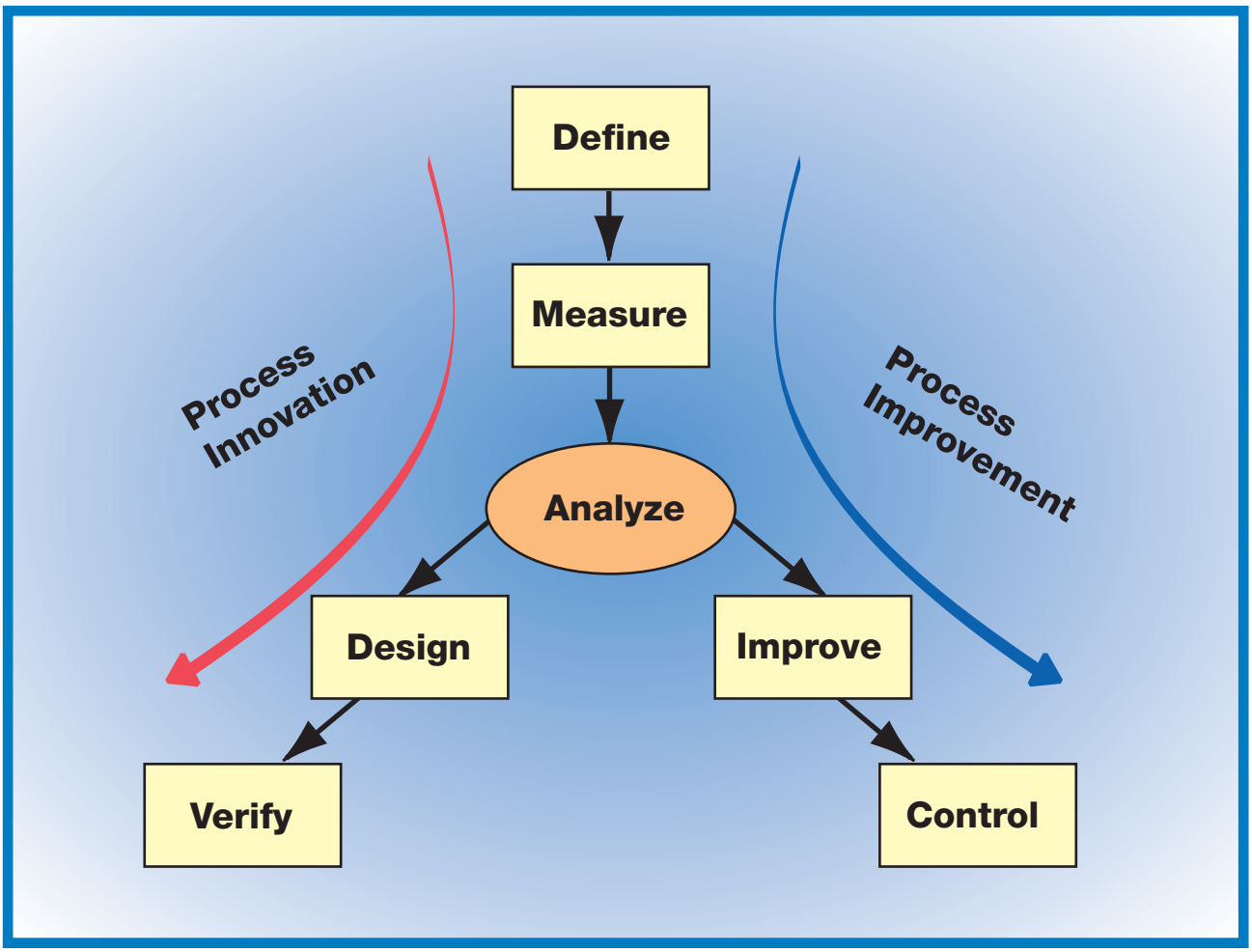
World Meteorological Organization

GUIDELINES ON QUALITY MANAGEMENT PROCEDURES AND PRACTICES FOR PUBLIC WEATHER SERVICES

PWS-11

WMO/TD No. 1256



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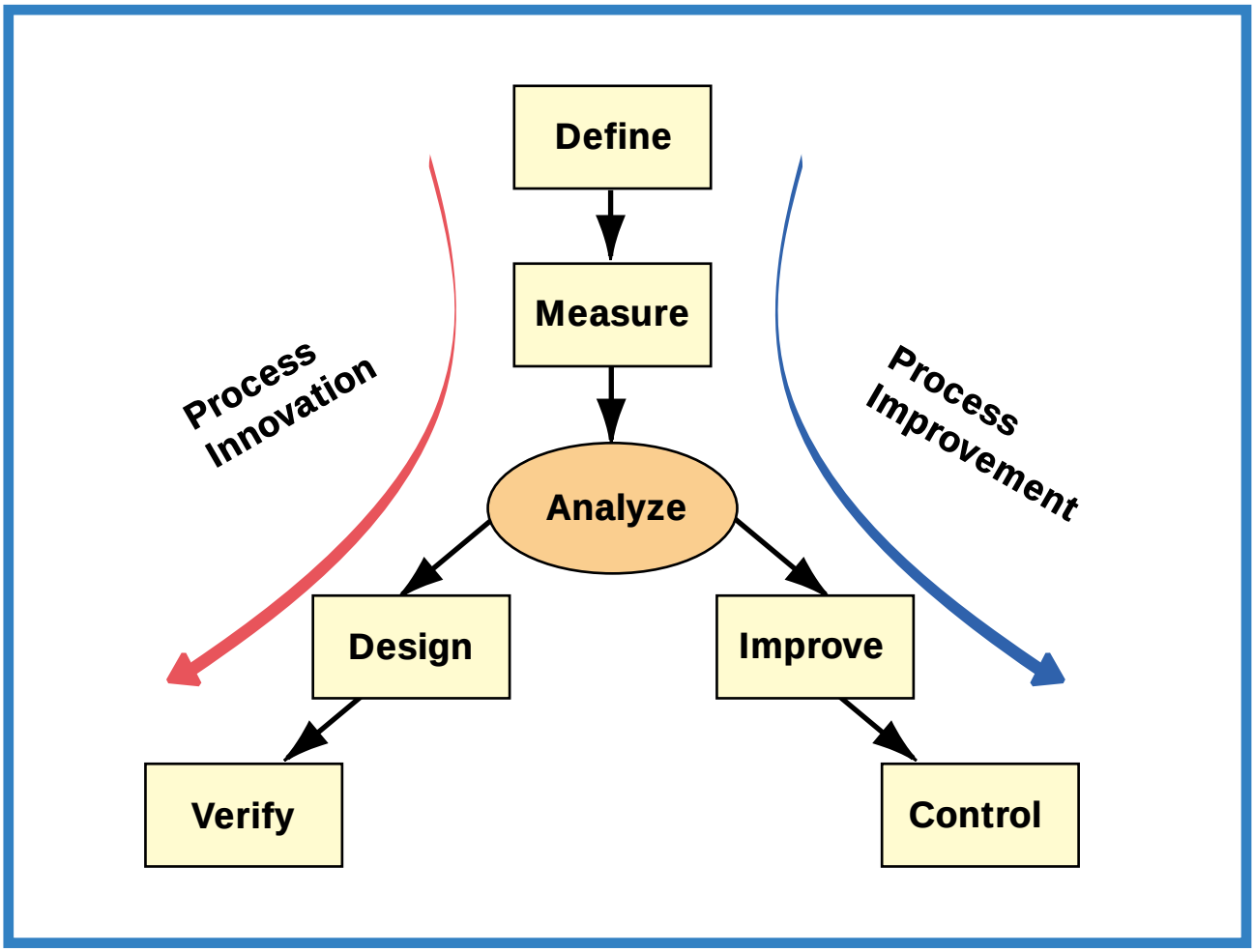

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Chapter 1

INTRODUCTION AND KEY PURPOSES

The Commission for Basic Systems at its Extraordinary Session in Cairns, Australia (4 to 12 December 2002) in reviewing the work of the Public Weather Services (PWS) Expert Team on Product development and Service Assessment (PDSA) requested that it continue to work on the important issue of formally defining quality management processes and develop additional material describing quality management practices in the realm of public weather services deliverables. This was later articulated in PDSA terms of reference "g" and "h" as follows:

- TOR(g):"Develop a set of recommended core service assessment criteria and questions to be used by NMSs in service assessment and promote awareness of the existing guidance material on service assessment among NMSs."
- TOR (h): "Supplement existing WMO guidance on PWS, develop additional documentation on quality management procedures and practices that would allow the overall quality of outputs and delivery of PWS to be monitored and improved continuously"

The PDSA Expert Team has already developed, in 2000 and 2002, material to support efforts in quality management practices, namely WMO/TD 1023 *Guidelines on Performance Assessment of Public Weather Services* and WMO/TD 1103 *Supplementary Guidelines on Performance Assessment of Public Weather Services*. These guidelines essentially focused on the assessment of PWS from a scientific and user perspective with general information on how to incorporate them as part of a comprehensive quality management strategy. Nevertheless these documents provide a basis for a continued effort in the development of additional guidance material on quality management practices. In the end it became evident that it would be difficult to separate TOR (g) from that of TOR (h) in the response as they stem from the same quality management framework.

This document is in response to the direction given to the PDSA Expert Team and presents background material on quality management systems for use by NMSs. Specifically, it seeks to give a broad overview of quality management including structured problem solving, systems management along with some of the leading quality management theories such as Balanced Scorecard and Six Sigma. In addition, a description of change management is given: what it means and how it applies in the PWS context is addressed along with some core assessment criteria and issues. The ideas presented herein are best considered, amended and applied in a way that adds value to PWS. The document starts with a broad overview of quality management followed by some core assessment criteria and issues. Next described is a number of leading quality management dimensions and approaches whose consideration for adoption would suggest the requirement for further examination of the respective theories. The issue of change management is discussed both from the perspective of organizational renewal and of program evolution. Because of their importance to the programs of NMSs, public education and outreach are given a separate treatment. Process improvement or reengineering in government is of obvious concern to NMSs. Finally, the issue of ISO certification is discussed.

Chapter 2

CORE ASSESSMENT CRITERIA AND QUESTIONS

With reference to TOR (g) typically, assessment issues deal with questions that management or politicians want answered. Among them, of course, are questions of relevance (what are users' and taxpayers' needs?). Is the program the correct way to fulfil these needs or should these needs be fulfilled through some other ways or by someone else?), effectiveness (Does the program achieve the results it was set to achieve in order to fulfil the identified needs?) and cost-effectiveness (are there more economical ways to attain the desired results?). Imbedded in these questions are also questions of reach (do we reach all the people that we need to reach?) as reach obviously affects both relevance and effectiveness, and can bear a lot on costs. The reach question also includes determining those that we won't try to reach and why we won't, in addition to making sure we do reach those that we need to reach (the intended audience, which, of course, depends on the service: marine forecasts only need to reach marine interests, for instance).

To the extent that all NMSs have the same ultimate goals, that's fine, but let's not forget that these goals do vary from country to country, according to political will and citizens' wishes. While public weather services within NMSs may have generally common basic objectives, the NMSs themselves are situated in quite diverse governmental organizations ranging from ones with a commerce focus to ones with a military or transportation focus to those functioning in an overall environmental focus. That means that the ultimate goal of the NMS, apart from protecting life and property against hazards - which is a basic role of democratic governments, ranges from having to deal with protecting, preserving and enhancing the quality (and people's enjoyment) of the natural environment through sustainable development, to that of economic prosperity and competitiveness. What's a success in assessing one NMS - e.g. making industry more profitable - may not be of much relevance to those with an environmental agenda.

There should, therefore, be some caveat as to what the assessment, seen on a global scale, would cover. It is suggested that the first level in the set of recommended core service assessment criteria and questions focus on the context of protection of life and property against hazards of a meteorological origin and that the secondary levels focus on those dealing with the context of economics, military, transportation, sustainable development, etc.

From the context of the suggested first level, WMO/TD 1023 and WMO/TD 1103 represent a foundation or tool kit upon which or from which to build a recommended set of core service assessment criteria and questions. These could include:

- Have the needs and expectations of the customers/public been validly identified and documented?
- Has the full range of the customer, which encompasses the individual citizen to a nation's political leadership, been considered?
- Have these needs been converted into requirements for the NMS' products and services which achieve the objective of satisfying these needs and expectations?
- Have these requirements been cast into objectives that the NMS intends to achieve whether it is cost, delivery or the specification it will supply?
- Are these objectives in line with the corporate vision of the NMS?
- Have overall benchmarks (e.g. levels of service, accuracy, etc.) been set for the product or service to be provided?
- Are these consistent and validated with the needs and expectations of the customers/public in terms of a common understanding and acceptance of what is to be provided?
- Have criteria for success in satisfying these benchmarks been established and the methodology for their measurement defined?
- Have the process steps for the achievement of NMS objectives been defined and documented (e.g. primary objectives for each of the business processes such as forecast quality, delivery effectiveness, etc.) each with their individual benchmarks and success criteria?
- Has a risk assessment been undertaken overall and for each process (at least for the critical ones) to identify indicators of effective operation and their potential for failure?
- Is there an overall (and for each process level or at least the more critical ones) effective corrective or preventative action strategy and capability deployable when processes fail or look (through in place indicators) likely to fail?
- Is there a mechanism (user satisfaction surveys, consultation, etc.) to determine if the customer needs and expectations are met at any point in time and, if not, why?
- Does this mechanism contain elements to monitor the evolution of the customer needs and expectations over time?
- Does the process infrastructure include elements supportive of a continuous improvement culture?
- Most importantly, is there the strong and formal commitment of the senior executive management of the NMS and is this commitment manifest through the hierarchical structure of the NMS?

The above considerations fit in nicely in addressing the quality management question. In supplementing the existing WMO guidance on PWS and developing additional documentation on quality management procedures and practices the questions and issues addressed above have the making of a framework for a quality management system when integrated across the functions, products and services of a NMS.

Chapter 3

QUALITY MANAGEMENT OVERVIEW

3.1 OVERVIEW

A variety of market forces and the push to survive in a climate of ever tightening budgets, have led NMSs to increase their focus on customer satisfaction. One of the major strategic changes that have occurred in recent years is an increased emphasis on quality, specifically quality management. Traditionally, quality control has been based on the economics conformance level model whereby there is a balance between prevention and appraisal cost and the internal and external failure costs where optimum is achieved when marginal prevention and appraisal costs equal marginal failure costs. Under this scenario there will always be an "acceptable" level of defects thus the number of defects will never equal zero. By contrast, proponents of Total Quality Management (TQM) suggest that higher quality will result in lower costs thus the optimal conformance level occurs when defects are zero. This emphasis on quality has also resulted in a demand by organizations - NMSs are no exception - for external recognition of quality which, in turn has led to the International Organization for Standardization (ISO) to develop the ISO 9001 series of international quality management standards for quality assurance of products and services.

According to ISO 9001:2000, quality can be described as the degree to which a set of inherent characteristics fulfil requirements and expectations. It further defines quality as the totality of features and characteristics of a product or service that bear on its ability to satisfy given needs. Quality is conformance to specifications, but specifications, being customer driven, change and thus are multidimensional and dynamic. To better control quality the ISO standard suggests a process oriented approach. By defining, measuring, producing and controlling each process that produces a deliverable, quality can be improved throughout the entire organization. This in turn leads to better system control and the ability of an organization to change and adapt to customer needs

A quality management system is a system to direct and control an organization with regard to quality. Quality management contains all of the overall management function activities that determine quality policy, objectives and responsibilities, complementing them by means of quality planning, quality control, quality assurance and quality improvement within the quality system. Quality assurance is the set of all planned and systematic activities implemented within the quality system. A quality policy describes the overall intentions and direction of an organization related to quality as formally expressed by management. A quality manual is a document specifying the quality management system of an organization. Therefore a Quality management system is the recognition of the evolution of the concept of quality from reactive to preventative, from directive to participative, from technical to managerial, and from just production to include the entire organization especially service delivery.

