Structure of ANTARES Q System

Training Session (?)

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INFN-Bo

KM3NeT Q Workshop
Amsterdam Jan. 30-31, 2014

Let me introduce myself…..

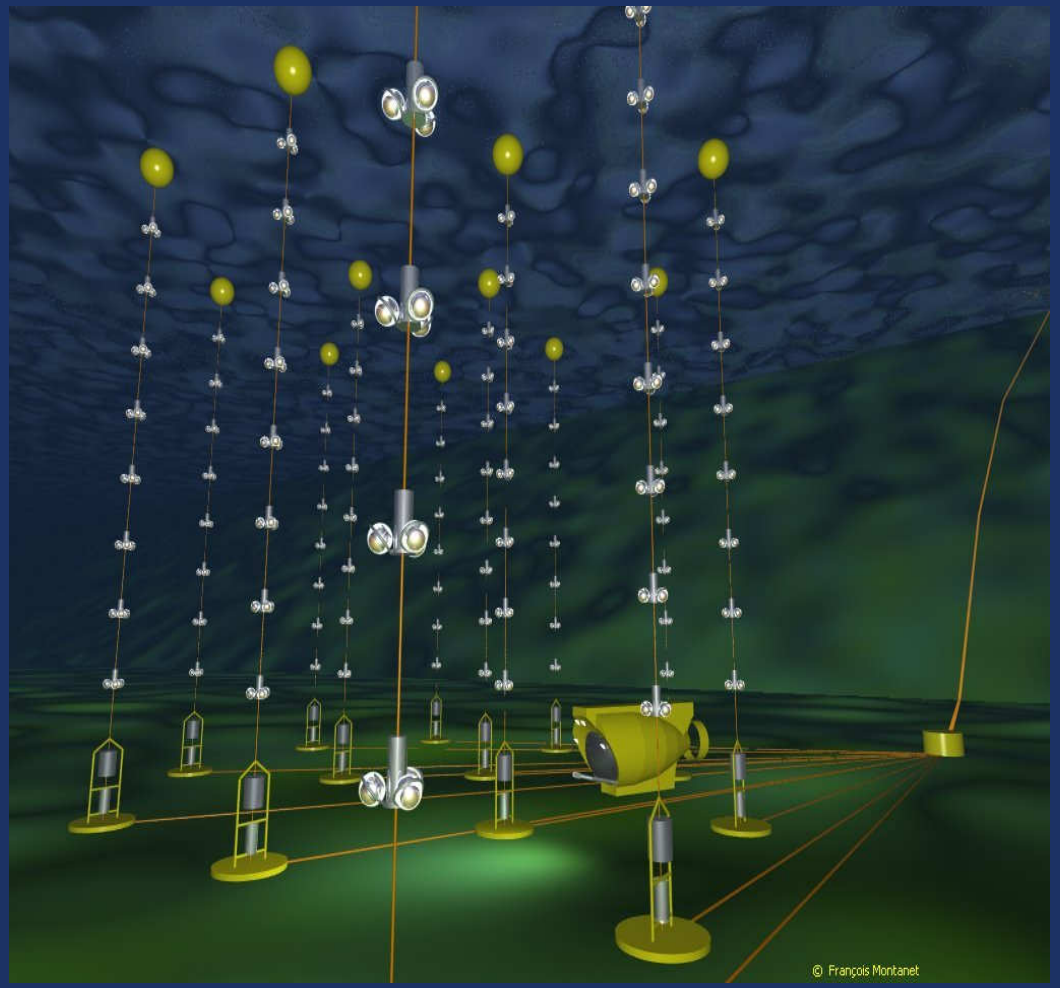
First of all let me say that I am/was
(now I have retired but still volunteer….)
an Astrophysicist (fields of research = Cosmic Rays, Astroparticle, CMB, theory and experiments)

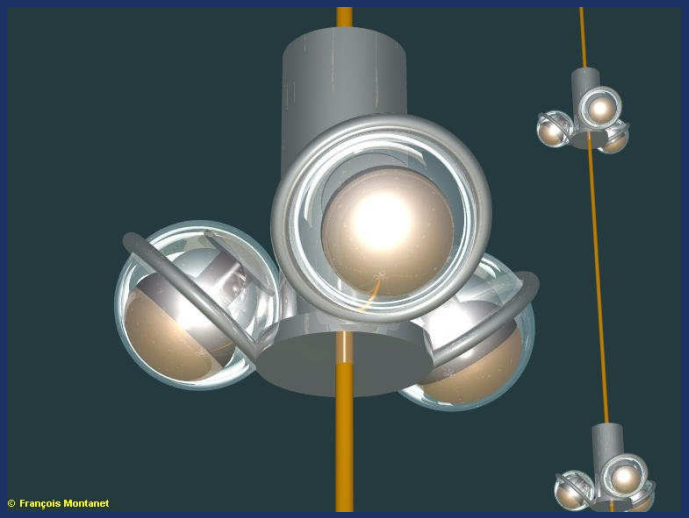
- By the end of 2003 (Nov. 18th) I have been asked to become the Coordinator of the
  Sub-Project QUALITY for ANTARES

No real experience in Quality System !

It took me long time (up to Nov. '04) to organize myself. Meanwhile I started to make propaganda inside the Collaboration

ANTARES > 2002..





In the sea at 2400 m depth

BUT pay attention to a change of attitude

Before 2000 experiment = project

The term, in science, meant the pursuit of a well defined experimental apparatus performing a measure to be confronted with theoretical predictions

Nowadays, in within the funding agencies people speak about "product"

The term project is used when referring to the design, definition and production phase of an instrument or experiment whose result is known as "product"

Characteristics of our Product

- It is an experiment whose characteristics are similar to those of an experiment in space

It must operate in an hostile environment with difficult access

- Appropriate (sea) technologies; high costs

- Its success is related to operating over long time scale, continuously and with all its components well functioning

