missing from Ohno's set is the waste of information movement (Prasad, 1996). Waste of information movement is concerned with unnecessary transfer of information between two or more dissimilar systems (computing systems or otherwise). Examples include conversion from one format to the other, upload and download of information, files retrieval and storage, unnecessary notification or notes, one-to-many communication instead of posting it publicly (many-to-many), data security, etc. This completes the set of eight wastes shown in Figure 4 (Prasad, 1996):

$$\text{Wastes} = \cup\,[\text{Waste of overproduction, Waste of correction, Waste of material movement, Waste of processing, waste of inventory, Waste of waiting, Waste of motion and Waste of information movement}]\,. \quad (3)$$

2. Re-engineering strategies

Removing the barriers and roadblocks to a large extent involves eliminating eight wastes (those described above) and the associated reworks. W. Edwards Deming has proposed 14 things that companies, large or small, can do to ensure that change is an ongoing and positive experience (Deming, 1993). Re-engineering plays a pivotal role in the CE process. The key to any (manufacturing company) competitive posture lies in its ability to re-engineer a business for agility – both physically and logically (Womack *et al.,* 1990). Factories, systems, and organizations must differentiate and remove non-value-added functions from the chain of work and foster open lines of communications. Re-engineering helps define strategies for bringing manufacturers, suppliers, and customers closer together (Liker *et al.,* 1995).

Re-engineering means taking steps to redesign and simplify business systems and processes, search out best practices (3Ps) (Prasad, 1996), to develop a more competitive and core competent workforce (Prahalad and Hamel, 1990), and to explore new business methods (Kearney, 1997) (see Figure 5). It fosters out-of-comfort-zone thinking (Luther, 1997), relies on value-added benefits to

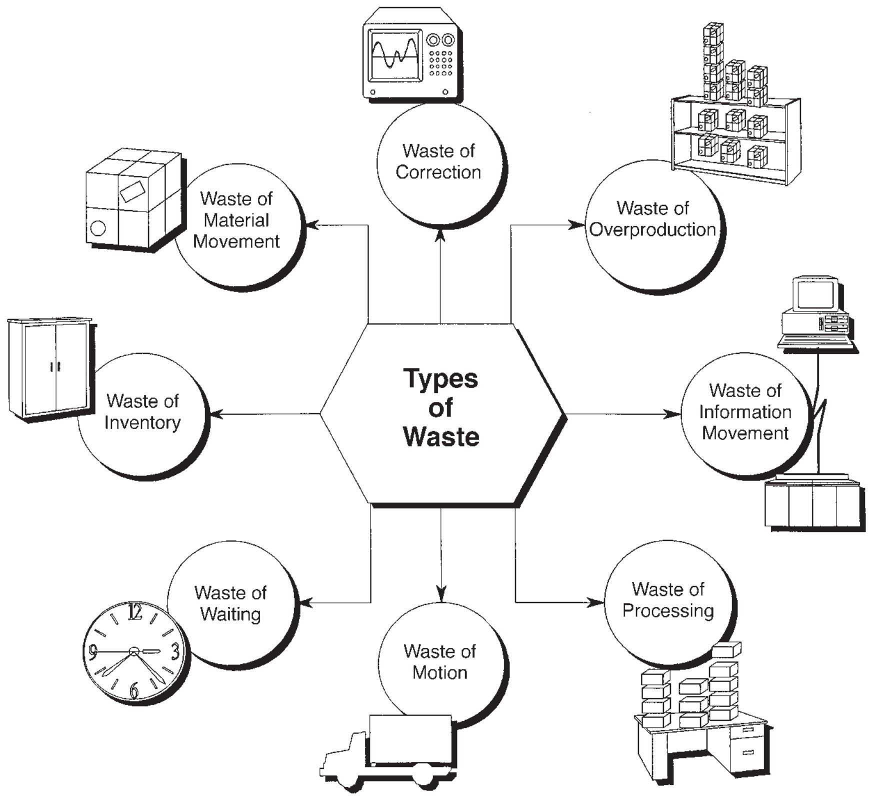

Figure 4.
Eight types of waste

both the customer and the business (Clausing, 1994), relies on strategic technology insertions (Shillito, 1994) during product life cycle, and focuses heavily on 7Ts (talents, tasks, teams, techniques, technology, time, tools) (Prasad, 1996). Re-engineering, like computer-supported acquisition and logistics systems (CALS) and CE (Bauman, 1990), requires follow-through until the new process is firmly entrenched. These product improvement efforts can be categorized into four primary re-engineering strategies:

(1) a set of continuous process improvement (CPI) tactics (e.g. consistent or common environment);

(2) a set of restructuring tactics (e.g. common best corporate system);

(3) a set of organizational traits (e.g. agile and virtual organizational traits);

(4) a set of renovation tactics (e.g. best industry practices, innovative and unmatched practices).

The key in managing change is, therefore, to establish an optimal balance between the types of process improvement strategies that were chosen and introduced from each category. Product and process re-engineering follows its

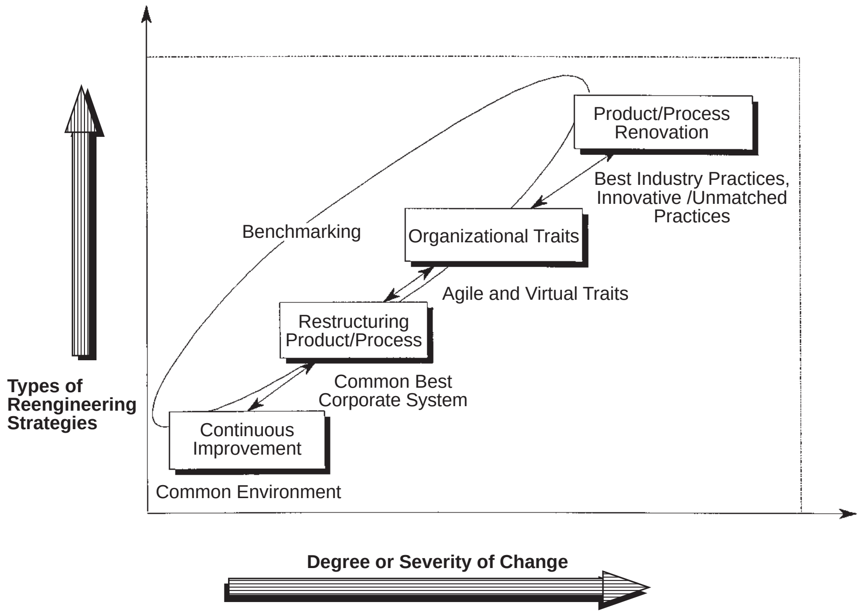

Figure 5.
Degree of severity in managing change

own life cycle (Prasad, 1996). Figure 5 shows the degree of severity in managing change:

$$\text{Re-engineering strategies} = \cup\,[\{\text{Continuous process improvement (CPI) tactics}\}, \{\text{Restructuring tactics}\}, \{\text{Organizational traits}\}, \{\text{Renovation tactics}\}]. \quad (4)$$

A soft example of a process improvement trait is benchmarking. Benchmarking is a trait that is common to all four re-engineering strategies. Benchmarking is an above-board and perfectly legal way of finding out how competitors are doing compared to one's own system (Luther, 1997). One could also learn from this exercise what are the identified better options/features in the competitors' product and imitate or perhaps improve on those (competitors') approaches or 3Ps. Other soft traits are "as-is" flow-charting, value engineering, value analysis, etc. Figure 5 illustrates four strategies of process re-engineering.

2.1 CPI tactics

This section begins with CPI strategies, traits, goals and objectives to effectively manage the changes described earlier. Continuous improvement is the basic trait for causing change. If the process is stable, CPI allows pace with the known common changes. In CPI, some prevalent tactics used are to identify and eliminate wastes, to identify and eliminate rework. Some popular CPI traits are:

- motivation and reward system;
- scope and applications;
- employee participation; and
- management commitments.

