Introduction of new Instrumentation as a Quality Management Process

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Abstract

To equip a meteorological network with new measurement instrumentation is a considerable investment for a national weather service. To assure that such a task will be successful a scheme was developed which describes all necessary steps chronologically. It names all necessary persons and documents and shows decision marks. The scheme represents a process. It is a guide line to be followed; in individual runs some steps may be more or less extensive. When the new instrumentation is in operation it has to run for a long period. Changing user requirements will then be the driver for modifications. To bring modifications in operation and to minimize data loss during this time, a further process is described for this task.

This presentation will illustrate the processes graphically and textually. Though the examples relate to particular conditions in the national German weather service they could stimulate others to adapt them for their purposes.

Introduction

Quality management (QM) is an important tool in Meteorological Services to assure the availability, the reliability and the timeliness of their products. In the field of observation and automatic acquisition of meteorological parameters the services began to apply documented QM years ago. For instance R. P. Canterford et al. [1] described a quality management system (QMS) in their Met. Service with respect to data quality. Pevny et al. [3] reported on the installation of QM in a company.

WMO accompanies the adoption of QM: The WMO Council [4] noted the decision of the XIV. WMO Congress to work towards a Quality Management Framework that could advice the National Met. Services to develop their own QMS. C. Richter and J. Dibbern [5] presented a certified QMS for the German Met. Service as a whole and especially described the part of data collecting which is a core activity of Met. Services as a documented production process which is transparent and auditable.

This presentation will introduce the procedure to select new measurement techniques and implementing them in an operational network. It is documented as a process and it is a supporting process for the data collecting activity mentioned above.

Presentation of a Process

The process is described in a short graphical form similar to a flow chart. It is supplemented by a textual description. The ISO 9001 standard [2] defines a "process" as a set of interrelated or interacting activities which transforms inputs into outputs. The text should also explain the goals of the process, list the customer requirements, name influencing quantities, define characterizing numbers and list joined processes as well as further applicable documents.

The graphics is a matrix of lines and columns; each line represents an action. Besides the main column with different symbols (single action, connections, decision rhombus, junctions and connected or subordinated processes) there is a describing column with short text. Then there are input and output columns showing input documents and elaborated output documents. There are three additional columns for designating the affected groups or

persons of the respective action: either to be responsible for the action or to assist in the action or to be informed of the action and the result of it.
When describing an activity of a Met. Service as a process, transparency of the action is achieved, and *you* recognize *your* work as a service for a customer. When performance indicators for the processes are defined it is possible to evaluate its quality
It is not necessary to adhere rigidly to the process description for each cycle. Before starting, participants could determine to realize some actions in parallel instead of a timely sequence. It is also a property of the QM to change the flow when it is realized that the process did not run optimal in the past. Finally the staff in the Met. Service will accept that the organization is only successful when working *process-oriented* though this cuts through the standard organizational structure of the Met. Service.

Process for the Introduction of new Measurement Instrumentation
Some reasons may be the signal to start the process: requirements for more efficient measurements, more accurate and additional measurements, the needs to replace old instrumentation that cannot be maintained any longer. The kind of technique may be a sensor or an algorithm or a system that includes sensors and the data processing unit. Often it is a network of stations to be equipped. This process is not a periodical production process but a non–periodical supporting process.
Sometimes new requirements are necessary on a system or a sensor. Then a process for a *system modification* is started. This is also expressed in the QMS and it is similar to the process described here. A software or a hardware update is a typical system modification. The work routine to perform an update in a network is described like a process, too. It is imbedded in the *modification process*.
When defining a process the goals and the customers requirements and benefits are to be mentioned. Introducing new instrumentation will reduce costs on a long term because measurements are automated, data are more reliable, and they are available online. This is essential for the warning management, the forecasting and the climate monitoring as well as the consulting and reporting business.
With the start of the process a special *Working Group* (WG) is founded consisting of the future data users, the technical servicing personnel and the persons responsible for the process (PR), (see figure 1). The WG proposes a course of action. This should fit into the strategy of the Met. Service, it should estimate financial and human resources and the time needed to realize the intention. When extensive resources are needed a separate project plan is brought forward including milestones, periods of tasks etc.
The proposal is then submitted to the decision makers (DM). Either they will agree and give the directive to perform the following steps, they agree with some restrictions or they reject the proposal.
The next step is a *market survey*. It is checked whether the user requirements can be fulfilled by marketable devices. If there is no marketable device available an initiation could be given to the strategic process of Research and Development (RD) to start a *feasibility study*. When introducing systems often software development is necessary to fulfil all customer needs.
If standard sensors are available but not yet proved in the Met. Service, laboratory and field tests should be performed first. *Sensor testing* is a subordinated process.
All the results of testing and the studies are discussed in the WG for adapting requirements.
After that a specification is compiled. This is a central task because the specification document is essential for a contract and the future acceptance of the product by the users. At this time within the process, a scheme is developed for evaluation of the tender.
Now activities are handed over to *purchasing*. This is a separate process done by from the Administration & Finances (AF) department because in the public sector special business rules are to be followed. After a contractor has been selected the next central task will be the *acceptance test* of the prototypes. When the tests are passed (and only then) the whole number of systems will be delivered from the contractor (CO).