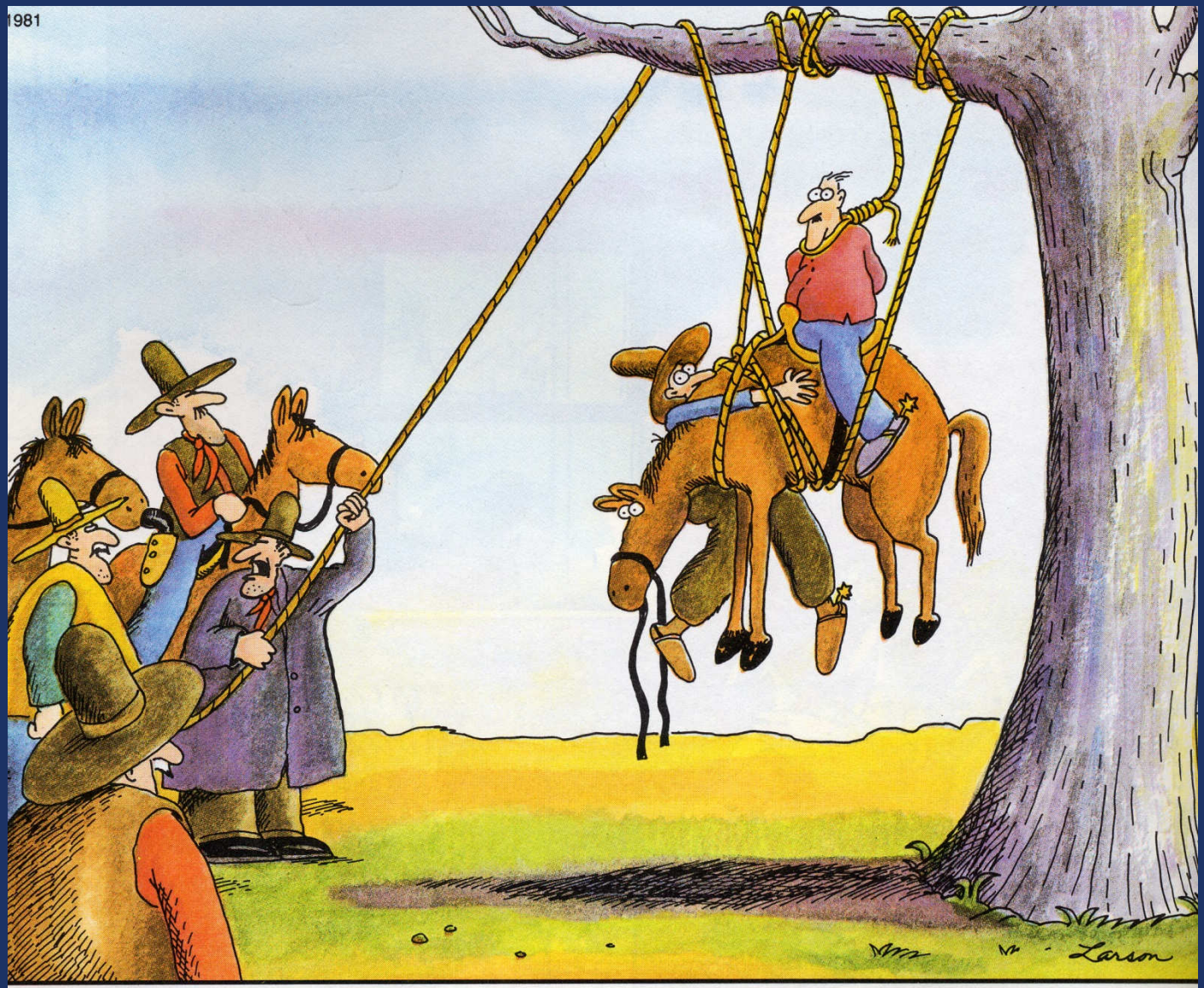
A Quality Culture for physicists

M.A. Pick, EFDA, Garchng bei Munchen, Germany europhysicsnews vol. 35 no. 5, 2004, 171

- It is absolutely necessary that the scientific community in Europe reinstate its credibility on its capability of accomplishing what it is promised…..
- Students at university must go through lecture courses on implementation and management of Quality

What is Quality?

What the taxpayers ask you not to do…..



"OK, OK, OK… Everyone just calm down and we'll try this thing one more time."

Definitions

Quality = the ability to satisfy the implicit and explicit requirements of the customer

Quality Assurance

- A formal methodology designed to assess the quality of services provided. Quality assurance includes formal review of care, problem identification, corrective actions to remedy any deficiencies and evaluation of actions taken
- Those planned and systematic actions necessary to provide sufficient confidence that a laboratory's product or service will satisfy given requirements for quality
- remove non-conformities before QC

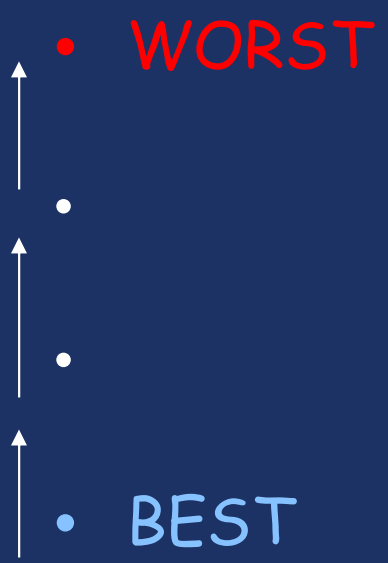
- Quality Control

- A system by which a desired standard of quality in a product or process is maintained. Quality control usually requires feeding back information about measured defects to further improvements of the process.

- System of control meant to guarantee, by periodic inspections, that a certain amount of quality is being maintained during the production of the product in question. Materials, procedures, tools, etc., as well as the product itself are inspected.

Quality of the product can be assured through:

- Test of the product
  (Quality by testing)
- Well defined production
- Test during development / prototyping of the product
- Well defined principle in design and development
  (Quality by design)



