

Managing Scientific Projects

Part ① related to Quality Management

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INFN Perugia
Thursday 18th 2014



01

qual·i·ty

| 'kwälətē | noun (pl. qualities)

Quality Planning

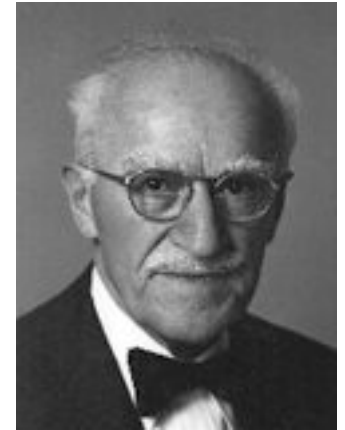
vs.

Quality Control

Quality

Two meanings:

1. “Quality” means those features of products which **meet customer needs** and thereby provide customer satisfaction;
2. “Quality” means **freedom from deficiencies**.



<http://www.qualitygurus.com>

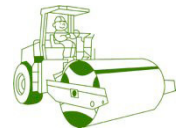
Joseph M. Juran

The difficulty in defining quality is to translate future needs of the user into measurable characteristics, so that a product can be designed and turned out to give satisfaction at a **price** that the user will pay.



<http://www.qualitygurus.com>

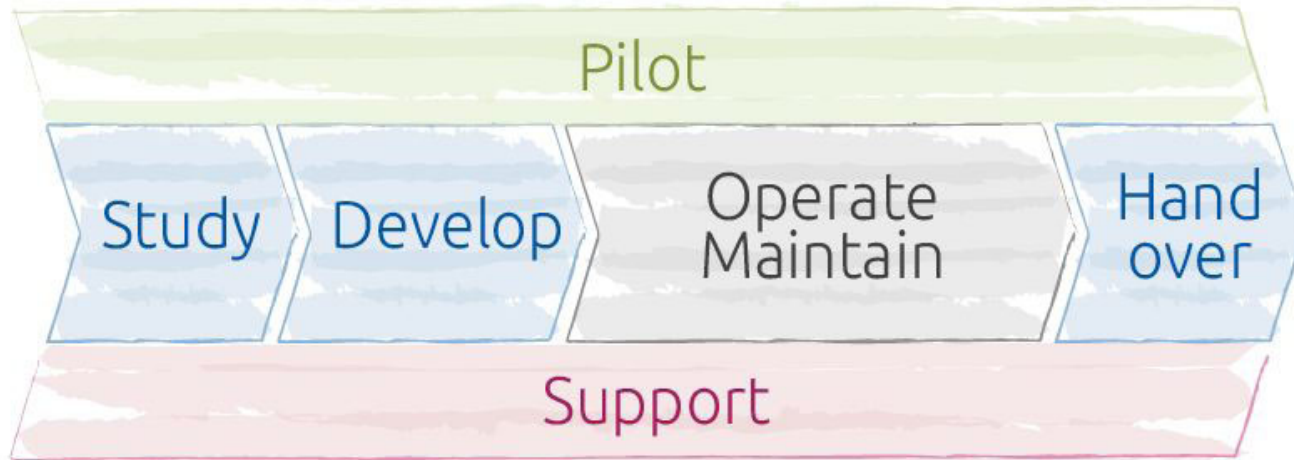
W. Edwards Deming



Efficiency vs. Effectiveness



E.g. Quality at CERN



Quality of our **facilities** and **equipment**

Quality of our managerial and operational **processes**

Freedom of deficiencies

Stakeholder satisfaction

Effectiveness

Quality at a glance

Quality Management



**Quality
Planning**



**Quality
Assurance**



**Quality
Control**

Quality

At a glance

Quality Planning

Quality Assurance

“

I say what I will do

Someone checks that it is appropriate

I do what I have said

I provide evidence of compliance

”

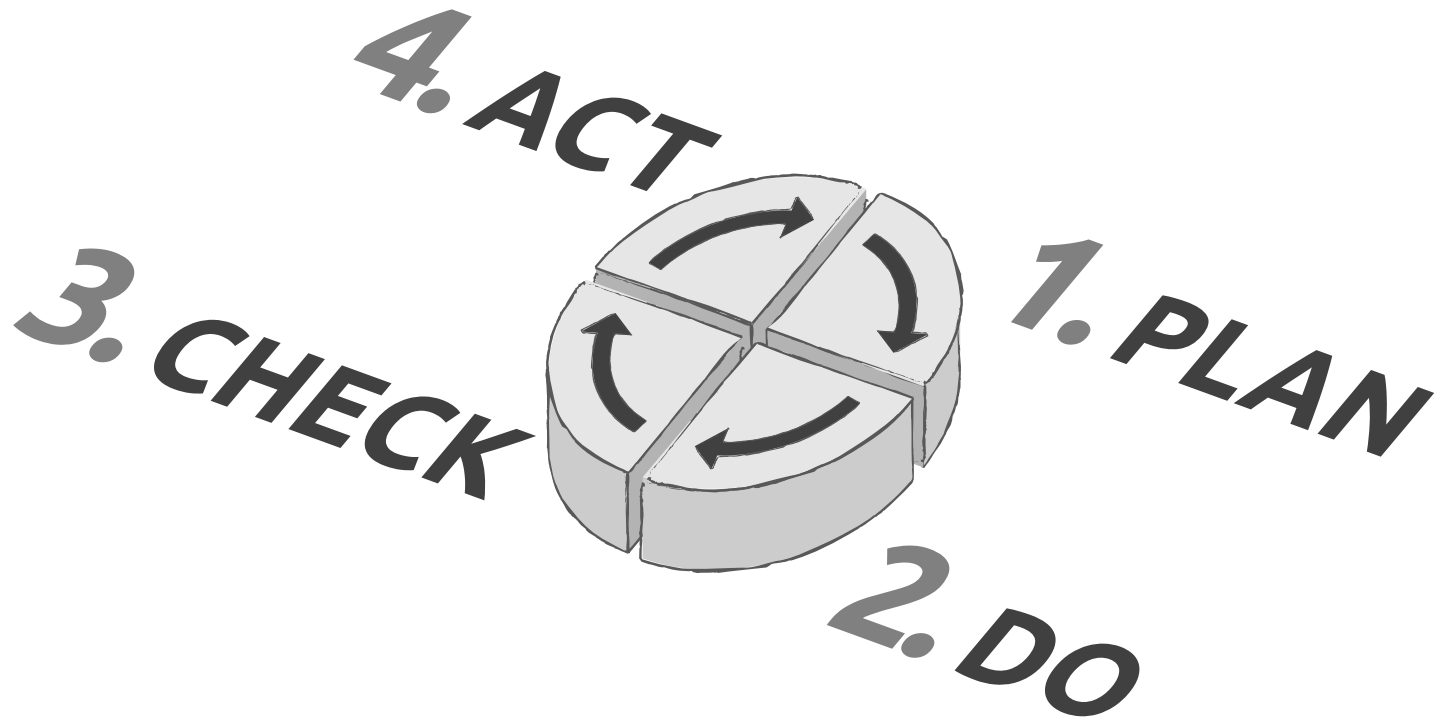
Quality Control

“

I also identify defects in the processes
and seize the opportunity to improve them