2.2 Restructuring traits

Restructuring is the next level of process improvement strategy. Restructuring means transforming from old ways of conducting business to a new way:

(1) Using the same level of abstraction in product, process, enterprise and behavioral modeling, and

(2) At a minimum, maintaining the systems' performance (product functionality and semantics) and efficiency same as the old level. This may amount to:

   - Re-focusing the efforts in the definition phase, so that the product is done right the first time it is released for design-intent,
   - Prioritizing the tasks with the customer in mind, and a
   - Definition of a common best corporate system (for example, 3Ps) for CE.

Some specific examples of restructuring traits are:

- Partnering
- Cross-functional integration
- 3Ps (policies, practices, and procedures) and
- Empowerment.

2.3 Organizational traits

Over the last few years there has been a flurry of activity in the study of manufacturing systems, and, more particularly, the mechanical design process. There is no consensus about what the term "design" means, nor is there an agreed-on description of a process improvement methodology. Often process improvement has been wrongly construed as simply an organizational "restructuring" (Besterfield *et al.,* 1995). By carefully restructuring departments into a modern multi-functional setup, an enterprise cannot expect to reap all the desired productivity gains. Though organizational "restructuring" has the potential of breaking down cultural barriers, the product realization process, such as "serial engineering", remains intact (Prasad, 1996).

One of the important elements of "managing change" is the organizational trait. There are two elements of organizational traits: agile and virtual. They form the left arm of re-engineering strategies. The right arm consists of CPI (continuous process improvement) and restructuring. These two arms are sandwiched between renovation traits at the top and CE infrastructure at the bottom (see Figure 6). There are four agile organizational traits supporting the business goals:

(1) lean manufacturing 17 tactics (Prasad, 1996);
(2) reconfiguration;
(3) responsive; and
(4) plug compatibility.

The virtual organizational traits supporting the objectives are:

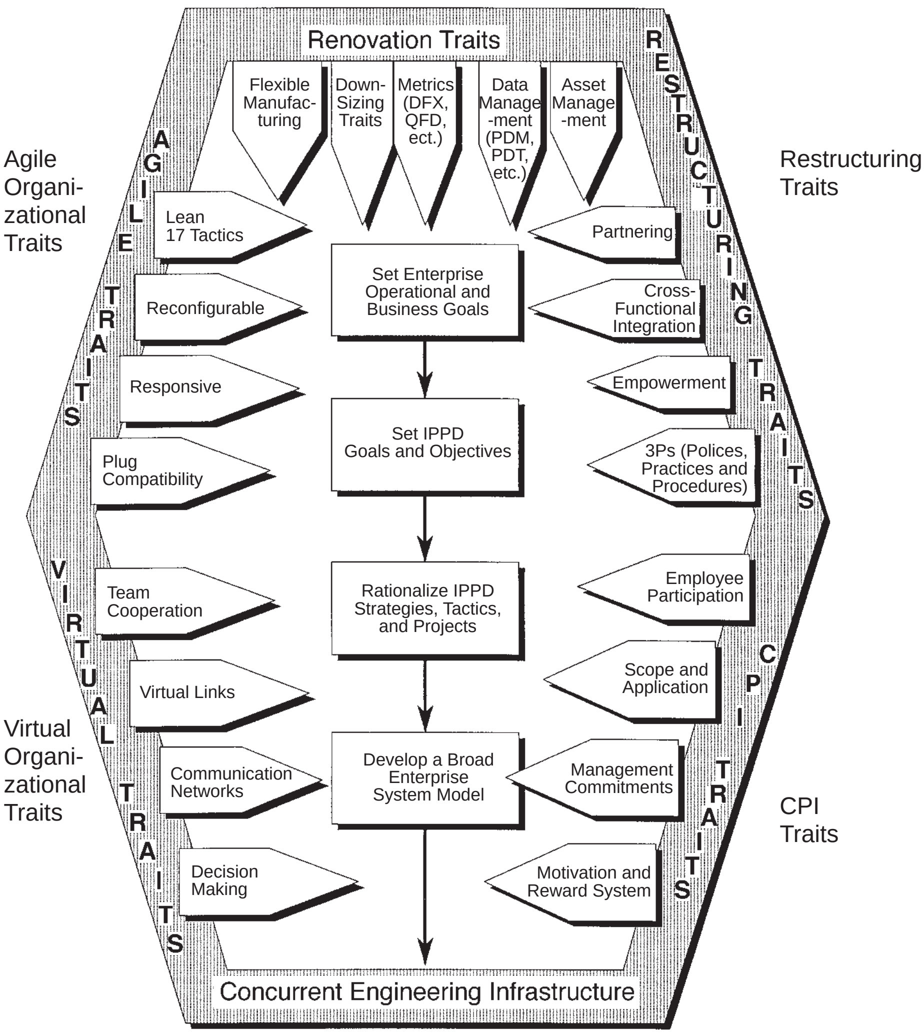

Figure 6.
Re-engineering strategies and business goals

(1) decision making;
(2) team cooperation;
(3) virtual links (Gadient *et al.,* 1997); and
(4) communication networks (Prasad, 1997).

2.4 Renovation traits

Renovation is the highest level of strategy for managing change that commonly cannot be handled by the continuous improvement, restructuring methods, or organizational traits. In the words of Hammer this type of "re-engineering strives to break away from the old rules about how we organize and conduct business, (by) recognizing and rejecting some of them and then finding imaginative or innovative new ways to accomplish work" (Hammer, 1990). In essence, the three are complementary rather than opposing strategies to improving processes. Some examples of renovation traits are:

- flexible manufacturing (Heim and Compton, 1992);
- down-sizing traits, survival of the fittest (Himmelfarb, 1992);
- metrics (design for manufacturability, DFM/DFX, QFD, CAE, etc.) (Anderson, 1990; Clausing, 1994);
- data management (PDM, PDT) (Donlin, 1991) and
- asset or cost management (Bhote, 1996) (see Figure 6).

Unlike restructuring, renovation involves alterations in the level of abstraction to reconfigure the subject system. It may involve reconstituting this subject system into a new form or to a new level of abstract descriptions, and a prior implementation of the altered form.

3. Tenets of process improvement

Regardless of how a process is ultimately implemented or accomplished, process improvement (PI) is always concerned with providing a broad range of benefits: some that are productivity related (how efficient are the resources being utilized?) (Arai, 1997) and some that are performance related (how effective are the results or the returns?) (Clark and Fujimoto, 1989). Productivity benefit measures involve anticipated or measured level of activities, such as number of parts manufactured per unit of manpower, number of lines of coding per unit of time, number of reports done, etc. Performance benefit measures involve anticipated or measured level of outputs relative to a specified set of goals – for example, expected return on investment, customer satisfaction, expected or measured profitability, market share, etc. PI benefit measures are necessary for both program planning and program evaluation. Program planning relies on past performance and judgments whereas program evaluation needs measurement information combined with judgments in computing either the efficiency or the effectiveness factor. In this context the following definitions apply (Roberts, 1994).

3.1 Process efficiency

Process efficiency is concerned with degree of economy – how well a process uses available 7Ts (Prasad, 1996) (talent, tasks, teams, techniques, technology, time, and tools) to achieve the desired results. Improvement in process efficiency is concerned with eliminating process waste and rework (Ohno, 1988). "Waste of processing" is the unnecessary process-related efforts, which adds no value to the output (product or service) that are being performed (see also Figure 4 for other types of waste). Examples of "waste of processing" include expensive machine or a process to produce the same quality part, lack of clear customer specifications (Griffin and Hauser, 1991), enhancement that is transparent to the user, process bottlenecks, etc. (Kearney, 1997). Examples of process rework include endless refinements, repeated functions, unnecessary iterations, redundant approvals, etc. Waste of processing is of two types:

(1) waste caused by the individual slack conditions; and

(2) waste caused by the lack of integration or coordination (7Cs).

During "waste of processing" slack condition, one or more of the following six elements are active at the work-site: machine, management, manpower, materials, method and money.

Efficiency is the result of the integration of six Ms (machine, management, manpower, materials, methods and money) at the work-site (Prasad, 1996). Some common factors that can cause slips (or waste in the manufacturing set-up) are: unevenness of the mating surface; overburden (due to heated or loaded conditions); and the process method used. Similar to slips – which are due to the individual contribution of the six Ms – overburden, unevenness and process methods are also caused by lack of integration or synchronization between six Ms and the outputs.

