IAEA-TECDOC-1491

Management of continual improvement for facilities and activities: A structured approach

IAEA
International Atomic Energy Agency

April 2006

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The originating Section of this publication in the IAEA was:

Nuclear Power Engineering Section
International Atomic Energy Agency
Wagramer Strasse 5
P.O. Box 100
A-1400 Vienna, Austria

MANAGEMENT OF CONTINUAL IMPROVEMENT FOR
FACILITIES AND ACTIVITIES: A STRUCTURED APPROACH
IAEA, VIENNA, 2006
IAEA-TECDOC-1491
ISBN 92–0–102906–3
ISSN 1011–4289

Printed by the IAEA in Austria
April 2006

FOREWORD

In recent years there has been an upward trend in the safety and operational performance of nuclear installations. Safe, efficient operation is their goal. Continual improvement of the processes of organizations has led to enhanced safety performance and efficiency benefits such as cost reductions and improved cycle times. Many organizations have experienced significant cost improvement largely by or through better financial management and a common drive to reduce costs brought on by commercial pressures.

Without the use of a structured methodology to identify and implement improvements, changes to an organization to reduce costs through cutting staff and activities could eventually fail to produce the desired changes and even have a negative effect on safety and overall performance.

The following fundamental principles are considered essential to the effective introduction of structured continual improvement:

- Long term commitment from senior management throughout the entire organization;
- The implementation in the organization of a process management approach such as that advocated by IAEA Safety Standards, ISO 9001, Malcolm Baldridge National Quality Award and European Foundation for Quality Management Business Excellence model;
- The alignment of the processes with the objectives of the organization through the organization's business plan;
- The utilization by Management of the process information as an input to managing the organization;
- The employment of the information derived from the process performance to identify and prioritize the processes that require improvement;
- The active participation of all staff of the organization to using its processes in order to contribute to continual process improvement (CPI).

This publication defines a structured approach for continual improvement and focuses on the way an organization can improve its processes. It is recognized that there are many different approaches and methods available in the marketplace to improve processes. The methodology used in this publication contains steps and practices that are common to many of those improvement strategies.

An essential element of any strategy is recognition by senior management that continual improvement changes could potentially impact either nuclear or conventional safety. Thus, it is essential that changes to processes and organizations be properly evaluated for their potential impact on safety; and, that the implementation of such changes is controlled effectively with additional safety measures put in place as deemed necessary.

Special thanks are due to N. Redman, Amethyst Management, United Kingdom, who largely contributed to this publication.

The IAEA officer responsible for this publication was P. Vincze of the Division of Nuclear Power with the cooperation of R. Nichols of the Division of Nuclear Installations Safety.

EDITORIAL NOTE

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CONTENTS

1. INTRODUCTION

1.1. Background

The IAEA Safety Standards [1, 2] require that an integrated Management System be established, documented, implemented, maintained and its effectiveness continually evaluated and improved to enable the organization's goals and objectives to be achieved. The processes of the Management System must also ensure that any stakeholder[1] or legal requirements are met in addition to meeting customer and product requirements.

It is generally recognized that there are a number of different strategies that can be used to effect continual improvement. For this publication to be most useful, it is imperative that the organization has documented and defined its processes; and, that it uses the information from managing those processes to identify and prioritize improvement initiatives.

To aid the development and use of processes it is important that:

- Processes and information are as simple as possible;
- Process indicators have been developed and implemented for each process;
- Improvement of processes is an ongoing, normal business activity; and,
- All those involved in a given process – including employees, contractors and suppliers – are engaged in any improvement activities undertaken.

Continual improvement requires the ability to understand the processes that impact on the objectives of the organization; to measure process effectiveness and efficiency; and, to make changes to these processes based on factual information and knowledge.

For continual improvement initiatives to succeed, the following basic principles must be in place.

- Sustained senior management leadership must be provided in terms of active attention, commitment and support.
- The organization must be clear on the overall goals of the improvement programme.
- Continual improvement initiatives should be an integrated part of the organization's business plan.
- The benefits of improvements should be evaluated against the cost and resources used in their development and implementation.
- Specific, measurable improvement objectives and targets should be set.
- A simple and practical methodical approach should be used.
- Improvements should be based on data and facts; and, on a belief that the status quo can (and should) be challenged.

[1] Stakeholders are individuals or groups having an interest in the performance of an organization. Stakeholders have typically included the following: customers, owners, operators, people in an organization, suppliers, partners, trade unions, the regulated industry or professionals; scientific bodies; governmental agencies/regulators (local, regional and national) whose responsibilities arguably cover nuclear energy; the media; the public (individuals, community groups and interest groups); and other States, especially neighbouring States

— All staff should be encouraged to be involved in continual improvement and, as necessary, provided training on relevant strategies, tools, and techniques.
— Improvements to processes should be understood by those expected to implement the new or modified processes.

When continual improvement is introduced into an organization, it is not uncommon to encounter difficulties such as the following.

— Senior management fails to provide the necessary leadership by establishing sustained high-level commitment and enthusiasm for the programme.
— People regard the initiative of continual improvement as a passing phase and not a permanent new approach.
— People tend to resist change by protecting existing boundaries and practices.
— Process mapping becomes a goal rather than a tool to use in working towards goals.
— Teams over-analyze problems rather than focusing on results-oriented solutions.
— Too much time is spent criticizing the current process.
— The organization underestimates the degree of radical improvements that are possible.

The implementation of process improvement could impact nuclear or conventional safety. Therefore, it is essential that all changes to plant, processes and organization are properly evaluated for impact on safety, and implementation is controlled effectively with additional safety measures if necessary during the period of change. Managing Change in Nuclear Utilities, IAEA-TECDOC-1226. [3]

1.2. Objectives

The objectives of this publication are to explain how an approach to continual improvement can be implemented and how to conduct process improvements. It also describes some good practices and some of the problems that may be encountered based on experiences in a number of different organizations in the nuclear field. A number of case studies and a summary of some of the many improvement techniques available are provided. There are many different approaches and methods available in the marketplace to improve processes. The methodology used in this publication contains steps and practices that are common to many of those continual improvement strategies.

This publication should assist readers in successfully applying continual improvement in their own organizations in the pursuit of enhanced safety and improved performance.

1.3. Scope

This publication is relevant to all organizations that have adopted continual improvement strategies and that seek to continually improve their processes. The methods and solutions that are described herein are based on practical experience in Member States from developing and implementing continual improvement activities. The intended users of this publication are:

— The most senior manager in an organization who is responsible for establishing continual improvement as a major characteristic of the organization’s culture;

— Line managers who lead, sponsor and implement continual improvement efforts; and,
— All staff involved in continual improvement.

1.4. Structure

This publication is divided into six sections that describe:

— A structured approach to continual improvement;
— Senior management responsibilities;
— Organizational issues associated with continual improvement;
— Personnel considerations associated with continual improvement;
— The steps of continual process improvement (CPI); and,
— Continual process improvement success.

The publication's annexes provide detailed information about certain facets of continual improvement; examples related to the text; and, case studies of companies that have had successful experience using continual improvement strategies.

2. A STRUCTURED APPROACH TO CONTINUAL IMPROVEMENT

This section provides an overview of a structured approach for implementing an organizational continual improvement programme. Although individual continual improvement projects can be successful within an organization, greater success can generally be achieved through an organization-wide coordinated approach that is linked closely to the goals of the organization and its business plan. A structured approach to continual improvement is represented in Fig. 1. Information on the elements of this approach is described throughout this section.

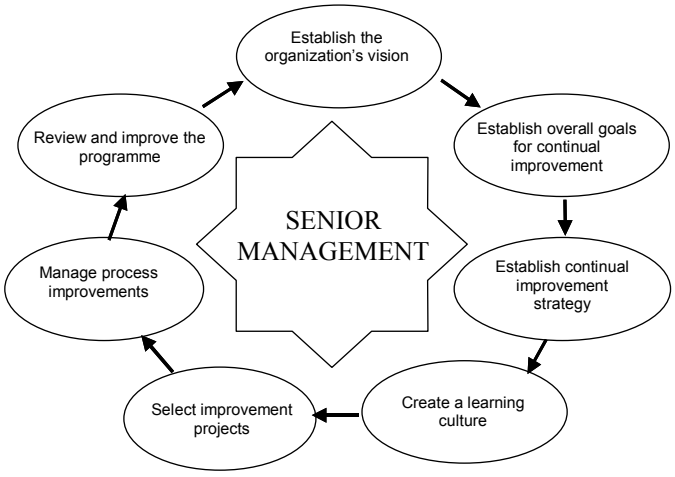

Fig. 1. A structured approach to a continual improvement programme.

2.1. Senior management

Senior managers play a crucial role in the success of continual improvement programmes. Without the leadership, commitment and involvement of senior management, a continual improvement programme is unlikely to be successful. (Section 3 describes the responsibilities of senior management in continual improvement).

2.2. Establish the organization's vision

A clear vision for the organization, embracing continual improvement, should be established. This should be a simply stated description of what the organization wants to achieve. All people in the organization should be able to understand it and identify how they as individuals can contribute to its achievement.

2.3. Establish overall goals for continual improvement

Clear top-level goals for the continual improvement programme should be identified and cascaded into business, plant, department and individual objectives. These goals should be aligned with the vision of the organization and form an integral part of the business plan. The business plan should include the overall continual improvement programme along with specific improvement projects, their targets, and the resources needed to achieve those targets.

2.4. Establish continual improvement strategy

A range of different continual improvement strategies can be adopted to suit an organization's safety goals, business needs, culture, priorities, etc. However, there is generally a common route that all organizations will follow in identifying their continual improvement programme.

An essential element of any strategy is recognition by senior management that process improvement changes can potentially impact either nuclear or conventional safety. Thus, it is essential that changes to plants, processes and organizations be properly evaluated for their potential impact on safety; and, that the implementation of such changes is controlled effectively with additional safety measures put in place as deemed necessary. Many successful organizations have given their continual improvement programmes an identity that becomes synonymous with the success and quality of their performance. It should be recognized that the successful integration of continual improvement principles may take four to six years of sustained leadership and commitment in order to become a natural part of the organization's culture.

To support the strategy, a framework should be established that includes requirements for:

- Developing performance indicators;
- Providing reasons for such a major improvement programme;
- Communicating plans to raise the level of awareness of all staff; and,
- Defining the continual improvement methodology (Annex I provides examples of process improvement methodologies).

The strategy should also indicate what is to be accomplished by all levels of management to implement the requirements of the continual improvement programme in their area, such as:

— Which process improvement tools might be used;
— Establishment and maintenance of the process improvement programme;
— Communication of the continual improvement tools;
— Development and education of personnel; and,
— Improvement of both internal and external environments.

The strategy should be flexible enough to allow the selection of the most appropriate approach for each improvement. A rigid approach that restricts the use of the most suitable tools and methodologies should be avoided. It is important to develop a strategy that outlines to the staff the plan (or roadmap) for the introduction of the phases of the continual improvement programme. A major action timeline should be developed as part of the plan. The phases typically include preparation, launch and full-scale implementation. The kinds of activities that should be carried out within these three phases of the continual improvement programme are outlined below.

2.4.1. Preparation phase

— Ensure the organization's vision embraces continual improvement.
— Establish overall goals for continual improvement.
— Carry out a gap analysis of the future with the present.
— Establish the cooperation and commitment of top management.
— Prepare top managers to lead continual improvement.
— Engage staff representatives in continual improvement.
— Create the right infrastructure to support the continual improvement.
— Ensure key processes and process owners are identified.

2.4.2. Launch phase

— Establish the case for continual improvement through the use of performance indicators.
— Communicate the strategy and tools of continual improvement.
— Create a shared understanding of the vision with all staff.
— Involve staff in identifying internal good practices and improvement opportunities
— Identify and implement pilot processes to be improved.
— Publicize early successes.
— Benchmark external good practices and processes for the pilot projects.
— Review and improve the continual improvement programme based on the lessons learned in the pilot projects.

2.4.3. Full-scale implementation phase

— Expand the scope of continual improvement activities to other processes across the organization.
— Expand and embed both internal and external benchmarking activities.
— Ensure that decisions are based on facts and measurements rather than just opinions.

- Ensure that the ways staff are managed and treated – both individually and collectively – support the goals and improved processes of the organization.
- Ensure that the processes of the organization are aligned.
- Ensure that plans for implementing process improvements include training and familiarization of those involved.
- Identify and involve staff who show an interest in continual improvement in all levels of the organization.
- Reward and recognize staff who participate in successful improvement activities.
- Where feasible, involve stakeholders in improvement initiatives to ensure that changes are effective and benefits maximized.

To implement a continual improvement programme will require an appropriate organizational framework and infrastructure. More information on this requirement is contained in Section 4.

2.5. Create a learning culture

A learning culture should be created within the organization that allows continual improvement to take place as a normal and expected part of business activities for all staff. This can be achieved in a number of ways, but will usually require sustained attention over a long period of time. For example, it may include establishing an appropriate set of values for the organization with senior managers demonstrating their personal commitment to continual improvement through their personal involvement, sponsorship and prioritization of continual improvement projects. A key objective is to establish a culture where all staff feel they have an important role in continual improvement, and that they are supported and recognized by their senior management team.

The importance of achieving the right attitude and involvement of the staff of the organization cannot be underestimated. It is important that senior management focus its time and effort on this area. This requirement for success is covered in more detail in Section 5.

It is essential to foster an environment where staff can also implement smaller, local continual improvement projects that can be completed with line management involvement, alongside the major continual improvement projects sponsored by top management.

2.6. Select improvement projects

The organization should carry out an overall assessment of its processes; and, based on data, identify those that should be improved first. Factors such as the impact on safety, customers, costs and the availability of resources may be considered when these decisions are being made. Decisions should be made in full alignment with the goals of the organization to ensure that the maximum benefit for the resource available is achieved.

Other factors to be considered when identifying which processes to improve first include:

- Proposals or suggestions from staff and other stakeholders;
- Competition, deregulated markets and the business environment the utility operates in for example mergers/acquisitions;
- Opportunities identified in earlier process improvement projects;
- Organizational changes;

— Technology changes; and,
— Changes in legal requirements.

A number of techniques or inputs can be used to assist in the identification of priority areas for improvement. They include the following sources:

— IAEA Operational Safety Review Team (OSART);
— World Association of Nuclear Operators (WANO) evaluations;
— Malcolm Baldridge Award[2];
— European Foundation for Quality Management Business Excellence[3] model;
— Views and feedback from stakeholders such as customers and regulators;
— Feedback from and interviews with a broad cross-section of employees using proactive analysis techniques such as Appreciative Inquiry [4];
— External benchmarking;
— Intra-organizational brainstorming; and,
— Results of activities such as management assessments, self-assessments, independent assessments, operating experience feedback, management reviews, corrective action programmes, and process management.

Once senior management has agreed on the priority areas, process improvement projects can be established. A recommended approach for improving processes is detailed in Section 6.

2.7. Manage process improvements

Continual improvement may be defined as seeking to establish excellent performance in an organization. It is imperative, therefore, that the continual improvement projects and teams set the standards in terms of the approaches taken. Therefore, each continual improvement project should reflect methodological approaches such as those advocated in this publication that utilize clear objectives, defined targets, good communication, and effective measurement of results. The requirements of those who will have to implement the changed processes must be considered in this context.

As each project in the continual improvement programme is accomplished, checks should be carried out to ensure that the changes have been effectively implemented and embedded and that the projected improvements are being realized. This may result in projects being adjusted if the required improvement has not yet been achieved.

An approach for establishing an effective framework for process improvements is described in Section 4.

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[2] The Malcolm Baldridge National Quality Award was established by the Congress of the United States of America in 1987 to enhance the competitiveness of US businesses by promoting quality awareness, recognizing the quality and performance achievements of US organizations, and publicizing successful performance strategies.

[3] EFQM, a not-for-profit membership foundation, is a primary resource for organizations in Europe seeking to excel. Founded in 1989 by the chief executive officers of prominent European businesses, EFQM is now the hub of excellence for globally minded organizations of all sizes and sectors – both private and public.

2.8. Review and improve the programme

At regular intervals, the continual improvement programme should be reviewed to consider questions like those suggested below.

- Have the drivers for the strategy changed which could lead to a revision to the strategy and programme?
- Are the strategy, infrastructure and tools effective?
- Can improvements to the strategy be made through applying any lessons learned?

As prioritized improvements are successfully implemented, senior management should determine which new priority projects should be initiated.