”

Deming Wheel



“I also identify defects in the processes and seize the opportunity to improve them”

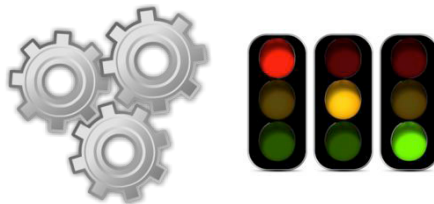
Quality Planning



Standards to apply



Processes to follow

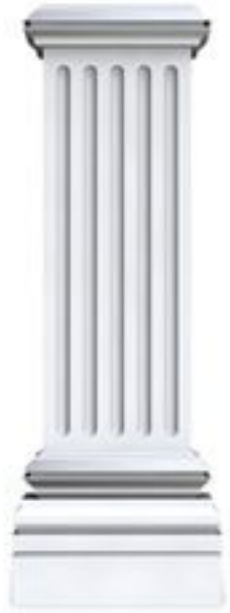


Tools to use (IT tools, templates, forms...)



Roles to assign





Quality Planning



Processes to follow



- For releasing **documents**
- For managing **configuration**
- For managing **projects**
- For managing **operations**
- For ensuring **safety**
- For handling **non conformities**
- For managing **risks, crises**
- For **acquiring**
- More broadly:
for **decision making**

Standards to apply



7

- **Managerial** process
- Engineering** process
- Product**-related
- Process**-related



**Quality
Planning**

V&V

(verification
& validation) ↙

Traceability

of performed tasks <
and deliverables

Change

requests, decisions <
and implementation

Non conforming

products and deliverables ↘



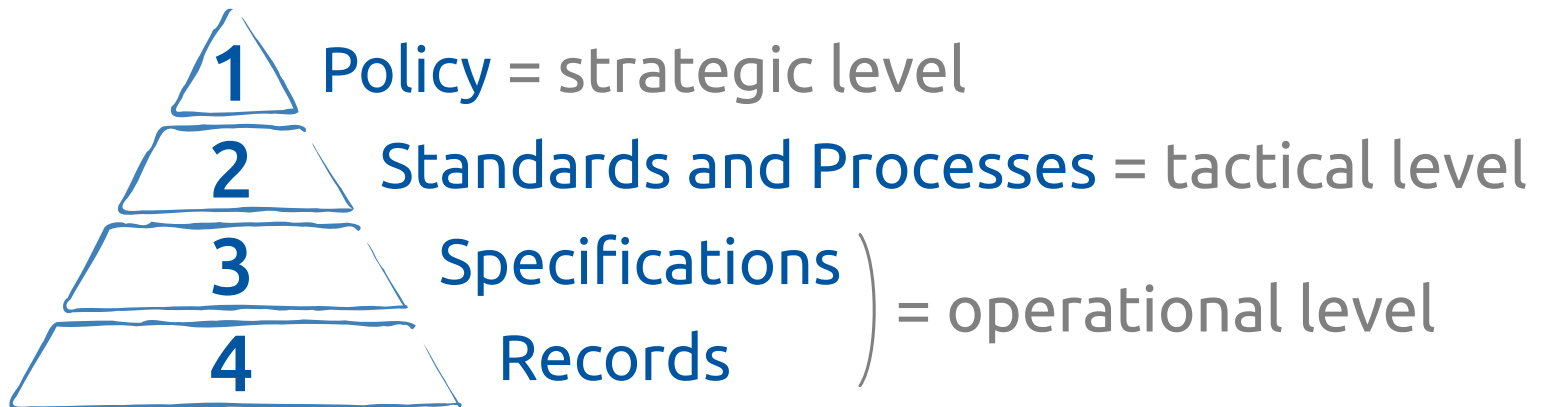
**Quality
Control**

ISO 9001:2008

At a glance

➔ Six **documented processes** are required to meet the ISO 9001:2008 :

- ➔ 4.2.3 Control of documents
- ➔ 4.2.4 Control of records
- ➔ 8.2.2 Internal audit
- ➔ 8.3 Control of non conforming products
- ➔ 8.5.2 Corrective actions
- ➔ 8.5.3 Preventive actions



The QA Trade-off

Resources
to dedicate
to QA

Value
created by
QA



Quality Planning

At a glance, in a NPD project context

- ➔ Defining which **standards** are applicable
- ➔ Defining which “**tools**” to use (incl. document **templates** and **forms**)
- ➔ Assigning **roles**, i.e. setting up a **project organization**
- ➔ Defining key managerial **processes**:
 - ➔ For releasing **documents** (incl. verification and validation)
 - ➔ For ensuring **project deliverables** comply with **customer needs**
 - ➔ For managing the **configuration** (i.e. the baselines)
 - ➔ For handling **issues** and **non conformities**
 - ➔ For planning, scheduling, costing, hiring project participants, managing risks, reporting the progress, buying supplies and services...
- ➔ More broadly, for **decision making**



Quality Control

At a glance, in a NPD project context

➔ Implementing straightforwardly the Project QA Framework provisions:

- ➔ Proceeding systematically to the **verifications** and **validations** as they have been planned
- ➔ Insuring the **traceability** of the tasks (how they were performed) and of the task's deliverables (specifications vs. actuals) by means of records
- ➔ Releasing **change requests** when a baseline shall be modified
- ➔ Releasing **non conformity** reports when a deliverable is not as expected...