Important factors in obtaining reliable quality parts

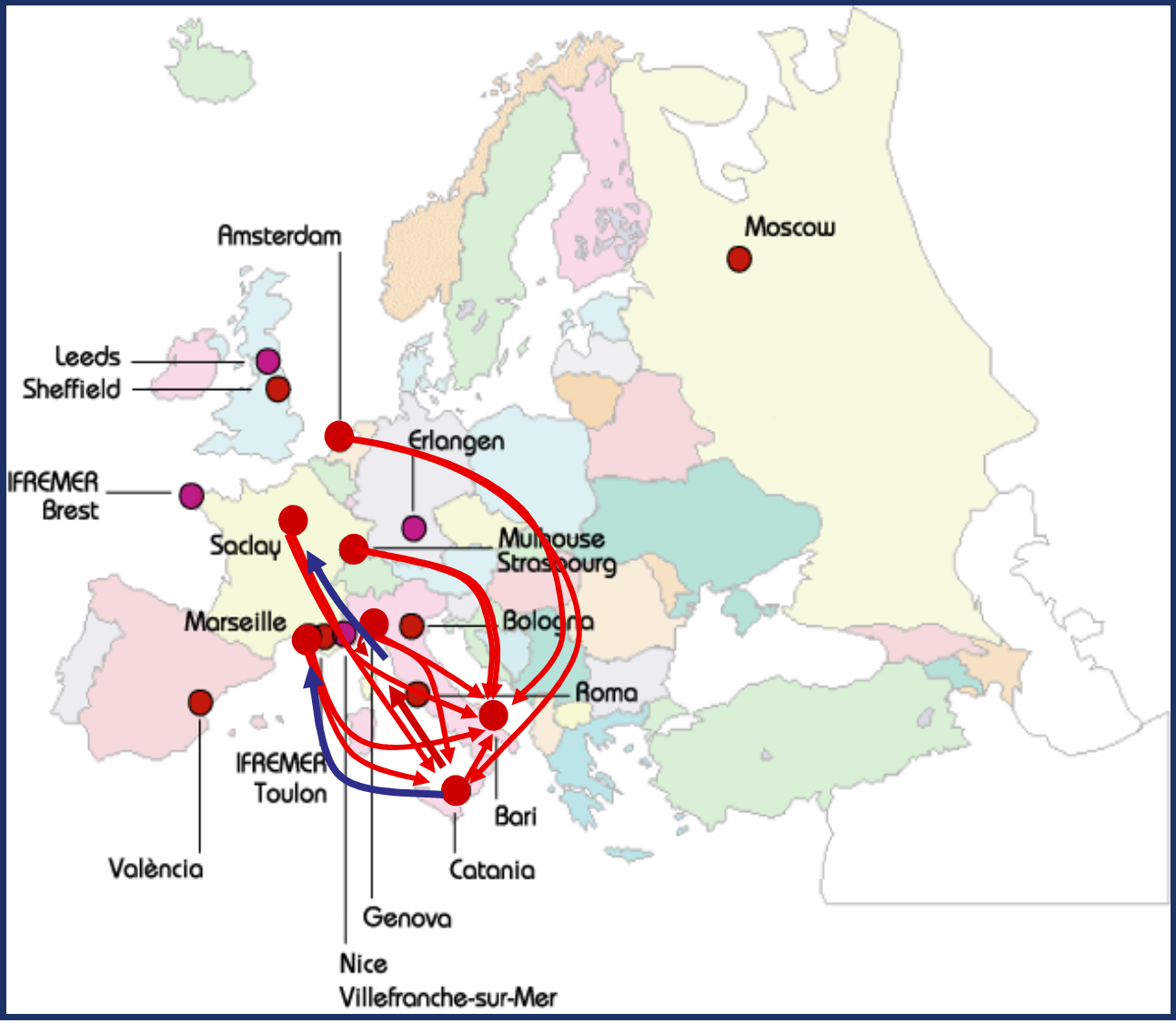
- Build Quality, don't try to obtain it through testing
- Upgrading through screening should be last resort
- Highest quality and reliability is always the lowest total cost

What is/was ANTARES ?

- 1 Junction box
- 12 lines
- 1 line = 5 sectors
- 1 sector = 5 storeys
- 1 storey = 3 OM + LCM + Instr.
- 12 BSS
- 1 BSS =SCM/SPM + Instr.
- 12 buoys
- 40 cables - different lengths, type connectors
- 300 LCM
- 900 = PMT + glass spheres
- 2000 water tighten connectors
- 3000 o - ring
- ~ 4000 el. boards
- ~ 4000 mechanical parts and screws
- Different type of other instruments (acoustic devices, Laser beacons, environment monitoring devices)
- Skilful DAQ, S/W

23 distinct centres
Ca. 180 researchers and engineers
Ca. 40 technicians
6 different national languages

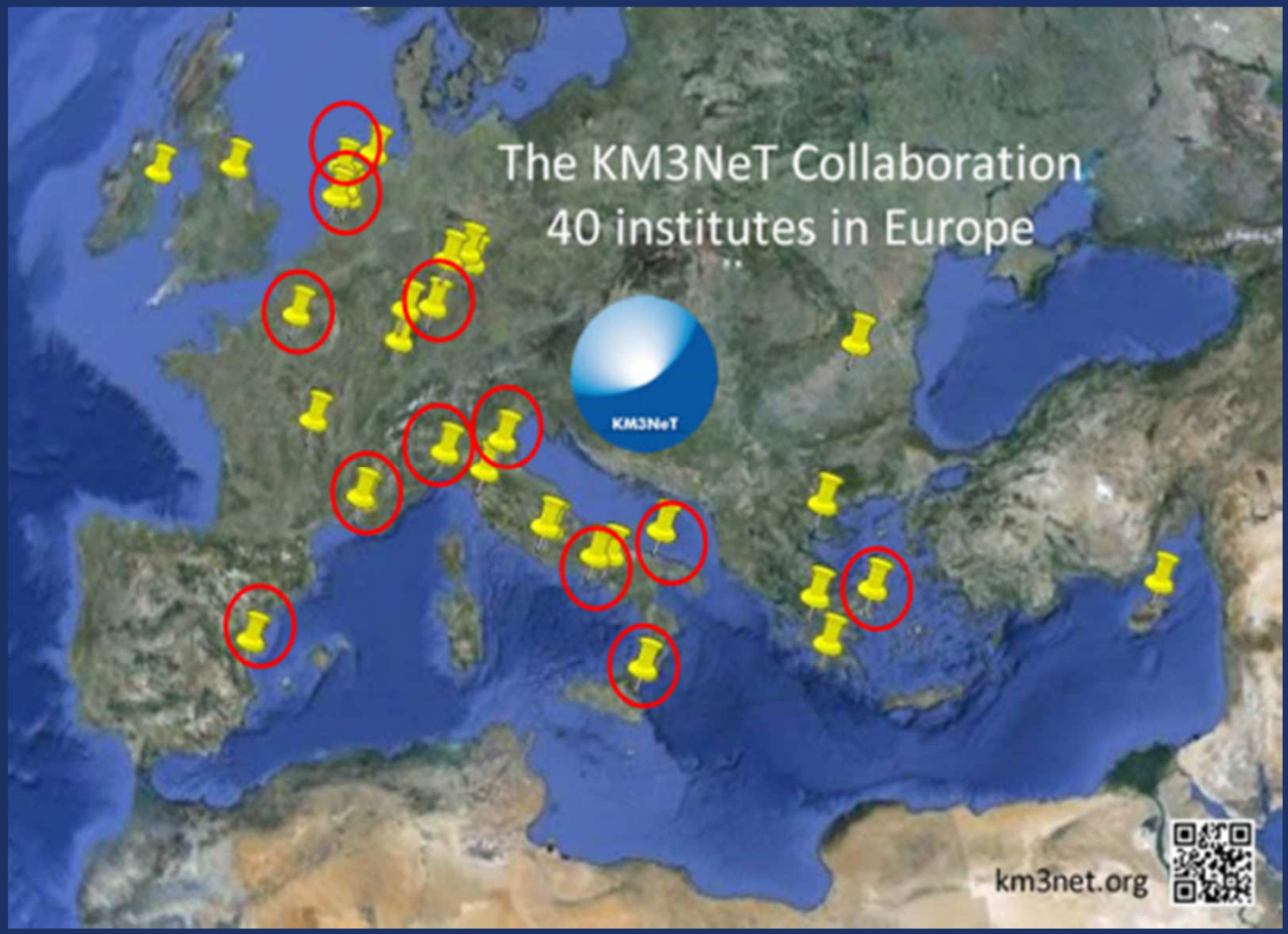
not a unique production site,
few accumulation points
(Saclay, CPPM, final Foselev)



Furthermore

- Wide range of culture, sensitivity, different type number and complexity of activities from one site to the other
- Different stages of implementation of quality system

KM3NeT 3 times larger



Starting point:
Have a reference system

Most used

- International Standard ISO-9000 series = Quality managements
  ISO-9001:2000, ISO-9004:2000

Strongly "industrial" oriented

- http://qualite.in2p3.fr

But we are "physicists".....