Quality, as quality management authors have defined is a subset of the following components of an organization: The role of top management (i.e. committed executive leadership and support), the role of the quality department or quality auditor (if existing), training, product/service design, involvement on the part of suppliers in quality management, process management and improvement, quality data and reporting (quality measurement and information), employee relations (workforce management, employee empowerment), customer involvement, adoption and communication of total quality management (zero defects mentality), benchmarking, and "open" organization. Powell (1995) found executive commitment, open organization and employee empowerment significantly correlate with total quality management performance. Brooks (1995) substantiated that performance improves as a result of ISO certification indicating that it imposes a certain level of discipline and provides marketing advantages through perceptions of higher quality, improved customer satisfaction, competitive advantage and reduced audits. Although ISO certification can be greatly beneficial to an organization, entities that do not have a formal total quality management program or are not ISO accredited but still subscribe to the same philosophies of executive commitment and employee empowerment can still be very effective.

A basic but fundamental approach to quality is the quality improvement loop. This can be perceived to include four keys steps. The first step is to prepare to do something, i.e. plan one's action. This is the resource management role of preparing and planning. The second step is to do the best one can, which translates into product realization in management parlance. The third step has to do with checking the results of one's action relative to the satisfaction of the client. In a management sense this translates to measurement, analysis, auditing, and management reviews. The final step involves reacting to received information and to improve future action. This can be seen to form the foundation of a process-based quality management system and facilitates continuous process improvement.

From a public weather services perspective the objectives of a quality management system can be seen to include:

- Compliance with legal or statutory requirements;
- Determination of user requirements over and above statutory requirement;
- Assurance that customer expectations are satisfied;
- Aligning with the NMS mission and vision;
- Assurance that remedial action is taken on under performing processes;
- Pursuit of continual performance improvement.

Under strategic quality management upper management establishes long-range quality goals and defines strategies to meet them. The organization's strategic quality plans contain components for identifying goals and their deployment across functions, resource planning with a focus on

prevention, measurement of performance, planned audits and staff training.

The costs of poor quality include appraisal, prevention, and internal/external failures. Appraisal costs occur when there is inadequate accuracy in the determination of the degree of conformance. Prevention costs occur when errors are not kept to a minimum. Internal failures occur when product/service defects are found before being delivered to the customer. External failures occur when the product or service delivered to the customer falls short on meeting the requirements. There are additional hidden costs such as the loss of customer confidence and goodwill. The classic representation is that of author Steven Covey's four quadrants with its categorization of issues and activities as important or not important and as urgent or not urgent. The focus is then on the important not the urgent: thus the prevention of failures is better assured.

Quality management also has significant costs (project teams, training, performance measurement, audits, etc.) but they are less than the alternative.

3.2 ADVANTAGES OF QUALITY MANAGEMENT

A quality management system fosters mutually beneficial supplier and customer relationships. The most obvious advantage of pursuing such an approach is that it helps to obtain and keep customers through the provision of quality products or services to them. It assists NMSs with optimizing science and technology opportunities with the customer's evolving needs. It is very common for complex organizations such as NMSs to not master every aspect of their production processes. A quality management system supplies the tools whereby processes are described in terms of what the intended result is and the extent to which that intended result is achieved. Thus a clear articulation of the key NMS business processes can be produced. A quality management system supports a process or system approach to management thereby fostering a factual approach to decision-making (i.e. measurement and analysis). The auditing process ensures that proper documentation exists and is known and available to those in charge, and that staff are trained and execute the documented direction. Records provided by the quality management system may be used to control that every step was carried out according to the documented procedures. Quality management also provides assurance to responsible authorities, governments and stakeholders that the NMS has effective management resulting in fewer quality audits. All of this translates into greater quality awareness throughout the organization. Quality management provides a framework for continual process improvement thereby helping NMSs in the battle of sustainability. It fosters a culture of quality and operational excellence and provides mechanisms for prompt and effective action on faults and/or complaints. By allowing staff to concentrate on progressive work rather than rectifying errors quality management eliminates large amounts of unproductive work thereby having the positive effect of increased productivity and efficiency. Another effect of implementing a quality management system in an organization is the change in focus from the short term (finding and fixing errors as they happen) to the longer term strategy of how to satisfy the customer's needs. The increased emphasis on technological change has resulted in a re-examination of traditional performance measures with a demand for a broad range of measures and a focus away from shorter term in favour of longer term measures. Finally, a quality management approach helps a NMS stand out from the crowd, thus attracting more and better qualified candidates for recruitment.

3.3 CHALLENGES OF QUALITY MANAGEMENT

Critics have argued that ISO standards specify minimum standards which relate to quality systems but do not guarantee product or service quality. Initial Costs are also a drawback to quality management. These include but are not limited to, the costs of external consulting, and audits. Besides cost, acceptance of an outside consultant's direction may present some difficulties. Further, if used, the acceptance of an outside auditing and certification for ISO compliance may be further sources of stress. The operational status of a meteorological entity in accordance with its mandate (which may vary across different countries) or legal existence may impact the NMSs ability to fully adopt quality management practices. Another difficulty is that of the perception of bureaucracy (documents, forms, records, etc). At least initially a quality management system can be perceived as a constraint requiring time and effort in terms of describing processes and documenting procedures, and of producing records, attending meetings that produce further paperwork. Staff can feel dehumanized by being subject to or controlled by a system with their performance being checked at every turn. Errors or shortcomings are highlighted to be rectified while performance that meets the standard may appear not to get the equivalent attention. Quality management initiatives tend to be of a very long duration, following a slow methodical pace associated with the implementation of quality management systems and this fact can be a source of disappointment. There can be a perception of loss of executive command and control to "the system" and, again if pursued, a general fear of the "ISO 9000:xxxx unknown" along with further disappointment if one does not get the results one wished for. Workforce concerns and resistance represent a critical challenge that the project manager must be prepared and adequately skilled to address.

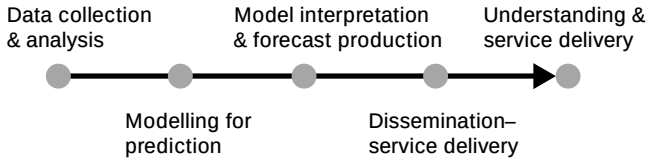
3.4 GETTING STARTED ON QUALITY MANAGEMENT

A good assessment looks not only at the end result, but takes and analyses measurements throughout the process that leads to the service. A process, in quality assurance, is defined as the series - generally but not always sequential - of steps/operations that must occur for the final product, good or service to be produced in a manner that satisfies the customers. In other words, quality management is control not only of the final product, but of the entire process. By controlling each process

that leads to a final product one can better find, fix, and prevent failure that leads to a defective product.

In the context of public weather services for example, one could define the processes that make up a weather forecast:

i. Data collection and analysis
ii. Modeling for prediction
iii. Model interpretation and actual production of the public forecast
iv. Dissemination of the forecast and reception by users
v. Understanding & use of forecasts: customer utility



Forecast value added chain

To improve the quality of the final product, there is a need to know what's going on in the process. That means, of course, measuring people's utility e.g. total satisfaction (understanding, usefulness, etc.) such as defined in WMO/TD 1023 and WMO/TD 1103.

While most NMSs have quality management systems for data collection, it is necessary to view the entire process chain as a whole to control the process. For example, data received may be good but if not in time for the forecast cycle (dissemination – service delivery) it is of no use. By dividing each part of the forecast value added chain into processes and sub processes where specific measurement points such as when data is received and whether the forecast is disseminated on time, allows the management to better understand where the problems (if existing) are and how better to correct them.

Most NMSs have quality assurance measures for models and forecast production. However, it is not enough just to produce numbers, they must be thoroughly analyzed so their full story is unearthed and action taken wherever shortcomings are detected. Therefore a feedback loop between performance measurement and planning should be developed, since planning is often the way by which resources are distributed and, as a result, the best way to correct systemic changes.

In the area of service delivery or dissemination most NMSs need to add some performance management functionality. There is a need to know when (or whether) a forecast was sent, when (or whether) it was received by the dissemination system and if it was OK, whether that system has worked to display or broadcast the message as intended. Partners should also be polled to know if they receive the products as are intended (timeliness, completeness, etc.).

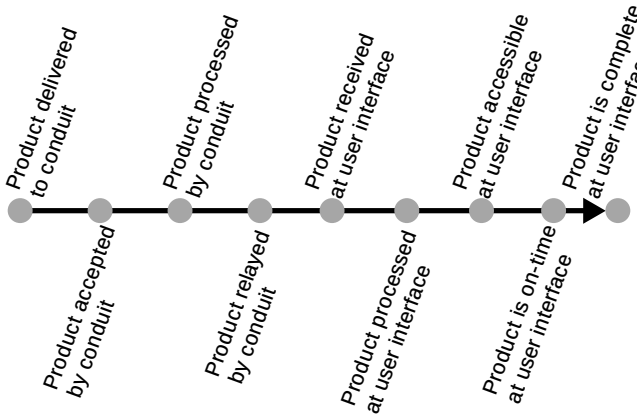
To measure customer utility, apart from surveys and focus groups, there are the more traditional measures of output (how many web-page views, how many brochures distributed, how many questions received, how many interviews on TV/radio, etc.).

To define and control the five broad processes described above, they will need to be further broken down into sub-processes. Dissemination, being one of the critical processes in the total NMS value-added chain, could be broken down to the following sub-processes:

1. The product arrives at the appropriate dissemination conduit;
2. The dissemination conduit "accepts" the product;
3. The dissemination conduit processes the product;
4. The dissemination conduit relays the product along its channels;
5. The receive end of the conduit receives the product at the user interface;
6. The product is processed at the receive end of the conduit by the user interface;
7. The product is accessible at the receive end of the conduit by the user interface;
8. The product is complete and intact at the user interface;
9. The product is on-time at the user interface;
10. The intended user receives the product at the user interface; and
11. The user understands and uses the product appropriately.

Items 1 through 9 represent possible measurement points which, if data is available, are candidates for automated capture. Item 10 may be an issue of the selection of the appropriate dissemination conduit. Item 11 may be a function of the presentation of the information by the conduit. Items 10 and 11 are not candidates for an automated process. It may be the case that not all of these process items are relevant for some dissemination conduits. On the other hand certain dissemination conduits may have additional measurement points that are candidates for automation.

The first 9 items can be thought of as process nodes, which, in turn, could be broken down further into sub-nodes, e.g. subcomponents of processing activities:



Generic dissemination process chain

Finally the dissemination conduit or the manner in which the conduit behaves may be a function of the particular product being disseminated. The obvious case in point would be that warnings are given a greater priority; the specific dissemination conduit may be required to behave differently and would be subject to potentially different benchmark standards.

A possible starting point in developing an approach to performance management of the dissemination processes of

an NMS is the analysis of each dissemination conduit against the framework of the above listed items. Considering the first 9 items as process nodes, the analysis should determine the availability of performance data for each node. If data is available, can it be retrieved? If so how and at what cost? If data is currently not available, can it be generated by some means and at what cost? Documenting currently available data sets and comparing it with what further data sets can be established for process control is essential for the pursuit of quality control and ultimately customer satisfaction.

The pursuit of customer satisfaction on the part of a government entity could be an elusive target leading to frustration on the part of the NMS and its staff. The ISO 9001:xxxx rigor may not be feasible for all NMSs to incorporate for a variety of reasons. Those NMSs that find implementation of ISO standards cost prohibitive should at least implement the basic components of quality management as listed below:

- Clearly articulated mission statement or mandate;
- Comprehensive level of service statement(s) understandable to the client/customer;
- Mechanisms for soliciting and validating user requirements;
- Mechanisms for ensuring scientific currency;
- Comprehensive standards and operational procedures for the NMS's key processes and product/service offerings;
- Technical and scientific performance monitoring of key indicators for each key process (and sub-process where critical);
- Fault response strategy and capacity;
- Mechanism or strategy for continuous program renewal; and
- Mechanism for user-based assessment of end products and services.

Chapter 4

QUALITY MANAGEMENT CONCEPTS AND APPROACHES

The intent of this chapter is to provide a brief overview of a number of concepts related to quality management. Any application of the concepts presented here will require further research into the specific topics themselves. Extensive literature exists on all of these topics as can be revealed through documents, journals and web searches. Chapter 8 presents the ISO context. Any of the tools described herein can be employed in their own right as well as within the ISO context in support of quality management efforts.

The January 12th, 2004 edition of Fortune Magazine presents an interview with Peter Drucker, a long time management guru who more than forty years ago coined the expression "knowledge worker". Dr. Drucker, still an active university professor at the age of 94, is quoted as saying "It's not computerization that's important, it's the discipline you have to bring to your process.""You have to take the assumptions out of the mind of the decision-maker and put them explicitly into the process, along with a method to check them, and only then can a computer help you manage it. Older executives find it excruciating to have to be that explicit, because they just don't want to be. Besides, as we all know, many decisions are ultimately made by the hydrostatic pressure in the boss's bladder." Putting rigor into process definition is difficult and, as government or government-like organizations populated largely with "knowledge workers", the challenge to NMSs can be severe.

Whatever quality management approaches are chosen a frequent challenge is the achievement of top management support for the initiative. A middle level manager may get a vision about how a particular quality management initiative could dramatically improve operations. Similarly, pro-active front-line workers seize the initiative to map out and improve their process. However, such isolated improvements rarely make it to full blown organization-wide initiatives. While continuous process improvement is widely regarded as worthwhile, the dedication of time and money to do it is often elusive. There are a couple of ways of overcoming this top management reluctance. One of these is to demonstrate significant improvement benefits while maintaining a low organizational profile. Some might call this the stealth approach. This would have to be done carefully employing a rather rigorous structured process. Another proven technique is that of a limited initial commitment project to address several issues of executive interest and show dramatic results quickly. Senior management is actively involved up front in articulating the business challenges and scoping the projects and if benefits materialize, the initiative is rolled out across the organization.

4.1 STRUCTURED PROBLEM SOLVING

While there are rarely perfect or ideal solutions to problems, structured problem solving skills are essential for the efficient identification and elimination of root cause errors in any process. Structured problem solving uses a methodology to analyze the problem and its potential solutions. It can be used at any level in an organization and for any type of problem. Also, while it may seem like stating the obvious, there are a number of steps that can comprise an effective approach for the objective identification, definition and resolution of problems and prevention of their recurrence. Such a problem solving process includes defining problems in a clearly understood manner, encouraging a wide range of ideas, defining solutions in terms of current strengths and consideration of the practical constraints for successful application of a solution.

The obvious first step is to clearly define the 'problem statement' as a single contained problem in such a way that it focuses the thinking on the issue thereby minimizing the potential for getting side-tracked. Defining and verifying the root cause is critical. The problem statement should be concise, accurate and action oriented. This can be done in a qualitative manner at first but eventually is placed in quantitative terms. The background to the problem is important to appreciate as well. The background includes any additional information, data, clarification of terms and points made in the definition, any constraints, previous attempts at solving the problem, goals and benefits of finding a solution. Establishment of a problem solving team is appropriate at this point.

As a next step brainstorming is an effective way of generating alternative solutions. By brainstorming it is meant that participants are encouraged to use their imagination solving the problem without discussion of the validity of any potential solution. During the discussion, all possible solutions should be written down (tabled) as they are expressed.

When all possible solutions are tabled, the team evaluates the potential solutions by discussing and documenting the merits of each. Every solution has its weaknesses such as cost, the skills required, time required for execution and long term sustainability. The mostly likely solution ideas need to be clearly and succinctly stated in terms of an attainable target. Sometimes groups of similar ideas are combined into a single heading. As each solution is discussed a ranking should be placed next to it so that the optimal solution stands out from the rest.

The selection of the optimal solution that constitutes a permanent corrective action or achieves the desired goal is a key step. Often the ideal solution is not the best solution due to implementation considerations. Secondly, the solution may not be immediate but rather gradual as learned behaviour takes hold. Also, the optimal solution may only emerge after additional information is obtained through the selection and application of a solution that is subsequently discovered to be less than optimal. At this stage of the process the benefits and concerns associated with each solution are evaluated. If the concern is simple it can be overcome by careful deployment, training, etc. A critical concern may require a separate problem statement by itself and a problem-solving approach in itself.