3. SENIOR MANAGEMENT RESPONSIBILITIES

It is fundamental to the success of the Management System and to the implementation of continual improvement throughout the organization that senior managers provide strong leadership; visible and active support; and, demonstrated commitment. Appointing an executive sponsor is a demonstrable way of showing support and commitment.

Such an executive sponsor must be the person who has complete managerial responsibility for the whole area affected by the continual improvement programme. For example, a utility-wide continual improvement programme, the executive sponsor would be the chief executive or president; whereas, for a site or location-specific continual improvement programme, the executive sponsor would be the site manager or site vice president.

The executive sponsor must mandate the programme and actively support continual improvement by insisting on the support of all other managers. Sustained attention will be needed to avoid the tendency to think the new programme (continual improvement) is a fad or ‘topic of the month’. To encourage improved individual and organization performance, executive sponsors should empower and make individuals accountable for their work.

The role of senior management in continual improvement includes the following responsibilities.

3.1. Establishing a vision for continual improvement

A key role of top management is to provide an organizational vision that embraces continual improvement. The top manager should use the vision as an essential tool in communication of the overall objectives for continual improvement thereby motivating the workforce and aligning continual improvement activities with the objectives of the organization. Involving a cross-section of employees in the process of developing a vision has been found to increase ownership and commitment throughout the organization.

3.2. Establishing overall goals for continual improvement

It is essential that senior management understand how the continual improvement programme fits in with the strategic goals and objectives of the organization. Senior management should establish overall goals for the programme to ensure clear alignment; to define senior

management expectations; and, to provide a top-level means of measuring progress. The objectives should define quantifiable measures and targets to provide visibility at all levels of the organization of the importance of the continual improvement programme; and, to communicate how each project, team and individual person contributes. The cascade of continual improvement projects, continual improvement teams, and individual participants should have objectives and targets that are aligned.

The continual improvement programme goals should be embedded in the organization's business plan to demonstrate that the programme is part of the normal business of the organization; to show that it is an integral part of business activity; and, to demonstrate that senior management is fully committed to its success.

3.3. Creating the motivation for change

Senior management must convince everyone in the organization about the need for significant change as part of achieving widespread commitment to continual improvement. Generally, people find change very uncomfortable and prefer to keep things the way they have been, even when they know that not changing will eventually lead to failure. Therefore, senior management must motivate staff by communicating clearly the benefits that active participation in the continual improvement programme would bring for each person, department or function within the organization.

A credible purpose and reason for improvement should be developed and communicated to all staff in words relevant to the staff involved. Often the driver for improvement will be clear. For example, during deregulation of a power supply industry or where immediate business failure is apparent, improvement is the only option. If the business driver is longer-term or the threat is in the future, senior management may face an even greater challenge in motivating the organization to start the continual improvement programme. Failure to successfully establish this motivation amongst the workforce and other affected parties can put the continual improvement programme at risk. Again, it has been found that involving a cross-section of employees in the design of and communication about changes has a positive impact on acceptance, motivation and performance.

Aligning the way people are managed to the goals of the continual improvement programme is a major factor in successfully motivating the staff in an organization. This is covered in more detail in Section 5 of this publication.

3.4. Establishing commitment and alignment of the senior management team

It is vital that all members of the senior management team are fully in agreement about the purpose and objectives of a continual improvement programme. Inconsistent messages from the senior management team can be confusing and divisive to the employees and potentially destructive to the programme.

In some organizations, senior management meetings (or retreats) have been used successfully as forums for the most senior managers to communicate their expectations for continual improvement programme implementation to their management team. The most senior manager explains what continual improvement is all about; why it is being implemented; the expectations for continual improvement; and, the timeline for implementation. Such meetings are also good forums for senior level managers to receive training in the philosophy and methodology of continual improvement.

If there is limited internal experience available, many organizations have successfully used external authorities or consulting experts who are knowledgeable of the nuclear industry and experienced in continual improvement programmes. However, it is essential that senior management teams retain overall ownership of continual improvement programmes.

Following such meetings, the senior managers should understand the continual improvement process to be used in their organizations so that they can conduct their respective duties in a manner consistent with programme principles and act as project sponsors. With the advice and consent of the continual improvement programme manager, sponsors should have the authority to remove any barriers identified by each improvement team (see Section 4.2.1.1.).

To aid the effectiveness of continual improvement, senior managers should be aware of their roles and responsibilities within the continual improvement programme; have knowledge of the programme itself; and, have a personal action-plan to support improvement teams and the implementation of the continual improvement programme.

The role of senior management in continual improvement is as dynamic and critical as any other management responsibility. Simply put, if continual improvement gets the unqualified support and visible participation of senior management, it is quite likely to succeed. However, the converse is also true: limited support and participation by senior management can be fatal.

Many organizations use inaugural meetings like those described above to establish a Quality Council or Steering Committee for continual improvement. A typical Quality Council or Steering Committee is headed by the most senior manager and includes all senior managers, the continual improvement programme manager and workforce representatives. The Quality Council or Steering Committee reviews and approves the continual improvement programme progress and provides committed and sustained involvement and leadership. An example of a Quality Council or Steering Committee charter is given in Annex IV.

3.5. Managing the continual improvement programme

Senior managers can lead improvements to the Management System by promoting and sponsoring the use of continual improvement and by ensuring that they empower staff involved in continual improvement. Such goals can be achieved by actions like the following:

- Acting as sponsors for process improvement projects and identifying a project leader;
- Clarifying roles to give staff a clear understanding of their responsibilities in the projects;
- Confirming the priorities of projects;
- Clarifying performance deliverables by setting clear performance standards for improvement projects and knowing how these contribute to an organization’s goals;
- Giving authority and knowledge of the limits of authority for each improvement project;
- Providing resources to ensure that improvement teams have the time, equipment, materials necessary to complete continual improvement projects;
- Providing improvement project teams with the knowledge and information to make good decisions;
- Giving improvement project teams real accountability for organizing their work and meeting performance targets;

— Staying involved with continual improvement projects through participation in individual teams, remaining aware of project developments, and removing barriers to improvement opportunities;
— Understanding the application and use of the tools used in continual improvement in order to provide guidance as necessary;
— Monitoring progress against the improvement plans and targets; and,
— Ensuring that team members have the skills needed to fulfill their roles.

Through investing the time to act as sponsors, senior managers can continually demonstrate and sustain their commitment to and involvement in the continual improvement programme. This matter is discussed more in Section 4.2.

3.6. Creating a continual improvement culture

As discussed in Section 2.5, continual improvement is even more effective if it is introduced into an organization that has a learning culture. It is important to know and understand the culture of an organization. This will help identify what needs to be changed to promote continual improvement. The role of leadership is essential in creating the proper culture for continual improvement. It may be necessary to move the organization towards an implementation-focused, can-do, need-to-improve, 'finish what we start' culture. In other instances, a 'results-at-any-cost' culture may require recalibration of a different nature. Each organization's culture is unique; the constant is the pervasive impact of that culture on the organization as a whole.

Creating a learning culture in an organization is a complex and difficult issue; and, many of the issues addressed in various sections of this publication can facilitate that goal. Some desirable factors are listed below.

— Demonstrating trust of staff members and treating them with dignity and respect can greatly reduce, if not eliminate, fear and anxiety about impending changes.
— Involving employees as equal participants in planning and decision-making increases understanding, creates ownership and strengthens commitment.
— Providing feedback on performance to teams and individuals and helping them to identify individual performance improvements builds mutual understanding and teamwork.
— Seeking, being receptive to and acting on feedback on their performance can provide senior managers with great insight and engender respect from employees.
— Giving staff the 'permission to fail' frees them from the fear of failure.
— Creating a culture that promotes open and honest discussion results in strengthened teamwork, pride of ownership, and more efficient identification of improvement opportunities.
— Praising, supporting, providing feedback and continued direction to continual improvement teams using both formal and informal means of recognition enhances self-esteem and motivates employees.
— Encourage individuals to look for more efficient and effective ways of accomplishing their assigned tasks demonstrates senior management's confidence in the employees.

4. ORGANIZATIONAL ISSUES ASSOCIATED WITH CONTINUAL IMPROVEMENT

4.1. Organizational foundations

In order to fully use the guidance in this publication, it is necessary that the organization have a process-oriented approach to the management of its activities. There are several basic organizational systems, structures and roles that provide a firm foundation for the effective implementation of continual improvement. If these basic foundations are not in place, or are deficient, effective implementation of a continual improvement programme will be made more difficult.

The organizational foundations are:

- ***Leadership*** – See Section 3.
- ***Business planning*** – An integrated system of planning that ensures everyone is clear about their goals – from organization to individual level – avoids resources' being wasted on irrelevant activities. People's efforts and the organization's resources can then be focused on what really matters to ensure that sufficient resources are allocated to continual improvement. Continual improvement initiatives should be aligned with and supportive of the business plan of the organization in order to maintain a healthy balance between the present needs of the organization and those of its future.
- ***Accountability*** – Staff should be held accountable for discharging their continual improvement actions and for achieving milestones.
- ***Infrastructure-*** Continual improvement requires infrastructure – systems, resources and people as described in this section.
- Learning culture and organization – See Section 3.
- ***Teamwork*** – Continual improvement is as dependent on good teamwork as it is on specific techniques. Improvements can be accomplished much more easily if people are working together as a team.
- ***Project management*** – Developing and introducing process improvements through continual improvement requires that each improvement be planned and managed as a project using all the skills and expertise, tools and techniques of project management.
- ***Communication*** – Effective and diverse communication systems provide the linkage between all the steps of continual improvement. Without intensive communication, continual improvement efforts become poorly directed and isolated from the rest of the organization.
- ***Oversight and assessment*** – Continual improvement should utilize information from all types of management oversight, assessment, operating experience, proactive analysis (such as Appreciative Inquiry), reactive analysis (such as Root Cause Analysis), work observations, benchmarking, corrective actions, and other human performance improvement processes to help identify areas on which to focus attention and to determine priorities so that organizational resources might be utilized wisely.

4.2. Roles which enable Continual Process Improvement (CPI) programmes

Thus far, this publication has addressed functions in terms of either an organization or its senior leadership. Yet, effective continual improvement is most dependent on those

individuals who are closest to the processes and the work involved. This section addresses such persons and suggests how their individual and collective efforts could be organized and facilitated.

4.2.1. Example CPI programme structure

A number of common role and team approaches can be identified in organizations who have successfully implemented continual improvement. The role of top management has already been emphasized; however, adopting an appropriate mix of the roles listed below will assist in implementing continual process improvement (CPI) projects effectively. See Fig. 2 and the illustrative continual improvement structure and roles described thereafter in the text.

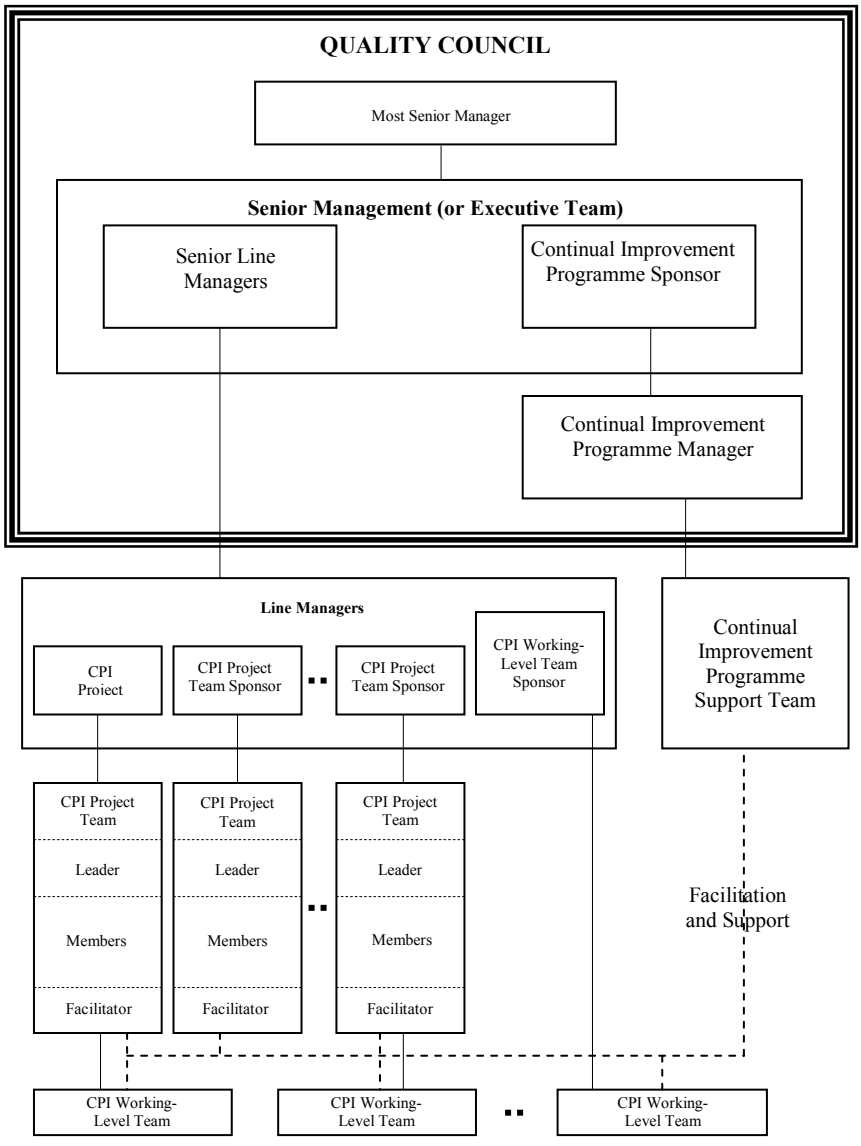

Fig. 2. Example of continual process improvement (CPI) organizational structure.

There are many types of continual improvement structures that could be established to implement an organization's continual improvement programme. However, for purposes of illustration, this publication describes roles and responsibilities for those involved in continual

improvement programmes structured similar to the generic one shown above in Fig. 2. and outlined below.

Example continual improvement structure and roles:

- Quality Council (or Steering Committee)
- Continual improvement programme sponsor
- Line managers
- Continual improvement programme manager
- Continual improvement programme support team
- CPI project teams
- CPI project team sponsors
- CPI project team leaders
- CPI project team members
- CPI project team facilitators
- CPI working-level teams.

4.2.1.1. Quality Council (or Steering Committee)

A Quality Council (or Steering Committee) should be established by top management to co-ordinate the leadership and implementation of the continual improvement programme. The role of a Quality Council (or Steering Committee) typically includes the following actions:

- ***Establish*** the goals of continual improvement programme in a manner that aligns them with the organization's goals. Examples could include goals like the following:
    - Improved safety performance;
    - Improved stakeholder satisfaction;
    - Reduced outage cost and duration; and,
    - Increased number of project teams and higher degree of staff involvement.
- ***Establish*** a charter for the continual improvement programme (see Annex IV for an example). The charter is a written document that explains the continual improvement programme and provides guidance for the following structural factors:
    - Empowerment of the Quality Council (or Steering Committee);
    - Criteria for the success of the continual improvement programme;
    - Rules for the overall continual improvement programme;
    - Description of the different teams and their composition;
    - Guidance for allowable participation incentives;
    - Guidance on reviewing and approving all projects, sponsors, teams and participants to assure appropriateness, consistency and quality of implementation;
    - Guidance on how to review and disposition CPI team recommendations; and,
    - Definitions for CPI terminology.
- ***Ensure*** that a training plan is produced for all staff in appropriate continual improvement training – including all managers and supervisors.
    - Identify ideas for an initial process improvement project that will:
    - Focus on a well-known and visible issue so many people will learn about CPI;

- Impact a relatively limited area that can be more easily addressed;
- Provide a high probability of early success; and,
- Serve as a good pilot project for how effective CPI can be and, thus, motivate others to adopt CPI as a way of doing business.

— ***Maintain*** management oversight and identify hold points beyond which the continual improvement should not proceed without management approval.

— ***Approve and prioritize*** CPI projects to ensure that resources are being used prudently and that the objectives of each CPI project align with the organization's needs.

— ***Effect*** widespread communication of the positive benefits achieved by successful process improvements including the impact of process changes on the organization and recognition of the teams and individuals involved in the projects.

— ***Ensure*** that the infrastructure to support the organization's overall continual improvement programme is developed throughout the organization.

As continual improvement programmes mature, the Quality Council (or Steering Committee) would be expected to consider and sponsor process improvements that will impact significant portions of the organization and its culture. Examples of the kinds of organizational-level process improvements that might be achieved through CPI projects include the following:

— Optimize staff resources through determining what tasks can be eliminated, reduced, or combined to reduce reliance on staff augmentation by external vendors.