Not an "industry"

First hand solution

What is REALLY needed

- Rules
- Tools

How to establish rules

- Create a set of documents and forms where a common language for the managements of Quality Assurance and Quality Control is clearly stated

== the Quality Plan

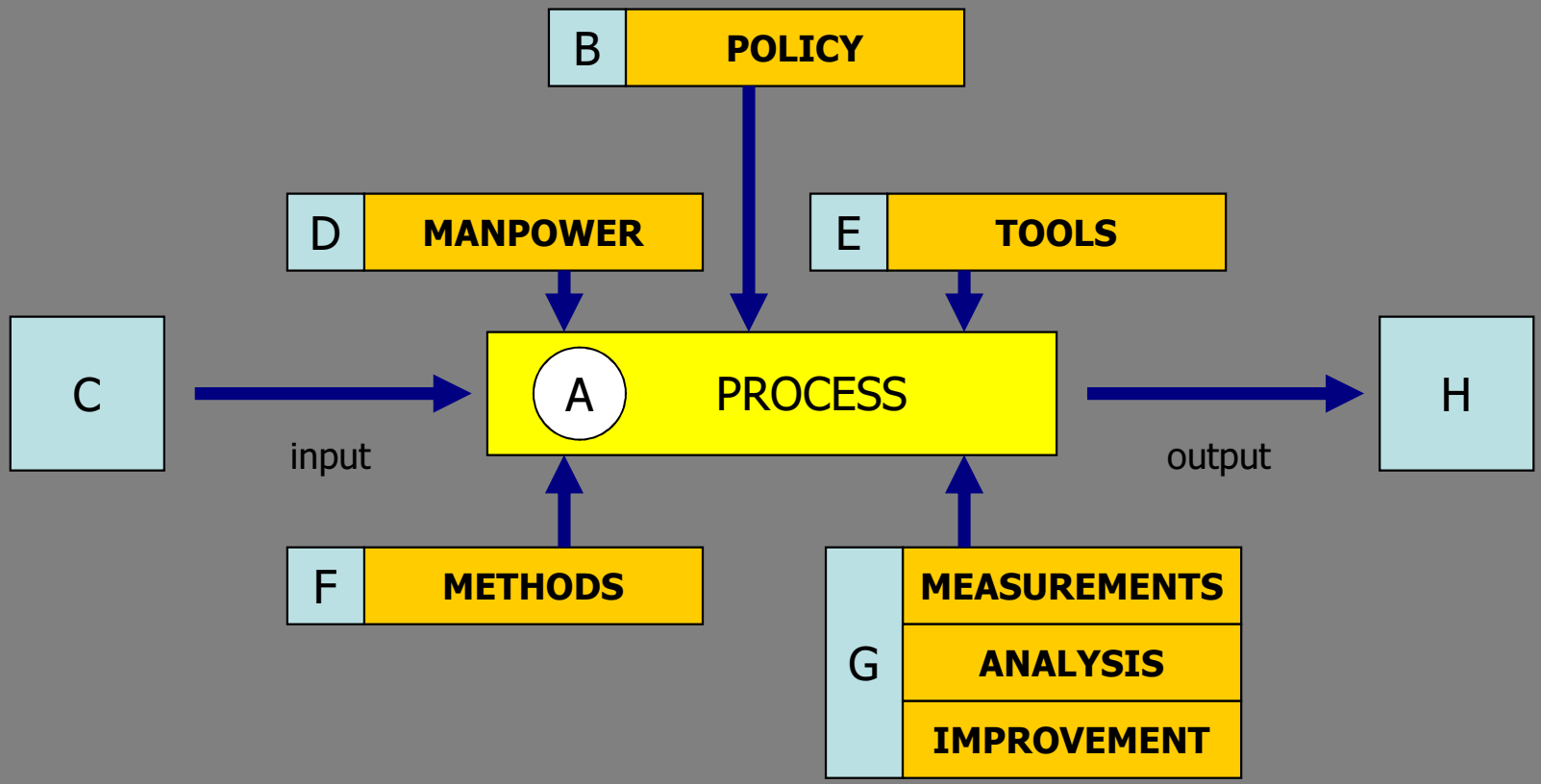
If possible the system has not to be too heavy, physicists are still reluctant to Q System

How to build a Q Plan

The (ANTARES/KM3NeT) Project…

- Is a set of interlinked processes
- Process = ensemble of resources and activities connected together that transform input elements in output elements

The process approach



We need to identify-1

A – Process
- What are the processes (description)
- What are the main ones
- What are the secondary ones
- What is their planning
- What need validation

B – Policy
- What is the scope
- What is the
- What is the strategy

C
- What the interactions/ interfaces with previous process
- Which documents define the criteria and methods
- What are the responsibilities

D
- No. of resources allocated
- Type of resources (e.g. expertise, etc.)