Once the optimal solution is selected a detailed plan is needed to verify and implement a corrective action. A check list of such a plan should include:

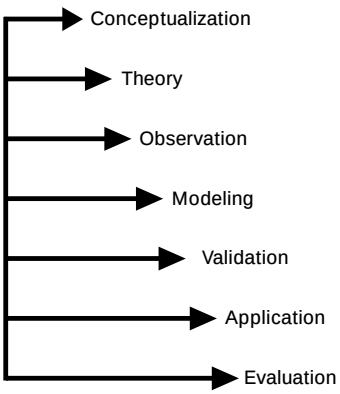
- Resources – time, skills, expertise, equipment, money, etc.;
- Commitment – agreement or cooperation of people involved;
- Focus and roles – of people involved with regard to what was required and when it was required;
- Risk assessment – possible difficulties recognized and coping strategies developed;
- Process sequence detailing and documentation – the difficult parts being thought through;
- Process monitoring – a monitoring system in place and alerting mechanism in case of deviation from the desired result; and
- Review – time and place for this.

Such planning ensures group ownership of the solution and focuses on the tangible results and becomes a framework for deployment.

After execution of the plan a review of what has transpired is important not only from the perspective of measuring the effectiveness of the applied solution but also from the perspective of continuous learning. Opportunities for process improvements are captured in this way and recurrence of the same problems are minimized or even prevented. Finally, but certainly not least, as part of this review it is important to recognize the achievement and the contributions of individuals who took part in the process.

4.2 SIMPLIFIED PROGRAM CREATION AND RENEWAL

An example of a simplified approach for continuous program creation renewal may look like:



Where each subsequent level may loop back to any preceding level.

For complex organizations such as NMSs the key objectives for quality improvement should include:

- Standardization of like processes across the NMS to effect economies of scale and reflect best practices;
- Direct linkage of process performance to strategic plans;
- Cross-functional integration of major processes to streamline performance, reduce waste and reduce duplication of effort;
- Application of proven standard methodologies, techniques and tools for process improvement;
- Integration of a culture which promotes employee initiative and responsible risk-taking in support of needs, both internal and external; and
- Functional management responsibility for ensuring the development and deployment of information management systems for redesigning functional processes.

This begs the requirement for definition and elaboration of some fundamental concepts and the paying of individual attention to areas specific to NMSs. Also, NMSs, as science based organizations, need to continuously balance evolving customer requirements with the evolution of scientific advances and capacities. Luckily, NMSs can capitalize on non-proprietary advances of other NMSs and of science in general to meet the needs and expectations that evolve in concert with science. This positive environment of international collaboration and coordination represents a unique dimension supportive of public meteorological services.

4.3 SYSTEM MANAGEMENT

To see where processes fall into the bigger picture it is useful to start at the top and define system management. This picture starts with the external requirements such as customer requirements, regulatory requirements and legal mandates. These external requirements are translated into management system requirements. Relevant staff is trained on these system requirements and performance measures are developed accordingly. Information that these system requirements have been addressed through one or more processes is generated. The extent of compliance with performance measures is assessed and the shortfalls are addressed through modified processes. Gaps between system requirements and external requirements can emerge from a gap analysis. Also external requirements evolve over time and this evolution needs to be monitored and reflected in revised management system requirements. Through this cycle, a learning and process improvement culture is established for the prevention of the recurrence of errors and the sharing of experience.

4.4 PROCESS MANAGEMENT

A process is a transformation of inputs into outputs through a series of activities (sub-processes) each with their own input and output components. For process improvement the focus is on what is produced. Raising process awareness and introducing process improvement will nudge the organization toward an optimal point where there are sufficient processes in place for staff to feel secure but not so much that they feel controlled.

A process map is a device for capturing and communicating knowledge of business processes. It shows who is doing what, with whom, when and how long. It shows decisions that are made, the sequence of events and any wait times or delays inherent in the process. Involving people in the context of process improvement is about assigning responsibility for the processes to staff that perform them and then supplying

the necessary management guidance and support to enable those processes to be performed well and improved continuously. Continual improvement of an organizational entity cannot happen in a sustained way without the active participation of the whole organization. Process mapping needs to be devolved to the process owners and not be a centralized activity. Process improvement should be an intrinsic and pervasive part of an organization.

Text based descriptions of processes tend to be overly complex and counterintuitive. There are many attempts to define what level of detail should be included but the only definition that a manager can understand is one that is written so that a new individual can pick up the job quicker and more comprehensively than without procedures and which can be used by the individuals for future reference. It is best to start by flowcharting because it is a good and simple way of representing processes. While describing processes by text can include more detail; flowcharting provides a visual flow of the processes and sub-processes that produce the product or service. It also reveals any bottlenecks, duplications, unnecessary steps and authority ambiguity that need to be eliminated. There are a number of software tools that can be used to facilitate this process description task.

Managers can then use an overview flowchart to give a broad outline with descriptive text amplifying and giving instructions and advice for each process node. This has the effect of breaking up the task of writing procedures into manageable chunks while allowing an overall control to be maintained.

4.5 STANDARDS AND BENCHMARKING

Simply defined, standards are documented specifications established by an authority, custom, or general consent as a model or example. In short, they describe the important features of a product, service or system. There are thousands of standards in use around the world that cover everything, from the simplest screw thread to the most complex information technology network. Standards can help organizations ensure their products and services are consistent, compatible, effective, and safe. They also help the public understand important safety requirements. Most standards are voluntary - there are no laws requiring their application - but an increasingly competitive market place for goods and services means that more and more customers are demanding adherence to specific standards. Governments also make some standards mandatory by referencing them legislatively or through regulations.

Benchmarking often appears as the mantra of senior managers. Internal and external benchmarking is a characteristic of successful NMSs. With benchmarking, an NMS examines its own business processes and uses an internal and/or an external standard for a performance comparison. Benchmarking is also the process of determining who is the very best, who sets the standard, and what that standard is. Once NMSs decide what to benchmark, and how to measure it, the object is to identify how the winner got to be the best and determine the steps to achieve similar success. Benchmarking is normally part of a larger effort, usually a Quality Improvement initiative. If the NMS doesn't know what the standard is it cannot compare itself against it. Most of the early work in the area of benchmarking was done in manufacturing. Currently, benchmarking is a management tool that is being applied almost everywhere.

Benchmarking has become embedded in the management philosophies of most organizations as part of the way they assess their place in the overall market. Nevertheless, there are many ways that benchmarking can go wrong. A survey of NMSs is not really benchmarking, whatever else it may be called. Such a survey will give some interesting numbers, but benchmarking is the process of finding out what is behind the numbers. In other words, a benchmarking survey may tell the NMS where it ranks, but it won't help it improve its position. Also, it can be the case that the so-called "benchmark" may simply not be applicable to the NMS's particular markets, customers or resource levels. An NMS must insist on identifying its own benchmarking partners and finding out from them what is achievable, and then whether it can achieve a similar level of performance.

Under budgetary pressures NMSs can easily become fixated on the cost of providing products or services that they fail to take the customer into account. Paring down the costs can rebound in lesser service delivery, so customers go elsewhere and ultimately the NMS becomes less relevant. The advice is to take a "balanced scorecard" approach when developing the NMS's benchmarking metrics.

A process is a group of tasks and a system is a group of processes. It is better to select one or several processes that form a part of the total system, work with it initially and then move on to the next part of the system rather than try to come up with one or two total organizational benchmarks. This is especially so since benchmarking presupposes an existing process that has been in operation long enough to have sufficient data about its effectiveness and its resource costs to make a reliable benchmark.

The selection of topics for benchmarking is also critical. Choosing a benchmarking topic that is not aligned with the overall strategy and goals of the NMS, or worse, cuts across some other initiative the NMS is already taking is not advisable. There needs to be some strategic top-level oversight of the benchmarking project and one must make sure that it is in line with the strategic goals of the NMS. Care should be taken to select a topic that is not too intangible and difficult to measure. Instead a part of a topic such as employee communication can be selected that can be observed and measured: for example, the process of memo distribution.

A significant amount of time and effort researching what and how to benchmark specific NMS's processes is fundamental to obtaining a useable outcome Benchmarking assumes that the NMS knows its own processes and its level of performance thoroughly. It is important to make sure that the benchmarking team is very clear about what it wants to learn before it approaches potential benchmarking partners.

It is essential to exercise care in selecting the right benchmarking partners. There is a rule of benchmarking etiquette that says one should never ask a benchmarking partner a question that one should have been able to answer oneself. NMS partners should be clear about what the NMS seeks to learn from them, how that information will be treated, who

will have access to it and for what purposes it will be used. Ideally, this should be part of a formal agreement.

4.6 BALANCED SCORECARD

Balanced scorecard, introduced by Robert Kaplan and David Norton in the *Harvard Business Review* for application in the private sector, is a strategic control methodology which uses a multi-dimensional framework for describing, implementing and managing strategy throughout an organization. It adds value by providing concise, relevant and balanced information which enables clarification of an organization's vision by translating it into a tool for communicating strategic intent and tracking performance against goals. It structures an organization's focus on cause and effect relationships between the four perspectives of customer, financial, internal business process and learning and growth. The customer perspective requires organizations to specify specific customer area and core outcome measures in terms of what the customer values. All objectives and measures in an organization should eventually be linked to the achievement of one or more objectives from the financial perspective. The internal business process perspective requires the organization to identify its critical processes for meeting the objectives in the targeted customer areas. Looking at the learning and growth perspective strategies aimed at superior levels of performance will generally require investment in people, systems and organizational alignment and capability.

The balanced scorecard compels managers to take a wide view by focusing energies, attention and measures on all four perspectives thereby organizations become driven by their mission rather than short-term financial concerns. There are three key success elements in a balanced scorecard: (i) cause and effect relationships – each measure should be a part of a chain of cause and effect relationships the resultant network of which reflects the strategy; (ii) performance drivers – organization and strategy specific; and (iii) linkages to financial measures – all objectives should eventually be linked to financial indicators rather than being pursued indiscriminately. The balanced scorecard methodology entails a series of steps combined into the milestones of: (a) define the measurement architecture; (b) build consensus around strategic objectives; (c) select design measures; and (d) build the implementation plan. In the end the balanced scorecard approach attempts to ensure that the organization's focus is on its vision and strategy.

The private sector attempts to align corporate initiatives with the need to meet customer and shareholder expectations. The public sector or government organizations include customers, stakeholders and employees in their performance management efforts to reach some balance among the needs and opinions of these groups along with the achievement of the organization's stated mission. A public or government organization needs to try to achieve a balanced set of measures in order to know and take into account what the employee requires to meet the stated expectations and organizational objectives.

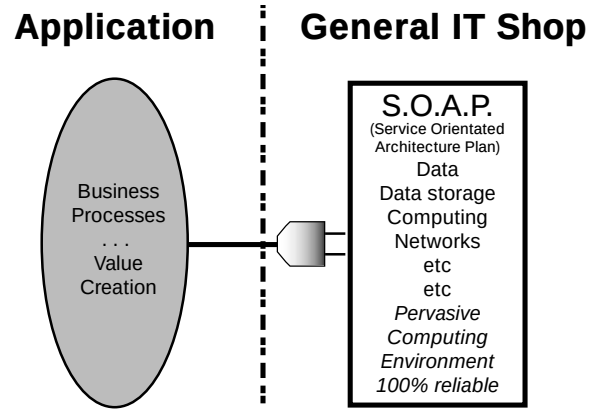
Use of a "scorecard," because it balances both internal and external stakeholder concerns, gives a more comprehensive and balanced picture of how a government organization is doing. The measures traditionally used tend to focus almost exclusively on internal processes and fail to measure the three important areas of the real cost of doing business, the impact of the process on the customer, and their impact on the employees. The use of a "scorecard" provides a "line of sight" focus on the vision and the stakeholders namely, customers, employees, and taxpayers. The balanced measures approach solidifies an organization's focus on future success by setting objectives and measuring performance from distinct perspectives.

Thus there is a need to balance the organizational mission with customer, stakeholder and employee perspectives. This is done by establishing a results-oriented set of measures that balance business, customer and the employee through: defining what measures mean most to the customer, stakeholder and the employee; committing to initiate change by exploiting expertise, broad involvement, a non punitive system and clear guidance on establishment, monitoring, and reporting on measures; and through the maintenance of flexible approaches. It is also done by establishing accountability at all levels of the organization through leading by example; cascading accountability and sponsorship across levels in a performance based organization; communication to and with employees (e.g. intranet) and to and with customers (e.g. Internet); and making accountability work such as through reward mechanisms. Further, it is done by the collection and use of data from customer feedback mechanisms as well as from properly designed and implemented performance measurement systems, and analysis of these data, including a root–cause analysis. This will present a complete picture including open reporting of the results of these analyses. Finally there is a need to connect the dots – that is connect it to the business plan and budget to give real meaning to the people running and affected by the program.

4.7 INFORMATION TECHNOLOGY

Many strides have been made as regards information technology (IT) support to industry as a whole and public weather services in particular. As early as 1985 Peter Drucker defined organization as "a structure in which information serves as the axis and as the central support." Computer-based technology is rapidly becoming as common and reliable as electrical, telephone and other household infrastructure services. In fact, if it has not already, it will soon become a pervasive technology that is required and not an option. The public weather services specialist, in developing an application for a client or the general public requires this utility grade service to supply all his input, output, computation and data storage needs. Indeed, this specialist wants only to "plug-into" these services to develop, operate and deliver his service to the client. Hewlett Packard has identified this pervasive computing environment as part of their Enterprise Strategy. A simplistic representation of this concept is presented in the following graphic.

The growing availability of telecommunications has offered technologies like distributed systems and client-server architecture that facilitate the process of empowerment of the lower levels. In the "informated" organization, workers



are "empowered" by virtue of access to necessary information to perform higher-level tasks. Easy access to relevant information concerning the immediate environment, along with information generated within the system by means of cheap internal information systems, facilitates the delegation of tactical decisions relating to softer information to the grass roots level of the organization.

To take full advantage of the technological capability, NMSs need to change their systems development approach from building "stovepipe" systems to building total organizational integrated shared data systems. Those systems need to rely on modern relational data base technology with standard data definitions and enterprise-wide models to provide the consistency needed for data sharing. An examination of all major software systems used by the NMS is required with goals of reducing the costs of data collection, verification and processing; reducing the costs of systems design, development and maintenance; and improving accuracy, completeness, availability, timeliness and usefulness of information for operational users and decision-makers.

The advance of "Internet-worked" information technology is resulting in a fundamental transformation of governance structures. Indeed, we are seeing a remaking of the relationship between government and the citizen as customer or consumer of public services and between government and the citizen as owner or stakeholder. The transaction costs associated with this relationship are decreasing drastically as the reach and speed of communications technologies increase exponentially and as the tools become more robust. The market is becoming smarter and more demanding for rapid customization of services to meet their individual or group needs. Stovepipe bureaucracies, command–and-control management structures, and stultifying decision-making processes play against the increasing agility and flexibility the market requires. The leverage of knowledge through innovation is becoming critical to economic activity. Lending truth to the real notion of partnerships, networks enable the suppliers, infrastructure providers and the customers to trade, share, and enhance knowledge to build value for mutual benefit.

In an environment continually pressured to reduce operating costs and control public debt and deficits, governments are facing demands for improved services delivered with increasing flexibility and efficiency without having to pay a premium for it. The technologies employed need to be collaborative, immediate, involving and empowering. Thus an adaptive enterprise-wide strategy like the one identified above is becoming essential in order to meet such demands. However essential, these complex and sturdy technologies require significant resources to acquire and implement. Nevertheless the new technologies are knitting government, the market and civil society closer together making governments more accountable to the public, giving citizens greater voice and allowing near real-time participation in government and democratic processes.