— Optimize costs through determination of functions that can be outsourced to reduce net costs.

— Reduce reactor downtime by involving a broader cross-section of knowledgeable staff in the planning and preparation of outages.

— Maintain continuity of experience from one generation to the next through enhancing personnel development and succession planning.

— Streamline facility operations and maintenance through integrating its planning and scheduling functions.

— Achieve better long-range planning through considering a broad array of plant-life factors such as staff demographics, knowledge management, fuel configuration management, power-up rates, waste storage and disposal.

4.2.1.2. Continual improvement programme sponsor

The role of the continual improvement programme sponsor includes the following:

— Reports to the most senior manager;

— Serves as a member of the executive team;

— Serves as a member of the Continual Improvement Quality Council (or Steering Committee);

— Provides policy, strategic direction and leadership for continual improvement;

— Provides clear goals and expectations;

— Endorses the appointment of CPI project sponsors;

— Regularly attends continual improvement support team meetings;

- Mandates programme engagement throughout the organization;
- Assigns emergent items and projects for resolution or implementation;
- Monitors continual improvement effectiveness and compliance;
- Reviews continual improvement agenda and action plans; and,
- Resolves conflicts and disagreements related to continual improvement activities.

4.2.1.3. Line managers

Line managers have a very important role in process improvement projects and the potential impact they have is often greatly underestimated. Since they usually have a face-to-face daily link with the largest number of staff in the organization, their importance to process improvement is vital.

Line managers support continual improvement by:

- Being the link between the staff and management;
- Authorizing individual staff members to participate in process improvement teams;
- Being good communicators;
- Understanding and supporting management expectations and policy;
- Respecting the staff while communicating and implementing management expectations and policy; and,
- Practicing exemplary leadership.

4.2.1.4. Continual improvement programme manager

The continual improvement programme manager is appointed by the continual improvement programme sponsor to manage and support the overall continual improvement programme and to ensure that those working on process improvements follow the requirements of the process.

The continual improvement programme manager:

- Provides administrative control for the continual improvement programme including maintaining structure, organization, overview of CPIs and a CPI data base;
- Works with process improvement team sponsors, leaders, and the Quality Council (or Steering Committee) to identify potential areas of waste and organize teams to analyze these areas;
- Ensures that neither managers nor staff members have ‘hidden agendas’ of personal gain as they advocate improvement projects;
- Supervises the Continual Improvement Programme Support Team and, through that group, provides training and support for mangers and staff involved in CPI activities;
- Promotes enthusiasm for and confidence in the continual improvement programme through introducing and reinforcing CPI techniques at all levels of the organization;
- Utilize the performance indicators of the organization to determine the baseline from which the success of continual improvement will be measured (see Annex IX);
- Uses observation and coaching to ensure consistency and formality in implementation and evaluation of improvement projects;

- Communicates continual improvement successes and ‘lessons learned’ throughout the organization; and,
- Makes regular reports to the Quality Council (or Steering Committee) on successes, “lessons learned’ and the overall health of the continual improvement programme.

4.2.1.5. Continual improvement programme support team

The process improvement support team coordinates training and provides support in the practical application of process improvement skills as well as knowledge of the philosophy of process improvement. Training should be simple and customized for each part of the organization so as to provide a sufficient amount to ensure employee effectiveness without providing more information than is needed. Trainer presentations should focus on the practical application of process analysis, data collection, process mapping, waste quantification, and process formalization.

In the start-up phase of a continual improvement programme, the process improvement support team plays a vital role and is very active in advising, facilitating and motivating the process improvement project teams and the process improvement working level teams.

4.2.1.6. CPI project teams

Process improvement project teams are established to carry out process improvements that will impact a significant portion of the organization and/or the organizational culture. The membership of the process improvement project teams normally includes representation from all parties involved or affected by the process, including, contractors and suppliers. Members are also selected to provide a range of experience and skills relevant to the process as well as skills in the process improvement process. However, excessively large teams should be avoided as experience shows that teams with 6–8 members are more effective.

In organizations with more than one site, the CPI project team structure can include peer group teams that address process improvements in specific functional areas such as operations, maintenance, procurement, etc. An additional objective of these peer groups is to develop standard processes that can be implemented at all sites increasing consistency and, often, cost effectiveness. Such standard processes also make training, further improvement and benchmarking easier. (See Annex VI for an example of a peer group hierarchy)

4.2.1.7. CPI project team sponsors

No matter how small or large the team effort or potential for improvement, the team should have a management member as a sponsor. Sponsors are individuals at management or supervisor level that oversee the majority of the process improvement projects. A sponsor is a supervisor, superintendent, manager, director, or senior manager. Usually the larger the impact of the proposed process improvement, the higher in the organization the management representative should be.

For example, the sponsor of a team to reduce surveillances on a station air compressor would be in the maintenance department line management. A sponsor for a process change that involves a multi-department process improvement is usually in the line-management of the team leader. The sponsor is also an interface to top management and obtains the resources needed for implementing the improved process.

An excellent sponsor does the following things:

- Communicates a clear, measurable goals for the improvement;
- Communicates the purpose for and the boundaries of the improvement;
- Negotiates the participation of individual staff members in CPI teams with their respective line managers (after having received nominations from the CPI project team leader);
- Ensures that team membership (leader, facilitator, members) is matched to the task;
- Commits to providing necessary resources (i.e. time, money, and people);
- Ensures that the process improvement project is aligned with the organizational goals and objectives;
- Seeks and understands the organizational impact of the process improvement (i.e. understands the nature of resistance, encourages learning from mistakes);
- Seeks and understands the human impact of the process improvement (i.e. measures the capacity for undertaking the change);
- Is publicly supportive and reinforcing;
- Monitors progress and provides feedback – both positive and negative;
- Remains focused;
- Insists on clarity of decision-making authority and on process improvement roles and responsibilities; and,
- Ensures that the process improvement project is included in communications and participation mechanisms.

4.2.1.8. CPI project team leaders

The CPI project team leader:

- Should have excellent project management skills;
- Is directly involved in the process that is being analyzed for improvement;
- Identifies competent potential CPI team members and makes nominations to the CPI project team sponsor;
- Ensures the project implementation plan is prepared and achieved;
- Confirms the goals of the CPI project with the CPI project team sponsor;
- Coordinates the team member activities such as data collection, problem statement development, process mapping (as-is and to-be), quantification of waste;
- Is usually the spokesperson for the group and has a vested interest in successful implementation of the improved process; and,
- Develops an agenda for team meetings and runs them efficiently and effectively.

4.2.1.9. CPI project team members

CPI team members are nominated by the CPI project team leader to the CPI project sponsor who, in turn, negotiates their participation with their respective line managers. CPI project teams should include members who are:

- Experienced with the process being analyzed;
- Able to bring fresh ideas and thinking to CPI project team activities;
- Capable of providing the range of skills needed to carry out the project (for example accounting skills, safety, planning);
- Interested in and knowledgeable about the process being analyzed.

Data collection and communication with co-workers are important tasks of team members. Someone in the team is usually appointed to maintain records of team accomplishments and meeting summaries. This person also captures process improvements ideas and opportunities that are not within the team's scope that may be pursued by other process improvement teams.

Consideration should be given, where appropriate, to involving staff from contractors and suppliers as process improvement project team members.

4.2.1.10. CPI project team facilitator

Process improvement project team facilitators are often beneficial to teams to assist in maintaining focus and in the use of improvement tools. This is particularly true in the early stages of process improvements and when complex or difficult process problems are being tackled.

Facilitators can:

- Aid the development and quantification of problem statements;
- Ensure that teams focus on resolution of the problem statements;
- Provide observations and coaching when needed; and,
- Suggest suitable process improvement tools.

The facilitator is not an active part of the team but listens to the team presentations. The facilitator will often use open-ended questions to move the team forward; to steer it back on course to the subject under discussion; or, to focus the team on producing results.

4.2.1.11. CPI working-level teams

CPI project teams can initiate working level teams to tackle component elements of higher-level CPI projects. These types of CPI teams can also originate at the working-level. Line managers, supervisors or any member of the staff may set up a CPI working-level team to address process improvement opportunities within their areas of responsibility. These teams normally address a single work process and may be comprised of members from only one or from multiple work areas. While they do not need Quality Council (or Steering Committee) approval to address an improvement, they should have a line management sponsor who coordinates with the continual improvement programme manager the team's existence, objectives, progress, and results. Within the bounds of available resources, working-level teams are typically provided continual improvement programme support group assistance. It is important that such initiatives be reported, tracked, and trended.

It is sometimes felt that the smaller the team, the more efficient the effort. Therefore, the team membership should be concentrated on the essential skills needed to accomplish the particular

process improvement. As necessary, team members should actively seek expertise and input from those outside of the team through interviews and surveys. Once a working-level team's work is completed, it should submit a final report to the team manager of its CPI project team or, if it was created independent of a CPI project team, to the sponsoring line manager and to the continual improvement programme manager. The team should then be disbanded.

4.2.2. Factors in team management and dynamics

Care should be taken when establishing or changing team membership since team dynamics greatly influence results. Successful teams typically go through a number of stages of team development before becoming a high performing team. When new members are added, teams often have to cycle back to review issues previously resolved. When a team successfully arrives at the performing stage, there is a great sense of accomplishment.

The stages of team development are generally recognized as FORMING, STORMING, NORMING and PERFORMING [5].

Forming: When teams are organized, a number of needs and questions occur. Team members at this stage have high expectations as well as anxiety about where they individually fit as well as organizational parameters. 'Icebreakers' should be planned for the first few team meetings to facilitate the members' becoming better acquainted. Either the sponsor or the team leader should clarify expectations and the desired team outcomes.

Storming: In this stage, team members may rebel against each other and often against authority. Members may express disappointment with the lack of progress. They can feel angry about goals, tasks, and action plans. Team leaders should consider holding a retreat away from the normal work environment to allow team members to address their feelings and concerns with the group. Changing the team's membership or the scope of the project can often refocus and invigorate the group. Expectations of group member behavior both in and out of meetings should be made clear. Training on consensus building and conflict resolution can help to alleviate tension and create teamwork.

Norming: If teams successfully resolve the 'storming' issues, they will have reached this stage. Dissatisfaction should have been replaced by harmony, trust, support, and respect. Team members will have become more open and willing to provide feedback. Inviting a facilitator to work with the group can accelerate its work. Team norms should be monitored and updated regularly. Celebrating 'milestones' recognizing the team's work accomplishments can increase both morale and productivity. Additional training on meeting and group effectiveness could be helpful as well.

Performing: This stage describes a highly productive team. Team members work collaboratively and interdependently; show confidence in accomplishing tasks; share leadership responsibilities; and, perform substantive work. Take steps to ensure that the team continues to learn together. Sharing task responsibilities can engender respect for the capabilities of others and strengthen teamwork. Implementing strategies that influence how the group uses its time will increase its efficiency and effectiveness.

CPI team sponsors, leaders, and facilitators would be well advised to be aware of and sensitive to these sequential stages. Understanding the subtleties of these human interaction dynamics can help team leadership to anticipate and address phenomena that might otherwise seriously detract from a team's progress and have a detrimental impact on the team's results.

5. PERSONNEL CONSIDERATIONS ASSOCIATED WITH CONTINUAL IMPROVEMENT

It is important to create enthusiasm in the staff so that, ultimately, all employees will have the opportunity to become engaged in continual improvement activities. Initially, it is beneficial to identify those who have personally demonstrated the principles of process improvement to be the first staff to become involved in CPI activities. Staff involved in CPI should be trained in the tools and techniques appropriate to their needs. The senior management team should demonstrate high regard for those who are directly involved in continual improvement as well as those affected by changes due to CPI. It may be necessary to identify those who oppose continual improvement and to identify to either change their attitudes or to minimize their impact.

5.1. Impact on staff involved in continual improvement

Employees need to have confidence that participation in continual improvement is in their best interest. There are many intrinsic rewards including knowing that one's work knowledge and opinions are respected through implementation of process improvements.

It is also important to recognize that people who are involved in or being subjected to change go through a number of phases and that their need for communication, discussion, coaching and support at each stage can be quite different. Indeed, different individuals may need completely different management approaches. It is normal for stress levels experienced by staff to be raised during periods of change. This phenomenon can affect behavior and create a potential threat to safety and product quality. It is essential that all managers who are leading change initiatives take this into consideration, as it will help minimize problems during the change programme and result in a better organizational environment.

Section 4.2.2 presented the ways by which teams "come to grips" with the change process. But, it is equally – if not even more – important to have a sense of how individuals deal with change. One way of looking at the stages experienced by people during change is expressed in the statements listed below. This series of expressions reflects how change initiatives can actually change people's attitudes.

Denial – 'The reasons for the change are not happening, this does not affect me.'

Anger – 'Why are they forcing me to do this?'

Guilt – 'Why did I not realize this was needed? I have behaved poorly so far.'

Acceptance – 'I suppose it is the only way forward now.'

Involvement – 'It's not as bad as I thought. Now that I am taking part in the changes myself, things are getting better!'

Commitment – 'This is fantastic! I cannot believe that we have not been doing things like this before. I want to tell others about it!'

Further information related to interpersonal skills that can be used when dealing with staff is included in Annex VII. For the sake of long-term change, consistency and employee equity, it is crucial to manage the impact of process improvements on staff through staff review and career progression processes. Sometimes the results of continual improvement include

reductions, severance, and natural attrition (or, turnover) of staff. In these instances it is important to have plans and packages such as severance, retraining or redeployment for those who leave the organization. However, it is equally important to remember and provide for those that are staying within the organization; for, 'after the smoke clears,' those are the individuals on whom the organization depends to carry it forward into the future.

5.2. Recognizing staff for continual improvement success

Recognizing successes during continual improvement is an important way of reinforcing the new culture of the organization; but it also enables top management to demonstrate its support and commitment to continual improvement.

The selection of appropriate types of recognition should take major account of both national and organizational cultures. What may be seen as an attractive reward in one culture may be seen as trivial or ridiculous elsewhere. The organization should also be sensitive to what makes each individual feel appreciated. A particular form of recognition to one individual may be an embarrassment to another – even within the same organization. Individuals should be treated and recognized in a manner that makes them feel personally comfortable and genuinely appreciated.

The most underestimated (and frequently forgotten) way of recognizing the good contribution of staff is a simple, personal, 'Thank You' from management. This is as true at lower levels of management as it is from the uppermost levels of senior management. Peer pressure is universally recognized as one of the most powerful factors that influence an organization's culture. Accordingly, support and recognition from peers are extremely valuable reinforcers.

Recognition can be given through company news articles and by asking teams to present the success of their process improvement projects at company meetings and functions. Money, rewards and other gifts are appreciated; however, they should not be overused because they often do not have the same impact as peer and organizational recognition.

Rewards based upon the monetary savings of a process improvement may benefit employees; however, they can also be sources of discontent and jealousy between employees. Individuals not on the CPI team being recognized may feel slighted if they indirectly contributed key information to the CPI team's work but were not rewarded because they were not 'official' team members. Also, because of 'sphere of influence' to budget and production costs, not all individuals can affect savings to the same degree. For example, individuals performing clerical duties may not be able to eliminate waste and save money to the same amount as a programme coordinator with a large budget. Including CPI team participation into employee personal performance review and incentive bonuses has proven to be an effective reward.

There is also a need to recognize that interpersonal skills can help people to be more effective in continual improvement activities. Annex VII provides a brief description of some of the interpersonal skills that are typically used to support process improvement.

5.3. Openness and honesty

The goal of continual improvement is to identify opportunities, problems, inefficiencies, and waste and to initiate actions that address such conditions appropriately. Towards that end, creating an atmosphere of trust and fair treatment is essential to achieve meaningful continual improvement participation. People must feel secure and comfortable in identifying both unrealized opportunities and un-addressed problems. Personal or professional retribution must

neither occur nor be feared. Continual improvement is strengthened where there is a culture that promotes honest, open discussion in which both creative improvement ideas and potential waste and other problems can be identified. Such a culture allows teams to pursue projects in prime improvement areas – areas that earlier might have even been considered 'untouchable'.

6. THE STEPS OF PROCESS IMPROVEMENT

This section describes a methodology for a typical process improvement project. Annex I provides summaries of process improvement methodologies utilized by several nuclear utilities from Member States. Annex VIII provides some process improvement case studies from non-nuclear Japanese companies.