Quality Planning



Applicable Standards

- ➔ Standards related to the NPD **project management**
e.g.: ISO 21500:2012 or ANSI PMBOK 5th ed.
- ➔ Standards related to the NPD **engineering processes**
incl. PLM, CAD systems, geometrical tolerancing, etc.
- ➔ Standards related to the **product** to develop itself
in the fields of materials, of communication, of energy, of interfaces,
of software, of reliability, of availability, of maintainability, of safety, etc.
- ➔ Standards related to the **manufacturing and assembly processes**
incl. supply chain, plant engineering, etc.
- ➔ Internal standards related to **coding** (items, assets, docts., functions, etc.)
and **tagging** (label plates, barcodes, etc.)

Quality Assurance



Key Quality Assurance Processes

- ➔ Managing **documents**
i.e. authoring, versioning, circulating (verification and validation), releasing and archiving project documents, but also 3D mock-ups and 2D drawings
- ➔ Managing **expectations**
i.e. ensuring that the project deliverables comply customer needs
- ➔ Managing the **configuration** and handling **issues** and **non conformities**
i.e. managing baselines, managing change requests and orders
- ➔ Conducting **quality audits**

Handling Documents

1234 v. 5

Lorem ipsum dolor sit amet,
consectetur adipiscing elit.
Curabitur est purus, facilisis
a pharetra ut, mattis sit amet
lacus. Nullam vitae nisi urna,
quis pellentesque nisl.
Nullam sed velit dui. Cras at
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fermentum in vitae libero.

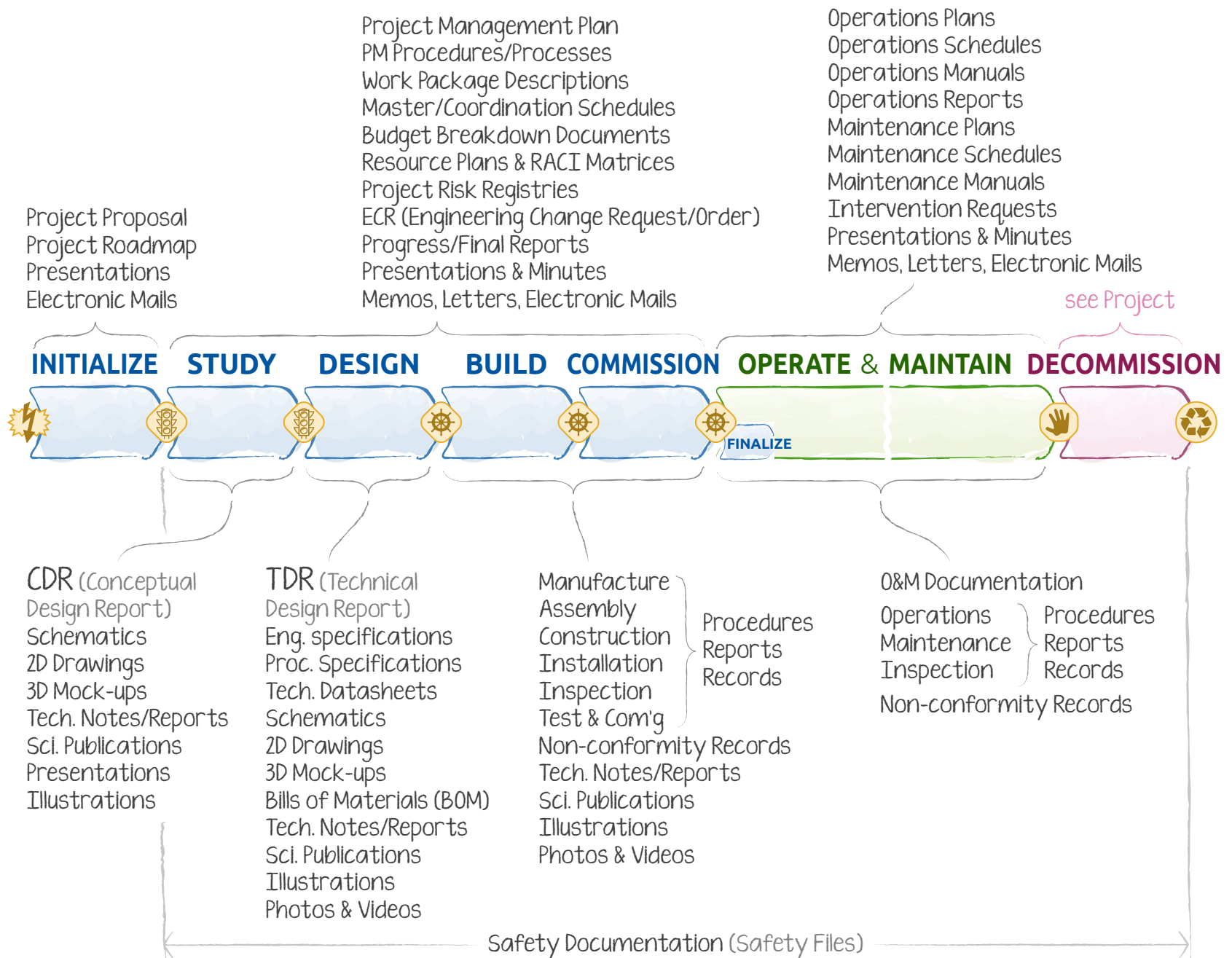
Handling Documents

- ➔ Agreeing upon a **typology** of documents
- ➔ Providing document **templates** and **authoring**
- ➔ **Identifying** documents (coding conventions) and **versioning**
- ➔ **Circulating** documents for **verification** then **validation**
- ➔ **Archiving** and **retrieving**

Typology of Documents

1234 v. 5

Lorem ipsum dolor sit amet,
consectetur adipiscing elit.
Curabitur est purus, facilisis
a pharetra ut, mattis sit amet
lacus. Nullam vitae nisi urna,
quis pellentesque nisl.
Nullam sed velit dui. Cras at
elit ut quam vestibulum
fermentum in vitae libero.



Key Documents

In a “Lean Project Management” perspective



8 documents!