We need to identify-2

E – The Tools

- Which instruments are available for:
  - Measurements
  - Calibrations
  - Analysis
- What type of maintenance is foreseen

F – Methods

- Which procedures have to be put in place
- Which records
- Which parameters are Critical/Non-Critical

G – Measures-Analysis-Improvements

- Which type of measure-analysis
- Which methods of calibration/measure/ analysis
- Which type of controls
- Which procedures, instructions prescribing methods and criteria

H

- What are the interactions/ interfaces
- With the following process
- Which are the documents defining methods & criteria
- Which are the responsibilities

Starting Points

- Technical Design Report (TDR) v 1.0, July 2, 2001
  - It defines the objects of the detector, the technical details of the project in order to allow the practical realization of the components necessary for the experiment
  - It contains the definition of the detector components identified in a Product Breakdown Structure (PBS)
- Risk analysis *(6-12-2004 never revised; for JB not official)*

Guide lines for Q Plan -1

- Aim
- Responsibility
- Project/Product Re-examine
- Product Conformity Control
- Docs and data Control
- Purchase standards, quality
- Identification and Traceability of products

Guide lines for Q Plan -2

- (Internal) Production
- Shipment, storage, packaging and delivery
- Reception
- Acceptance/Functional Tests
- Integration
- Measurement and test tools/procedures
- Requirements to external/internal suppliers

Guide lines for Q Plan -3

- Non Conformity Management
- Training
- Quality inspection (Audit)
- Documents for recording Q of a Product/Project/Contract

A Quality plan (general, local)

has impact on any activity

In our case S/W and readout has not been covered
but very difficult to devise the appropriate tools

Basic Tools

- Local Quality Supervisor (LQS) @ each "production" site
- Internal Document Archive (+DB of PBS)
  for communicating within the collaboration
- Documents

✓ Quality plan (fixing rules)
✓ Risk analysis
✓ Procedures (e.g. for tests, integration)
✓ Forms/tools for tracing products within different sites, Non-Conformities, Corrective/Preventive Actions, Acceptance Data Package, DCR, CeCo, etc.

- Product Readiness Review
  (external experts optional/it depends)
- Integration Readiness Review
- Audit(?)

LQS

They have been the BASIS of the Q system without them (and training) it would have been impossible to run the QA/QC project

=> in any "diffuse" experiment – in my opinion - they are the key essential ingredient

(for ANTARES to have full-time personnel in major production sites has been the key for success)

LQS is a trained person whose tasks are

- Identify the processes taking place at their site, their sequence and interactions
- Verify the coherence of procedures and protocols in order to approve and release them
- Verify periodically that the established procedures for assuring quality are observed and updated
- Report to the QCM on non-conformity and manage the procedure for its resolution

The LQS have the right to go to the product responsible/subproject coordinator and ask them to show the Quality of their product (doc., test and integration procedure, planning of activity etc.)

The product responsible/subproject coordinator has the responsibility to supply information to the LQS on

- undergoing processes status
- incoming/shipped products
- non-conformity
- procedure (approval/application status)

Documentation management, archive

- It is a key point for Quality system

During the progression of the project a large amount of information is created. It traces the History of the project regarding different aspects (technical, administration, etc.)

- Clear and simple rules rules in harmony with the research needs

Essential characteristics:

- Fast access
- Continuous updating
- Controlled diffusion

- Format
- Categories
- Diffusion rules

	Doc title	Page 1 of 2
		Ref :
	Author : XXX - CPPM, Marseille	Date :

Destination (to) :

Title :
Reference :

Author :

Summary :

Category :

DOCUMENT STATUS LOG				
Indice	**Date**	**Issue type**	**Reviewed by**	**Approved by**
A				

CPPM
163, avenue de Luminy - Case 902 - 13288 Marseille cedex 09
Téléphone : (33) 04.91.82.72.00 - Télécopie : (33) 04.91.82.72.99

- Which are the documents that must be created and effect Quality

Check reports
Test reports
Qualification reports
Review reports (PRR, PTR etc.)
Reports of material examinations
Results of sampling measurements
Tender contract
Procedures, protocols of manufacturing
Test procedures and validation of S/W
Planning
……..

Documentation

- Format-Classification-Approval (+ controlled diffusion)

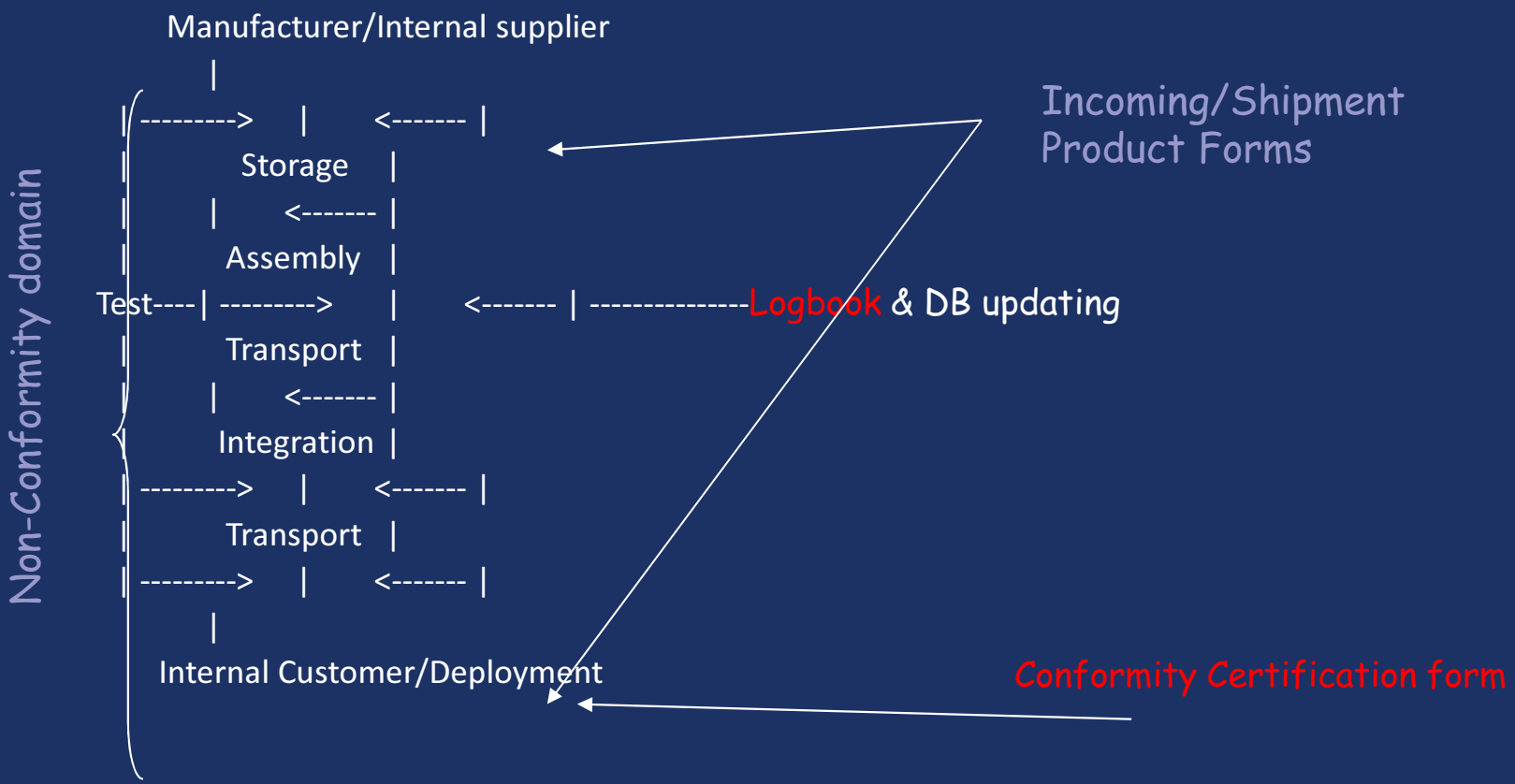
=> Approval procedure = not satisfactory

- Archiving

- Completeness => need an analysis

=> Frequently being late

Typical process



Documentation, Procedure, Protocols

Doc NCR - 1

Non-Conformity = unsuccessful matching of a requirement

NC Report = is a form to be filled in order to :

- Ensure that a NC product is segregated and it is prevented to be used
- Ensure that all NC are properly documented and traceable
- Eliminate or minimize the recurrence of problems by implementing the appropriate Corrective and Preventive Action

Doc NCR - 2

NCR is the best communication tool.