The lack of efficiency has an effect in reducing the product's life-cycle time. There exists an inverse relationship between process efficiency and the life-cycle lead-time. Figure 7 shows the relationship between process efficiency, η and the lead-time, T. Figure 7a shows the trend when the process is at an original unchanged state. The dashed lines show how the lead-time decreases from T_1 to T_2 when the efficiency is improved from η_1 to η_2. Figure 7b shows how conditions might change if the original process is altered or improved. Three curves are shown (in Figure 7(b)) corresponding to the following three situations: When the initial state (given process configuration) is altered using (a) CPI; (b) Restructuring techniques or (c) Renovation strategies. In each case, at the start of the improvement process, the rate of decrease or drop is obviously quite steep indicating that a small increase in efficiency has a large impact on the lead time. This trend slows down as incremental improvements continue to be made in the efficiency of the original state of the process. At a later point in improvement, it is more difficult to squeeze in additional decrease in cycle lead-time. A lot more effort (7Ts) is required to achieve meaningful gain in lead-time. This means the efficiency has reached its peak for a given

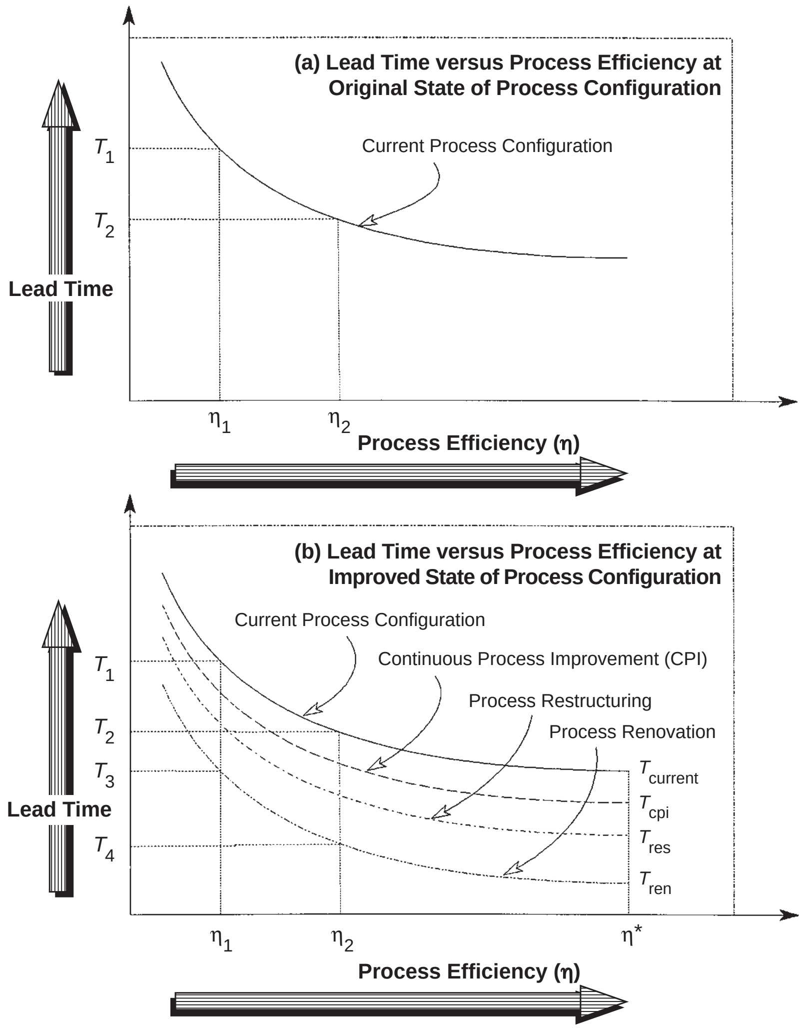

Figure 7.
Effect of process improvement strategies on lead time

state of process configuration. In Figure 7(b), therefore, three peaks are shown corresponding to these three process improvement situations. Clearly the peak efficiency is a function of the following:

- State of the current process;
- 7Ts employed to achieve the desired results (Prasad, 1996); and
- re-engineering strategies (for example, benchmarking, CPI, restructuring, renovation, etc.) chosen to accomplish the process improvement.