Thus, from a business process or value creation perspective, area application development teams need only to focus on that area where they have expertise or competitive advantage. In the IT context it makes little sense for two or more significant IT establishments to staff and build infrastructures supporting non-stop applications environments. This will place strain on building and staff resources thereby resulting in compromises in the quality of the support provided and in the robustness of the IT infrastructures that value creation applications areas of individual business must rely on. It could be further argued that this concept could be extended to the centralization of application development. On the other hand, it could be validly argued that the optimal results in application development efforts in an NMS organization are the results of successful marrying of the skills and expertise of meteorological and IT/coding skills in conjunction with a background in statistics. This results in optimal value creation for the business application area. Too often IT application shops tend to be staffed exclusively by IT personnel lacking application area knowledge and sensitivity. The typical history of NMSs is that the application area produces the most successful and greatest value results when operating in a multi-disciplinary environment.

4.8 STATISTICAL PROCESS CONTROL

The effectiveness and quality are the key ingredients of a successful organization. The more faults a process produces, the higher the cost, and as soon as they affect the customer, these costs increase rapidly. Inspection alone is not enough. A better approach is to prevent these faults initially. The basic premise of statistical process control is that every process exhibits variation. Natural variation, within specifications, is an indicator of a process under control. Measuring, accepting and documenting this natural variation comprise the essential first step which is, in reality, a study of the capability of the process. Criteria need to be established as regards how well the data fits the design specification. The second and separate step is monitoring the ongoing production through sampling and plotting the spread on control charts, employing automation where possible. The control chart identifying a point that is "out of control" indicates a change in the process has occurred and a causal reason needs to be found and mitigated. Like any quality management technique statistical process control requires the understanding and commitment of those involved in the activity including senior management.

Even though every process has an inherent variation, the variation is typically within predictable limits. Any datapoint that lies outside of this predictable limit is an unusual or "special cause" variation that needs to be noticed as soon as

it occurs. There is also a "common cause" variation where causality is from a combination of multiple causes, thus giving a random appearance to the variation. One can use control charts, and various subspecies thereof, to detect both special and common cause variation in a process. All control charts have three basic components: a centreline, usually the mathematical average of all the samples plotted; upper and lower statistical limits that define the constraints of common cause variation (commonly drawn at 3 standard deviations from the centreline – a good balance point between Type I or alpha errors and Type II or beta errors for normally distributed data); and performance data plotted over time. The point of making control charts is to look at variation, seeking special causes and tracking common causes.

Special causes can be spotted using several tests like in the simplest case, graphing the data points and noticing if one or more data points fall outside the control limit. When a process is being affected by special causes of variation, it is called "unstable" or "out of control". Removing special causes when they are harmful or integrating them when they are beneficial is an important part of process improvement. Tracking down special causes relies heavily on people's memories of what made that occurrence different from all the others. Upon spotting the cause the first thing is to limit any damage or problems with an immediate, short-term fix. Next, search for the cause by collecting as much data as possible the first time around, noting details and traceability factors about a sample or recorded event. Once discovered, develop a longer-term remedy to the cause. It is important not to stop when the special cause of variation is eliminated. Rather the next thing is to reduce common cause variation via systematic process improvement.

Variation can be systematically reduced, even in stable processes, enabling gradual tightening of the specification limits, and an overall increase in product quality at lower cost. In stable processes no special cause jumps out, therefore for improvement, all the data about the process needs to be looked at. Amongst the people in and around the process there are enough ideas for improvement to make a significant impact. There are ways to search for and remove common causes of variation such as experimentation and stratification each of which are helped by disaggregating data.

A good guideline for experimentation with a process is the Plan-Do-Check-Act (PDCA) cycle (W. Edwards Deming) which is really an iteration of the scientific method. In the planning stage the problem is recognized and analyzed and possible solutions formulated. In the doing stage the most likely or effective solution is implemented in a test site. The check is used to compare results of the test solution and the original method to see if there are real improvements. Acting involves replacing the old method with the successful solution. The PDCA cycle can be used generally as a process improvement tool and calls for creative/divergent and analytic thinking affording the opportunity to break through paradigms and see beyond the current way of thinking about a process.

Sometimes, common causes of variation can be found using stratification of data making experimentation unnecessary. Stratifying data is essentially the separation of data into categories according to what characteristics are shared. This can be done iteratively, i.e. at one level then within one of those categories further stratified to discover links to root causes. Stratification can be made easier with Pareto charts, bar charts, or pie charts that can display counts of things in different categories. Even a cause and effect diagram could be used to build a tree of branching characteristics, each one being stratified further and further until root causes are reached.

Both stratification and experimentation can be helped by disaggregating the process and viewing its components individually. By studying the components separately a problem that exists in one component but is covered up in the whole can rise to the surface. In disaggregating, the parts that are being viewed separately must still be aligned toward the same shared goal and focused on serving the next step in the process. Disaggregating is about bringing pieces into view rather than actually separating them and relies heavily on regular meetings between managers of the different parts of the process so that the pieces can be discussed in the context of the whole system.

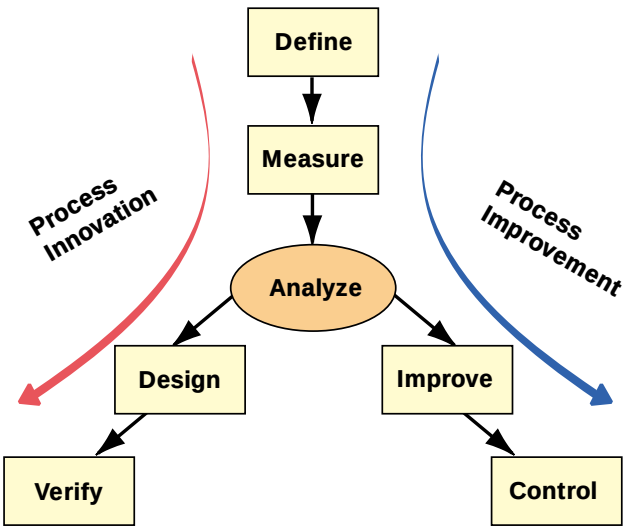
Finally, software tools for statistical process control are abundant and can be adapted to be of use within an NMS context. Before firing up any such software, however, a few points need to be kept in mind. Understanding the aims of the study is the most important stage in the pre-analysis process. Therefore the study design needs to be clear, the target population defined and the sample population chosen from it. Especially for process observational studies the main and target parameters must be defined. A control group is a necessity and proper selection is important. Avoidance of biased results needs to be pursued through techniques such as proper randomization. Finally certain types of data gathering should be left to subject area professionals.

4.9 SIX SIGMA

The term ISO refers to a set of quality management standards which are process standards not product quality standards even though such a series of standards represents a framework under which the process improvement might take place. Six Sigma is a managerial philosophy for business improvement. It is characterized by statistical measures of success, a problem analysis methodology and a business culture that aligns the organization around a common set of goals which are evaluated using measures of productivity, cost-effectiveness and quality.

The statistical measure for Six Sigma is the standard deviation of a performance measure with six representing virtual perfection in a process as a result of flawless execution of well defined work procedures. The improvement measurement used is one that achieves consistently high performance in a characteristic that is critical to a product or service quality as defined by its customers. From a meteorological perspective a 6 Sigma target might be that the current day maximum temperature be correct plus or minus 3 degrees Celsius. This is to say that plus and minus 3 degrees Celsius are the six standard deviation limits of the temperature accuracy distribution. This would mean that only in 3.4 cases out of a million would the difference between the predicted temperature and the actual temperature be outside these limits.

The problem analysis methodology encompasses either a problem solving process or an innovation process that are designed to work together to achieve sustainable performance gains. The problem solving process is illustrated by a series of steps leading to the right hand side of the graphic below while the innovation process is represented by the steps leading to the left hand side of the same graphic. The lead executor of the problem analysis methodology serves as an analytical catalyst for a business team to solve its own problem or to create a new approach to conducting business or serving customers. Statistical and graphical tools are used to identify sources of variation in the business process that keep it from consistently achieving the desired result. Thus, the practice is that of designing quality into the product or the process to meet customer needs and implementing a disciplined work process that delivers the product or service according to that quality standard.



The third component is a business culture that emphasizes motivation of teams to work on common problems to achieve higher levels of performance effectiveness and productivity at lower cost. Training and selection of project leaders, training and engagement of business leaders, and the selection of projects are critical dimensions of success in the business improvement exercise. Business leaders provide a blending of business analysis and process analysis to the problem solving process for sustainable changes in the way the organization works to benefit the customer.

As is the case with other similar quality management approaches a key challenge is the establishment of the key drivers in improving performance and creating a competitive edge. Along with these drivers it is necessary to identify and prioritize the most profitable high impact initiatives. It is essential to ensure that they fit with real business needs. Accordingly, it is crucial to define, develop and implement a business process management system that delivers great results where the business needs them.

The proponents of Six Sigma indicate that it works because it focuses on specific, scaleable improvement "projects"; uses dedicated resources; is supported by engaged management; follows a practice of management by fact and data; defines clear accountabilities; uses efficient advanced tools; and employs a specific breakthrough roadmap. The need for something like Six Sigma is evidenced by the fact that about half of all problems are recurring problems. As opposed to a reactive strategy a preventative strategy can reduce the amount of "fire fighting" activity.

Often problem solving methods are ad-hoc due to a lack of or inaccurate data and tools and inadequate problem definition and prioritization. As can be expected entities adopting Six Sigma employ a lot of the same tools used in other quality management approaches such as statistical process control/improvement tools.

For organizations wishing to further investigate Six Sigma and its applicability to their organization it is suggested that they investigate entities such as any of the quality assurance institutes or any other source of the wealth of information that exists in documents, journals and on the web.

4.10 SURVIVING THE UNEXPECTED SHUTDOWN

Citizens and businesses rely on access to public weather services 24 hours a day and seven days a week. By its very nature a break in the availability of public weather services occurs when those services are most needed, that is, during inclement weather. All NMSs need to structure their organization and service delivery mechanisms in such a way as to avoid breakages in the availability of services and if such breakages are unavoidable then they need to strive to minimize the duration of the breakage in the availability of service. An NMS needs to discover what risks need to be avoided; closely examine processes, policies and procedures to ensure requirements are met; develop an awareness of what processes actually impact the essential services provided; and develop an appreciation of the NMS continuation plan as an integral part of the business plan. Disaster recovery is planning ahead to avoid problems and being prepared in the event a problem occurs. It consists of business planning and preparation, business systems and technology preparation, and incident response planning.

The key to surviving shutdown risks is to plan accordingly and create mitigating actions in case one actually occurs. There are risks that affect the physical facilities or environment, that affect the health, safety, or welfare of personnel or general public, and risks that affect operations. A business impact analysis will help understand the degree of potential loss which could occur. Such an impact analysis should include financial impacts, operational impacts, extraordinary expenses in continuing operations, current state of preparedness, seasonal impacts, technology requirements for resumption and recovery, other special resumption and recovery resources, and an information systems support for resumption of time-sensitive operations. The data gathered in such a process is pivotal to identifying key issues and justifying resources needed to mitigate risk. The resumption sequences, potential delays or service postponements need to be documented and endorsed by the senior management of an NMS. A crucial component here is the establishment of a method or rating system for grouping operations, processes, and application systems on the basis of their importance to the overall function of the organization. Such a method expresses the maximum and minimum time the organization can withstand an interruption of the particular operation or application system.

Chapter 5
CHANGE MANAGEMENT

Human beings are by their very nature problem solving creatures. From a rational analytical perspective a problem is nothing more than a situation requiring action but in which the required action is not known. Accordingly, 'problem solving' is the activity of searching for a solution: a course of action that will lead to the solved state. While the impulse to resist change is there, it is principally there when it is someone else's change that is being imposed on a person or group of people which conflicts with their existing structure, domain or paradigm. People resist change due to lack of information, lack of a shared understanding of the problem and discomfort with the problem-solving style of others. Just as societies are learning to live and prosper in an environment of increasing diversity of people, in an overall global context with organizations individuals need to work effectively with a diversity of thinking styles. In short, the modern organization needs individuals who think both inside and outside of the box. Indeed what is required is to build a climate and a culture of innovation.

For NMSs change management ranges from structural and organizational change of various portions of the total organization to controlling the gradual evolution of certain meteorological programs. Some general theory and issues associated with the more dramatic organizational change are discussed below. From the latter perspective, within NMSs, increasing cultural diversity and especially evolving technology are providing the thrust for increasing evolution of the public weather services program. More and more the end-user receives his or her forecast and weather observation information in different forms and formats and the understanding of the content is highly influenced by those forms and formats. Increasingly the forecaster is producing elemental forecasts that are transformed into products through automated means. These products take a variety of audio, visual and textual forms each with their unique communication advantages and disadvantages.

An obvious example of this is the standard setting activity for forecast products of an NMS. There is a need to set and adhere to very specific standards for things like the classic public forecast products since the choice of a word or term triggers a specific icon on a web page display, a specific translation in a translation program, a particular digital voice file which in turn triggers certain transmission technologies which, in some cases, are burned into the firmware as part of those technologies, etc. The message here is that the interconnected natures of the "system" through automation technologies dictate that some controls need to be placed on the very choice of the individual words and phrases that comprise a public forecast. This means that anytime a change is contemplated a process must be in place to ensure all potentially affected people, systems and technologies are taken into consideration and for the most part accommodated in the implementation of such changes.

5.1 WHAT IS CHANGE MANAGEMENT?

One definition of change management is that it is the task of managing change which, in turn, implies making change in a planned and managed or systematic fashion with the aim of effectively implementing new methods and systems in an ongoing organization. The drivers for changes can be within and controlled by an organization or the changes could be in response to an 'environmental situation' over which the organization exercises little or no control, e.g. budget reductions.

The change process can be described in a variety of ways. One can think of the process as in Kurt Lewin's change theory as an unfreezing, changing then refreezing of systems in an initial state of stability. Many changes find their origin in some dissatisfaction or frustration with an existing situation which becomes manifest in some form of anxiety. Change is stimulated when the combined effect of this disconcerting anxiety, a vision of what is possible in the future and the force of some positive first steps towards reaching this vision balance or exceed the anxiety that might be brought to the forefront by moving to a change target. In this situation an unfreezing takes place and openness to learning and change begins. The focus becomes one of results, of prioritizing choices, and of keeping participants from feeling overwhelmed. The art of change management lies in the various tactics that change agents employ to create employee psychological safety. Also, it must be remembered that the degree to which cognitive redefinition takes place in employees is a function of the extent to which the change solution fits the employees' personality or culture. Once this congruence occurs a refreezing to the new status can occur. Learning moves from the individual or unit to the whole organization and the responsibility and accountability moves from senior management to a mixture of senior management plus the whole system.

A problem solving context is often applied to the change process in that managing change is seen as a matter of moving from one state to another, typically from a problem state to a solved state. Normal steps of problem analysis such as goal setting, alternative generation and evaluation, planning, obtaining buy-on, support and commitment etc. form parts of the process. The change process can also be thought of as one where the future state is known, the current state is to be left behind and the change problem is some structured and organized process for getting from one state to the other. This usually includes identifying the differences between the two states, determining ways of eliminating these differences and putting into place operators which effect the elimination of the differences. Alternatively the change process can be defined along the lines of how, what and why in an ends-means centred process. Finally the change process is a function of where the manager is within an organization as functional areas have their unique functional attributes. Typically large organizations have the three broad

dimensions of (i) core units characterized by responding to the 'how' question through standardization and adherence to routine, (ii) buffer units that buffer core units from environmental turbulence through planning activities answering the 'what' questions and (iii) perimeter units such as customer service which respond to the 'why' questions.

5.2 ORGANIZATIONAL CHANGE MANAGEMENT SKILLS AND STRATEGIES

Organizations as social systems require first and foremost political skills and people skills. Furthermore, Organizations as complex technical and financial systems require analytical skills, systems skills and business skills. Change management must exploit all of these skills for effective results.

The specific strategy employed depends on the circumstances. In an environment of strong resistance to change the exercise of authority and a staged transfer of the individual from the old state to the new state may be the appropriate path. Conversely, if only weak resistance is evident then effective communication of information and incentives would smooth the path to redefining and reinterpreting existing norms and values and developing commitments to new ones. If the stakes are high nothing can be left to chance meaning all tools need to be available for successful implementation. A short time frame and/or the absence of adequate expertise at making change may dictate an approach of exercising more authority. In contrast, a longer time frame and the availability of expertise could mean that a more people- interactive approach would suffice. The degree of dependency of the organization on its people or vice versa will also influence the strategy employed. Most knowledge-based organizations, such as NMSs, are characterized by mutual dependency which would imply the requirement for some level of negotiation.