The treatment (opening, resolution, closing) of the NCR is the fundamental tool for the QA/QC system, entraining the circulation of the information and the recording of any Problem

Rules for the management of the NCR must be given in a dedicated Q document

Non Conformity Report

ANTARES Quality Form		Ref : 1-QUA-02-03 -C
NON CONFORMITY REPORT		Edition date : 18/1/2005
QCM/NC number	LQS/NC number	Page 1/1

Recording by the operator

IDENTIFICATION

PBS number:	Date:
Author of the report:	Prototype/production stage:
Entity responsible of the product:	Supplier:

→ **Observation made during**

☐ Reception: incoming inspection ☐ Qualification test
☐ Removal from storage ☐ Shipment
☐ Integration ☐ Other:

→**Description of non-conformity:** circumstance, effects… (use an additional page if necessary)

→ **Action taken to prevent misuse:**

Form transmitted to (1):	Date:

(1)Transmit the form to the LQS

Evaluation by : Resp. of the product, SpjCoo, LQS

CLASSIFICATION

☐ Major ☐ Minor

ANALYSIS OF THE NON CONFORMITY

Consequence(s) of the non-conformity:

DECIDED TREATMENT:

☐ Use-as-is	☐ Repair	☐ Change of product	☐ Reject	☐ Return to the supplier ?

Description of decided action	Responsible	Time allotted

VALIDATION OF THE FINAL DECISION: Visas of

Product resp:	SpjCoo :;	LQS :
For Major NC → Approval of:	TechCoo :	QCM :

CLOSURE OF THE NON-CONFORMITY

→ Planned actions have been completed and corrective/preventive actions have been initiated

LQS : (Date and visa)	SpjCoo : (Date and visa)	Product resp : (Date and visa)
For Major NC → Approval of	QCM : (Date and visa)	

2 classes:

MAJOR

Impact on:

- Equipment performance
- Functional requirements
- Interfaces with other systems
- Health and safety

Closure validated by Tech. Coor. and QCM

minor

All the others

Closure validated by LQS

I would like to remind that

Quality concerns also HSE

- H = Health
- S = Safety
- E = Environment

Report on ANTARES Technical Experience during Construction and Deployment of the Complete Detector
1QUA-01-43C 27/06/2009

Report on ANTARES Technical Experience during Operation and Maintenance of the Detector 20/02/2011

Recommendations on

- Quality aspects – 1°
- Technical aspects – 2°

Quality Aspects - 1

- Require the Q introduction in future product since the beginning
- Require a phase development of future project
- The process approach with the introduction of LQS for managing the local ANTARES structure has been proved a good solution. It is recommended for similar future projects.
- All the subprojects should be complying with Q rules. All the Laboratories should work complying with Q standards. Works should not be assigned to laboratories that are unable to comply with Q rules.

Quality Aspects -2

- Documentation is fundamental and the making of any product cannot proceed without a base of approved documents. Approved documentation must be produce before starting production. Extensive documentation is the only way to overcome the problem of the personnel turn over. A document manager should be put in charge.
- The Q should be valid till the dismissal of the experiment and apply also to exploitation and maintenance.
- Quality should be applied to dismounting phase, and even in this case it should be designed and planned well in advance.
- Top management should consider Q subproject decisions and indications mandatory for the prosecution of the project

Technical aspects

- Select a good and stable part design
- Insure the manufacturer has a good quality system in operation
- Impose stringent pre-contract inspection
- Establish a minimum failure rate level through qualification testing
- Perform stress screening and burn-in with tight limits
- Develop test benches (+S/W) well in advance
- Make dedicated inspection (e.g. X-ray) for any defects that had been missed

Report on ANTARES Technical Experience during Operation and Maintenance of the Detector

20/02/2011

- Set up a powerful Q System and make it work throughout the life of the experiment
- Define a good maintenance organization
- Prepare a detailed Risk Analysis, constantly improve it and stick to it
- Good fibre handling practice is a must
- Be prepared to underwater connection problems
- Be prepared to leaks
- Ask to experts, but make all possible checks yourself

Summary

- The introduction of a QA/QC project had a fruitful impact on the collaboration and on the management of the ANTARES project. Without Q plan it would be impossible to successfully progress in the construction and deployment of the complete detector.

- The introduction of Q occurred with great delay with respect to the beginning of the activities and so the solutions to different problems has been found *a posteriori* whereas many of them could be avoided.

- The personnel has recognized the utility of Q standard in their work. The major result of the ANTARES experience can be considered that a culture of Q has been introduced and experienced in a wide scientific community.

Summary (continued)

- The success of the system can be assured only if all the people involved in the collaboration give full support to actions the LQS and comply with the rules
- Training of the people involved in the Q system is essential
- Great improvements have been established when more resources (dedicated persons) have been actually put into the Quality system

Caveat

The satisfaction of the
"Planning /Milestone Date" constraints
is not the most strict requirement

It is usually in conflict with Q


That's all Folks!