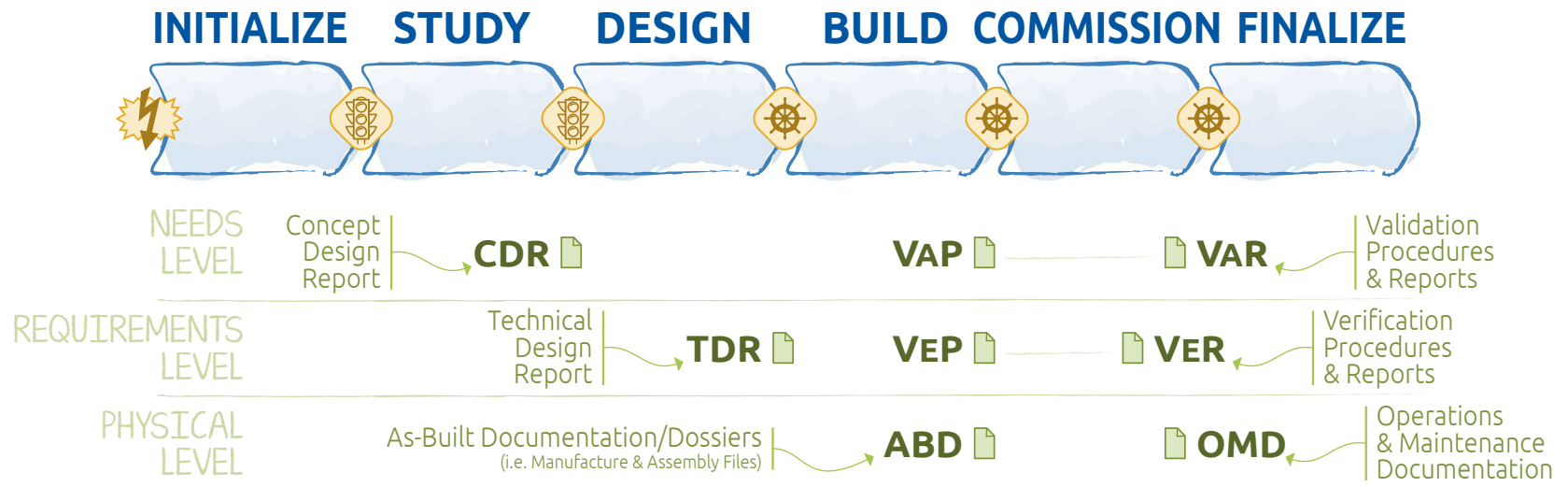
Key Results

Project Management Documents



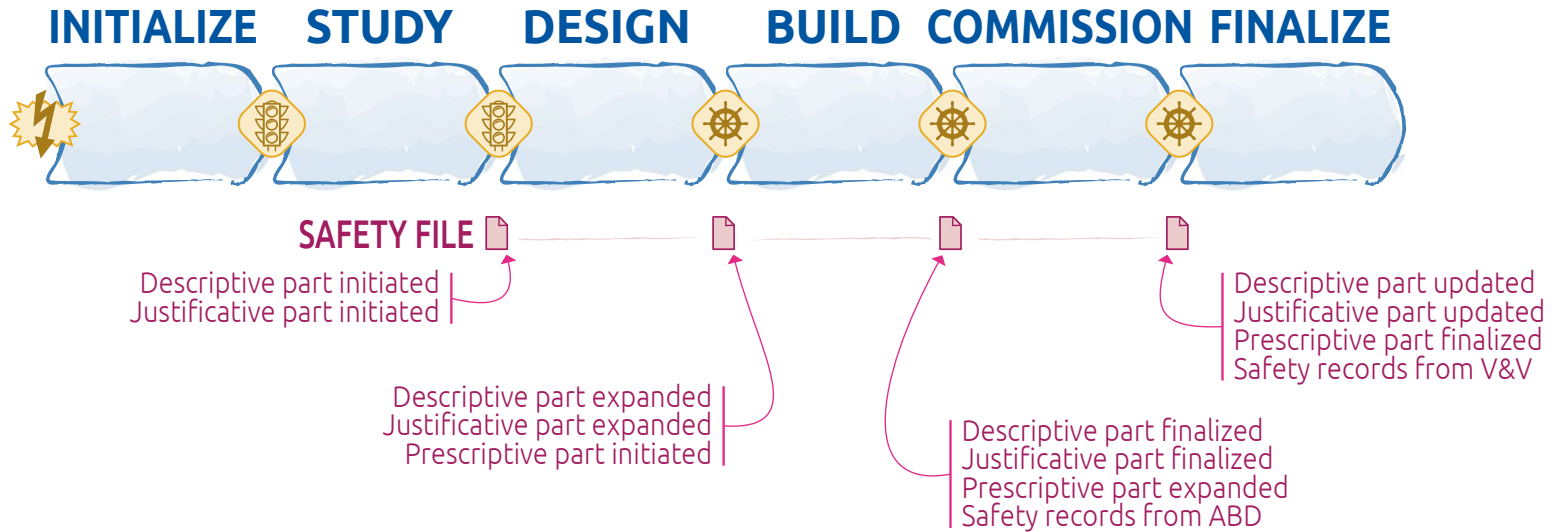
Key Results

Technical Documents



Key Results

Safety Documents





Project Management Documents

- Project **Requirements Register**
- Project **Work Breakdown Structure**
- Project **Master Schedule**
- Project **Coordination Schedule**
- Project **RACI Matrix**
- Project **Cost Estimate**
- Project **Budget**
- Then, Project **Progress Reports**
- Project **Risk Register**
- Then, Project **Contingency/Continuity Plans**

Document Templates

1234 v. 5

Lorem ipsum dolor sit amet,
consectetur adipiscing elit.
Curabitur est purus, facilisis
a pharetra ut, mattis sit amet
lacus. Nullam vitae nisi urna,
quis pellentesque nisl.
Nullam sed velit dui. Cras at
elit ut quam vestibulum
fermentum in vitae libero.