Change management is generally characterized by engagement and volunteering, a clear sense of mission or purpose, team effort (recognizing that, in reality, team effort is the coordination of individual activities for pragmatic ends), generally a flat team structure, relevant but dispersed skills and high energy, configured response as opposed to preconfigured routines, and often flexible priorities including temporary measures and freedom of action.

5..3 THE IMPACT OF CHANGE ON PEOPLE

Changes, especially changes to technology, require attention to the impacts they have on both process and people. Human change is a profound and dynamic psychological process that involves painful unlearning without loss of ego or identity and difficult relearning as one cognitively attempts to restructure one's thoughts, perceptions, feelings, and attitudes. Change management is the process of aligning the organization's people and culture with changes in business strategy, organization structure, technology and business processes. Since changes invariably involve some loss to some part of the organization or to some people the change process has a tendency to elicit an emotional response which shifts the employees' focus from the business to transition issues. Failure to account for the impacts that change has on people in the organization can result in increased resistance to new technology, decreased quality and customer service, high turnover and absenteeism, difficulty in recruiting and retaining high performers and damaged internal and external brand equity.

The objective of change is the realization of business transformation objectives, higher return on technology investments, retention of high performers, maintained and improved productivity and improved employee satisfaction and morale. Effective transition leadership serves as a catalyst, a system and process helper, a solution giver and gatherer and a resource linker. Such a leader has several attributes such as: taking accountability; providing clear direction; modelling the way for the team; building relationships with customers, peers and the project team members; communicating openly and frequently; inspiring and motivating while providing constructive feedback; and creating opportunities for wins along the way.

5.4 CONTROLLING GRADUAL EVOLUTION OF PROGRAMS

The less dramatic, mundane evolution of programs in an NMS also requires an application of change management principles. Here the change process can be more incremental as opposed to fundamental and organization-wide. Nevertheless, many of the aspects of strategic direction setting, action planning and broad participation still apply. The example cited in section 4.7, of weather forecast and weather observation information is a manifestation of the convergence of the computing and telecommunications technologies and how individuals from both the service supplier and service user perspective use those technologies. The merging of formerly disparate technologies with different managerial traditions and the problems of managing each dimension in this interconnected reality calls for a major reappraisal of the organizational structures and management processes. Indeed, information technology is resulting in a dramatic decline in coordination costs leading to more technically coordination-intensive business structures that allow effective management of previously disparate functions. Managing and controlling the gradual evolution of components of a meteorological program requires open systems thinking to comprehend the increased interdependencies between the system and its environment and between the various parts of the system. Recognizing that environmental dependency inhibits an organizational unit's ability to function autonomously, the organization must manage such dependency to survive as an independent entity.

On one hand, the empowerment that comes with easy access to information from distributed systems and client-server architectures has facilitated a dynamic and complex environment driving the organization structure to a more organic state. Such an organic state with sophisticated technical systems facilitates flexibility, product differentiation and quick responses through networks and is characterized by flexible systems of projects and teams. On the other hand, organizations structure themselves to minimize coordination

costs by grouping activities to achieve the benefits of process specialization, supporting task predictability and generating a decreasing diversity of outputs. The reduced differentiation and increased integration of activities reduce human coordination costs which are replaced by cheaper information technology and "automated" coordination. To survive effectively, the adaptive organization forms real cross organizational alliances bringing together competencies and technical alliances aligning standards and protocols. These inter-organizational linkage channels are becoming necessary conditions for doing business. Thus, returning to the initial example of forecast product standardization, both in the obvious textual sense and at the meta-code level, the results of this activity facilitates the across system coordination for speedy and effective delivery of the service to the end user. The necessary control mechanism for change management then is the methodology employed for the standardization of that multidimensional forecast product which is the collective result of input from all components of the value chain involved.

Chapter 6
CONDUCTING PUBLIC EDUCATION AND OUTREACH PROGRAMS AND MEASURING THEIR SUCCESS

The measurement of success in public education and outreach represents a particular challenge for NMSs. Conducting formative evaluations while a program is underway and follow up evaluations to monitor program impact maximizes a program's success and effectiveness. Results can and should be measured effectively. Such evaluations can provide sufficient data to assess whether target audience increases in knowledge, behavioural and attitudinal change. Through these results, education and outreach programs can be changed and improved. Quantitative measures can provide only limited information on such outreach. Qualitative evaluations can often provide greater insight. As Lofland (1971) explains: "In order to capture participants in their own terms, one must learn their categories for rendering explicable and coherent the flux of raw reality". Creative and exiting uses of qualitative evaluation, story telling, personal descriptions and other methodologies help us understand raw reality and give credence to the value of education and public outreach.

6.1 PUBLIC EDUCATION AND OUTREACH

The meaning of the term 'public education' is easier to define than that of "public outreach'. Education involves the transfer of information resulting in the acquisition of knowledge that will allow the learner to make decisions based on the knowledge that they have acquired. On the surface public outreach tends to focus on the output of information rather than the actual acquisition of knowledge, yet to be effective, that knowledge needs to be acquired. The not-so-simple act of pushing out information must have a purpose. The acquisition of knowledge and its effectiveness in changing behaviour is a function of how, where and when the information is pushed out. Public outreach can be used for both matters of short duration concern and concerns of longer core program duration. It involves ways of reaching out where the public is 'tuned in' to hear, see, and/or read. It reaches beyond a select group of learners and brings information to a much broader audience. Public outreach engages potential learners and encourages knowledge acquisition. Another very important dimension of public outreach is that of bringing knowledge of client needs, perspectives and expectations into the organization, to inform policy and shape the services the NMS offers. Accordingly, the aspect of changing behaviour of staff and managers within the organization applies as well. Education and public outreach can be perceived as being along the same continuum of audience accessing and processing new information. where as public outreach fosters a sense of interest and awareness in the information and in the opportunity for knowledge acquisition, education moves the learner further along the continuum to a point where the learner can make decisions based on the interest and knowledge acquired. The ultimate aim of both is the shaping of human behaviour.

6.2 MEASURING SUCCESS IN PUBLIC EDUCATION AND OUTREACH

The desired attributable outcomes for most outreach activities are sustained changes to behaviours, practices and actions. These can come several months to years after the outreach activity has been initiated. The response to the UV index program is an example of a behaviour change that was years in the making and a fairly successful one. Some behavioural changes can take a generation or more. Sometimes cross generational influences effect the behavioural changes. There is also some truth in the old adage of teaching the children who, in turn, teach their parents who may be the main target group.

Indicators of behavioural change can include observed physical behaviours, practices and actions; observed and recorded policies, protocols and practices; and self-assessed (such as through surveys, etc.) practice and behaviour. Prerequisites to behavioural change can include changes in knowledge, attitudes, skills, aspirations and values. This readiness for or capability to change can be indicated by demonstrated capabilities; preparatory actions; and self-assessed (via a means like a survey) learning, attitude or perceptions and the level of recall of key information. The actual behavioural change is evidenced through feedback and demands for service.

If a NMS wishes to know how well its public education and outreach activities are performing and satisfying its customer needs, it is essential to establish a basis for measuring this performance. Quantitative evaluation, which uses statistical procedures, enables the expressing of established performance goals in an objective, quantifiable and measurable form. Such methods have not been able to establish valid performance measures in terms of behavioural evaluation and change. Qualitative evaluation measures, by gathering descriptive and anecdotal evidence, tend to be more responsive and can uncover information that can help ensure that the program being evaluated is meeting its prescribed goals. Non-traditional qualitative evaluation results can provide the best rationale for continuing a program, can describe the effectiveness of the program, and can provide program implementers with information on the level of interest raised and the knowledge acquired. With the proper structure, qualitative research allows for broader exploration of the participants' perspective which is valuable in assessing knowledge acquisition, behavioural change and eventually program effectiveness. A NMS will also want to know about

the customer support for the program and the strengths and weaknesses as perceived by the clients. Thus, what is needed is an evaluation methodology that will provide the rigorous, definitive data necessary for the measurement of the program effectiveness.

The first stage of evaluation is carried out at the very early planning stages of a public education or outreach program. This includes defining the intended outcomes, i.e. what the learners should be able to do and understand as a consequence of their learning. Evaluation needs to be carried out during the development stages of the program, product or activity. This allows the making of adjustments to ensure the program is achieving the intended outcomes and goals. Finally, evaluation must focus on the results of the effort to determine whether it was successful or whether it needs modification. Multifaceted evaluations, quantitative and qualitative, are required using a variety of instruments, techniques and opportunities to uncover data. Methods of evaluation include focus groups, surveys, observations, follow-up interviews, pre and post testing, debriefing meetings, field observations, in-depth interview protocols, telephone interviews, and other techniques. For web-based outreach material an on-line evaluation format can be used to gather even anecdotal information. Quantitative evaluations can measure changes in knowledge and attitudes but tend to be weaker in the case of behavioural changes where the inclusion of anecdotal evidence is of great assistance in gauging change and effectiveness.

Accordingly, best practices for evaluation of public education outreach programs can be considered to include:

- Establishment of a set of evaluation criteria for public education and outreach programs;
- Evaluation needs to be a key part of the program's work plan, about 10% of the budget;
- Through pre-testing or by some other means a baseline of pre-program level of knowledge and understanding needs to be determined;
- Both quantitative and qualitative evaluation methodologies need to be employed;
- Evaluation needs to take place at the early planning phase (where clear measurable outcomes or objectives are postulated) , the development phase as well as the post implementation phase of the program; and
- The results of the evaluation activity need to be communicated and incorporated into program adjustments after review.

6.3 THE NMS CONTEXT

Focusing more specifically on the reality NMSs typically find themselves in, the broad objective outreach is to enable NMSs to take measures that will enhance customer satisfaction. Due to the very nature of the business the outreach and public education programs of NMSs tend to be more on-going or sequential as opposed to limited term project oriented. This has implications on how the program is carried out and evaluated. There are at least two broad categories of outreach and public education: a) the "hands-on" approach practiced daily by the outreach staff and others such as the warning preparedness meteorologists and b) the "remote" approach where an outreach service is provided and measured remotely. The "hands-on" approach describes the direct relationship between NMS staff and individuals from the supplier and user communities. In contrast, the "remote" approach is where an outreach service is provided and measured remotely and its effectiveness measured through some remote means.

There is a need to enhance the close relationship between provider and user, to ensure that users' needs are being met, and for both to better understand the capabilities and requirements of each other. A closer relationship can enhance the satisfaction of the users, who feel that the provider cares, who appreciate having their needs listened to and addressed, who will thereby receive a higher quality of service, with benefits in both safety and efficiency, who have a better understanding of how services can be and are provided, and of the significant overall infrastructure which is required to support their needs. The closer relationship can also benefit the provider, by having satisfied customers who appreciate the services provided, through higher job satisfaction when the staff know through interactions and feedback that their efforts are valued and their services "make a difference", and through a deeper understanding of the needs of the industry which stimulates the desire and determination to provide an even better quality of service.

Customer liaison and consultation is an important component of outreach. It is the responsibility of all managers to set the tone and emphasize the importance that should be attached to working closely with customer. This is especially true if the providing office is remote from the user and this can be done in formal and informal ways. More formal, multilateral, liaison and consultation meetings should be organized together with representatives of user groups. The meeting provides a forum to discuss the service and latest developments, potential future developments, etc. from both the customer and the provider viewpoint, to review the quality of the service, to review and update service specifications and to cover other things such as policies. In addition to multilateral meetings there can be regular formal meetings with individual customers and service providers to provide an opportunity to discuss on a one -on-one basis any issues concerning the supply of meteorological services with a focus on matters of particular interest to individual customers. Such one-on-one relationships can greatly assist providers in being able to respond rapidly to changes in the meteorological requirements of individual customers.

Event-based interactions with customers, such as is the case for some of the activities of warning preparedness meteorologists, are effective "heat-of-the-moment" outreach opportunities which, if addressed systematically with defined processes for gathering, storing and processing information, can yield information that leads eventually to improvement in the services provided. An important part of the overall interaction with the customers is for there to be feedback on the quality of the services. Any complaints or compliments should be formally recorded in a book or other register and made known to staff together with details of any action taken, any further investigations undertaken, and recommendations for improvement. It is worthwhile to analyze compliments

and complaints to look for trends, etc. The ISO 9001 key principles and implied process steps that apply here are those of adherence to an appropriate process that yields the desired results. For assessment, it is necessary to focus on the measurement of the effectiveness of the particular "hands-on" activity. The involvement in this category of outreach activity and its assessment is spread throughout many parts of the organization. Moreover, a critical component of the "hands-on" approach is one that includes interaction with those within organizational entities that can potentially use the information as part of a continuous improvement process (Did they get the information? Did they use it? Did it help? Have an "interview the production manager" date!). Both quantitative and qualitative evaluation techniques can be employed here. The hands-on approach is particularly suited to the collection of anecdotal evidence.

Looking at the "remote" approach, clearly the evaluation methodology, while possibly common across several "remote" outreach activity types, will be a function of those activity types and, perhaps the programs they support. For assessment, here, it is necessary to focus on the measurement of the effectiveness of the particular "remote" activity. In these cases the ISO 9001, key principle of a system approach and a process approach are particularly applicable. Thus each outreach activity or at least every activity area should include an evaluation component that is executed as part of the outreach activity.

If, for example, one focuses on static webpage's on the world-wide-web, in which all modern NMS organizations are currently heavily investing, each page or group of pages has an "owner" whose objective is to communicate something to engender some understanding and acceptance of the issue presented. Organizational resources are expended in the provision of that information and some appreciation of the return on that investment is required if the organization is to achieve its program goals. It is not feasible to measure the effectiveness of each web page but the measurement of one page produced according to a certain style and standard can be an indicator of the effectiveness for other pages produced according to that style and standard. Accordingly, for such static web pages the strategic use of mini pop-up surveys for a few web pages can produce intelligence on this particular outreach methodology. One can even insert an option for the inputting of valuable anecdotal evidence through this means. Other traditional performance effectiveness measurement activity such as surveys and focus groups can be used for assessment of the effectiveness of web page outreach efforts but these are less immediate and rely on recall making the information derived less reliable. These techniques are better suited for customers that cannot easily or immediately be pinned down.

A popular, however traditional, group of outreach techniques employed are those associated with fact sheets, posters, wallet cards, press releases, and advertisements. Where the end recipient or recipient representative can be readily identified a more "hands-on" sensing approach can be used to gather intelligence on the effectiveness of the tool. Frequently, however, this is not possible so some "remote" measurement approach is needed to gain intelligence on the effectiveness of the tool employed. Also, some surrogate indirect data can be used to extract hints on outreach program effectiveness. One example might be schools requesting, receiving and distributing wallet cards on "minutes-to-frostbite" which would provide indicators of the acceptance of the particular tool employed.

Of course a "talking head" or spokesperson or subject area champion can be a most effective outreach tool and the measurement of recognition as a credible source may be the appropriate approach. There could be a variety of methods for undertaking this measurement from pure "remote" approach to something like the measure of the frequency of recall by the media community.

At some point, given the limited availability of resources, one has to decide which outreach tool to use for a given weather services program component in a given user community. While program and user specific expertise can help, the decision ultimately is a combination of a "gut feel" and prior hard experience of what worked before. And, of course, conclusions on what worked before are drawn from the various measurements already undertaken of the specific program area activity effectiveness.

One important consideration is that there is no and will be no one single measure of the effectiveness of outreach of an organization. Further, one must be cautious about attributing measured satisfaction, understanding and response changes in the user community to outreach activities undertaken. Indeed, improved understanding of the hazards posed by severe weather and the user behaviour and response to severe weather information and warnings can be the result of something other than the outreach efforts of a meteorological service. This is not to say that syndromic surveillance methods should not be used. They should be used and can provide indicators of a gap, fault or undocumented need that a meteorological service can satisfy through improved or additional services. They can even suggest that the outreach support activity for a certain program area or for a component of the user community for a certain program area may be inadequate or absent. Regardless of the "remote" measurement methodology employed, expert help from disciplines such as psychologists, sociologists, economists, etc. provide further insight when analyzing the collected data.