Finally the personnel from the Servicing & Logistics (SL) department are qualified in training courses. The systems are handed over for installation. For a given period they are monitored to detect further flaws that become evident during operation.
Because this process can be influenced by a lot of external conditions, no performance indicators can be defined as a scale for the proper run of the process. But it is reviewed regularly and appropriate actions are taken for improvement.

Process of Software-/Hardware Updates

This is an example of a work instruction with several actions and several persons involved in. So it is described like a process and is embedded in the '*system modification*' process (see figure 2). Because updating a number of systems in an operational network is a critical task with the risk of failure and data loss it is necessary to follow the prescribed course.
First the product of the ordered modification is checked on completeness and integrity. A test specification is provided. Apparently heavy flaws of the product will cause a return to the manufacturer.
The update is tested with a system in the laboratory that can be fed with either real or simulated input data. Errors found are fixed in an error item list and the manufacturer is requested to correct them. This can have several iterations with a software update. When all faults are corrected an acceptance protocol is compiled. The update is applied to one or more field stations which are not part of the operational network, to be tested under field conditions for a certain time.
If the test run is successful then a certain number of operational stations in the network are updated. Any errors cause a return to the manufacturer and the procedure has to be started over again. If the subset of operational stations was running a preset time without errors then the complete network is updated and the responsibility is placed to the servicing department.
It depends on risk estimation to skip one or more steps of the instruction: in a network of airport systems data loss has more negative consequences than in a volunteer network.

Final Remarks

QM and its processes are not an inflexible framework but a living system. It should be modified when there is a need for. When planning a project to place a tender for new instrumentation the corresponding QM process description has to be considered. It reminds all collaborators concerned that modern successful acting in a Met. Service will consist of processes. Generally processes will run not only within a certain organizational unit of the service but they embrace different branches of the service. This will result in enhanced ability of communication and organization of the collaborators.

Literature

[1] Canterford, R. P., Evans, D. K. and Allan, L.C.: Developments in a modern QM-System: Observations Quality control, network performance and Metadata Database.TECO-2000, Beijing, 2000.
[2] International Standard Organisation, 2000: Quality Management Systems – Requirements (ISO 9001); EN ISO 9001:2000.
[3] Pevny, G., Einsiedler, W. and Meir,M. : ISO 9001 QM for the Operation of Hydro-meteorological Measuring Networks. TECO-2002, Bratislava, 2002
[4] WMO Council, 55th Session: Abridged final report with resolutions, WMO-No. 961, Geneva, 2003
[5] Richter, C. and Dibbern, J.: A Quality Management System for the Process of Collecting Meteorological Data. TECO-2005, Bucharest, 2005.

Strategic Process: Data Collection, Data Management

Process Description Introduction of Sensors and Systems

Process: Introduction of sensors and systems | **Sub-Process: -- --**

current No.	input		description	E	A	I	output
		Start					
10		foundation of a WG	A working group of users as partners of different DWD branches handling and using the data, servicing the measurem. technique and IT-infrastructure	DC	PR WG	DC	
20	meteorological and technical requirements	generate a proposal for realization	WG valuates the requirements and submits a proposal for decision. Contents:project schedule, estimation of resources (personal, means), benefit argumentation	PR	WG	DC	harmonized concept for decision
30	budget; strategy of measurement technique	giving the order	Decision makers signalize putting through the purpose	DC		AF	order
40		marketability	Find out marketable systems or sensors fitting to the requirements	PR			
50		devices available ?		PR	WG		
60		yes / no → QMS Development	sensors: if not available from the market, a development cooperation may be pushed, beginning with a feasibility study	RD	PR	DC	QMS Development
70		devices known ?	On marketable Sensors (commercial off the shelve) no testing is needed if usefulness in meteorology is obvious or field test results are present.	PR			
80		yes / no → system-/ sensor-testing		PR	WG	DC	test reports
90	test reports	matching test results	Data users agree to test results, requirements from continuous operation are met	PR	WG SL	DC	
100	user's, technical & environm. requirements	writing a specification	Legwork of WG members, examination of the purchasing team	PR	WG AF	DC	DCecification & evaluation scheme for the assess-ment of tenders
110	DCecification, evaluation scheme		Public tender: when procuring marketable sensors, sample devices are delivered for testing before contract	AF	PR CO	DC	process: procurement
120	manuals, operating instructions, training documents	acceptance test → 1 / 2	when procuring systems including software developm., prototypes are delivered and running after contract , final acceptance after test phase	PR	WG SL CO	DC	internal instructions as a result of testing, qualified internal servicing personal by training