Project Document Template



Unique ID	Version	Status	Date
101	0.2	DRAFT	2014-02-22

the whatever project



DOCUMENT TITLE

Authored by:
Alberte
Barnabé

Verified by:
Cyprien
Denise

To be validated by
Ernest

This document is uncontrolled when printed.
Check the Project Document Register to verify
that this is the correct version before use

04.3



Project Proposal / Roadmap

Project Roadmap



It is a document that summarizes the direction to be followed by the project team for the whole duration of the project

Other names for this document:

- ➔ (Project) Charter
- ➔ (Project) Mandate
- ➔ (Project) Mission Statement
- ➔ (Project) Brief



Project Proposal

Typical Table of Contents



- ① **Executive Summary** To the attention of the Project Board
- ② **Initial Situation** Problem statement, rationale, current situation
- ③ **Project Objectives**
- ④ **Possible Solutions**
- ⑤ ***A priori* Preferred Solution**
 - ⑤.1 Description of the preferred solution
 - ⑤.2 Stakeholders and “approched Project Board” membership
 - ⑤.3 Phasing, project organization, masterplan
 - ⑤.4 Required resources
 - ⑤.5 Outcomes and benefits of the project
- ⑥ **Preliminary Risk Register**



Project Proposal

Editorial Process



- ➔ **Authoring:** Project Initiators
- ➔ **Verification:** Some experts in the field
The foreseen Project Manager
A few possible Key Project Participants
- ➔ **Validation:** ∅



Project Roadmap

Typical Table of Contents



- ① Executive Summary
- ② Initial Situation
- ③ Project Objectives
- ④ Possible Solutions
- ⑤ *A priori* Preferred Solution
- ⑥ Preliminary Risk Register
- ⑥ Decisions
 - ⑥.1 Decisions w.r.t. the **STUDY** phase
 - ⑥.1.1 Validation of the PB membership and project organization
 - ⑥.1.2 Decision w.r.t. the preferred solution
 - ⑥.1.3 Decision w.r.t. budgets and masterplan
 - ⑥.2 Decisions w.r.t. the **DESIGN** phase
 - ⋮



Project Roadmap

Editorial Process



- ➔ **Authoring:** Project Initiators
- ➔ **Verification:** Some experts in the field
The foreseen Project Manager
A few possible Key Project Participants
- ➔ **Validation:** **Project Board**

04.4



Project Management Plan

Project Management Plan



- ➔ The “entry point” to project information
- ➔ The aim of the PMP is twofold:
 - ➔ Ensuring that the project participants agree upon and share a common framework for organizing their project
 - ➔ Giving the project board the assurance that the project expectations are well understood and that everything is done to ensure the operational success of the project
- ➔ A few possible approaches depending on the project participants maturity level w.r.t. project management processes

See openSE brochure #1000 “Setting up a Project Management System”

Project Management Plan

Typical Table of Contents
Simple Approach



- ① **Project Overview** Reformulation of the Project Roadmap
- ② **Project Organization** Project Board, Project Team, roles, OBS
- ③ **Project Management Processes**
 - ③.1 **Scope Management** WBS, Work Packages, Work Units, Activities
 - ③.2 **Time Management** Master and Coordination Schedules
 - ③.3 **Resource and Cost Management** Manpower, budgeting, EVM
 - ③.4 **Quality Management** Document management, V&V, configuration management, issue and non conformity handling
 - ③.5 **Communication Management** Meetings, reporting periodicity
 - ③.6 **Risk Management** Project Risk Register, Project Continuity Plans
 - ③.7 **Procurement and Contribution Management** Ordering, contracting
- ④ **Applicable Standards**