In the final analysis the evaluation of a public education program or an outreach strategy should recognize the purpose of the outreach activity, delineate the set of current and potential outreach activities by type, define how the effectiveness of each type could be measured in a systematic and due-process manner, define a policy framework - organizational orientation within which outreach and its measurement is to be accomplished-and finally, identify those tactical thrust areas and steps achievable in the short to medium term.

Chapter 7
PROCESS IMPROVEMENT IN GOVERNMENT ORGANIZATIONS

It is a popular belief that government services are considered to be of poorer quality than private sector services. This negative view of government services is supported by very little hard evidence, but it lessens public esteem for government institutions and services and erodes morale within the public service. The actual perception findings counter this popular belief indicating that public sector services occupy a wide range along the quality service continuum. Indeed, those public sector organizations that follow a process improvement path with the client in mind often are perceived to be of higher quality than that often found in the private sector.

All too often, however, the public sector senior management cadre is seized by a variety of "paint-me-a-feel-good-path" initiatives such as reflected in the classical government-wide service improvement initiatives. Such initiatives get at parts or only service end-points of the total system when they really should be looking at the total system comprised of processes. In short, a process approach is what is required as opposed to a functional approach in the increasing technically interconnected new organizational reality of NMSs.

7.1 A CASE FOR PROCESS IMPROVEMENT

Like the private sector, government organizations have a bottom line and for most, it is their mission: what they want to achieve. To achieve that mission an organization must incorporate the roles of customer, stakeholder and employee in its day-to-day operations. Today, the competition for scarce resources is driving the need for NMSs to demonstrate cost efficiencies and value for the resources. NMSs must not only operate with dwindling resources but must also contend with a public frustrated with their efforts. NMSs must find a new way to work: they must reengineer or improve their processes for results. Process improvement is also about creating a better place to work. Despite the cynicism with which government is viewed from the public it is filled with people who serve the public often with more than a little altruism. Process improvement in the NMS is not just about cost reductions or about budget cuts. Process improvement is about the NMS providing dramatically improved services that are competitive with the private sector. NMSs within governments are learning organizations. They need to learn, grow, change, and be receptive to change. What does make sense to them is analyzing current business processes and making sure business processes work for the customers.

To build a business case the NMS must have necessary and sufficient business (mission delivery) reasons for reengineering or process improvement along with the organizational commitment and capacity to initiate and sustain reengineering. It must also secure and sustain political support for reengineering. The successful NMS will find that the political case must be made as well, by constantly identifying, analyzing, and addressing the current and future issues and needs of political stakeholders. Budget and personnel pressures are strong motivators for fundamental process change. If there is a consensus from several sources of information, such as results from customer surveys, audits or performance evaluations, and meetings with suppliers or other involved stakeholders that document and emphasize dissatisfaction with agency products and services, then officials and employees cannot ignore the message that processes or sub-processes are broken. A senior leadership mandate for change, sometimes aided by benchmarking against other NMSs or similar organizations, can provide the spark for process improvement or reengineering. Finally, the overall government environment can provide strong pressure for change.

Moreover, NMS commitment and capacity is required to support process improvement bearing in mind the "old baggage" of past reform activities. Capacity considerations include funding, internal skills, access to tools or expertise, and the ability to absorb new or continued process improvement efforts at the same time the NMS meets other demands. In a political context, where government organizations such as NMSs are often given contradictory missions and objectives, the choices resulting in social goals require officials to act not only with efficiency, but with fairness, openness, honesty, responsiveness, and accountability. Finally, NMS process improvement frequently calls for partnering with other organizations who deliver products and services to common customers.

7.2 A PROCESS APPROACH

To be successful in making a quality improvement the improvement effort must manifest itself within the actual way the NMS is doing business: that is the NMS needs to adopt a process management approach as a core element of its organizational culture. The improvement cannot be a separate activity outside the process of how the NMS is doing business. Here, process management replaces functional management. In line with the NMS's mandate it needs to set clear and unambiguous mission, specific directions and goals cascading down to process-specific goals and decision-making across and down the organization. This means that the NMS needs to define, model, and prioritize business processes important to its mission performance. These must be communicated at every level of the organization. Care should be taken at the initial stages of launching the idea through an extensive introduction campaign. To be successful, NMSs should start by identifying the processes (normally fifteen or less) key to mission performance across the organization. This step is difficult as most managers and staff have little experience with a business process orientation. Identifying and defining business processes

important to the NMS and its success must be done from the top and accepted by the rest of the NMS. High level process modeling means simply putting each process and key sub-processes on one or two pages in a flowchart schematic. The individual process modeling includes key sub-processes and activities, showing inputs and outputs, and identifying process products and services for customers. High level models can serve as visual business plans because they explicitly define an organization's mission, how that mission is accomplished and reveal areas where the NMS is weak on strategy. Models show where processes cross unit or functional boundaries or extend outside the NMS, where others are involved in delivering products and services to customers, and highlight opportunities for process improvements.

As core to their organizational culture senior managers must "own" the process improvement through personal responsibility, involvement and decision-making and must "adjust" organizational structures to better support process management initiatives and finally "create" an assessment program to evaluate process management. The NMS leadership have the responsibility to: set strategic directions and performance goals for process improvement; identify key business processes and prioritize them for improvement; do regular reviews of key process improvement; develop process models on an ongoing basis; provide a channel for policy and legislative issues; provide process improvement sponsorship and resource support; provide guidance for process improvement projects; mediate unresolved turf issues/disagreements; and coordinate various improvement projects. Top management, through executive committees and process owners and sponsors, must continually assure process improvement teams that their own commitment to process improvement is unwavering.

A successful NMS will have another leader to serve as the day-to-day "point person" for the details of improvement efforts with the responsibility to: be accountable for improvement of an assigned process and related sub-processes; provide a decision-making bridge to the NMS's executive committee; lead project steering groups if one is assigned; select and manage individual project improvement teams, including resource support; provide a specific charter and deliverable requirements for teams; manage external relationships such as to legislative and oversight bodies; and ensure that a cross-functional, cross-boundary focus is maintained, resolving issues as necessary.

A typical cycle can be perceived to include the following logical sequence of steps:

1. With respect to mission, establish a good understanding of the business and functional requirements for the process under study;
2. With respect to meeting the above referred to requirements, an assessment of the current status of all process elements (process, people and technology) is required;
3. With respect to process, data, organization, and technology, it is necessary to establish what the actual baseline is;
4. Stakeholder interests in the process need to be identified and quantified;
5. New standards of performance, and design measures and key indicators need to be established;
6. Next is the need to identify potential improvement initiatives that will raise the process performance to the desired level though conducting an improvement analysis program;
7. A change management program needs to be designed such that it will address organizational and technical issues in order to align improvements in these elements with potential or planned process improvement;
8. This is followed by the development of a process vision and the construction of models of the desired versions of process, data, organization, and technology based on the vision and improvement initiatives;
9. The identification of alternative means of achieving this desired future state is a logical next step; followed by,
10. The performance of economic and risk analysis on all alternatives and the selection and documentation of a recommended course of action;
11. Perform enterprise engineering to construct an organizational and technological platform suitable for the improved, redesigned, or reengineered process consistent with the NMS's own improvement methodology and established standards;
12. This is followed by testing (prototype or pilot), implementation, deployment, operation and maintenance of the improved process and supporting systems and;
13. Evaluation of the process, updating of baseline models and preparation for the next cycle of improvements.
14. Finally, while it is not an entitlement, the process improvement culture is reinforced through an appropriate reward mechanism.

Only a strong organizational culture with determined management and a controlled feedback mechanism will ensure the effective implementation of the quality improvement system.

7.3 PERFORMANCE MEASUREMENT

The continuous measurement and tracking of performance is essential. Up, down and across the NMS there needs to be an understanding of the value of measurement and how it will be used. Further, performance management needs to be tied to the current and future expectations of the customer or stakeholder. It offers the only way for NMSs to assess whether the desired results are achieved, and if further process improvement is needed.

Performance management builds on manager and staff understanding of the value of measurement and how it will be used. The measurements must be realistic and appropriate to the situation. Performance evaluations which reflect process goals and teamwork within processes reinforce employee behavioural changes. Individual worker productivity is not singled out for criticism; instead how the individual makes a contribution to team goals and outcomes is emphasized. The specifics of mission delivery can be lost on employees if the NMS does not establish measurable goals or measures too many things.

As a benchmark an NMS needs to set a baseline for each of its performance measures, based on three or more years of historical data. That is, a measurement period most often needs to precede the setting of a benchmark which must be realistic to the specific process area and not just off some foreign shelf. Further, an NMS should set progressive performance goals (moving performance targets up over time as the NMS meets earlier goals) as a valuable tool in overall process improvement and a strong catalyst if ambitious goals must be met in a relatively short time period. Good performance measures should continue to be relevant to process performance indicators before and after a process improvement initiative. More importance should be attached to external or mission oriented performance measures versus indicators support and management processes.

The reality is that NMS programs cannot satisfy all customers and stakeholders equally in terms of performance targets. In addition, NMS officials have to contend with the general public, a customer whose expectations can be vague. Often, an NMS is motivated to undertake process improvement initiatives by evidence of a performance gap between actual performance and customer expectations. To bridge this performance gap extensive communication with customers and stakeholders is needed to determine what the performance problems are and how well the NMS is doing to meet its performance expectations. The NMS needs to find out what business processes should deliver as final products and services, what performance levels should be, and what suggestions customers and stakeholders have about factors that might enable improvement. The methods for securing customer and stakeholder input vary ranging from customer and employee surveys and focus groups, to interviews with key decision-makers and other influential personnel, or meetings with front-line employees and representatives of counterpart organizations. Finally, stakeholder input is often secured through meetings and telephone calls. This input provides organizations with information for improvement targets and measures. This communication also has an educational aspect to it in that customers and stakeholders' customers might learn that changing the process and/or subprocesses may mean that customers will have to change the way they do business with the NMS. An example might be that of changing the delivery and presentation of public forecast information.

7.4 STRATEGIC MANAGEMENT SUPPORT

Central support and the practice of change management are also critical. Human resource management strategies need to be developed to support the effort. Process change will require the support of a technology framework and information management strategies and efforts need to be integrated and coordinated across the entire organization. Finally, an internal and external communication and education program will be of great assistance. The reality is that significant change takes longer than the usual tenure of a manager or executive initiating it. It is therefore essential to instill the commitment to process improvement within the successor ranks of the organization.

There are a number of key enablers for process improvement. Among them human resource strategies are the number one change management factor. The number one fear that employees have is that they will lose their jobs, declared "surplus" or at best be redeployed in another job. In the cases where these strong redeployment policies for movement to meaningful jobs exist, employees engaged in process improvement activities are more comfortable and know to eliminate one's own job represents a career or job improvement opportunity. Successful NMSs will also foster significant union involvement in their process improvement activities. Mindful of the long-term needs of process improvement, the NMS needs to select and train personnel who will instill and sustain innovation values. In filling managerial and supervisory positions, NMSs should look for individuals who will be innovative, take risks, support staff in doing the same and who possess the flexibility to give up or share decision-making authority with teams. Unfortunately, existing central administrative personnel classification, selection, recruitment, training, and compensation processes can be seen as serious barriers to ongoing improvement. To succeed, the NMS may have to use various strategies to deal with or overcome central personnel requirements.

Information technology is a major enabler of process improvement. Information resource management personnel can be strong partners on process improvement teams. This partnership often results in new or redesigned information systems being well-tested in a piloting environment, with the full involvement and approval of line personnel. Information technology architecture provides the structure and standards for linking information systems across processes. New measurement systems in many NMSs capture the "value-added" of information resource management by supporting mission delivery. The investment needs of information resource management are strategic issues. Further, as computing technology moves into the pervasive phase of a mature technology, utility grade service level is what is required. The differentiator is the speed with which the infrastructure can be changed to address what the NMS requires and this competitive differentiator is business agility.

Another useful piece of change management infrastructure can be a support group to facilitate and support process improvement teams. Such a group can provide expertise, training, a focal point on networking on best practices, maintain an integrated approach across the NMS, help management define the high level core processes, help institutionalize process improvement and bring its tools and techniques to bear in a minimum length of time. Support groups can be instrumental in moving organizations from functional to process-based focuses.

Important to the change management infrastructure are programs for educating employees on process improvement concepts and goals and communicating overarching and specific project goals and progress. Such programs help the management of expectations and assist employees, stakeholders, the general public, and customers in understanding the NMS's strategic directions and the various improvement projects that will achieve those directions. To ensure consistency of the NMS's message across a variety of projects using multiple media this includes the formulation

of communication and education strategies and products that are part of a full communication and education plan. A variety of tools can be employed ranging from brochures, newsletters and briefings to walkthroughs and workshops. These methods keep process improvement visible and recognize its successes.

7.5 MANAGING PROCESS IMPROVEMENT

To ensure process improvement for results, clear project selection criteria with defined purposes and goals are required. Further, a disciplined, structured approach executed by a well-trained diversified expert team is critical.

Any process improvement effort starts with understanding what a business process is and what the mission-critical business processes are in the organization. A business process is a collection of related, structured activities that produces a specific service or product for a particular customer(s). Thus, a business process has a purpose and a specified start and end. Mission planning starts with understanding the current state of the NMS in terms of its internal and external environment. It ends with setting group and individual objectives to deliver the plan.

Once a process within an NMS has clearly identified inputs and outputs the process then adds value through the entire process: from the input through the output. Sub-processes of activities and tasks within each process create smaller value chains and the output from one sub-process becomes input for the next part of the chain. Mission processes are those which produce products and services for the external customers of the NMS. Support processes are those which generate products, services, or information for internal use. Management processes are those which facilitate the mission and support processes to work together to meet customer expectations and needs. A process is how the NMS delivers value to customers, regardless of the hierarchy and vertical structural designs. Functional units need to make decisions about how they would work with regard to the entire process that crosses many functional units. Together, all of the processes in an NMS form a total delivery system for products and services. Some, called the "core" business processes, are the most vital for mission performance and NMS survival. Process improvement efforts are used normally where there is a substantial gap between what customers and stakeholders expect and actual NMS performance such as in precipitation forecasting for example. A totally "clean sheet" approach often is not viable for an NMS as different policy agendas and expectations permeate decision-making across all levels and branches of the NMS and the governments they must respond to.

Process improvement can include continuous business process improvement, redesign of an existing process or major sub-processes within a process, or total reengineering. In other words, processes or sub-processes can be improved incrementally, redesigned to maximize efficiency, or reengineered to achieve maximum effectiveness. Each approach differs as to philosophy, timing, scope, leadership, means, performance gains, costs, risks, and pain. Selection of an approach to help solve a particular problem depends on what is broken and what performance gains are expected. A successful NMS will tailor its improvement approaches to the breadth and depth of the change needed within sub-processes and across a process. At the process level, one or more sub-processes might need only incremental improvement; others may need redesign, while others truly are candidates for reengineering. At the NMS level, all three approaches may occur as part of a total process improvement effort. The key linkage across all of the approaches is a commitment by the NMS to process management and performance measurement that are connected to strategic priorities.

While managing performance through processes can result in large successes it does not come without several potential pitfalls. The first potential pitfall is that of focusing on the wrong things. An organization can waste effort on activities that are not really important for business goals, can have unclear goals or priorities, start all sorts of uncoordinated improvement actions, think process improvement is about reorganization and not recognize cross dependencies. To combat this, a simple high level process framework needs to be developed providing a common process language with information databases linked to the processes.

Senior management role is to establish process improvement actions which have been thoroughly prioritized, properly scoped and with internal dependencies and implications understood. If this role is misunderstood or not properly carried out a potential pitfall will be realized. Once the improvement project is started the role becomes one of acting as a supportive sponsor for the process team.

Communication on managing performance through processes can be tricky and a potential pitfall. Communicating a clear view and the fact that major process improvements need to be limited in number and prioritized from the top is important. Also, manager participation in setting up the process framework and by taking ownership is important. Communication and taking ownership is facilitated by an 'involving' leadership style employing teams focused on wide-cross functional process goals.