Table I shows a comparison of the change management process with respect to a dozen or so chosen characteristics.

Elements	Continuous improvement	Restructuring	Renovation
Requirements	Little investment, but collective effort and time put in are large	Little investment, but more management effort is required	Large investment, but little effort to maintain
Approach	Collective input, every vote counts	Selective input, key groups consensus driven	Rugged individualism, results driven
Basis	Built on conventional know-how and attitude	Built on existing trained staff, leaders, new training, and reorientation	Built on technology transfer, in-house innovation, or technological breakthrough
Orientation	People/work-groups	Organization, leaders, management staff	Technology, process, methods, etc.
Involvement	Everybody	Leaders and management staff	Selective, few "champions"
Focus	Geared to eliminate waste, defects, error, or to make process improvement	Geared to change the pace, manpower rotation, new product orientation	Geared to make quantum jump in technology use or break traditions
Time-frame	Continuous and ongoing	Incremental and periodic	Intermittent and fragmental
Mode	Maintenance and improvement	Reorganize and restructure	Scrap and rebuild
Change	Gradual and components-wide	Incremental but system-wide	Radical and sometimes volatile
Pace	Slow, smaller steps	Medium and large steps	Giant leaps
Effect	Long-term, permanent, and unnoticeable	Short-term, permanent, and sustainable	Short-term, dramatic, and noticeable
Constraints	Time	Skills, employees' talents, ability to manage	Technology feasibility, applicability, or cost
Return on investment (ROI)	Mild	High	Dramatic

Table I. Comparison of re-engineering strategies

4. Hybrid re-engineering strategies

Work-groups empowered and charged with CPI typically lack the authority, perspective, and/or capability to implement radical changes that cut across functional lines. It is not true for restructuring. The restructuring team involves multi-disciplinary leaders from each facet of the organization. Such technical leaders charged with restructuring have the needed authority and perspective to implement radical changes that cut across functional lines. Similarly, in the renovation team, a majority of the experts come from outside the immediate area of investigation. This way, the changes proposed can impact other processes, or otherwise impact the interest of the organization as a whole rather than a few specific units. An example of renovation is the reorganization of a company by "product line". In this case, each area of the organization involved in the particular product must work together with common organizational goals and objectives. Incorporation of best industry practices or innovation and unmatched practices are some examples of renovation efforts.

There are many ways to accomplish re-engineering strategies: top-down, bottom-up or incremental. The top-down and bottom-up approaches are discussed in Prasad (1996). In the case of "incremental re-engineering", new tools and systems can be introduced one batch at a time. As the team gets familiar or trained in one set of systems or its use, other sets are introduced progressively. The deployment is done on an incremental basis: "pay-as-you-go" type to ensure a managed impact. Reduced lead-time for process improvements can also be achieved by combining a couple of process re-engineering strategies discussed in Section 2. The two new hybrid re-engineering strategies that have been found useful at EDS are:

(1) combined CPI and restructuring strategy;

(2) combined restructuring and organizational strategy:

- Combined CPI and restructuring strategy: some processes do not need to be redesigned at frequent intervals, since most of the original processes remain intact. It might be just enough first to design the system for optimum performance and then incrementally improve it (the system) over time as the needs for fine-tuning become evident. Reengineering in this case consists of a one-time design for optimum performance and a series of CPI steps followed by a restructuring strategy fired at regular intervals as shown in Figure 8a.
- Combined restructuring and organizational strategy: some processes tend to have a useful life of their own. Other times, due to changing external environment, market conditions, or changing technology, these original processes no longer remain an effective solution/option. In such cases, these processes have to be restructured a number of times throughout the product's life cycle. Applying agile or virtual organizational traits at frequent intervals may very well be in the best interest of the corporation to stay healthy for the long haul. Re-engineering in this case consists of a one-time design for optimum performance and a series of restructures followed by application of organizational traits at regular intervals as shown in Figure 8b.