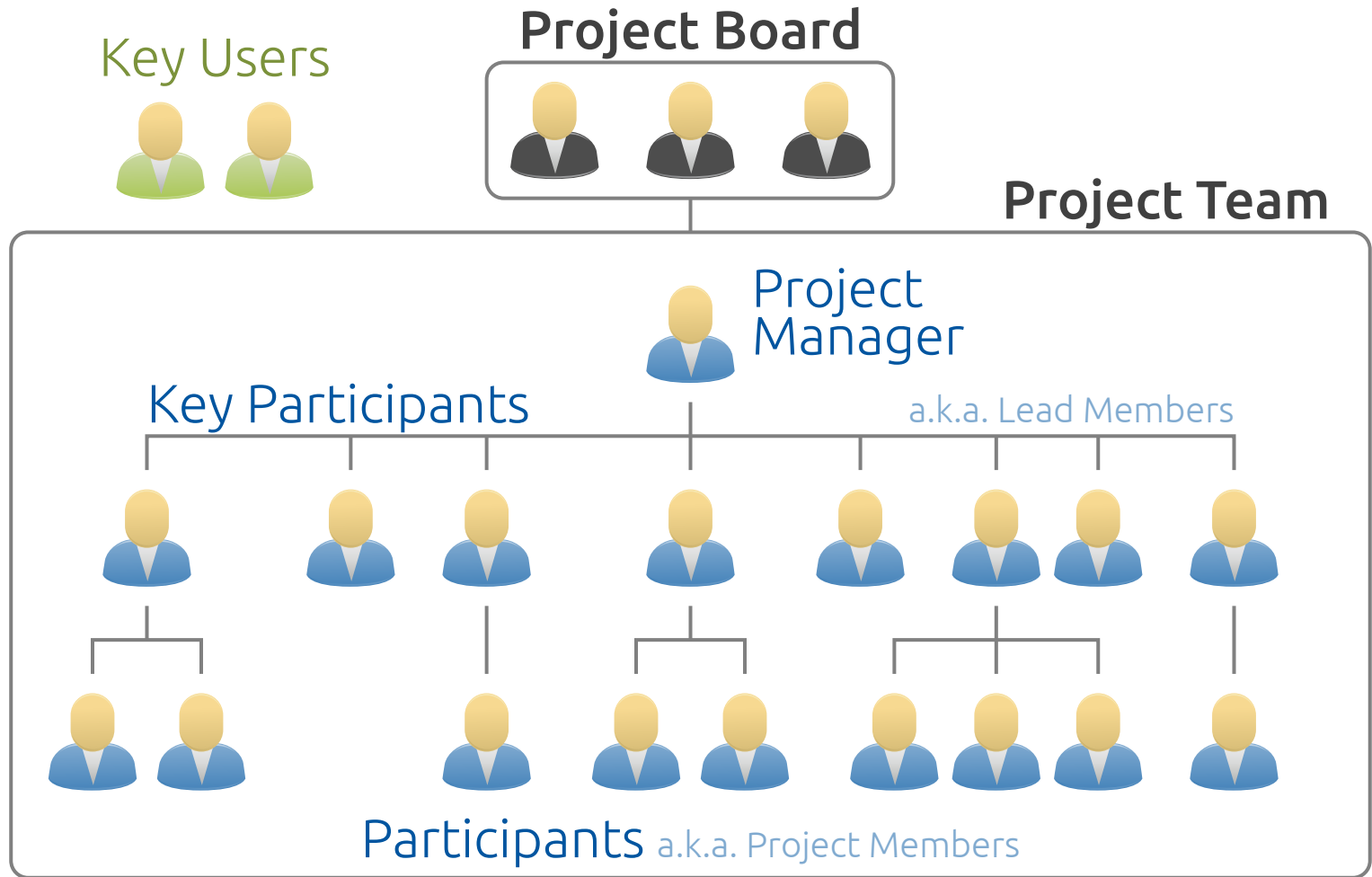
Project Management Plan

Editorial Process
Simple Approach



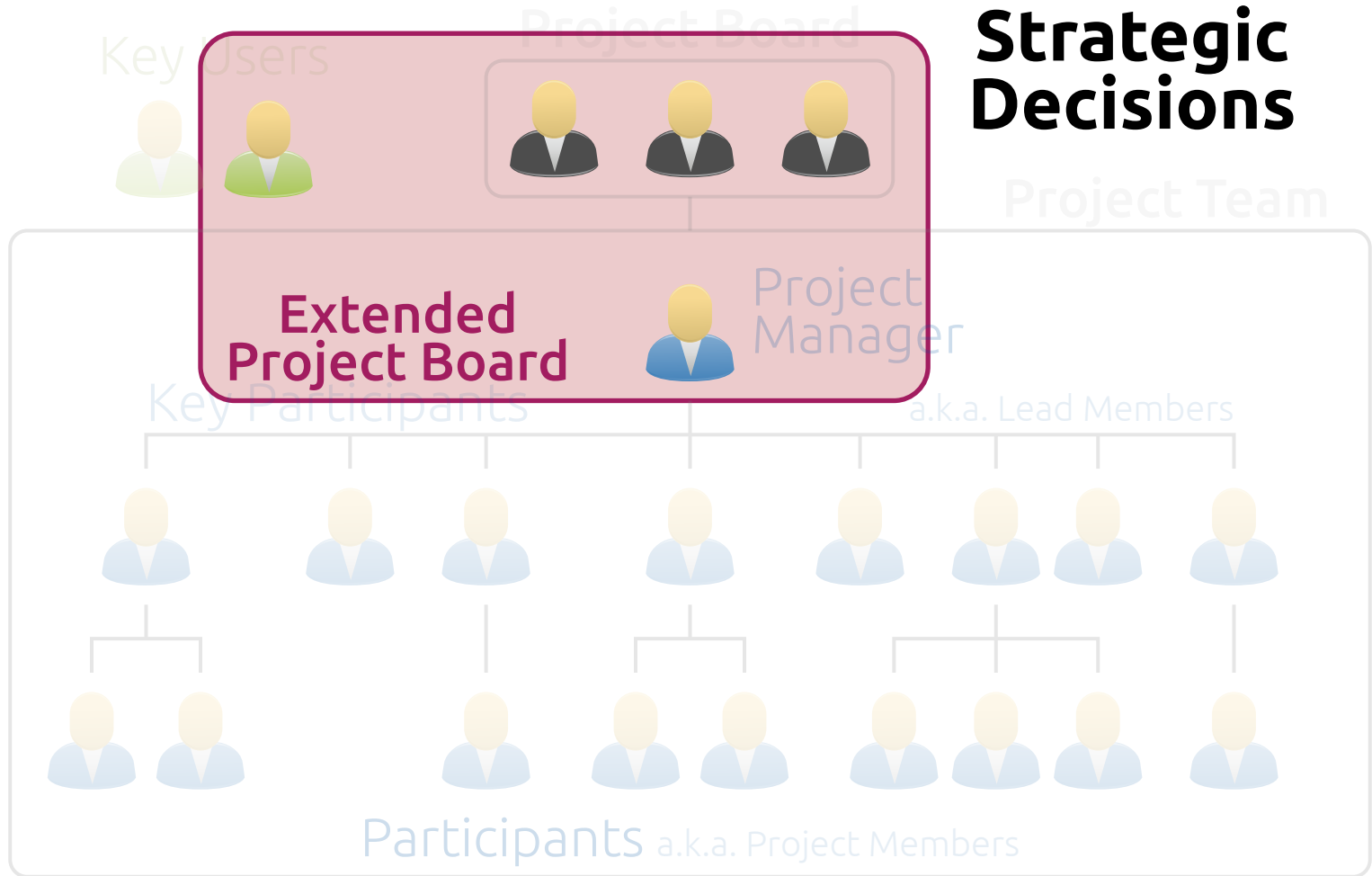
- ➔ **Authoring:** Project Manager + a few Key Project Participants
- ➔ **Verification:** Some other Key Project Participants + some Project Management Experts (e.g. members of the PMO)
- ➔ **Validation:** **Project Manager**