In considering the range of application of continual improvement methodology to enhance an organization's performance and product results, ensure that 'missed opportunities' are not inadvertently created by only applying CPI techniques to *reactive* situations as historically has been the case in the nuclear industry. It has been said that the nuclear industry 'drives its vehicle' by only looking through a rear-view mirror. While it is imperative that abnormal and undesirable events be closely examined to determine causality in order to prevent recurrence, the vast majority of activities at a nuclear facility on a given day are done properly and, in many cases, exceptionally well. Therefore, it only makes good sense to be on the lookout for activities that are usually done so well that they go unnoticed and become taken for granted. Success breeds success. The application of continual improvement methodologies such as appreciative inquiry and benchmarking in a *proactive* manner can often reveal surprising opportunities internal to the organization that warrant consideration of transferring good practices to areas other than those where they are being used effectively but without fanfare. Therefore, do not restrict the application of continual improvement methodology to 'problems' – identify, praise and spread the countless things that people do well every day (and night).

Staffs carrying out process improvements need to be properly trained and supported in using appropriate tools and techniques. (Annex II briefly describes some commonly used process improvement tools.) There are many tools available for assisting in process improvements; however, it is essential that the appropriate ones be utilized for the particular improvement opportunity or performance problem being tackled. Therefore, a flexible technique system is needed which neither focuses on using a single tool nor prevents alternative, more suitable tools from being adopted. Improvement tools can help in analyzing processes; in eliminating process waste and variability; and, in standardizing processes, procedures and management systems. All continual improvement tools and techniques are not equally effective for all situations. Avoid overuse or, worse yet, misuse of favorite tools and techniques.

Figure 3 shows the steps in a typical process improvement project. Each step is described in detail in this section.

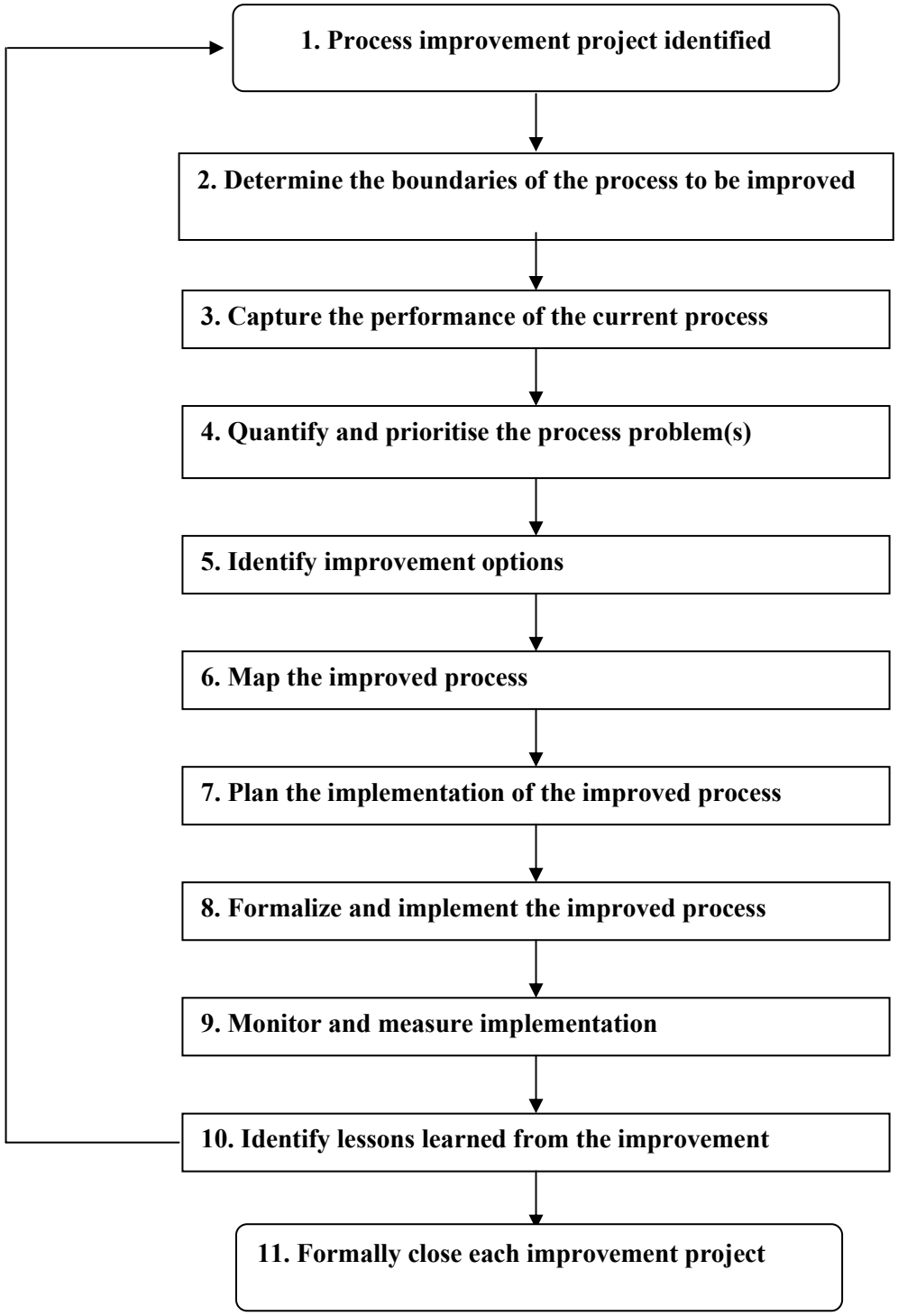

Fig. 3. The eleven steps of a continual process improvement project.

6.1. Step 1 – Process improvement project identified

At this step, the individuals and groups described in Section 4.2.1 should be considered. The overall process improvement goals should be agreed upon by the CPI project team sponsor and the CPI project team leader before seeking the approval of the Quality Council (or Steering Committee) to proceed with the project.

6.2. Step 2 – Determine the boundaries of the process to be improved

The scope of the process to be improved should also be agreed to by the CPI project team leader and the CPI project team sponsor. In some cases, the scope of the process improvement project may be limited to a part of a current process rather than including the entire process. Therefore, it is necessary to define the scope of the process to be improved; the customer of the process who is influenced by process improvement; and, who uses the output of the process. The terms of reference (See Annex V for an example of a typical Terms of Reference) for the process improvement project team should be developed and agreed upon by both the CPI project team leader and the CPI project team sponsor. A high-level map of the process may help with understanding the scope of the process improvement project.

6.3. Step 3 – Capture the performance of the current process

The team should produce a more detailed map of the 'as-is' process to facilitate an accurate understanding of the current process.

The process improvement project team should collect data on the current performance of the process to be improved. This enables the team to quantify the performance of the process from various viewpoints and to develop a problem statement. It is necessary to understand the current effectiveness of the process to identify potential improvements. It is important that the team seek out the views of the customers and suppliers of the process regarding process and product/service performance.

An early step should include analysis of the work within each process to determine its value to the organization. The work within a process can be categorized as follows:

- Value-adding; and,
- Non-value-adding.

6.3.1. Value-adding work

Value adding work produces or delivers a service or product for which a customer in some form or other is prepared to pay. A sequence of value-adding processes is often referred to as the value chain.

6.3.2. Non-value-adding work

Non-value adding work is work for which the customer normally does not want to pay (but may have to due to organizational or regulatory requirements). In the course of the analysis, the work in question may be deemed 'necessary' or 'unnecessary'. The former type of work should be minimized and the latter type of work should be eliminated.

6.3.3. Definition of process waste

Process waste can be illustrated by the following examples:

- Defects (faulty products, rejects, reworks)
- Overproduction (producing more than customers want)
- Over-processing (providing greater quality than customers want to pay for)
- Transportation (movement of raw materials, work in progress, or product)

— Inventory (warehousing, checking, financing)
— Motion (movement of people, machine or documents not adding value to the product)
— Waiting (time lost by people, machines, or items between steps in the process).

6.3.4. Definition of process variability

Variability in process performance and, hence, in process output reflected in product quality, can arise from the process itself (including unclear expectations and inadequate procedures); from inputs to the process; and, from other 'up-stream' conditions. The inherent variations in the characteristics of a number of process inputs may combine to make reliable control of the process output impossible to meet. Generalized sources of variability include:

— People
— Material
— Methods[4]
— Measurement
— Technology and equipment
— Environment.

Further details regarding the sources of process variability are provided in Annex III

6.4. Step 4 – Quantify and prioritize the process improvement possibilities

Data is gathered to identify opportunities, quantify problems, measure results and provide information to enable situational and trending analyses to be carried out using tools and techniques appropriate to the improvement initiative. For opportunities to spread 'good practices' and investigate the feasibility of creative and innovative ideas, it is important to determine the necessary and sufficient conditions for the practice or new idea to 'take root' and flourish. For performance problems, it is essential to understand the true causes of the problem to ensure that adequate interventions and improvement options are identified.

There may be some organizational performance indicators in place to enable the overall impact of the improvements to be determined (old process vs. new process). It is important that the process improvement project team conducts the right amount of analysis to understand the situation. (For instance, it must be recognized that practices that succeed in one environment may well not produce similar results in different environments; and, it is rare indeed for a given problem to have only a single 'root cause'.) Since analyzing a situation is usually easier than developing viable forward-paths, teams tend to spend a lot of time on analyses that are of little or no value.

A CPI team should define measurable criteria for success for each improvement and determine a clear, quantifiable project statement. Project statements should:

[4] Processes may need analysis to establish if they are capable of meeting customer or process requirements. For example, a tight specification on a machined component may be impossible to meet reliably if the machine being used is not capable of working to the required tolerances.

— Avoid causal terminology (e.g. ‘due to’, ‘lack of’, ‘insufficient’);
— Include quantification (e.g. time, money, hours, events, occurrences, dose rates);
— Link to at least one existing process; and,
— Exclude proposed solution options.
— Examples of poor problem statements:
— Reactor disassembly wastes time due to insufficient training. (not quantified, implies cause)
— Implementing a new work control programme will reduce work order backlog. (not quantified, implies solution)
— Lack of resources results in 115 reports a year. (implies cause)
— Examples of good problem statements:
— Performing quarterly surveillance of station air compressors takes 32 person hours a quarter (128 person hours a year) and results in 9 millirem exposure (36 millirem per year).
— Approval routing time for an operating procedure is 93 days.
— Over a one-month period, maintenance staff waste up to 30 minutes per maintenance activity (600 maintenance activities per month) waiting for operators to complete isolation work.

6.5. Step 5 – Identify improvement options

In this step, the CPI project team identifies options to correct true causes of process problems or to seize improvement opportunities. The process improvement team should develop potential improvement options that:

— Meet the goals set for the project;
— Attack verified true causes or focus on particular aspects of good practices or ideas;
— Meet customer requirements;
— Deliver value to the organization; and,
— Take into account any constraints such as regulatory requirements.

A record should be kept of the analysis of all potential options so that options considered but rejected can be understood if the process is revisited. Action words should be used to define improvement options similar to the following examples.

— *Eliminate* a task that is no longer needed such as preventative maintenance on obsolete installed equipment.
— *Reduce* surveillance time by using performance history to extend frequencies.
— *Transfer* tasks to more cost-effective employees.
— *Change* working hours from five days to four days.
— *Combine* tasks into one evolution such as valve and actuator motor maintenance.
— *Rearrange* work to better fit scheduled resources.
— *Simplify* the method used for fire protection equipment inspections.

For improvement options, SMART objectives [6] should be established to make sure there is sufficient clarity. Accountability for the accomplishment of CPI team objectives should be assigned in conjunction with cognizant line managers. (The CPI project team sponsor can be particularly helpful at this point in the process.) These objectives will be monitored and measured as the improvement project proceeds. SMART objectives are:

- Specific target outcomes
- Measurable in terms of success
- Achievable in that they can be implemented and there are sufficient time and resources
- Relevant to the vision, goals and business plan of the organization
- Timely in that it is known when the objective should happen.

Where appropriate, consideration should be given to developing partnerships with other organizations to generate improvement opportunities and to establish processes that cut across organizational boundaries more effectively.

6.6. Step 6 – Map the improved process

This publication does not seek to set down any protocol or definition of process maps as they can vary from organization to organization. Teams should endeavor to identify ideal processes but they need to recognize that there may be some constraints preventing immediate adoption of seemingly ideal situations. In this case, implementation should focus on an improved process that makes significant progress towards the ideal. This leaves the team with an option to return later to make further improvements. The team should map improved processes so that the changes can be easily identified when compared to the current process. Mapping of the improved processes can take place in an earlier step if it is more logical to do so.

6.7. Step 7 – Plan the implementation of the improved process

At this step, the implementation of the improved process should be fully planned and resourced using project management techniques to manage each improvement. At this stage, the need for a pilot or trial for each improvement project may be considered. Development of a documented project plan enables challenges to the proposed project to be made. The rigor and extent of project management, risk, and communication planning will depend on the scale and scope of the CPI project.

Each major activity of the project plan should be identified and then broken down into tasks and responsibilities with any dependencies between tasks identified. Each activity should be scheduled into a timeline and sequenced in a logical manner (sometimes referred to as a critical path network). Once the activities are logically set out, it is possible to analyze and identify areas or timelines where delays may be introduced.

The skills and resources (equipment, people, and money) necessary to implement the improvement should be identified in the plan and sought from those controlling the resources. The plan should also identify any training needs for the improved process. Any budgetary constraints should be taken into account.

An effective communication plan that includes both formal and informal communications should be developed for each process improvement. Different types of communication may be required for the different groups affected by the improvement. All messages should be

carefully coordinated to assure that the right people hear the right information at the right level of detail at the right time and before they find out by hearsay or gossip.

The team should also strive to identify all the risks associated with implementation and develop a risk management plan including risk assessment/mitigation activities for each improvement. These risks can come from various sources such as business, regulatory, human resources, workforce representatives and society.

6.8. Step 8 – Formalize and implement the improved process

The improved process should be fully implemented only after all supporting documentation has been formalized and is in place. Process changes may be formalized in documents such as procedures, policies, work orders, training programs, and guidelines.

The improved process should be given to the process owner for implementation. The process owner should ensure that staff are competent; understand the improved process; and, support the implementation. In addition to pilot projects as mentioned earlier in this publication, organizations should strongly consider the merits of running both old and new processes in parallel until the new one is proven to be acceptable.

6.9. Step 9 – Monitor and measure implementation

It is essential to monitor and review the implementation of process improvements using the previously identified performance measures to demonstrate successful implementation. A common problem is that a lot of time and effort is expended to conduct analysis and identification of the improvement. However, inadequate attention is often paid to ensure that implementation is fully effective and to ensure that all the projected benefits are achieved. It may be necessary to conduct assessments (self and independent) of the improved process as a form of monitoring.

The SMART measures for each improvement that were identified earlier should be monitored to ensure that the targets are achieved. It is important to measure actual results and to compare them to expected results. Checks should also be carried out to ensure that the goals and objectives contained in the terms of reference have been realized.

Trending data for adverse and positive trends resulting from the implementation of the improvement is necessary to monitor process improvements and to ensure that there is a positive rather than a detrimental effect on the organization's high-level performance indicators. If a detrimental effect is observed, then implementation should be reconsidered. This may result in repeating steps of the process.

6.10. Step 10 – Identify lessons-learned from the improvement

The lessons-learned from implementing each process improvement project should be examined and analyzed to identify problems/difficulties/successes so that the lessons-learned can be utilized to ensure the success of other process improvements projects. The learning can be applied by capturing the improvements in revised documents or by replication.

This learning gained from each process improvement project should be considered by the continual improvement programme manager for input to the overall review and improvement of the continual improvement programme as described in Section 2.8 of this publication. This

is intended to ensure that learning is used to improve the continual improvement programme and the process improvement methodology adopted by the organization.

At this step, it is also relevant to identify any other potential improvements that could be made to the improved process. This is particularly relevant where the improvement that has just been implemented has only been applied to a small part of an overall process. The new improvement opportunity should go through all of the steps in process improvement. Also, it should be acknowledged that an improved process could in time be the subject of further continual improvement. For example, the planning aspects of an Outage Management Process could be improved; and, then – at a later date – isolation scheduling could be the subject of a further improvement.

6.11. Step 11 – Formally close each improvement project

One way to reduce management workload is to ensure that each process improvement project is formally closed down when it has been fully implemented and the lessons-learned have been applied. Process improvement projects should be formally closed to demonstrate to staff that the improved process is now part of normal operations. The process improvement project team leader of each project will require excellent interpersonal skills to ensure a fair and smooth reassignment of project personnel to new tasks or back into the line.