7.6 GETTING STARTED

Implementation is hard and some of the process improvement initiatives are controversial. Some require the backbone to take risks that are potentially damaging to one's career. Some demand that managers and employees adopt a new way of thinking and working. Forces against change will organize opposition. Like any other major management and operational improvement effort, process improvement requires sustaining power: a long-term commitment to a progression of projects that may last several years. An overall game plan may include the following: define organizational mandate, mission(s), and customer and stakeholder interests; undertake modeling of organizational external mission, support, and management processes and sub-processes; identify accountable process owners and establish executive team responsibility for process management; assess the current and projected key process/ sub-process customer and stakeholder performance gap;

select processes/sub-processes to improve, setting goals and specific outcomes; prioritize processes/sub-processes for improvement based on a strong business and political case and in line with a realistic assessment of organizational capacity and expertise; identify barriers and possible pitfalls to the improvement effort and strategize to prevent or minimize their impact; for individual process improvement projects, follow an agreed-upon proven methodology and staff with a focused, dedicated team supported by consultants and other experts; continue a process improvement program that integrates all improvement efforts, evaluates performance continually against customer and stakeholder requirements, and shares lessons learned.

The NMS should insist on having senior managers directly involved in the process improvement through management committees and the business process owners. Senior management need to address the systematic process problems identified in the analysis of the business process and service delivery flows. Process improvement needs to be managed as part of the activity of managing the NMS mission as opposed to separate from it such as solely an information technology or business process modeling component initiative. To be successful the NMS should build experience testing methodologies, training personnel, and getting managers on board to build capabilities over time. Process improvement is a long term effort and both short and long term deliverables, performance management and measurement systems need to be built as part of the process. Finally NMSs need to realize that process improvement is part of continuous improvement, and that effort must be sustained if performance is to keep up with customer and stakeholder expectations.

NMSs must continuously do battle with outmoded processes and service delivery problems that will attempt to creep back in. By its very nature, process improvement continually prods the NMS to manage for results.

Chapter 8
THE ISO CONTEXT

8.1 ISO OVERVIEW

While it is recognized that ISO certification does not guarantee quality products and services, it does provide documentary evidence that process monitoring systems are in place that will facilitate responsible management response to the information provided. There are a variety of tools that can be employed to enhance service and product quality. A brief overview of a subset of these is provided in Chapter 4 "Quality Management Concepts and Approaches".

WMO is considering the establishment of a Quality Management Framework, (QMF), intended to provide guidelines and recommendations applicable to the development of elements of quality management for operations of NMSs including the enhancement of quality and efficiency of service delivery, taking into account end-user requirements. In its preparation, the QMF is to take account of the comprehensive and hierarchical set of documented WMO procedures, practices and guides. This is further addressed in Section 8.7.

Implementing a Quality Management System (QMS) within an NMS needs to be a decision by top management. The objective of a quality system needs to be clearly defined so that the system can be effective. The design and implementation of a QMS will vary depending on the type, size and products of the NMS. Each NMS will have it's own objective. A QMS will assist by:

(i) Managing costs and risks;
(ii) Increasing effectiveness and productivity;
(iii) Identifying improvement opportunities;
(iv) Increasing customer satisfaction;

A well-managed quality system will have an impact on:

(i) Customer loyalty and repeat business;
(ii) Market share/competitive advantages;
(iii) Operational efficiencies/cost reductions;
(iv) Flexibility and ability to respond to opportunities;
(v) Effective and efficient use of resources;
(vi) Participation and motivation of human resources;
(vii) Control on all processes; and
(viii) Reputation

The objectives of a QMS for an NMS should mirror the above in some form.

General principles for an ISO certification are described below:

- ISO 9001:2000 requires a quality system to be documented, tested, measured and assessed;
- Management commitment is essential for the implementation and ongoing success of the QMS;
- QMS objectives must be measurable and reflect the overall NMS objectives.
- The QMS must be able to be managed properly; adequate resources must be allocated;
- The system must be reviewed regularly and measured for effectiveness; adjustments must be made to reflect major changes to the NMS and business practices;
- The system must be practical and accessible to all employees within the NMS.

It is not essential to gain accreditation for a QMS to work effectively. It depends on the NMS if it wishes to gain accreditation. However the benefits should be considered:

- The NMS will be recognized as an organization that is committed to providing quality products, improvement and customer satisfaction;
- The NMS will gain respect through the industry as a fully accredited quality organization;
- The visible stamp of accreditation tends to improve consistency and increase quality awareness throughout the organization.

As already stated the term ISO refers to a set of quality management standards which are process standards, not product quality standards. In a sense the ISO 9001 series of standards represents a framework under which the process improvement discussed in an earlier chapter might take place. The ISO 9001:2000 standards apply to all kinds of organizations including those in the government. To be certified, an organization must meet the ISO's requirements not ISO guidelines. While the ISO 9001 quality management standards are not product standards, their implementation has the effect of controlling product quality and saving organizational resources in the long term. ISO 9001 is important because of its international and systemic orientation.

Very much like a mission, an NMS must decide to develop a QMS that meets the ISO 9001 Standards because it feels that it needs to control or improve the quality of its products or services, to reduce the costs associated with poor quality and/or to become more competitive. The first step is to identify the gaps that exist between the ISO 9001:2000 Standard and the processes of the NMS. This is followed by taking steps to fill those gaps the undertaking of which should improve the performance of the organization's processes. Once the QMS is fully developed and implemented an internal audit needs to be carried out to validate that every single 9001:2000 requirement is met. Only after this is successfully achieved can the organization seek to get registered as meeting the requirements of the ISO 9001 Quality Management System.

8.2 EIGHT KEY PRINCIPLES OF ISO 9001

The ISO 9001 series of standards refers to the following eight key principles for quality management, which are phrased here in the context of an NMS.

(*a*) Focus on Customers: NMSs need to understand current and future needs and expectations of their users or customers who receive their services. This includes internal customers. NMSs must meet customer requirements and hopefully exceed customer expectations. The key benefit is increased effectiveness in the use of the NMS's

resources to enhance customer satisfaction. Applying this principle typically leads to ensuring that the objectives of the organization are linked to customer needs and expectations as well as a communication of customer needs and expectations throughout the organization. Further, this principle leads to a systematic management of customer relationships and the measurement of customer satisfaction and acting on the results.

(*b*) Provision of Leadership: The top management of the NMS, particularly the chief executive or director, need to clearly establish the direction of the NMS and create an environment where all staff are encouraged to work towards that direction and the objectives of the NMS. The key benefits are that activities are evaluated, aligned and implemented in a unified way and miscommunication between different levels of an NMS can be minimized. Applying this principle typically leads to a consideration of the needs of all interested parties including customers, employees, policy makers, government authorities and society as a whole. The result is a clear vision of the NMS's future with challenging goals and targets set and committed to in an environment of trust, shared values and without fear. Applying the leadership principle means the NMS staff is provided with the resources, training and freedom to act with responsibility and accountability in an inspiring and encouraging environment where people's contributions are recognized.

(*c*) Involvement of People: People at all levels are the essence of an NMS and their full involvement enables their abilities to be used for the NMS's benefit. Accordingly, NMSs must encourage the involvement of people at all levels and help them to develop and use their abilities. The result is the involvement of motivated and committed staff within the NMS using innovation and creativity to further the NMS's objectives. The staff will also be accountable for their own performance and eager to participate in and contribute to continual improvement. The application of this principle typically leads to NMS staff understanding their roles, importance of their contribution and acceptance of the ownership of problems and their responsibility for solving them. A common end-result is the open discussion of problems and issues and the free sharing of knowledge and experience.

(*d*) Use of a Process Approach: Activities and related resources of the NMS need to be managed as processes. They are of different kinds: operational, scientific or administrative. They exist only because there are expectations to fulfil in order to gain the satisfaction of a customer. Beyond lower costs through effective use of resources, key benefits include improved, consistent and predictable results and focused and prioritized improvement opportunities. Applying this principle leads to systematically defining the activities necessary to obtain the desired result and establishing clear responsibility and accountability for these activities. In the process of analyzing and measuring the capability of key activities the interfaces of these activities as well as the risks, consequences and their impacts on customers, suppliers and other interested parties are identified. The consequent focus on the factors such as resources, methods and materials improves the operation of those key activities.

(*e*) System Approach to Management: Identifying, understanding and managing interrelated processes as a system contribute to the NMS's effectiveness and efficiency in achieving its objectives. The benefit of a systematic approach is the integration and alignment of the processes that will best achieve the desired results and the ability to focus effort on the key processes. The result is an enhancement of confidence that the interested parties have in the consistency, effectiveness and efficiency of an organization. Applying this principle typically leads to structuring the system to harmonize and integrate interdependent processes to achieve the NMS's objectives in the most effective and efficient way. This will provide a better understanding of roles and responsibilities and reduce cross-functional barriers. The result is an understanding of the NMS's capabilities and the establishment of constraints prior to taking action. Targeting and defining how specific activities should operate means their continual improvement through measurement and evaluation.

(*f*) Encourage Continual Improvement: Continual improvement of the NMS's overall performance should be a permanent objective of the NMS. Adopting this principle means the alignment of the improvement activities at all levels to an NMS's strategic intent resulting in improved organizational capabilities and enhanced flexibility to react quickly to opportunities. Application of this principle can mean the employment of a consistent organization-wide approach to continual improvement, its adoption as an objective of every employee and the provision to those employees the necessary training and tools to accomplish the improvement and the recognition and acknowledgement upon their achievement. This, of course, necessitates the establishment of goals to guide and measures to track that improvement.

(*g*) Factual Approach to Decision Making: Effective decisions are based on the analysis of data and information. They should never be based on unsubstantiated beliefs or suppositions. The benefit is informed decisions and an increased ability to demonstrate the effectiveness of past decisions through reference and factual records. Also there is an increased ability to review, challenge and change opinions and decisions. A factual approach requires the assurance that the data and information are sufficiently accurate and reliable; analyzed using valid methods and accessible to those needing it. As data and information are at times imperfect they need to be balanced with experience and intuition in making decisions and taking action.

(*h*) Mutually Beneficial Supplier Relationships: The NMS and its suppliers are interdependent and a mutually beneficial relationship enhances the ability of both to create value. Beyond the optimization of costs and resources, benefits include the increased ability to create value for both parties and the flexibility and speed of joint responses to changing market or customer needs and expectations. Mutually beneficial relationships with

identified and selected key suppliers result in clear and open communication, such as on sharing of information and future plans, and the establishment of joint development and improvement activities through the pooling of expertise and resources with partners. Such relationships balance short-term gains with long-term considerations.

8.3 ISO 9001 2000 REQUIREMENTS:

Central to the way ISO is applied to QMS is the use of a process approach. A QMS can be thought of as a single large process that uses many inputs to generate outputs. This large process is, in turn, made up of many smaller processes each of which uses inputs from other processes to generate outputs which, in turn, are used by still other processes. The ISO 9001:2000 QMS dictates the following requirements:

(*a*) Quality Management System Requirements: The NMS needs to document and use a quality management system. The NMS must identify key processes to meet customer requirements; establish the order of these processes and how they fit together; identify how it will control these processes; make resources available to support these processes; and measure these processes to not only ensure they do what the NMS wanted but also that the NMS plans for their improvement. A quality system must include a written quality policy and quality objectives; a quality system manual (including an definition of scope and exclusions, identification of procedures/processes plus a process flow description); control quality system documents and a set of procedures for their control; and a provision for the control of quality records.

(*b*) Management Responsibility Requirements: Top management should support the QMS and its continual improvement by promoting the importance of quality and meeting customer requirements; establishing policies with input from employees and clients; ensuring quality objectives are established; conducting management reviews; and managing all resources to make sure the system can meet the requirements of the customer. Management makes sure customer requirements are fully understood and delivered on so as to produce maximum customer satisfaction. Management must establish a quality policy, underpinned by individual objectives either across people/departments or other divisions that: is written by and for the NMS; commits to continual improvement; links to quality objectives; is communicated and understood by employees and is regularly reviewed. Management shall ensure that quality objectives, measurable and consistent with the quality policy, are established at relevant levels and functions within the NMS as well as ensuring that the planning of and changes to the quality management system is carried out appropriately. To ensure control of the QMS management should define responsibilities and authorities, appoint management representatives and support internal communication. Routine management reviews should include a broad range of inputs (audit results, customer feedback, process performance and product conformity, preventative and corrective actions, previous actions and their outcomes, changes and recommendations for improvement) and review outputs that include plans for process/product improvements.

(*c*) Resource Management Requirements: The NMS must first identify the resource requirements and then provide the resources to implement the QMS. The NMS must ensure the quality of its human resources by: determining the competence requirements for personnel; providing training or taking other action to ensure that this competence is achieved; evaluating the effectiveness of those actions; ensuring staff are aware of how their roles fit in with the NMS processes; and by keeping adequate records on human resources. The NMS needs to ensure a quality infrastructure by identifying infrastructure needs and providing and maintaining that infrastructure. Finally the NMS must determine and manage the work environment to ensure customer requirements are met.

(*d*) Product Realization Requirements: Planning the product realization processes requires that the NMS determine the quality objectives and requirements of each product or service; determine the processes and have documents to support those processes while ensuring the required resources are available; check the product/service against defined criteria for product acceptance; and keep records to prove the QMS is under control. The NMS needs to control the customer-related processes to identify the customers' product requirements, review those requirements and to communicate with the customers. The NMS must have in place systems for the control of the design and development of products and services through: design and development plans, specification of inputs (technical, regulatory, customer supplied information, etc) and outputs (characteristics, acceptance criteria, outreach and public education); reviews to validate satisfaction of requirements and identification of perceived problems along with rectification actions; verifications that the design/developments have met input requirements and validation against acceptance criteria, and finally through the recording and management of design and development changes. The purchasing function procedures need to be such that requirements are communicated clearly in every respect, product purchases are appropriately documented and purchased products are verified. The NMS must ensure that production and service is planned and implemented under controlled conditions including the validation of the production processes, the ability to identify and track internally throughout the production process, the protection of property supplied by customers and the preservation of the product during processes and delivery. The NMS needs to identify process monitoring and measuring needs and select, calibrate, protect and validate monitoring and measuring mechanisms.

(*e*) Measurement, Analysis and Improvement Requirements: The NMS must plan and implement analysis and improvement techniques required to

demonstrate that a process is capable of producing the desired results; give sufficient evidence demonstrating the effectiveness of the quality system; and continually improve the QMS. The NMS's quality monitoring and measurement system needs to be able to monitor and measure customer satisfaction, plan and perform regular internal audits, monitor and measure quality processes, and monitor and measure product characteristics. The NMS's QMS requires documented procedures for the identification and control of nonconforming products/services and the verification of their correction. It further needs to define and document the quality information management needs, collect the QMS data and be able to provide the quality management information. The NMS should strive to continually improve its quality management system through the use of its quality policy, objectives, audits, analysis of data, corrective and preventative actions and management review.

8.4 GAP ANALYSIS AND REMEDIAL ACTION

To develop a QMS that meets the ISO 9001 2000 Standard a gap analysis needs to be performed. The gap analysis will identify the gaps that exist between the standard and the NMS's actual processes. Once the quality gaps are pinpointed steps can be taken to fill them. By this approach the NMS will not only meet the ISO 9001 2000 Standard but also improve the overall performance of its quality management process. Various gap analysis tool kits have been developed by a number of ISO certification consultants that may be of assistance to the NMS. Alternatively the NMS might attempt to develop its own toolkit based on a detailed examination of the ISO 9001 2000 requirements. Essentially, the gap analysis consists of addressing the five sets of requirements identified in the previous section and determining, in detail, as to whether a) the requirement has been met in which case no action is required, or b) a gap has been identified and some remedial action should be taken, or c) the requirement is not applicable in which case, again, no action is required. The identification of a gap means that at least one of the NMS's processes fails to meet the ISO 9001 2000 requirement and that further development is required in that a process needs to be modified, improved or created. This gap analysis very much uses a process approach that is exactly what ISO has made mandatory.