Roles

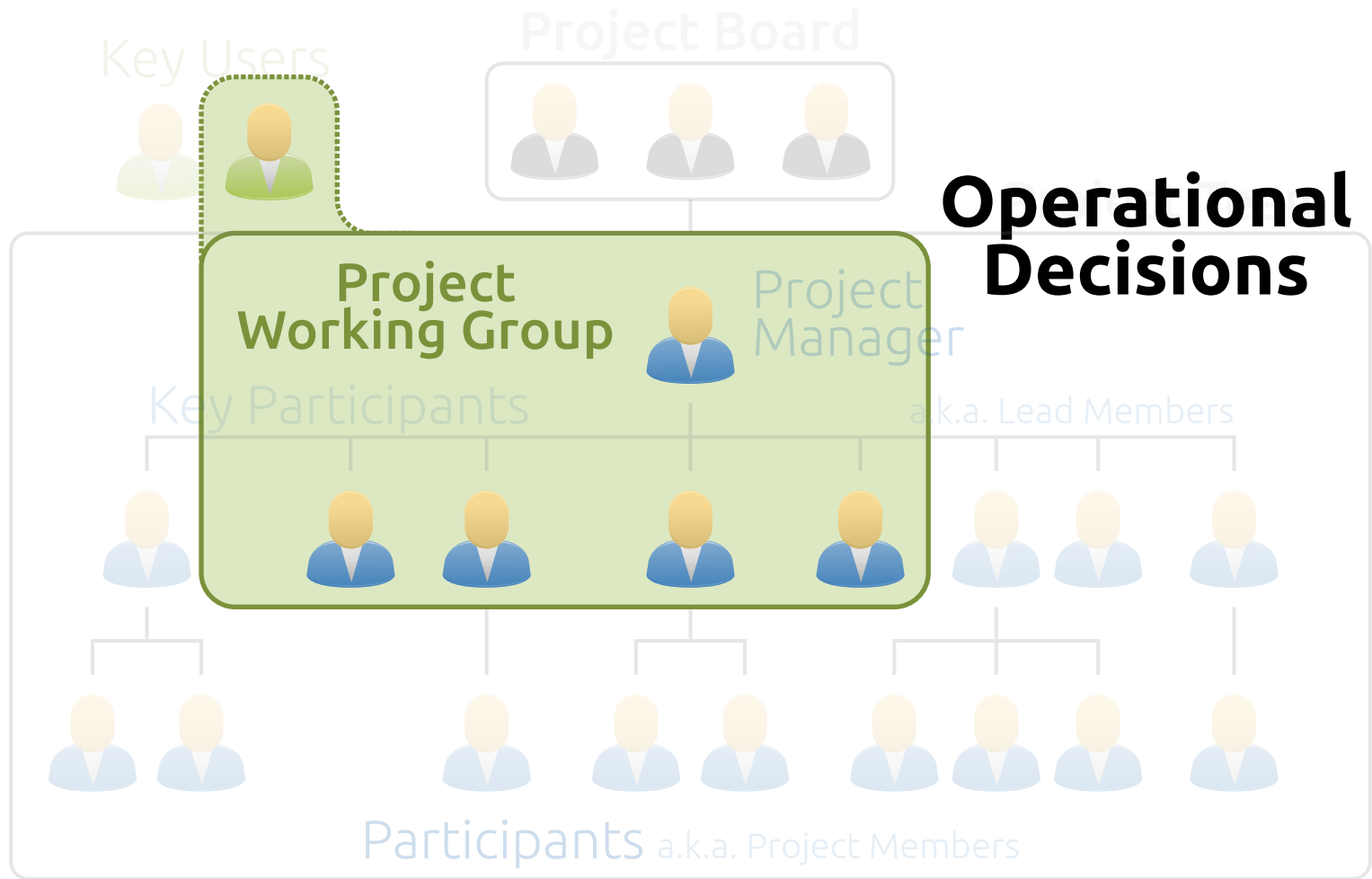


Roles

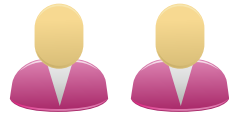
Strategic Decisions



Roles



Roles



*Project Initiators (**PI's**)*

Roles



*Key Users (**KU's**)*

Roles



*Project Board (**PB**)*

Strategic/Steering Board/Committee

Project Owner, Product/Systems Owner

Comité de projet (CoP), — de pilotage (COPIL)

Donneur d'ordre, Maître d'ouvrage (MOU)

Projektausschuss, comitato di progetto



- ➔ Ensure the **strategic management** of the projet
- ➔ Is ultimately responsible w.r.t. successfull completion
- ➔ Guarantee the acquisition and availability of resources
- ➔ Validate transitions between phases
- ➔ In case if conflicts, arbitrate

Roles



*Project Manager (**PM**)*

*Project Leader (PL), Project Coordinator, Coordinator
Chef de projet (CP), Maître d'œuvre (MŒU)
Projektleiter (PL), capoprogetto (CP)*

- ➔ Ensure the **operational management** of the project
- ➔ Is responsible for the organisation of the project and for its coordination

Roles



*Project Participants (**PP**'s)*

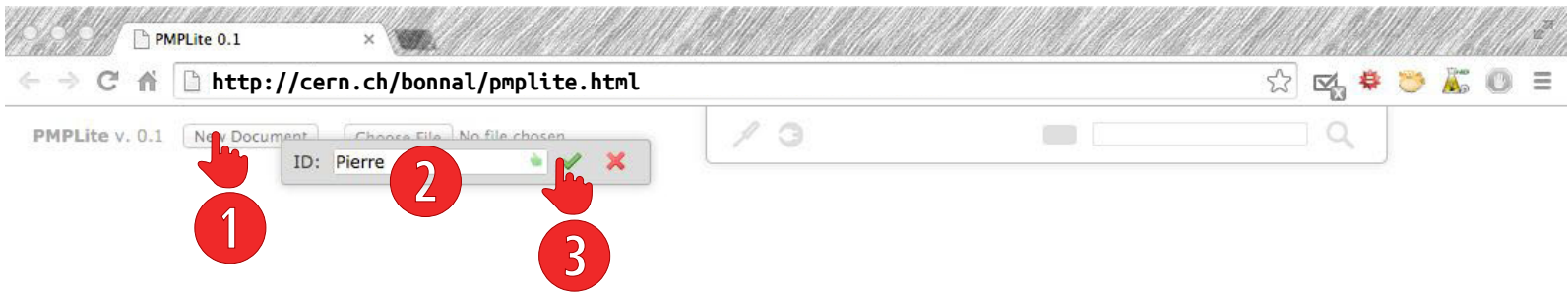
PizzaExpress

Consegna a domicilio da drone

Your lab is invited to design and develop a remotely operated **drone** for pizza delivery by the air.

Your 2nd task: drafting a **Project Management Plan**





PMPLite v. 0.1

New Document

Choose File No file chosen

✎ ↻ Pierre

LC



▼ [ID] ✎ PROJECT MANAGEMENT PLAN ✎

Project Name

4 [Project Name] ✎

Abstract

[Document abstract] ✎

Contributors

+ Pierre ✎ 🔒

▼ Lead Contributor/Editor ✎

5

PMPLite v. 0.1

New Document

Choose File No file chosen

Add **PMP body**

Save

Expand Collapse

6

▼ [ID] ✎

PROJECT MANAGEMENT PLAN ✎

Project Name

[Project Name] ✎

Abstract

[Document abstract] ✎

Contributors

+ Pierre ✎ 👤

▼ Lead Contributor/Editor ✎

PMPLite 0.1

http://cern.ch/bonnal/pmplite.html

PMPLite v. 0.1 New Document Choose File No file chosen Pierre LC

[ID] PROJECT MANAGEMENT PLAN

Project Name **[Project Name]**

Abstract [Document abstract]

Contributors + Pierre Lead Contributor/Editor

1. Project Overview

[Project Overview]

2. Project Organization

2.1 Project Board Membership and Organization

[Project Board Membership and Organization]

2.2 Project Team Membership and Organization

[Project Team Membership and Organization]

3. Project Management Processes

3.1 Scope Management

[How the project WBS and activities are managed]

3.2 Time Management

[How the project charter and coordination schedules are drafted, released and dispatched]