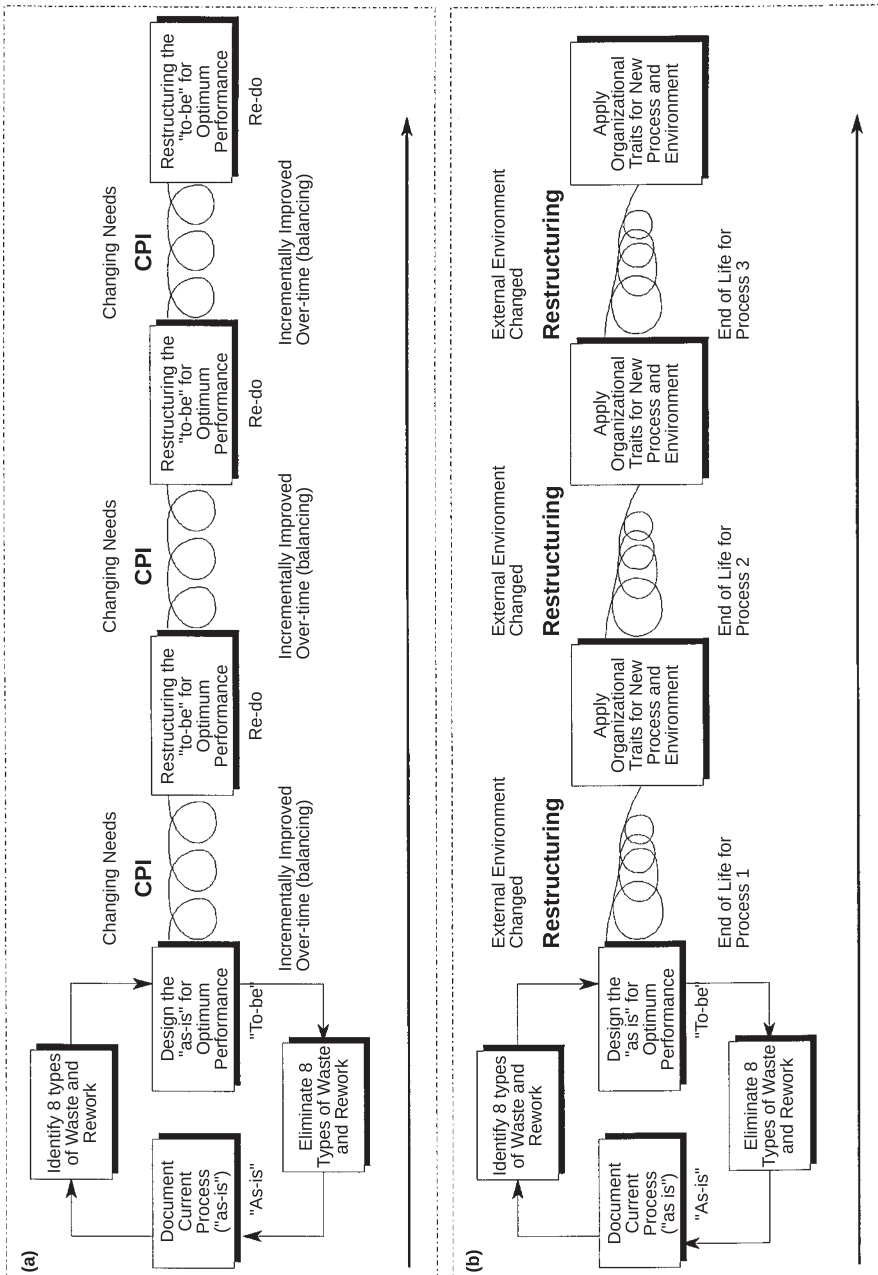

Figure 8.
Hybrid re-engineering approaches

5. Concluding remarks

One of the elements of change management is understanding the change process for best results. Improvements may result from product change, process change, cultural (human factors) change, requirements change, or enterprise operations change. Juran and Gryna (1993) mentioned that any change has a cultural bearing on one's formed comfort zone. When the level of change exceeds this zone, management often encounters some degree of resistance. The effective management of a process necessitates a hybrid strategy that takes into account the "who", the "how" and the "what" of the changes. By combining re-engineering traits with workflow methodology at EDS, we have created a more robust set of re-engineering strategies – called hybrid re-engineering strategies to process improvements.

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