SPARES

Management top levels

- The QCM has great responsibility; he can ask for stopping the processes especially if safety issues are in play
- He must have access to the experiment management committee where decisions on works, planning resources are taken
- Institution Board (top decision level of the project where the representatives of funding agencies are present) must receive regularly a report on Q system

Client re-examination

"ambitious" personal suggestion

Quality Coordination Forum

Iis a coordination group that discusses issues and implementation with respect to project/program quality, coordinates the activities of individual quality working groups (e.g. LQS + laboratory personnel)

The objectives of the QCF are to integrate quality approaches, improve utilization of quality resources, define and analyze quality related risks, communicate quality lessons learned, and improve quality processes

The QCF meets approximately three times a year, and work groups coordinate on an ongoing basis

Purpose of the team:

- Define and analyze quality related risks
- Communicate quality lessons learned
- Improve quality processes

Focus:

- Project/program quality and the supply base

Process:

- QCF meets face-to-face two/three times a year
- Day to day QCF work takes place in Q work groups coordinated by the QLF

- Members:

- The Q management of KM3NeT, LQS and Industry Quality Representatives

Product history and management
= traceability
= Data Base

PBS 2.1.04 / 2.0

an example of bar-code for the ARS_MB serial 2.0

history list for a product

PRODUCT : ARS_MB serial 2.1.04/2.0

Date	Location	Status	people	Comment
22/11/02	Strasbourg	free	jean Pierre Pineau	first test
25/11/02	Strasbourg	broken for pieces	ALBERT Arnauld	broken during test. bad manipulation of the ARS mother board

STATUS for a product

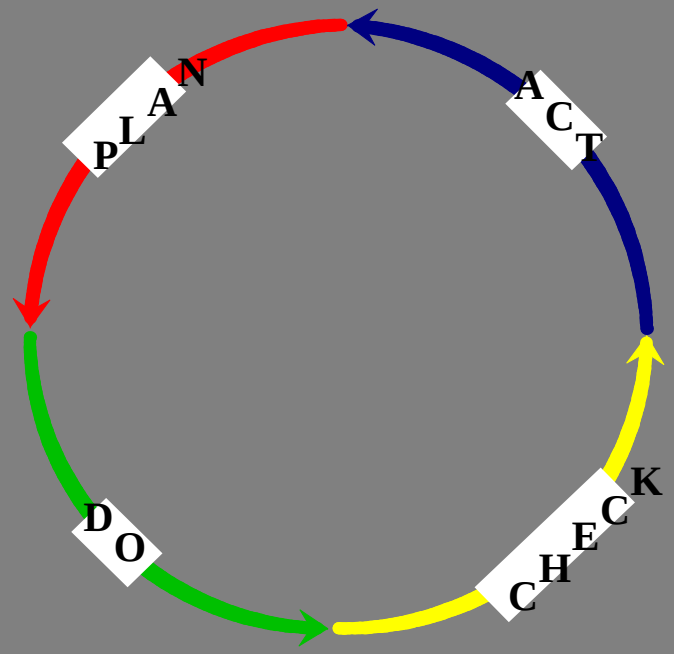
PRODUCT : ARS_MB serial 2.1.04/2.0

DATE : 29/05/2003 LOCATION : CPPM

STATUS : INTEGRATED

COMMENT : integration of ARS_MB 2.1.04/2.0 into LCM 2.1/1

Continual improvement is the basic supporting concept of the Quality system



Tools = Documentation + Description of processes +
Management of interfaces + Audit + Statistical analysis +
Corr.& Prev. actions+ Re-examination by the Top Management (SC,IB)

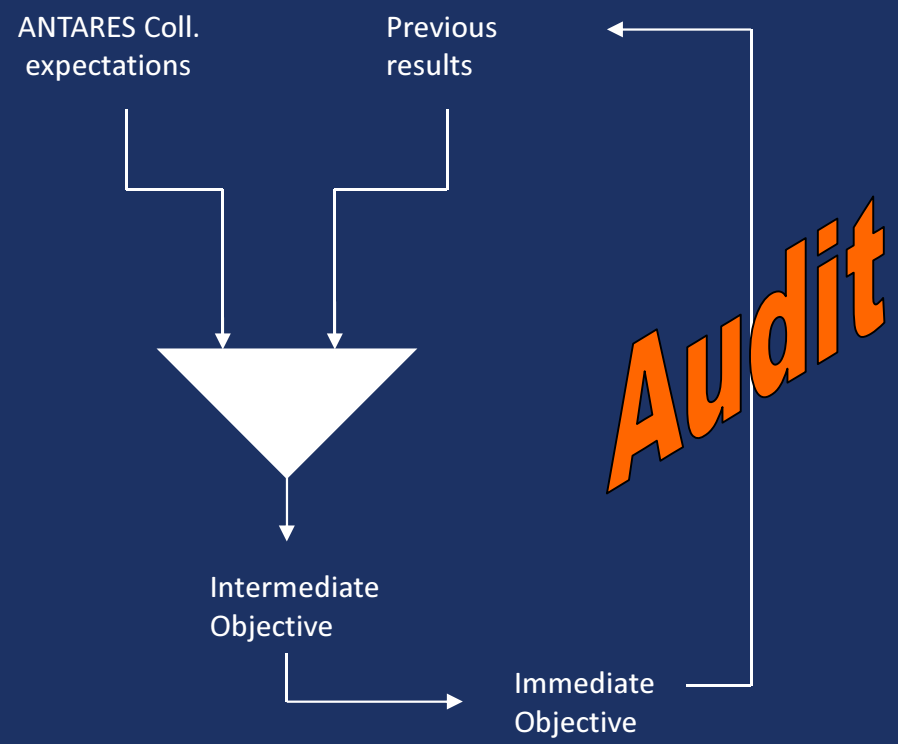
4 - Audit

- PRR (not all docs always ready)

- Audit Training
- Audit activity done but for CEA-Saclay, Foselev, NIKHEF and Erlangen