The CPI project team leader should:

- Appraise team members of their performance
- Celebrate success of the project (or explain disappointments or surprises)
- Reward and recognize team members in a manner that they want to be rewarded
- Ensure that each team member has been reassigned
- Produce and agree to a final project report to be signed off by the sponsor
- Communicate completion to the organization
- Finalize the housekeeping such as filing, invoices, records, release of assets, etc.
- Ensure any follow-up actions or assessments are implemented.

7. CONTINUAL PROCESS IMPROVEMENT SUCCESS

It is important to publicize wins and successful improvements throughout the organization by using established communication media. This provides confidence in the CPI programme and encourages staff to participate in future improvement opportunities.

Activities that can aid the celebration of success include:

- Sharing the success with peers using devices like CPI bulletin boards that display the project details;
- Announcing the success in company meeting and gatherings;
- Placing an article in the organization’s newsletter or other communications; and,
- Publicizing successful process improvement projects at internal or external best practice conferences/seminars.

- The organization's website/intranet may also be used to display and communicate process improvement activities. This could include:
  - The process improvement projects;
  - The process improvement support team composition and contact details;
  - Information on the status of process improvement implementation;
  - Process improvement methodology, guidelines, procedures, etc.;
  - Database of improvements and best practices; and,
  - Performance indicators that measure the progress and status of each continual process improvement project such as:
  - Analysis of the current status
  - Definition of the as-desired process
  - Determination of the areas for improvement
  - Development of process improvement options
  - Implementation plan status.

Success should be considered as a foundation for improvement that will empower and motivate staff to identify further improvement opportunities and to quantify and eliminate waste. **Success breeds success.**

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[5] CONWAY W.E. The Quality Secret: The Right Way to Manage, Conway Management, Nashua, New Hampshire, USA (1992).

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ANNEX I. PROCESS IMPROVEMENT METHODOLOGIES

Though there are many different approaches used for continual process improvement (CPI), this annex provides specific examples currently being implemented in some Member States.

I-1. TEPCO – JAPAN

In TEPCO the following 10 steps outline the process improvement methodology:

Step 1: Determine the boundaries of the process that requires improvement, Organize, Capture "as-is" SIPOC (Suppliers, inputs, process, outputs, customers).

Step 2: Benchmark the process against industry "Best Practices". - Set goals.

Step 3: Capture the current "as-is" process.

Step 4: Map any sub-processes.

Step 5: Capture issues with the current process "Brainstorm".

Step 6: Prioritize the issues.

Step 7: Create metrics/measures.

Step 8: Create schedule and assign responsibility for each issue, determine the root cause & potential correction plans.

Step 9: Create the "to-be" process diagram & SIPOC.

Step 10: Implement improvements & measure effectiveness.

Step 1 Define the scope of the process to be improved, identify the customer of the process, who is influenced/affected by process improvement and the output of the process. Consider the added value to be produced by the process improvement. SIPOC is a strong but simple tool to support the Step 1. (See Fig. I-1.)

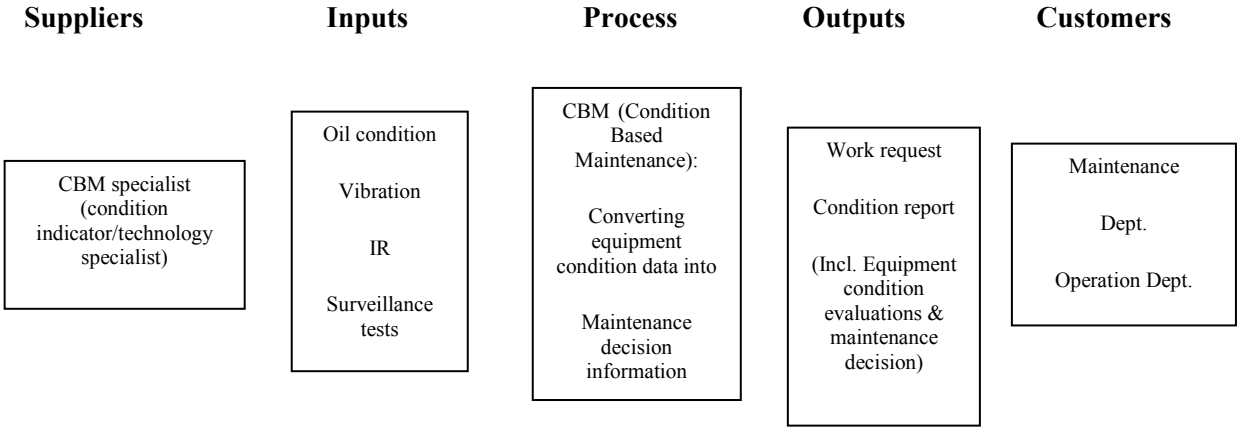

Fig. I-1. SIPOC example.

Step 2 is the benchmarking process which can be defined as a comparison of business processes to identify industry best practices and set goals that lead to improved performance. The organizations to benchmark against could be any other utilities and industries all over the world. The activity must be systematically prepared, in other words our own processes must be sufficiently understood in advance, e.g. process owner, process customer, key performance indicators and their trend, current issues, etc.

Step 3 and 4 are the process mapping. It is an effective way to gain a thorough understanding of a process's steps and to see the process as it actually is, not just as people think it exists. It is important that the process map accurately reflects the process in order to determine the focus for your improvement efforts. Therefore, it is necessary to confirm the steps in the process, or validate your process map, to eliminate the risk of addressing problems based on assumptions rather than facts. Constructing maintenance process maps is a team effort, and selection of team members for this activity should be done carefully. The key is to recruit people who have the required knowledge.

In **Step 5** it is important to capture the issues based on as-is process and /or as-is SIPOC reflecting facts, though the tendency for the involved personnel to assume anything, which would not be logically supported, is often seen.

In **Step 6,** many ways can be used to prioritize issues. For example the 10000-yen investment by each member of process improvement team is one way to do it. The issues are prioritized depending on the total amount of invested money. Though it seems to be disorganized, it could usually lead us to reasonable prioritization that would be supported by all the members.

Step 7 is the process in which metrics/measures are developed to visualize the issues and measure the effectiveness of countermeasures. Those metrics/measures must be closely linked with the processes to be analyzed.

Steps 8 through 10 are the steps in which specific and deep analysis is implemented and solutions and detailed implementation plans are developed. People tend to conduct analysis well and energetically but face difficulties/resistance when they try to implement improvements. The tools that aid overcome the identified difficulties/resistance include potential risk analysis, communication plan development, human resource management, training requirement/plan identification, detailed scheduling, miscellaneous detailed considerations must be carefully monitored.

I-2. BRITISH NUCLEAR FUELS plc. – UNITED KINGDOM

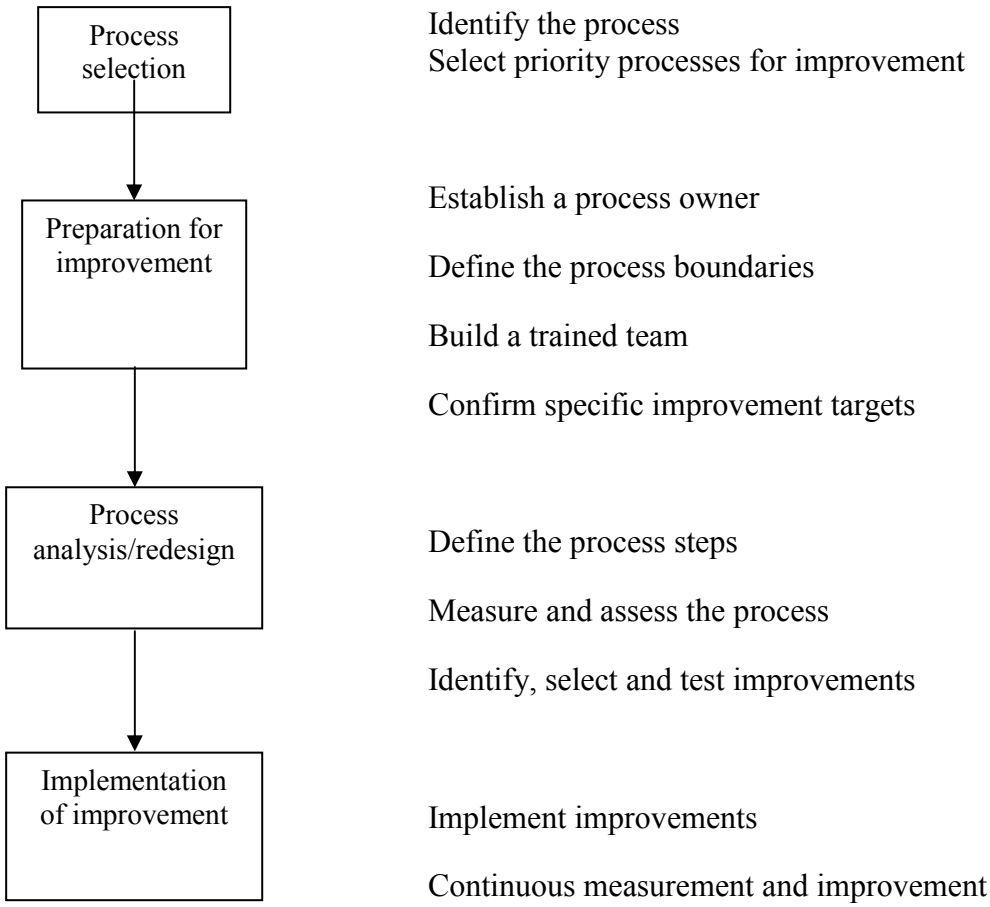

Fig. I-2. Example of process improvement methodology.

I-3. BRITISH ENERGY – UNITED KINGDOM

The following outlines the seven-step process successfully used by British Energy to manage its approach to continual process improvement.

Step 1 – Identify a process and the reason to work on it to work on.

Step 2 – Select a problem and set a target for improvement.

Step 3 – Identify the root cause of the problem.

Step 4 – Plan and implement the countermeasures to correct the root cause of the problem within the process.

Step 5 – Confirm the problem and its root causes have been decreased and the target for improvement met.

Step 6 – Standardize the process and implement it across the organization.

Step 7 – Plan any further actions.

I-4. ENTERGY CORPORATION – UNITED STATES OF AMERICA

The following charts depict the Entergy continual improvement programme.[5]

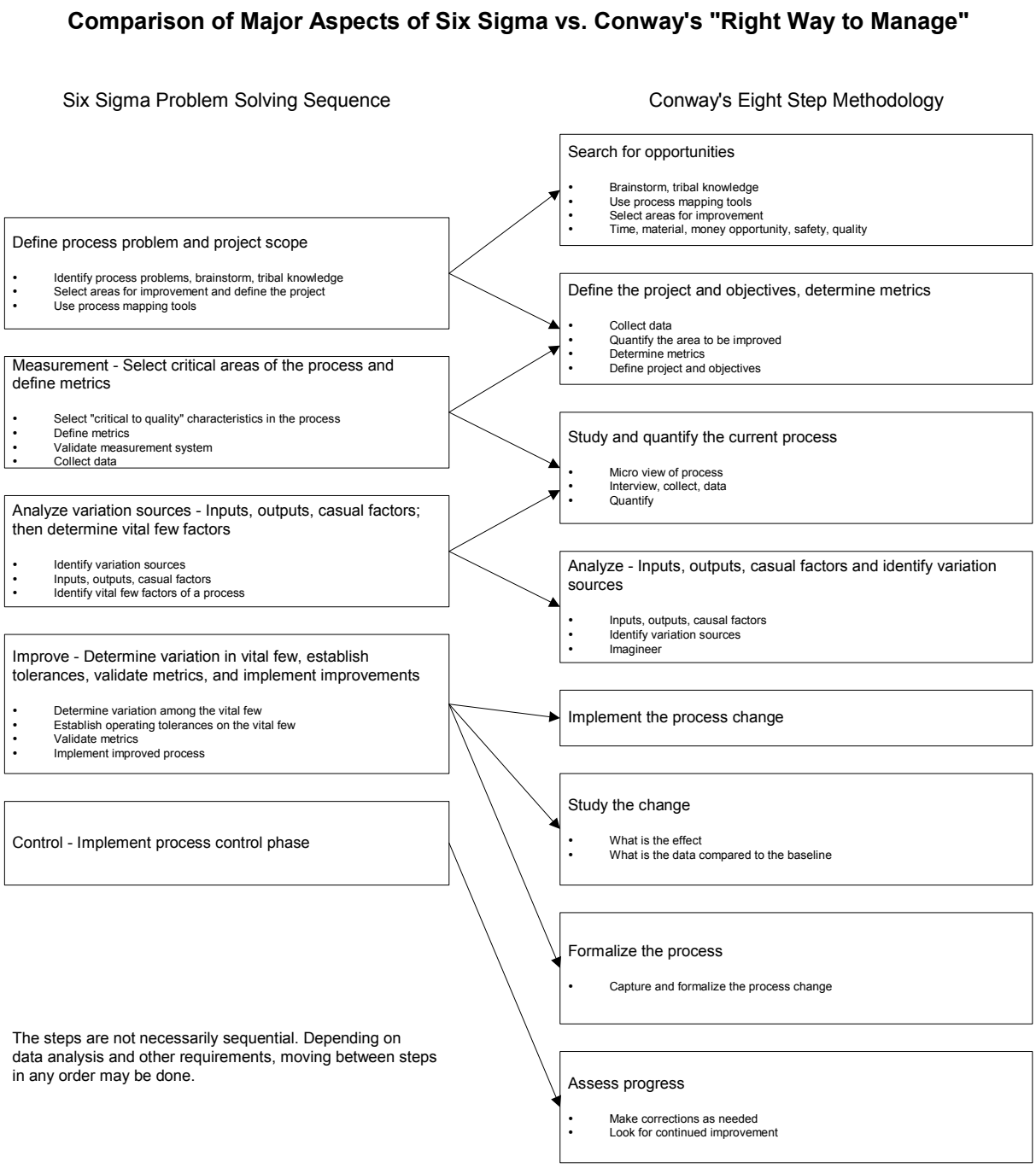

Fig. I-3. Comparison of Major Aspects of Six Sigma vs. Conway's "Right Way to Manage".

[5] This program employs techniques and methodologies from Bill Conway's *The Quality Secret: The Right Way to Manage* and Six Sigma.

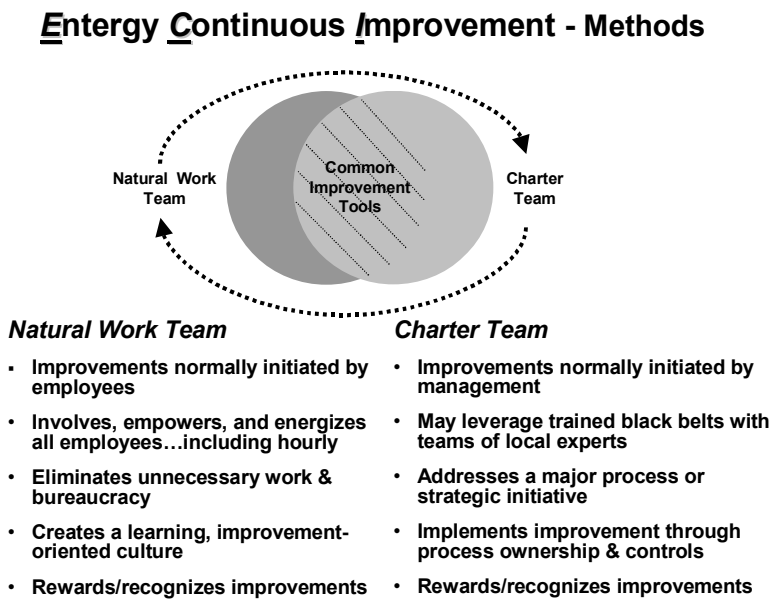

Fig. I-4. Entergy continual improvement – Methods.

ANNEX II. PROCESS IMPROVEMENT TOOLS

The following improvement tools are available in the public domain. The list represents the tools commonly used in process improvement. Staff participating in continual improvement projects should be trained in the use of these tools as appropriate. There is a plethora of literature in the public domain that explains how to use each tool. The tools should be selected for use to aid the activities described in each step of the process improvement project. Some tools can be used at more than one step.

Affinity diagram – Affinity Diagram is a tool for looking at patterns and for grouping and summarizing ideas. It is also known as the silent sorting technique, and is most commonly used at the end of a 'brainstorming' session where many disparate thoughts have been collected.