Strategic Process: Data Collection, Data Management	Process Description Introduction of Sensors and Systems	DWD

Process: Introduction of sensors and systems | **Sub-Process: -- --**

current No.	input		description	E	A	I	output
130		1 → 2 evaluation of acceptance test	where appropriate some minor DCecifications are passed though not competely fulfilled	PR	WG		test protocol with list of errors if any
140	test protocols	test passed ? — no	on a successful test systems or sensors can be installed in the network	PR	WG	DC AF	
150		yes: enter order for introduction		DC	PR		
160			QM process 'decentralized systems' gets release for installation and starting up the new technique and coordinates all activities for integrating into the network. PRP assists if necessary.	SL	PR		process: decentralized systems
		End					

E = Executing
A = Assisting
I = Information

PR = Process ReDConsibles
WG = Working Group of users
CO = Contractor
DC = Decision Maker
RD = Research & Development branch
AF = ADCinistration & Finances department
SL = Service & Logistics department

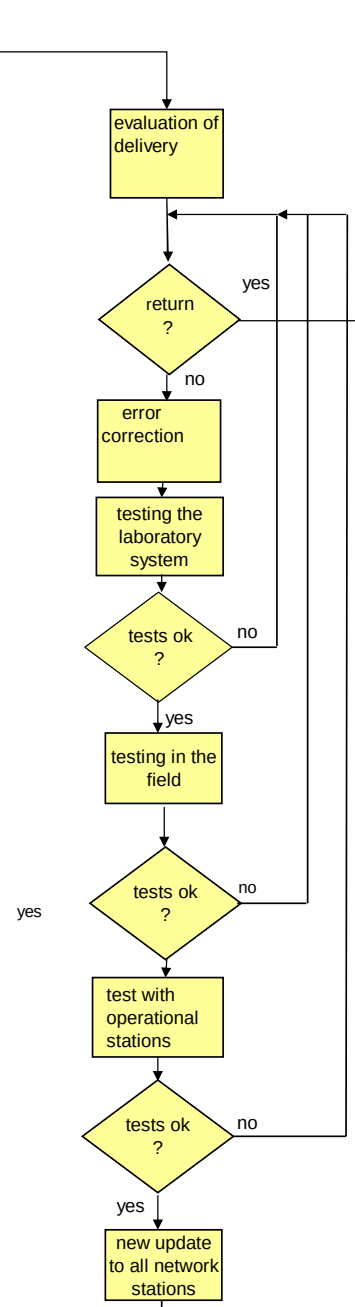
related documents | information | unclarified action

Figure 1: Flow chart of the process 'Introduction of Sensors and Systems'

Strategic Process : Data Collection, Data Management	Process Description Software-/Hardware-Update	DWD

Process: System-Modification **Sub-Process: Software-/Hardware-Update**

Current No.	input	description	E	A	I	output
		Start				
10	system modification					
20	test specification	checking delivery on completeness and apparent failures	PR			
30		return decision : either back to the producer or beginning error detection	PR		DC SL AF	system modification
40	error list	error detection and correction	PR CO			
50		new software version first tested in a test run on the laboratory system over a fixed time	PR			acceptance protocol
60		after a fixed time of trouble-free operation to the next step otherwise return and error correction	PR	CO	DC	
70		new software version tested in field stations outside the operational network (acceptance protocol to the purchasing	PR	SL	AF CO	acceptance protocol
80		after a fixed time of trouble-free operation to the next step	PR	SL	DC	
90		new software version at a small number of operational stations	PR	DM SL		
100		after a fixed time of trouble-free operation to the next step	PR DM	SL	DC	
110		updating and starting new software at all stations, controlled by the network center	SL	PR DM		
120		hand over to the superior process, i.e. to watching the operational network	PR	SL	DC	system modification
		End				



E = Executing
A = Assisting
I = Information

PR = Process Responsibles
CO = Contractor
DC = Decision Maker
SL = Service & Logistics department
AF = Administration & Finances department
DM = Data Management group

related documents | information | unclarified action

Figure 2 : Flow chart of the work instruction 'Software-/Hardware-Update'