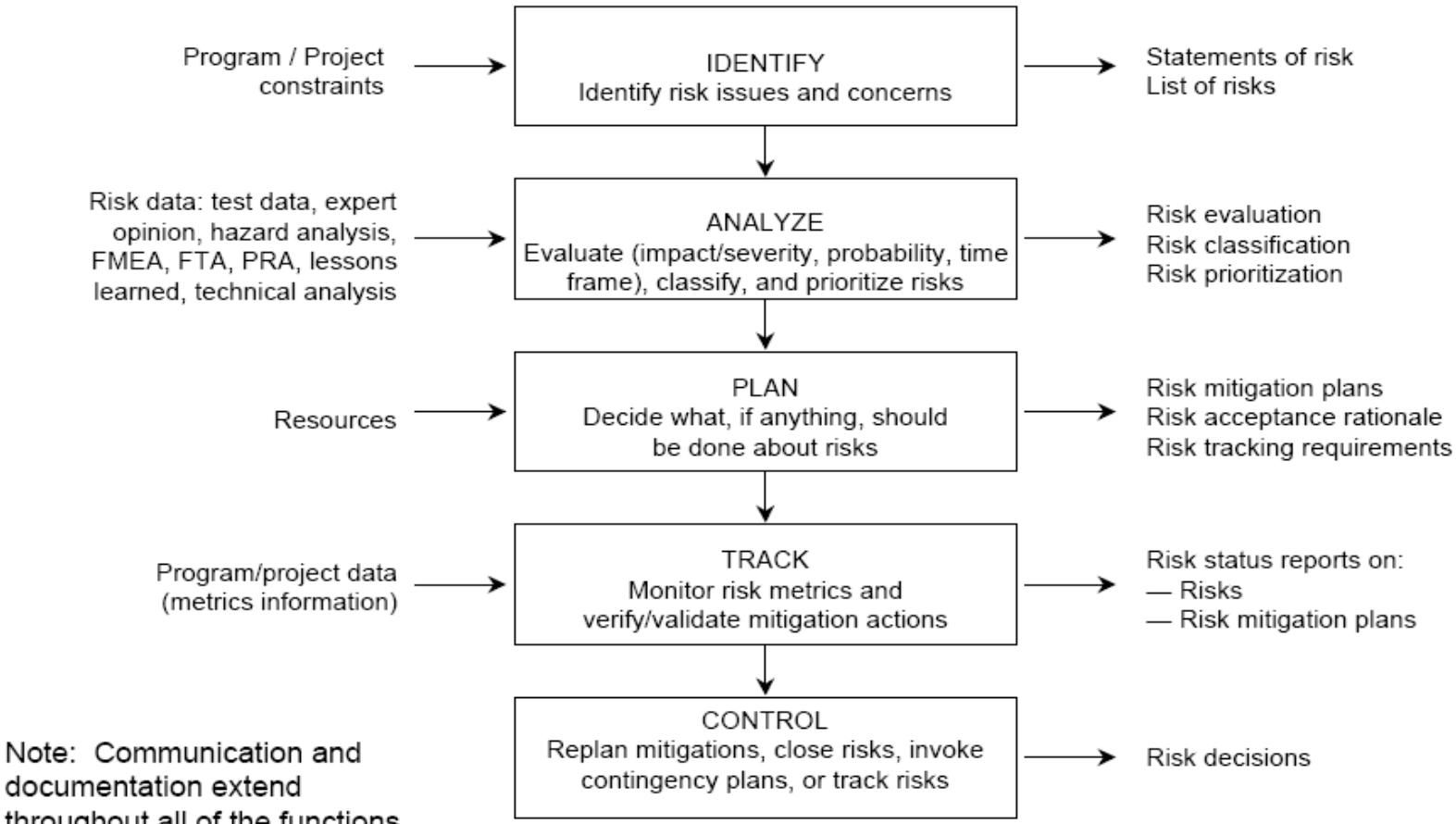
=> This activity has a cost (time, money [training and travel of personnel])

Audit ?



Part of Quality management focused on providing confidence that Quality requirements will be fulfilled

Risk Management Process



Note: Communication and documentation extend throughout all of the functions.

FMECA- A Bottoms-Up View to Design, Manufacture, Operations

Tire FMECA with Reevaluation of Risks

Part Name, Part Number	Potential Failure Modes	Causes (failure mechanism)	Effects	Risk Priority Rating				Recommended Corrective Action	Improved Rating			
				Sev*	Freq	Det	RPN		Sev*	Freq	Det	RPN
Cord	Fiber separation	1. Weak precursor material	Ply failure	4	3	8	96	Incoming inspection	4	1	8	3
		2. Handling damage	Ply failure	4	3	8	96	Increase process controls during mfg	4	2	2	16
		3. Cumulative fatigue	Ply failure	4	2	8	64	Monitor tire life	4	2	2	16
Ply	Delamin-ation	1. Dirt or grease	Loss of side wall integrity	7	3	8	168	Toluene wipe down during layup	7	1	1	7
		2. Twisted plys	Loss of side wall integrity	7	2	6	84	Automatic ply alignment	7	1	1	7
		3. Poor bond pressure	Loss of side wall integrity	7	2	8	144	Redundant tensioning system	7	1	1	7
Carcass	Disinte-gration	1. Poor tire alignment	Vehicle loss	9	2	9	162	Planned periodic maintenance	9	1	1	9
		2. Tire hits curb	Vehicle loss	9	2	9	162	Driver training	9	1	1	9

*Severity ratings 8 to 10 request special effort in design improvement regardless of RPN rating

Reliability Analysis

- The Reliability is the best way for quantifying the probability that a system, a product, a component will work without problems in a particular environment for a certain period with a certain CL
- Particularly suitable for a correct validation of a project/product for which an error can have severe consequences

Reliability Definition

$$R(T) = 1 - \frac{N_F(T)}{N_T(T)}$$

- T is the age of the item under test at the end of the test
- $N_F(T)$ is the number of items that have encountered a failure in the test time interval T
- $N_T(T)$ id the total number of tested items (or size of the sample)

Acceptance Data Package

• Collection of the whole available documentation relative to a LINE :

- General documents : integration procedures, synoptic…
- Traceability documents of the integrated products on each storey
- SCM/SPM
- BSS
- List of the Change Design Requests

- Edited by LQS and Integration Responsible
- Validated by Technical Coordinator and QCM

Typical/Basic Q Documents

- Q Plan - general
- Local Q plan
- Rules of shipment
- Internal Audit management
- Corrective/Preventive action (CA/CP) management
- Incoming product registration
- Accompanying shipment form
- Non-conformity report (NCR) form
- CA/CP form
- Test Report form
- Change Design (CDR) Request form
- Certificate of Conformity (CeC) form
- Acceptance Data Package

(space) project chronology

- phase 0 : mission analysis
- phase A : feasibility study
- phase B : preliminary design
- phase C : detailed design
- phase D : production/qualification
- phase E : operation
- phase F : decommissioning

As a minimum we can identify

- phase A : feasibility
- phase B : preliminary design
- phase C/D : detailed design/production /qualification

Phase A

- Preliminary development plan
- Product Tree
- Documentation management plan

Management

- Tender specifications
- Preliminary technical specifications
- Task assignment

Engineering

- Preliminary product assurance plan
- Preliminary risk analysis

Quality

Phase B

Manag.

- Development plan (technical requirements, budget, organization…)
- Configuration management plan (documents,diffusion, interfaces)
- Action management (task assignment, execution….)

Engineering

- Technical specifications
- Preliminary definition file (info. for production, control and use)
- Interface control document (elect.,thermal, mech., S/W…)
- Verification matrix (synoptic plan for verification of requirements)
- Change justification file
- Budgets

Quality

- Product assurance plan
- List (EEE components, materials, processes)
- S/W quality
- Risk analysis (FMECA, stress analysis, worst case analysis)
- Estimation of reliability and availability

Phase C/D

- Definition File
- Justification File
- Assembly, Integration and Test Plan
- Integration Procedure
- Test procedure and report
- User's manual

Engineering

- Lists (EEE components, Materials, Processes)
- End Item Data Package
- Log Book
- Test Readiness Review
- Post-test Review
- Anomaly management

Quality


THE END