Appreciative inquiry – Appreciative Inquiry (AI) is an increasingly popular proactive technique by which an organization's strengths and potential are identified through employee interviews focused on what is working well in a particular area of the organization. Considerations are then made concerning whether and how to transfer internal good practices and creative ideas to other areas of that organization.

Benchmarking (internal and external) – The purpose of benchmarking is to improve our own performance. To do so, we must first understand our own customers; our own processes; our own organizational structures; and, our own culture in which all these things exist. It is with this knowledge that we are ready to seek to learn how others perform well. Once we have learned how others do well, we can adapt what we have learned to improve how we perform. Benchmarking itself provides us with a proven methodology for learning – learning about ourselves and learning about others. Benchmarking is a methodical process involving careful research and an understanding of our own processes, products and services. This process helps us to gain the information needed to determine what needs to be improved; to obtain critical management support for improvement; to identify those who perform well; and, to incorporate what we have learned to change our performance for the better.

Brainstorming – Brainstorming is way of developing many creative possible solutions to a problem. It works by focusing on a problem, and then coming up with very many radical solutions to it. Ideas should deliberately be as broad and odd as possible, and should be generated as fast as possible by all participants. During brainstorming sessions there should be no criticism of ideas. Brainstorming is trying to open possibilities and break down wrong assumptions about the limits of the problem.

Barriers and aids analysis – This tool helps pinpoint the elements that are pushing for improvement (aids) and those which are resisting the improvement (barriers). It is used to develop strategies to overcome the barriers using the aids identified and also to help understand which aids might need to be sustained.

Bar charts – Bar Charts, like pie charts, are useful for comparing classes or groups of data. In bar charts, a class or group can have a single category of data, or they can be broken down further into multiple categories for greater depth of analysis.

Cause and effect (Fishbone) diagrams – A cause and effect diagram is a picture composed of lines and words in a fishbone design to represent a meaningful relationship between an effect (problem statement) and the potential causes in terms of people, methods, machines,

material, and environment. The 'Five Whys' technique can used to discover causes (see below).

Check sheets – A check sheet is simply a form on which categories of information and the number of occurrences of each category is collected systematically and recorded in a uniform manner to aid analysis.

Control charts – A control chart or 'run chart' is a moving picture of the variation of a process achieved by plotting the key parameters of a process and plotting them over time. It is a graph that plots a variable over a period of time making it easier to visualize what is happening in a process and helps detect trends and shifts in the average level of a process. It can also be used to indicate when a process variable is reaching a predetermined limit.

'Five whys' – This simple technique is used to identify the real issues behind a problem. An initial question is asked and the question 'why' is asked following the initial response and the four subsequent responses.

Flow chart (Process map) – A process flowchart is a map of a process that is simply a graphical way of representing the process flows and activities through a process using common symbols. It is used to document processes and helps analyze and standardize a process and plan improvements. It is a communication tool to aid understanding of the process.

Failure mode and effects analysis (FMEA) is a systematic approach that identifies potential failure modes in a system, product, or manufacturing / assembly operation caused by design or manufacturing / assembly process deficiencies. It also identifies critical or significant design or process characteristics that require special controls to prevent or detect failure modes. FMEA is a tool used to prevent problems from occurring.

Gap analysis – Gap analysis provides a detailed breakdown of both the qualitative and quantitative aspects of the difference between 'what is' and 'what is desired'. Such analyses are also sometimes used to reflect how much a given organization's performance differs from that of its competitors or from the organization's own vision.

Gantt project timeline charts - The Gantt chart offers a graphic display of activity durations illustrating time lines for proposals and projects. Sometimes referred to as a 'bar chart', it lists activities and other tabular information on the left side. Activity durations are shown in the form of horizontal bars on the right side of the chart, with time intervals over the bars.

Histogram – A histogram is a bar graph that shows the spread of variation; where it is centered; and, the shape of distribution. It shows measurement data distributed by categories.

Lean manufacturing – Lean manufacturing is a technique focused on removing waste from processes and systems of processes. It is based on the principle that you only do what you need to do to meet customer requirements; throughput times are kept very short; work in progress is minimized; and, there is little queuing between stages.

Matrices – There are many types of matrices. Typically, they are simple graphical frameworks or charts used to help organize and identify what to work on by insertion of relevant data in labeled cells and then weighting activities or proposals using rating scales tied to particular criteria (e.g. impact on the business, value for money, ease of implementation, and impact on regulatory requirements). Matrices aid comparisons that focus on key factors.

Mind mapping – The 'Mind Map' is an expression of 'Radiant Thinking'; and is, therefore, a natural function of the human mind. It is a powerful graphic technique that provides a universal key to unlocking the potential of the brain. The 'Mind Map' can be applied where improved learning and clearer thinking will enhance human performance. The 'Mind Map' has four essential characteristics:

(a) The subject of attention is crystallized in a central image.
(b) The main themes of the subject radiate from the central image on branches.
(c) Branches hold a key image or word printed on the associated line – details radiate outward from the respective lines.
(d) The branches form a connected nodal structure.

Pareto – A Pareto chart is a type of bar chart that organizes data to show what the major factors of the subject being analyzed are. It is a search for significance. The basis for Pareto is the '80-20 rule' – 80 percent of problems result from 20 percent of the causes.

PDCA – The 'Plan-Do-Check-Act' cycle is the foundation for continual improvement and can be applied to the development or improvement of any process. 'Plan' represents the need to think through exactly what you are going to do before you do it. 'Do' represents the undertaking of the activity that has been planned and to ensure that it happens as planned. 'Check' represents the need to review the results and impact of the activity in an objective and analytical manner. 'Act' represents the need to make changes to future plans in order to incorporate the learning from 'Check'.

Process decision programme chart (PDPC) **–** Is very similar in many ways to the Tree Diagram, but is specifically intended to look at all the decisions and uncertainties that exist in moving from the current situation to the intended future, and to look at all the possible outcomes and the contingencies for those that are unwanted. The PDPC can be used to extend the tree diagram to look at what can go wrong in all the detailed activities and to plan how such problems may be avoided or overcome. This can be done for all areas or, more appropriately, can be focused on areas that are particularly important or risky.

Root cause analysis – Root cause analysis is a tool that helps to identify what, how, and why something happened, thus allowing an organization to rectify conditions in hopes of preventing recurrence. Root cause analyses seek to discover underlying, often systemic, causes of undesirable events. A common error in conducting such analyses is to assume that there is only one root cause for a given event. Quite to the contrary, single root causes are rare and analysts are cautioned to not cease the process too rapidly upon discovery of what appears to be "the" root cause.

Scatter diagram (correlation chart) – A scatter diagram is a graph that shows the relationship and distribution between two variables in a process. It supports insights into the cause and effect relationships, which may be responsible for variations in performance.

Six Sigma – Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects (driving towards six standard deviations between the mean and the nearest specification limit) in any process – from manufacturing to transactional and from product to service.

SWOT Analysis – An effective method of identifying the **S**trengths and **W**eaknesses of a process and to examine the **O**pportunities and **T**hreats presented thereby. Carrying out such

analyses is often illuminating – both in terms of pointing out what needs to be done and in putting problems into perspective.

Total Quality Management (TQM) – TQM is a tool used to enable better customer satisfaction, lower costs, eliminate waste and reduce cycle times through the use of data collection and process mapping.

Tree diagram – The Tree diagram is a tool used to explore exactly what needs to be done in order to achieve a goal. The tree starts at the left with the goal to be achieved, and then branches to the right into progressive levels of detail as to how each objective and task breaks down into more detailed objectives and tasks.

Value stream mapping – A technique for mapping processes that helps to identify both value adding and non-value adding steps.

ANNEX III. SOURCES OF PROCESS VARIABILITY

Variability in process performance, and hence in process output reflected in product or service quality, can arise from the process itself; from inputs to the process; and, from other "up-stream" conditions. These are discussed below.

III-1. People

Employees differ widely in their abilities, skills, knowledge, willingness to engage, vision, ethics, and perspective. Thus, when a task requires human input, variability will potentially be introduced. This variability can be addressed by improving the way people interact with work processes by introducing better controls into key stages of the task; by redesigning the process tasks to reduce the probability of errors; and, by automating the work process wherever it is feasible. A wide range of human factors techniques can be used to improve interactions between humans and the processes and equipment with which they work.

III-2. Material

Differences in the characteristics of materials input to a process will introduce variability. Clearly material outside of specifications poses a major risk of poor process output that, in turn, can lead to failure to meet customer specifications. Over-specification can equally inject unnecessary costs.

Example: Safety-related fuel oil could be used for a power plant in-house heating system. However, this safety-related fuel is more expensive since it must meet strict specifications. This specification may be critical to the performance of safety-related plant equipment; however, it is usually not important for fueling an in-house heating system. The difference in cost between commercial grade fuel oil and safety-related fuel oil constitutes an opportunity to effect substantial monetary savings.

III-3. Methods

Methods for performing a given task can vary in complexity, costs, impact on equipment as well as on industrial safety, and quality. These variable aspects of methods offer opportunities to align the most appropriate methodology to the task at hand. Failure to do so can result in performance errors and increased costs.

Example: High Pressure Coolant Injection (HPCI) surveillance testing affords an example of how the choice of methods can make a difference. Operating HPCI in manual control for quarterly surveillance testing can save time, reduce personal exposure, and minimize challenges to plant equipment and primary containment.

Example: Use of a "full flow test valve" to adjust HPCI speed (3820 rpm) for quarterly in-service testing surveillance requirements stabilized HPCI speed at 3820 rpm and takes 20-30 minutes per surveillance. Furthermore, use of that method for surveillance requires that two auxiliary operators be exposed to a 15 mrem field. Making a process change to "manual control" instead of the "full flow test valve" speed reduces surveillance time to five minutes resulting in a 110 mrem savings per occurrence. Additionally, the shortened surveillance time reduces heat transfer to the suppression chamber and does not challenge either the technical specification maximum HPCI run time of 30 minutes or the suppression chamber water temperature limit.

III-4. Measurement

Variation exists between measurements. Differences in the accuracy of analog versus digital instruments constitute a form of variation. Accurate and consistent measurement may allow a power plant to operate at higher power levels without exceeding licensed power limits, thus increasing revenue. A site-glass is a common measurement tool used in many industries. Reading a site-glass can provide variations in obtaining measurements just due to the height of the person reading the instrument.

III-5. Technology and equipment

People using different technological devices and equipment to carry out the same task can introduce process variability. Also the capability of a piece of equipment needs to be matched to the demands of the product specification. For example, a machine tool capable of working to tolerances of +/- 0.5mm may be able to produce products requiring a specification of +/- 0.1mm but it cannot be guaranteed.

III-6. Environment

The environment where work is performed may vary depending on location. Instrument calibration can vary depending on plant conditions. Noise and ambient temperature may be different when a plant is operating as opposed to shutdown. These factors can influence worker comfort and time pressure thus impacting the performance of the surveillance. Resulting errors caused by uncomfortable environments are a source of rework. Other environmental sources of variation are working at heights; weather; wearing protective clothing and self-contained breathing apparatus; working in confined spaces; and, working on or under water. Minimizing work impacted by these sources of variation minimizes time and resulting re-work.

ANNEX IV. QUALITY COUNCIL/STEERING COMMITTEE CHARTER

This annex provides an example of a Quality Council charter. Note that it has an attachment on 'Criteria for Safety and Quality Team Successes.' Such attachments are often used by bodies like this to add clarity and intention statements without having to revise the entire charter.

PURPOSE

To establish a Quality Council to provide senior management leadership, oversight and coordination of the continual process improvement programme.

DEFINITIONS

Natural Work Team (NWT) (Process working level teams in the text of this publication)

- Addresses a single work process and is comprised of members of one to several departments.
- Does not need a quality council approved charter
- Usually originates at the worker level

Charter Team

- (Process improvement project teams in text of this publication)
- Multi-discipline membership
- Addresses a major process
- Usually originated by management
- Requires quality council approved charter
- Success determined by the quality council

PROCEDURE

The following personnel are members of the Quality Council:

- Site vice president (chairman)
- Director, engineering
- Director, nuclear safety assurance
- Director, communications
- Manager, transition
- Manager, continual process improvement
- General manager plant operations
- Manager, business services
- Manager, human resources
- Manager, training

A quorum shall be a minimum of five (5) members, including a chairman. The general manager plant operations or director of nuclear safety assurance will act as the chair in the absence of the site vice president. The Quality Council should meet at least quarterly.

CLARIFICATIONS

Continual successes will not be awarded simply because the same initiative has been applied multiple times. A process may be improved by another department only once for a continual improvement. Resolution of single issues of non-compliance with existing codes and standards is not considered a process improvement.

POINT CONTRIBUTIONS

Natural Work Teams (process improvement working level teams)

A Natural Work Team (NWT) success is awarded one point, unless it is a "Continual Team" success (a team that was once awarded a "success", and has made further improvements), in which case it is awarded two points.

A "Production" success which includes an increase in plant thermal or net output, or a savings of critical path time with written concurrence from the outage manager will be awarded four points.

A "Budget" success, which includes a current or future line item reduction to the budget resultant from a process change, will be awarded four points.

A "Safety/Quality" success, as outlined in Attachment I of this charter, will be awarded four points.

Charter Teams (Process improvement project teams)

A Charter Team success is awarded three points unless it is a "Continual Team" success (a team that was once awarded a success and has made further improvements), in which case it is awarded six points.

A Charter "Production Team" success (an increase in plant thermal or net output or a savings of critical path time with written concurrence from the outage manager) that results in a demonstrated savings of at least US$100 000 will be awarded 12 points.

A Charter "Budget Team" success which includes a current or future line item reduction of at least US$100 000 to the budget resultant from a process change will be awarded 12 points.

A Charter "Safety/Quality Team" success, as outlined in Attachment I, will be awarded 12 points.

Documentation

Documentation for all successes can include:

- A description of the process change,
- Quantification of savings or eliminated waste,
- How the change was formalized,
- Quantifiable performance indicators,
- A statement addressing safety impact of the change.

RESPONSIBILITIES

Quality Council

- Establish the criteria and documentation required to meet the continual improvement incentive goals and approve company performance measures.
- Advise teams in order to meet success criteria
- Award “successes” to teams that have achieved the criteria for a successful process improvement.
- Sponsor and sanction the formation of chartered teams.
- Provide the energy and create the belief in continual improvement principles by everyone in the organization

Managers/directors/superintendents

- Accountable for continual improvement initiatives within the department.
- Responsible for ensuring employee ideas are implemented via the continual improvement programme and methods.
- Develop a departmental culture where continual improvement becomes the normal way of doing business
- Identify and evaluate areas where waste can be eliminated.
- Provide the leadership, resources and sense of urgency to eliminate the waste in these areas.
- Provide the energy and create the belief in continual improvement principles by everyone in the organization

The manager, continual process improvement shall:

- Ensure that all employees receive appropriate training in continual improvement principles.
- Coordinate quality council meetings by establishing dates, agendas and issuing timely meeting notes.
- Track the success of all process improvement projects.
- Provide status regularly to the quality council and communicate status to employees.
- Oversee and mentor facilitator’s involvement in a team’s progress.
- Report quality council subcommittee awarded “successes” on a quarterly basis to the quality council.

Responsible Manager: _

Manager, Continual Process Improvement

Approved:

Site Vice President

Attachment I

Criteria for "Safety" and "Quality" Team Successes

PURPOSE
To establish criteria for continual process improvement successes based on Industrial and plant safety measures and quality measures. Successes must be the results of a formalized process change.

PROCEDURE

INDUSTRIAL AND PLANT SAFETY MEASURES

Industrial Safety: Significant process improvement in any of, but not limited to the following areas:

- Resolution of long-standing industrial safety issues as measured by trends of Event Reports, Observations, Injury Rates
- Reduction in Switching and Tagging issues
- Incorporation of applicable Operating Experience
- Reduction of hazardous chemicals
- Reduction of potential significant industrial safety hazards
- Reduction of contamiantion events
- Written approval by the safety supervisor is required for an industrial safety success.

Plant Safety:

Reduction in Core Damage Frequency (CDF)
Improvements in component or system availability by elimination of "risk" evolutions, or, means to do required work in a safer manner. Reduction on challenges to operators, emergency system actuations, forced power reductions, outages.
Written approval from the manager, system engineering is required for a success.

Regulatory: Improvement in regulatory margins/ performance as approved by the manager, nuclear safety assurance.