Having identified all the gaps and figured out which processes need to be changed the NMS can begin the process of filling the gaps. This can be done by preparing and implementing system development plans. The analysis questions used to identify gaps need to be turned into remedial action statements detailing not only what action needs to be taken but also identifying who is assigned the responsibility for them and when the action will be completed and recorded as such. Once all remedial actions have been performed and all system development plans have been implemented the NMS will have an ISO 9001 2000 compliant QMS.

8.5 FURTHER CONSIDERATIONS:

(*a*) Responsibilities Management: From an internal point of view responsibilities are very important, but they tend to be less visible from outside and hardly an issue, even though ISO 9001 actually has quite a lot to say about responsibilities. Job descriptions are only a real answer if you have an unusually good appraisal system and revise them regularly. The titles of the flowcharts need to be in plain language and summarize the task being described, in whatever jargon the NMS uses. What this method does not do is to add all sorts of extra bureaucracy to the administration, provided they are well organized. Following this approach one ends up with a set of procedures which exactly suit the NMS covering all the ISO 9001 areas in a meaningful way.

(*b*) Steps in Implementing an NMS's ISO 9001:2000 QMS: There are many different ways of applying these quality management principles. The nature of the organization and the specific challenges it faces will determine how to implement them. Many organizations will find it beneficial to set up quality management systems based on these principles by following the steps below:

(i) Identification of the goals the NMS wants to achieve;
(ii) Identification of what others expect of the NMS ;
(iii) Acquisition of information about the ISO 9001 family;
(iv) Application of the ISO 9001 family of standards in the NMS management system;
(v) Acquisition of guidance on specific topics within the quality management system;
(vi) Establishment of the NMS current status, determination of the gaps between the NMS quality management system and the requirements of ISO 9001:2000;
(vii) Determination of the processes that are needed to supply products to the NMS customers;
(viii) Development of a plan to close the gaps in step (vi) and to develop the processes in step (vii);
(ix) Execution of the plan;
(x) Execution of routine periodic internal assessments;
(xi) Determination of the need to demonstrate conformance;
(xii) Implementation of independent audits ;
(xiii) Continuance of business improvements.

(*c*) Maintaining the benefits and continual improvement: When the NMS adopts ISO 9001:2000, it must strive for the satisfaction of its customers and the continual improvement of the NMS quality management system. Continual improvement is a process of increasing the effectiveness of the NMS to fulfil the NMS quality policy and quality objectives. ISO 9001:2000 requires that the NMS plan and manage the processes necessary for the continual improvement of its quality management system. ISO 9004:2000 provides information that will be helpful in going beyond ISO 9001:2000 for improving the efficiency of the NMS operation.

(*d*) Certification, registration and accreditation: According to the standardized definitions, the three words are not

quite the same thing. In the context of ISO 9001, "certification" refers to the issuing of written assurance (the certificate) by an independent, external body that has audited an organization's management system and verified that it conforms to the requirements specified in the standard. "Registration" means that the auditing body then records the certification in its client register. The organization's management system has therefore been both certified and registered. For practical purposes, in the ISO 9000 context, the difference between the two terms is not significant and both are acceptable for general use.

On the contrary, "accreditation" means something different. In the ISO 9001 context, accreditation refers to the formal recognition by a specialized body - an accreditation body - that a certification body is competent to carry out ISO 9001 certification in specified business sectors. In simple terms, accreditation is like certification of the certification body. Certificates issued by accredited certification bodies - and known as "accredited certificates" - may be perceived on the market as having increased credibility.

(*e*) Certification is not compulsory: An NMS can implement ISO 9001 without seeking to have its management system audited and certified as conforming to the standards by an independent, external certification body. Like all ISO standards, ISO 9001 are voluntary standards. The NMS can implement them solely for the internal benefits they bring in increased effectiveness and efficiency of its operations, without incurring the investment required in a certification program. Deciding to have an independent audit of the NMS system to confirm that it conforms to the standard is a decision to be taken on business grounds.

(*f*) Publicizing the certification: If the NMS has invested time, energy and money to obtain an ISO 9001 certificate, it will wish to publicize its achievement. To help it to do so, ISO has published guidelines: Publicizing your ISO 9001 or ISO 14001 certification. The guidelines will help the NMS to apply good practice in publicizing, communicating and promoting its certification to stakeholders such as staff, customers, business partners and the general public.

8.6 STEPS FOR EMBARKING ON AN ISO CERTIFIED QUALITY MANAGEMENT SYSTEM

The formal commitment of the top management of an NMS is the essential first step as financial and human resources are needed to be allocated. The best way to set up a QMS is to do so as a project with a project manager. The project will require a steering committee which is best chaired by the top management of the NMS. With a costed project plan set up the next step will be securing financial commitment. Securing specialist consultancy support will assist the development of a quality system. A major early step in the project is the establishment of a framework for the documentation of procedures and their linkage to existing documentation of the NMS and for the establishment of quality records. The staff of the NMS need to be engaged and co-opted on the effort. In addition to awareness training, education training on quality management systems is required with more intensive training for those more closely involved in the effort. As part of the documentation effort each relevant process needs to be analyzed and cast in a standardized format consistent with the developed framework. Measures or indicators of quality need to be established and monitoring systems implemented along with associated fault procedures, and their application must be tracked. An internal audit capability needs to be developed and an audit system implemented. Based on the resultant audits working documents and processes need to be modified. Finally, once the NMS is comfortable with its progress in the effort it may choose to seek a certification audit by a certifying external agency.

8.7 EXPERIENCES OF SOME NMSS

The experiences of various NMSs with quality management have been detailed in a number of forums and documents. Amongst others, the UK Met Office, Météo-France, and the Meteorological Services of South Africa and Brazil each have gone through some ISO- related quality management experience and could be contacted for advice. Below, information provided by the meteorological services of Malaysia, Germany and New Zealand are highlighted.

The Malaysian Meteorological Service (MMS) has implemented since June 2000 a process-based QMS at the Kuala Lumpur International Airport (KLIA) Forecast Center that fulfills the requirement of the national and international standard MS ISO 9002:1994. As the old standard expired by 31 December 2003, KLIA Forecast Center undertook the process of migrating to the new standard ISO 9001:2000. The Regional Forecast Offices (RFOs) at Penang, Butterworth, Kuantan, Subang, Kuching and Kota Kinabalu are also in the process of implementating this new standard and are expected to be certified by the middle of 2004. For the MMS the scopes of the quality management system are:

- The ability to provide consistent products/services that meet customer and applicable regulatory requirements;
- Address customer satisfaction through the effective application of the system, including processes for continual improvement and the prevention of nonconformity; and
- Establish quality indicators to measure, review and control the forecasting processes.

The top management of the MMS is responsible for the development and implementation of the QMS and is constantly upgrading its effectiveness through:

(i) Regular communication with RFOs to ensure and fulfil customer satisfaction besides complying with ICAO/WMO, Department of Civil Aviation (DCA) and the military air force requirements and regulations. These are achieved through various avenues like meetings, staff discussions, training, etc;
(ii) Determining the quality policy;
(iii) Determining the quality objectives;
(iv) Conducting management reviews;

(v) Identifying and ensuring availability of resources like skilled personnel, infrastructure, finances, training and internal audit team through yearly financial budgets and development plans in all matters which enhance the QMS;
(vi) Identifying customer needs and ensuring customer/client satisfaction through questionnaires, feedback, and reviews.

The QMS in the KLIA Forecast Center has been working successfully since June 2002 and will be improved and upgraded to ISO 9001:2000 by 2004. At the RFOs, trial implementation is currently being carried out and would be ready for certification in 2004. There are plans for the future extension of the implementation of QMS to other services in MMS such as the public weather forecasts and climatological services. The QMS implementation is seen as an important yardstick in the competency of MMS to provide consistent and quality products and services in view of the current trend of globalization.

The Deutscher Wetterdienst (DWD) will implement a process-based QMS that fulfils the requirements of the international standard ISO 9001:2000. The DWD as a whole will be certified by the end of the year 2005. One part of the DWD, the Business Unit "Climate and Environment Consultancy" has been certified since five years ago. The scope of the quality management system is:

- Achieving the objectives of the organisation;
- Achieving conformity with interested parties (Federal and Land authorities) and customer requirements - in a framework of decreasing (human) resources;
- Establishing quality indicators to measure, review and control the business processes;
- Continual improvement of the processes to produce and deliver services more cost-effectively.

In July 2002 the Executive Board of the DWD started the project “Implementation of Quality Management in the DWD”. The working group "Quality management in the DWD" is responsible for the realisation of the project with assistance from external consultants. The head of the working group is the management representative of the DWD. There are several quality management systems defined to form the DWD QMS as a whole. The business and support processes of the organisation are identified and analysed. The existing processes and the responsibilities have to be redefined and rebuilt (target processes). The quality policy and the objectives of the organisation and the indicators of the processes have to be defined. The QMS in the Business Unit "Climate and Environment Consultancy" has been working successfully for five years. A first cost-benefit analysis shows that the benefits recover or even exceed the costs. The production in the regional bureaus is standardized in such a way that colleagues can get into the subjects in another bureau very quickly. The QMS of DWD was started in the expectation that similar cost-cutting results will be realized. The QMS and the certification of the DWD are important milestones for the position of the DWD as a strong National Meteorological Service and as an important partner to other National Meteorological Services.

The final example describes the experiences of the New Zealand Met Service.

1. Initial Steps:

Because of initial unfamiliarity with quality management systems and processes there was uncertainty as to what processes should be included in the quality management system and what documentation is required. A useful approach is to list out all the processes that may be relevant then go through them and cull out those considered unimportant. The advice of a consultant will be helpful for this exercise. Later, in the light of growing understanding and experience with running the quality management system, it may well be found that the workload to maintain the system is unsustainable, in which case further culling and rationalization will be needed. For example if quality management staff are having difficulty maintaining internal audit schedules, the schedules can be examined to see if the workload can be reduced. This can be done with reference to the "status and importance criteria" for audit scheduling. Processes considered critical to operations (i.e. if they failed there would be a major impact) should be on a regular audit schedule (e.g. annual). Other processes considered important but not so critical should be audited regularly but less frequently. The rest are subject to the "status" provision e.g. audited shortly after first implemented or documented; if a problem arises with the process; or if a manager requests an audit shortly after a change to the process to check effectiveness of the change. Routine daily operations can be considered "self-auditing" inasmuch as any problems will soon become apparent and generate an audit under the "status" criterion. Another way of reducing the audit workload is to combine similar processes into a generic process (e.g. calibration of heat sensors – the general process may be the same with specific differences for different types and brands referenced through user manuals. Each time an audit is required a different one can be examined).

2. Maintaining the System:

Once the system is up and running, the organization needs to continue to "engage" with it. This can be done effectively through the audit process, and the management review process that examines things like audit reports, corrective action reports and logs and other quality records. There should be at least one annual quality management review with executive managers. Management review meetings can also identify topics for audit thereby giving managers some buy-in to the audit process. There may be several internal audit programs within an organization. For example each division or work group may have its own audit program. Audit programs may have different scopes, e.g. divisional audit programs may focus on checking compliance with prescribed procedures while an organization-wide audit program may look at the effective implementation of policies and new concepts. Employees will be resistant to activities like documentation. This may be reduced by:

(*a*) Focusing on the principles and not requiring compliance with a rigid organizational mould. In other words there should be an organizational model with policy and procedural guidelines, but divisions can be given the freedom to use or modify existing material or develop their own systems as long as these are consistent and compliant with the organization’s quality management model.

(*b*) Providing quality management briefings and training for staff so that they understand the principles behind what they are documenting and it is therefore not just a mechanistic chore.

(*c*) Spreading the load. The people doing the work should do documentation. This also helps to stimulate interest through ownership. This approach can also help with auditing. If a large pool of employees is trained to do internal audits less demand is made on the time of each one.

(*d*) The quality manager understanding and being convinced of the need for documentation before asking others to do it.

(*e*) Making the task as easy as possible by providing advice, assistance and resources and elimination of unnecessary work.

Commitment of top management is absolutely vital. It will make it easier to get the resources and commitment required from other managers and staff to get the work done.

3. Scope of the QMS:

Initially it may prove easiest to run a pilot project to implement a quality management system in a small part of an organization. This may be selected on the basis of executive management commitment, customer demand or the nature of the work. Once the pilot system is fully implemented and/or externally certified, consideration should be given to broadening the scope. It may be tempting to isolate various bits of the organization from the quality management system or certification, but it may prove better and easier to cover the whole organization. This will mean that absolutely everything - from forecasting to accounts, to building maintenance - is subject to the quality management system and any associated certification and external audit, but if they were not included they would still have to be dealt with as "suppliers" to the divisions that are compliant. In practice quality management auditors may be happy to rely on specialized reports such as those from financial audits for some activities. Regulatory bodies may require parallel quality management audits, but the same quality management system will be able to address their requirements.

4. Promote and Celebrate Success:

It is important to celebrate and promote important milestones such as certification to a recognized standard. This increases the awareness of employees and customers of the importance that the organization attaches to quality management. Celebrate by arranging an award ceremony where senior government or other recognized people present certificates perhaps followed by a party. Promote recognized certification by including details on business cards, letterhead paper, websites and published reports.

5. Monitoring the System:

Once the quality management system is fully implemented quality managers will need to ensure that they have access to all the quality records necessary to monitor the system effectively. This is particularly important in an organization that has delegated implementation and maintenance of the system to work groups or divisions. Effective monitoring can be achieved by ensuring that appropriate records are placed online and effective systems are available to view relevant information from them.

8.8 WMO QUALITY MANAGEMENT FRAMEWORK

A specially convened workshop in Kuala Lumpur, Malaysia in October 2004 considered the issue of the development of a WMO Quality Management Framework (QMF). The workshop recognized that there was a lot of confusion about the benefits and risks of quality management systems in general and of ISO 9001 in particular. This lack of knowledge has resulted in the lack of recognition of less complex solutions, which have been successfully implemented by a number of NMSs. The workshop noted that the development of a WMO Quality Management Framework and the implementation of ISO 9001 are complementary, and not mutually exclusive, activities. It recognized that ISO 9001 has an element of international credibility which cannot be ignored in the development of a WMO Quality Management Framework. It suggested that non conflicting guidelines should be provided to WMO Members. Recognizing that a Quality Management System is becoming a basic requirement for all NMSs, the workshop noted that a Quality Management framework should not focus only on the ISO 9001 type alone but rather should consider a variety of options with each NMS choosing its own path. Consistent with the basic thrust of this document the workshop identified a basic feature of a Quality Management System as the definition and management of processes.

The workshop recommended the establishment of an Ad hoc Expert Group on the Quality Management and Quality Control aspects related to observations specifically to review/rectify WMO Technical regulations with respect to deficiencies, duplications, inconsistencies and errors and to develop documentation that describes work processes typical for observation generation. It also recommended that the consideration of QC aspects related to forecasting and warning products and services should be addressed in connection with the standing task of CBS, to develop standards or recommended practices on weather forecasting and the use of forecasting systems.

Chapter 9
CONCLUSION

It is undeniable that some NMSs who, if not already certified as a quality managed organization, could pursue such certification quite expeditiously. It is also undeniable that all NMSs possess many of the traits of a quality-managed organization. Most NMSs have many of the basic components. They can achieve the key steps to a comprehensive quality management system through the application of the basic concepts in increasing detail through the organizational processes. As previously stated the WMO is in the process of developing a Quality Management Framework, (QMF), intended to provide guidelines and recommendations applicable to the development elements of quality management for operations at national and international levels. A logical starting point for an NMS is to appoint a quality manager or auditor. This person can then lead the NMS through the process of developing a quality policy and a quality framework specifically designed for that NMS. With senior executive leadership support and long term commitment the gradual process of working on those broad process stovepipes of atmospheric monitoring, production and service delivery can be initiated and brought increasingly into a quality managed status. From a public weather services perspective it is hoped that this document provides some information and stimulus encouraging NMSs on this path. Certification is not essential but in today's environment the pursuit of quality management is. As the late Dr. W. Edwards Deming put it: "You don't have to do this – survival is not compulsory". Survival of NMSs is very important to the survival of the national public weather services programmes and activities. .

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