ALARA

Significant person-REM savings as approved by the manager, radiation protection.

QUALITY MEASURES

Equipment Performance – Significant improvement in (but not limited to) the following areas:

- Improvement in component or system availability.
- Reduction in percentage of failures identified in tests/ surveillances.
- Reduction in the number of limited condition of operations routinely entered

- Incorporation of applicable significant Operating Experience that results in a demonstrated equipment performance improvement.
- The above equipment performance successes must also be approved by the manager, system engineering.

Rework

Significant elimination of rework as approved, in writing, by the manager responsible of the area where the rework was eliminated.

Human Performance (HU) Adverse Trend

Elimination of significant adverse HU trend is based on positive performance as demonstrated by error rate comparisons of before and after data and approved (in writing) by the HU manager

Procurement

Significant reduction in rejectable parts as demonstrated in a reduction of deficiency reports.

ANNEX V. TERMS OF REFERENCE FOR TEAMS

Typically the Terms of Reference or Charter for a process improvement team would include the following:

- ***Title*** – What the activity or project is called
- ***Sponsor*** – The person who has ultimate authority for, and budgetary control over the activities of the process improvement team
- ***Team leader*** – The person with day to day responsibility for the team
- ***Background*** – Brief description of the background to this particular activity or project
- ***Objectives*** - Description of target results
- ***Cost/benefit/risks*** – An outline summary of the costs, benefits and risks involved
- ***Resource requirements*** – Number of man-days, skills and money required
- ***Scope*** – The extent of the process to be improved
- ***Process customer*** – Who is the customer for the process and what benefits does he want and need.
- ***Process Owner*** – Who is the designated process owner for the process being improved
- ***Team members*** - A list of the team members and the facilitator
- ***Deliverables*** – Any specific deliverables for the project
- ***Constraints*** – Any specific restrictions or requirements that have to be taken into account –e.g. cost limits, regulatory requirements
- ***Milestones*** – Any specific decision points or interim deliverables
- ***Critical success factors*** – A description of the factors affecting success e.g. What must we get right to succeed, who or what can stop us, are we good enough, what strategy should we adopt, how will we know when we have succeeded
- ***Sign-off*** – Signatures of the sponsor and team leader

ANNEX VI. PROCESS IMPROVEMENT PEER GROUP/TEAM EXAMPLE

TEPCO developed Peer Groups as a forum for continual process improvement activities. The concept of Peer Group is that peers from key functional areas at the different power plants within a utility communicate frequently and meet periodically to collectively drive change to address operational and business plan goals and to develop common processes for activities carried out at each plant/site.

The following examples of Peer Groups are consistent with the key functional areas in the organization at each nuclear power plants (see Fig. VI-1).

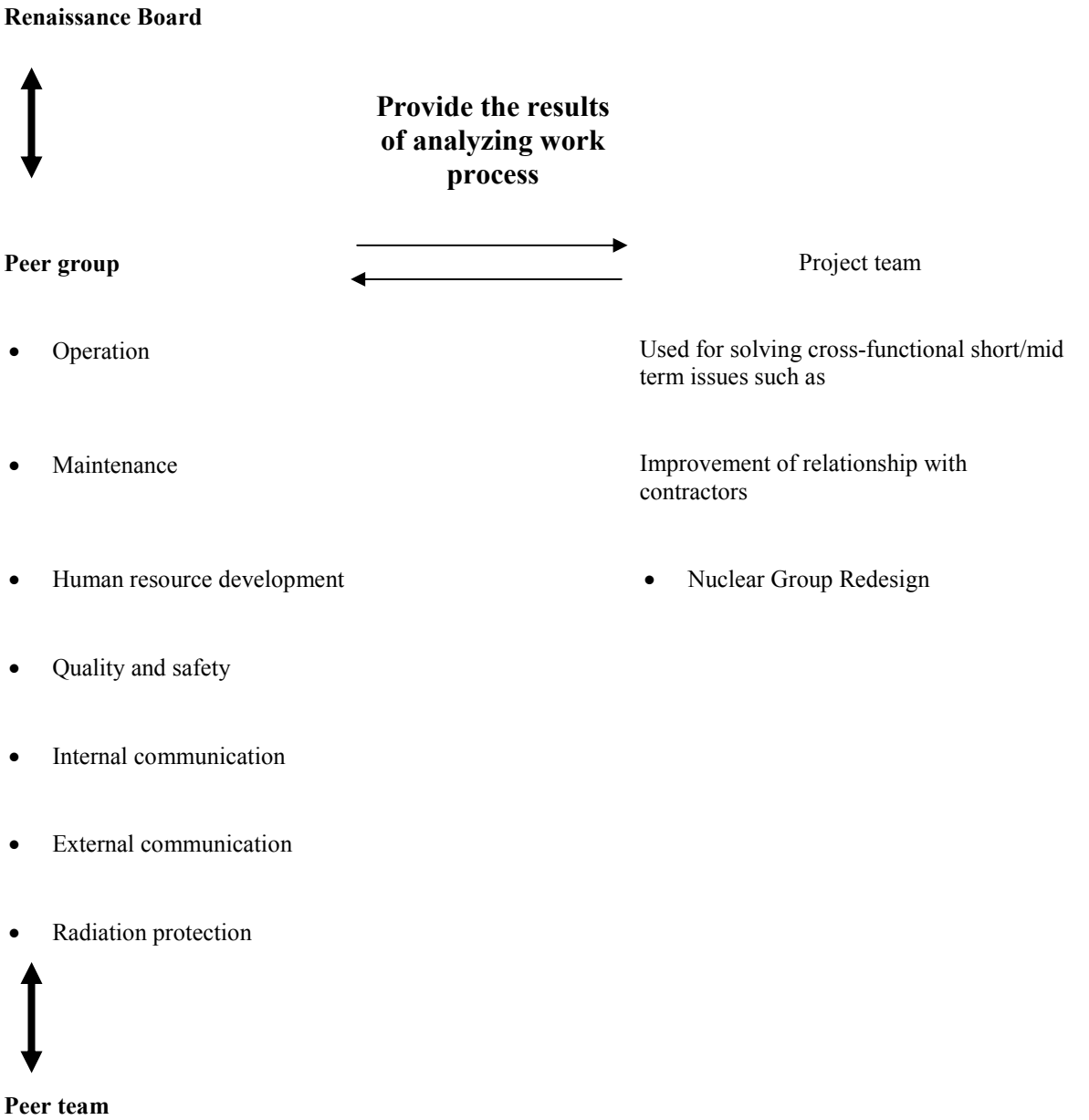

Fig. VI-1. Peer Group/Project/Team.

For example Operation Peer Group consists of operation directors from each plant/site and representative of the Headquarters. (see Fig. VI-2.)

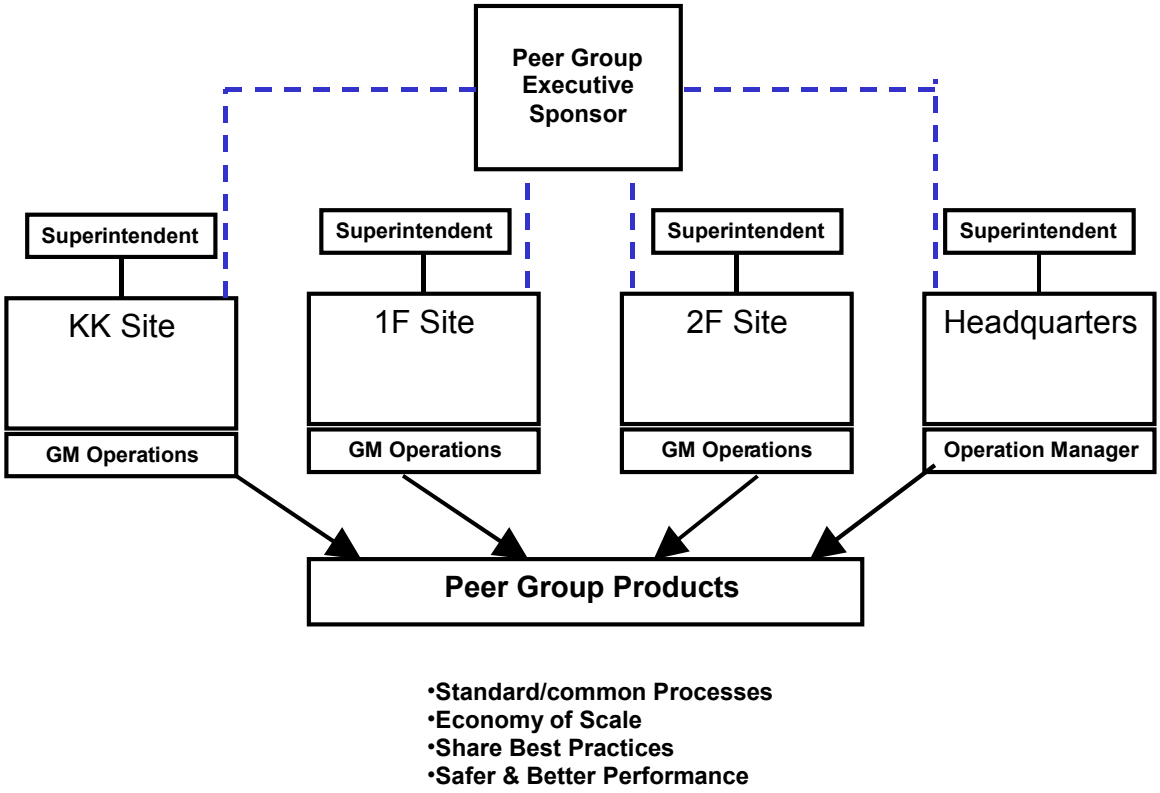

Fig. VI-2. Example of Peer Group.

Under Peer Groups (PGs) several Peer Teams (PTs) are developed for specific topic areas. Peer teams consist mainly of group managers, group members and representatives of contractors, who are the most knowledgeable of the process under discussion/review. Peer Groups can sponsor Peer teams with PTs periodically report their outputs to PGs. For example there are 8 PTs under Maintenance PG, such as:

- Outage scheduling PT,
- Work supervision PT,
- Maintenance member training PT,
- Condition based maintenance PT,
- Permit to work PT, etc.

Peer Groups/Peer Teams are expected to fulfill the following responsibilities:

- Standardize and optimize programmes, processes, and procedures across all the sites within their respective process areas as appropriate that would improve transparency and enable effective oversight & personnel rotation.
- Maintain ownership for respective area processes.
- Drive change initiatives and ensure implementation & organizational compliance.
- Create functional area goals & Performance Indicators.
- Monitor functional area performance and performance indicators; strive for continual improvement.
- Foster the identification and transfer/sharing of experience and company best practices as well as industry operating experience and best practices.
- Manage the sharing of resources across the organization.
- Implement continual improvement of respective processes and sub processes (Self assessment, new technology applications, etc.).
- Develop business plans and monitor progress.

It is difficult to achieve common work processes across all the sites as people at each site tend to persist in defending their own processes as the best, therefore, strong sponsorship is necessary to ensure that processes are standardized & common processes are implemented at all the sites.

In addition to peer groups and peer teams, Project Teams are organized to solve specific cross-functional and short/mid term issues. Project Teams could request PGs to redesign work processes for solving issues and PGs would provide the results of analyzing work processes back to Project Team (see Fig. VI-1).

ANNEX VII. INTERPERSONAL SKILLS UTILIZED IN PROCESS IMPROVEMENT

The followings are examples of interpersonal skills and their high-level definition that are utilised within process improvement by the TEPCO organization:

Active Listening Skills

Using Active Listening Skills creates a dialog that clarifies and deepens understanding between people as well as deepens the connection between them. The skills below are in order of increasing level of the listener's engagement.

- Silence
- Minimal encouragers, for example "I see.", "That's interesting !"
- Door openers, for example. "I would like to hear your thoughts about this"
- Asking Questions for example 'why?'
- Paraphrasing or playing back the message for example 3 way communication
- Perception checking.

Managing Interpersonal Conflict (VMOP – A mutual resolution process)

When there is a willingness and commitment to resolve a conflict, this four-step direct communications process surfaces the impact of the conflict and creates an environment to reach swift resolution.

Ventilation – "letting off steam": Through ventilating emotions with each other, each person's emotions subside and thus, they become more able to hear the each other in working toward resolution.

Moccasins – "walking in the other person's shoes": This stage allows each person to gain an understanding of the other person's point of view. If you work at understanding the other person, then that other person is more likely to be interested in your perspective.

Owning – "acknowledging your part in the conflict": In this step, both people "own" their piece of the conflict, acknowledging how they contributed to the misunderstanding or point of difference.

Planning – "contracting for the future": After both parties have heard and understood the other person and have owned what belongs to themselves, the two can now forge an agreement about what each will do differently going forward.

Decision Making Stances – Clarifying Decision Making Authority in Groups

The manager has the authority and duty to decide and announce how the group will decide – the boss decides what needs to be decided and the stance to be used. The followers have the responsibility to seek clarity about the decision-making stance. The followings are typical decision-making stances:

#1-*Autocratic*: Manager decides unilaterally with little or no input and announces the decision with rationales.

#2-*Consultative 1*: Manager nearly decides but is open to some influence; seeks some input from followers before final decision.

#3-*Consultative 2*: Manager states the problem, issue, or concern and indicates that he will decide, but that he is open to a high degree of influence and wants input (51% authority).

#4-*Voting*: Manager relinquishes veto power and casts a vote as a member of the group. He will support the majority vote of the group.

#5-*Consensus*: Manager relinquishes veto power and acts as a member of the group. The group strives for consensus.

#6-*Delegative*: Manager removes self from the group and delegates task or decision to the group with clear parameters(i.e. decision making authority, time and resources).

The Manager might use a couple of stances in finalizing the recommendations. (e.g. The manager might delegate to the group the task to create recommendations and indicate that the group must use consensus to do this and then present the recommendations for the manager to make the final decision (consultative)

Self-accountability is to perform my job responsibilities in alignment with my inner sense of social conscience and ownership, regardless of vested authority, and to call upon myself to account for my actions. ('Holding myself accountable.')

The ladder of self-accountability is an effective tool to reflect on how accountable or unaccountable each person is. (see Fig. VII-1.)

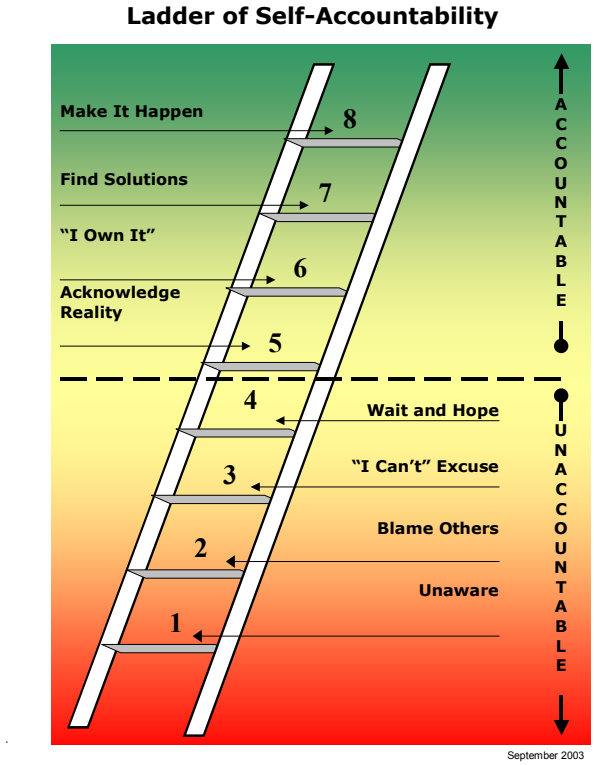

Fig. VII-1. Ladder of Self-accountability.

ANNEX VIII. JAPANESE CASE STUDIES OF PROCESS IMPROVEMENT

VIII-1. Process improvement activities at Toyota

Despite the current economic stagnation, Toyota continues to generate profits exceeding one trillion yen each year. In order to achieve this high level of profitability Toyota developed the Toyota Production Method; a system of wisdom. It has helped the company survive a potential bankruptcy crisis after the war, and evolve into one of the top international automotive manufacturers. Its underlining value is found not in the production method itself, but in its approach that relates to corporate management.

Processes are scrutinized thoroughly and put to constant improvement. Developing a team of solid human resources at the manufacturing frontline is essential in building a business structure that does not rely on sales increases and stands unaffected by the external environment. The spirit of the Toyota Production System is applicable to all industries, with many people, carrying the inspirational DNA of the System, providing consultation services.

Toyota production system with examples of the system applied to other companies

The following section describes Toyota's mechanism of process improvements, introducing some examples of companies that have achieved success and obtained practical benefits through applying Toyota's methodology.

Just-in-time manufacturing

Just-in-Time is a concept of producing what is required, when it is required, at a required quantity. Production volume represents the number of goods required by the market. Producing any more constitutes waste. Post-process is constantly specifying production volume to its pre-process, using the Kanban system to convey manufacturing instructions.

Mudatori (Waste elimination)

Mudatori means eliminating all waste from the production floor. Excessive production creates excessive operations/activities, and generates wasteful transportation and storage. Eliminating production waste leads to shedding waste in space, human resources and time. This notion of "Mudatori" is the most basic concept in the Toyota Production System.

Case of Company A – a major HMR supplier: The company has thoroughly streamlined its production lines to implement the Just-In-Time system, in which it only receives orders for the day's sales, and prepares the exact quantity of fresh HMR (Home Meal Replacements). VCR units have been installed to film production operations at the processing plant, so that staff can point to wasteful movements at production lines, long movement distances, and extended time required to clean production equipment. With collaboration from part-time workers, the management has adjusted the layout of production lines to almost half, for example, the production time for "roast sardines" from 44 seconds to 25 seconds per unit. Productivity has improved by 8% in lettuce shredding, while the cleaning time for production equipment has been shortened by almost 30% over 4 months. Visible improvements have also transformed the mentality of employees. Those who used to be reluctant to tackle problems raised, are now taking on new challenges with a sense of enthusiasm.

Five why's

This is an approach of asking "why?" five times to identify the true causes of a problem. When the same procedure is repeated every day, one falls into an illusion that it is the optimum procedure, preventing true problem solving. At Toyota, 5W1H signifies five whys and the description of their answers (how).

Kanban

This is a method for embodying the concept of Just-In-Time, in which post-process is always instructing pre-process on the volume and time required. Pre-process needs to produce at exactly the instructed volume, thus averting excessive production. Kanban normally contains instructions as to "what" should be manufactured "how much" and "by when".

Case of Company B operating a dry-cleaning plant servicing general dry cleaners: In the environment of economic stagnation, dwindling childbearing rate and technological offensive from the apparel industry, this company has explored many options and found a chance for survival in conducting direct information exchange with the apparel industry. This is how it has utilized the Toyota Production System. In the process of embracing the system, the company asked five why's to review its conventions, and found that those conventions were nothing more than its one-sided illusion that provided no benefits to customers. For example, under a catch copy of "overnight processing", it used to run dry cleaning operations throughout the night to process a massive amount of laundry brought in in-between different seasons. The company asked itself "why" repeatedly to realize that customers did not necessarily want to collect the laundry the following day. The system was subsequently modified to adjust processing schedule according to the desired collection date. Also, a large-scale cleaning/drying system had been introduced to achieve efficiency. Repeating "why?" led to a realization that customers preferred "small-lot production", processing individual items in small batches according to their materials, shapes and types of stains. The large system was consequently removed and replaced with small-lot cleaners, static dryers and equipment for post-cleaning finishes, incorporating the Kanban system.

Thorough standardization

Optimum business processes must be identified and standardized, so as to gain maximum productivity with minimum workload. It is necessary to examine how many minutes (seconds) and procedures it takes to produce each product, and what are the minimum WIP stages to ensure smooth production, before working out the optimum combinations.

Case of Company C, a non-life insurer: Company C joined forces with Toyota dealerships to take on the challenge of "business process standardization", achieving the formula of selling car insurance policies to car buyers at the time of purchase, an ideal scenario for non-life insurers. For example, based on customer survey data, the process of policy expiry notification has been standardized to three stages, i.e. (1) document-based notification one month prior to expiry, (2) follow-up telephone contact with the customer three days later (when the notification is delivered) and (3) encouraging the customer to complete the renewal procedure by the date half month prior to expiry. This move has raised the policy continuation rate from 85% to 95%. Standardization has been also made to the flow of business processes, regarding the point at which car insurance should be recommended in the course of sales talks. Dealerships that have adopted this standardization policy have seen their insurance contract rate grow 5 to 10% above the national average.

The following key terms are used in the Toyota Production System:

Production equalization

To equalize final production volume and to reduce variation stock accumulation is often attributed to variation in the amount of goods received from the post-process, causing the pre-process to fluctuate production and distribute according to demand peaks. It is most desirable to conduct constant production at a set volume.

People/space utilization

Thorough elimination of waste improves productivity, creating excess production staff/space without changing production volume. People/space utilization signifies using the excess personnel and space for new production activities.

Automation with a human touch

This is a concept inspired by the Toyota Automatic Loom, which had the function of immediate shutdown when thread brakes or runs out. Toyota has always assigned roles to not only machines but also their operators. When some trouble develops, the operator (human) stops the machine and investigates its cause thoroughly to prevent recurrence. In contrast, "automation without a human touch" does not utilize human wisdom. In the event of a mechanical malfunction, such a system may continue to mass produce defective goods.

Manufacturing is human resource development

The Toyota Production System is often described as something as the extreme opposite to the efficiency-driven system of the U.S. Ford Motor Company, involving full automation and mass production. Toyota's system stimulates operator motivation and encourages human innovation contributing to the overall operation, rather than having machine capacities dictate production plans.

Cell manufacturing

This is a manufacturing method that assigns multiple work processes to each worker and develops all-round skilled labor. It is positioned as an evolved form of the Toyota Production System. Unlike the belt-conveyer system, in which each worker is assigned a single plain task, the Cell Manufacturing system involves assembly cells, where individual workers are made in charge of multiple processes. It effectively reduces the number of people involved in the production of each product, and is therefore ideal for small-lot production. Also, increased involvement in the manufacturing of particular products is believed to increase the morale and sense of responsibility among workers.

Initiatives at Toyota

Toyota itself is currently undertaking the MR50 initiative "Maintenance Cost Reduction of CCC21" (Construction of Cost Competitiveness for 21st century), with the goal of halving the company-wide maintenance spending by 2005 from the 1998 figure, taking into consideration anticipated expenses associated with new facilities. Expansion into China has raised the sense of crisis over possible factory closures and job losses, driving factory workers into taking on a higher goal. To achieve the goal, the initiative consists of four pillars:

- Conducting CBM (Condition Based Maintenance) to ensure appropriate maintenance operations,
- Attaining technological improvement to extend the life of products,
- Reviewing the distribution of external/in-house maintenance operations
- Improving the efficiency of repeat maintenance work.

There is nothing special about the four pillars, but the stance of making "sincere and thorough efforts" is what separates Toyota from others. Examples of the effort to improve work efficiency are the "Work Sampling Method", in which movements of individual workers are observed and recorded every 2.5 minutes. The results are put to analysis to divide work processes into necessary and unnecessary ones. At Toyota, the concepts of "value and non-value" are well established among employees. Non-value or wasteful work processes are actively identified, defined and removed. As for necessary processes, their work speeds are assessed, so that slow processes are analyzed from the perspectives of skill levels and difficulties to identify related factors. An example of difficult work processes being improved is the dissembling/assembling of several equipment. A platform was installed to eliminate the process of handing over parts in dissembling, and provide an environment whereby all relevant workers can engage in assembling/dissembling at the same time.

Toyota's true strength

"Kaizen" means improvement, improvement without spending much money, involving everyone from managers to workers, and using much common sense. This Japanese word is now a popular word in industry, worldwide, to claim practicing innovative management methods. Of course, Kaizen is rooted in Toyota but the difference from other companies is that Toyota' s Kaizen is always being developed, changed in style and integrated. Toyota production system is based on waste elimination - that is to find waste, eliminate waste and standardize the work process. However, the current market requires totally aligned improvement, instead of just accumulation of partial improvements. Toyota is now, in order to meet customers' quality & timeliness requirements, examining all the aspects of business improvements, prioritizing them and implementing them, by involving all the employees and the affiliates, as seen in the challenges of CCC21.

Toyota's Kaizen also puts priority on classification between things to be changed and things not to be changed. Though it is important to focus on productivity improvement for better economics, safety and quality cannot be sacrificed in Kaizen. It is also has a priority to establish good working environments, in which employees are well motivated and enjoy participating in process improvement activities.

As explained thus far, Toyota is known for its hard skills seen in Kanban, Just-In-Time etc. Yet, the company's true strength is believed to lie in its corporate culture and environment, represented by individual employees. Their behaviors show the patterns of:

- Listening carefully to others,
- Examining what the problems are,
- Encouraging others / making proposals,
- Presenting ideas (wisdom) for survival,
- Consulting others,

- Thinking with an emphasis on manufacturing operations/goods
- Daring to try out new ideas.

The tradition is passed on from senior workers to junior workers. The workplace has the culture of respecting humans, recognizing the infinite potential of human wisdom, valuing the importance of "self-initiated thinking" and prioritizing the development of such human resources. Compared to other companies, Toyota has a superior perception of humans.

These behavioral patterns and perceptions have been apparently nurtured through the effective organizational structure and human resource mechanism that prepares for future developments and promotes innovation, as seen in the following examples:

- Establishing a voluntary research center as a venue for conducting studies on informal and outrageous themes.
- Building a network of internal colleagues and external human resources in different business sectors to encourage innovation.
- Introducing a human resource evaluation system that supports and praises activities of "future preparation".

Supported by these mechanisms, Toyota has naturally developed the workplace climate acknowledging that improvement is part of work responsibility, and promoting a deductive approach or "improvement for winning" through transforming the system to create innovation, rather than a recursive approach or "improvement for not losing". As identified here, Toyota and many other companies enjoying continual success have high priority in soft skills such as infrastructure development and communication that effectively lead their workers and organization into innovation.

VIII-2. Process improvement activities at JR East

In 1987, Japanese National Railways were privatized and broken down into seven regional Japan Railway companies. East Japan Railway Company or JR East is one of these companies with 75,000 employees. Obtaining ISO 9000 certification by one of its plants several years ago, has spread the moves for business process improvement across the company, including its head office. Using the common language called ISO, and adding JR's unique approach, the company is promoting business process improvement under the name of quality assurance activities. Their characteristic is the powerful leadership exercised by the head office, although frontline operations remain to be the main area implementing improvements.

The largest business mission of JR East is to transport customers to their destinations safely and securely. The management places top priority in "safety-related investments". It is therefore only natural that its business process improvement is oriented in preventing rolling stock failures. In addition to various initiatives concerning this area, the company has also set up a permanent exhibition on the history of major railway accidents at its training centre in Shirakawa, Fukushima Prefecture, with the aim of keeping the memory of such accidents firmly in people's mind.

Over one third of rolling stock failures are attributed to inappropriate maintenance, i.e. insufficient cleaning, inappropriate assembling, poor adjustment, careless oversight, inadequate wiring, poor inspection management, etc. These failures result from lack of awareness and skills in maintenance work, and are preventable if correct maintenance services

were performed. It is important to implement “basic actions” or “what has been prescribed” securely. Ensuring these elements to reduce maintenance-induced failures, could directly lead to the reduction of transportation trouble as a whole. The following are examples of initiatives for preventing rolling stock failures:

Initiative for eradicating failures

Of recurring accidents, ten cases of “significant accidents” or “failures requiring caution” are identified each year. For each of the cases, the head office determines recommended countermeasures, and instructs their thorough implementation to all workplaces. Under the mechanism, if a similar accident occurs due to a failure to implement the recommended countermeasure, the head office will conduct a strict workplace audit.

It appears easy, but often difficult in reality, to implement countermeasures, formulated from past accidents, across the board, and as continual commitment rather than a one-off measure. The head office must follow up the implementation to prevent oversight. The approach of tracing implementation after a set period of time, instead of simply presenting countermeasures, reflects the philosophy of ISO.

“Level targeting” for establishing a quality assurance system

From the perspective of preventing recurrence of rolling stock failures, the company has identified the current level of quality control for each check item, and set its improvement target in frontline operations at development workshops, etc. as an internal system for accident recurrence prevention. Check items are as follows:

- Conveying instructions, failure information, etc.
- Ensuring the implementation of countermeasures
- Preventing human error;
- Object checks
- Checklist
- Quantity control of short-circuit lines, etc.
- Quantity control of tools, etc.
- Maintaining technological capacity
- Education on new recruits / reassigned workers.

Each item is assessed at Levels a to d. Each level has minimum requirements, all of which must be cleared before a higher level is granted. Examples of descriptions of Levels a to d for Items A and B:

A – Conveying instructions, failure information, etc.

Level d - Instructions, failure information, etc. are conveyed verbally or in the form of a bulletin displayed at the workplace in principle.

Level c - Instructions, failure information, etc. are issued in writing.

All instructions, failure information, etc. are distributed or circulated in writing among all relevant employees.

Level b - All persons who have received issued documents must sign them.

Such documents or attached circulation forms provide space for entering signatures and signed dates.

Such documents or attached circulation forms carry the signatures and signed dates of all relevant employees.

Such documents or attached circulation forms are designed so that it is easy to verify whether all relevant employees have viewed the documents.

Level a - The supervisor verifies whether instruction documents, failure information, etc. have been conveyed to all relevant employees.

A supervisor has been assigned to verify whether all relevant employees have been notified.

The supervisor provides his / her signature and signed date on each document confirming that all relevant employees have been notified.

There is a ledger controlling all instruction documents, failure information notices, etc.

The ledger clearly states each document's title, document number, date of issue, date of notification completion, scheduled date of implementation inspection, and actual date of implementation inspection.

B - Ensuring the implementation of countermeasures

Level d - There are some failure countermeasures that have not been instructed for implementation.

Level c - All failure countermeasures have been instructed for implementation.

Instructions have been made on all information that requires notification to employees.

There are records showing that instructions have been made on all information that requires notification to employees.

Level b - Upon issuance of instruction documents or adoption of failure countermeasures, the relevant manuals are revised, and used for training. The implementation status is traced.

Manuals are updated upon issuance of instruction documents or adoption on failure countermeasures.

There are records showing that manuals have been updated upon issuance of instruction documents or adoption of failure countermeasures.

Training is provided to all relevant employees every time manuals are updated.

There are records showing that training has been provided to all relevant employees every time manuals are updated.

After manual revisions, work operations are put to tracing to verify whether the revisions have been implemented.

There are records showing that, after manual revisions, work operations have been put to tracing to verify whether the revisions have been implemented.

Level a - The implementation status of failure countermeasures is regularly checked.

The implementation of failure countermeasures is traced at a regular interval, e.g. monthly, quarterly, 6-monthly and at peak times.

There are records showing that the implementation of failure countermeasures has been traced at a regular interval, e.g. monthly, quarterly, 6-monthly and at peak times.

A good workplace is generally regarded at being around level C. However, in line with ISO standards, JR East has defined very strict Levels A and B to ensure prevention of failure recurrence. Each workplace is undertaking efforts to achieve process improvement, with the aim of stepping up one level each year, i.e. starting at Level D and reaching Level A in 3 years.

These two initiatives by JR East are characterized as a top (head office) – down approach, rather than a bottom-up mechanism initiated by the operational frontline.

ANNEX IX. EXAMPLES OF PERFORMANCE INDICATORS

The list below provides a number of items that are often utilized as indicators of the performance of organizations and individuals. In choosing performance indicators, careful attention should be paid to aligning them with the goals and objectives of the organization and with the expectations that have been clearly communicated to the individuals whose performance is being evaluated.

CPI project teams and CPI working-level teams should be particularly careful to only measure indicators directly related to the improvement areas upon which they are focused.

- Safety related events such as reportable accidents and lost-time accidents.
- Electricity production costs.
- Capacity factor.
- Unplanned plant scrams.
- Ratio of outage actual to planned durations.
- Maintenance re-works.
- Workforce numbers and costs (including non-permanent employees and outsourced work or staff augmentation).
- Error-free days.
- Operation and maintenance costs.
- Dose trends and limits.
- Stakeholder satisfaction.
- Number of days on-line.
- Employee retention, attrition, and recruitment experience.
- Average time employees remain in the same job assignments.
- Hours of training received annually on: (a) particular job assignments; and (b) performance improvement strategies and techniques.
- Number of employee suggestions received.
- Number of employee suggestions implemented.
- Percentage of CPI projects completed ahead of schedule; on schedule; and, beyond original (and extended) schedules.

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Consultants Meeting
Vienna, Austria: 2–4 June 2004; 1–3 March 2005

Technical Meeting
Vienna, Austria: 7–9 September 2004