3.3 Resource and Cost Management

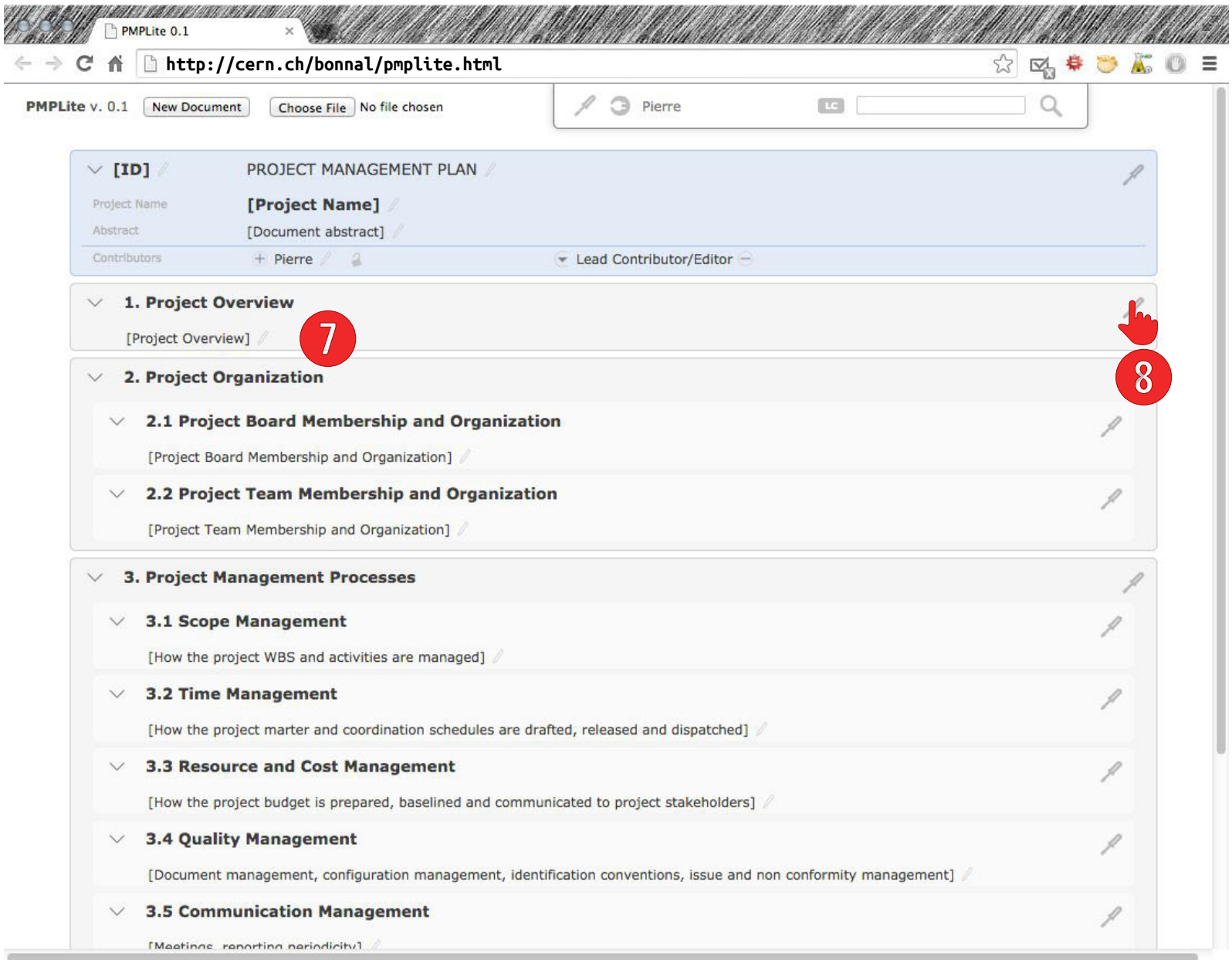
[How the project budget is prepared, baselined and communicated to project stakeholders]

3.4 Quality Management

[Document management, configuration management, identification conventions, issue and non conformity management]

3.5 Communication Management

[Meetings, reporting periodicity]



04.5

Document Identification & Circulation

1234 v. 5

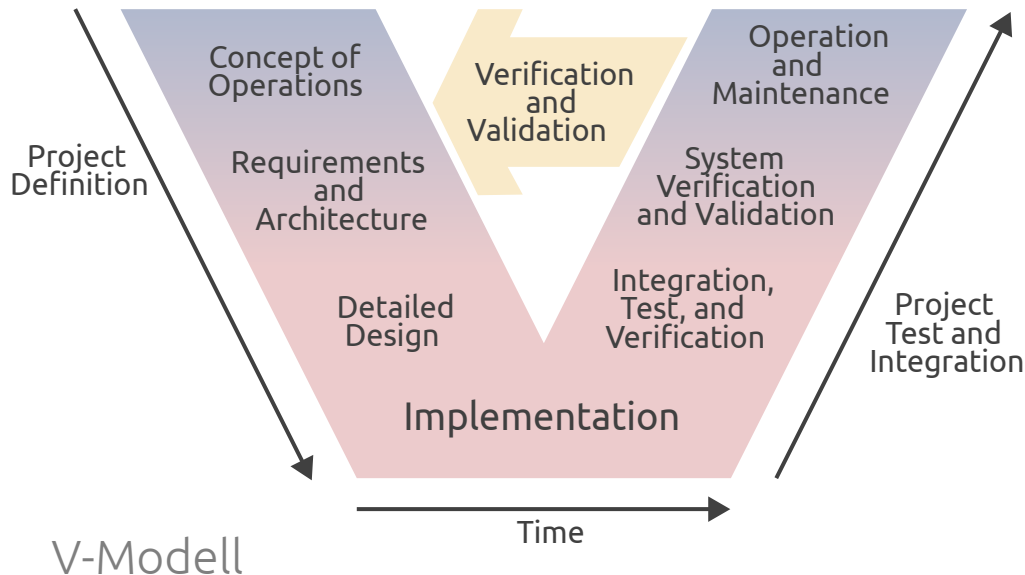
Lorem ipsum dolor sit amet,
consectetur adipiscing elit.
Curabitur est purus, facilisis
a pharetra ut, mattis sit amet
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quis pellentesque nisl.
Nullam sed velit dui. Cras at
elit ut quam vestibulum
fermentum in vitae libero.

Verification vs. Validation

Check vs. Approval

From Software Engineering but also widely applied to document lifecycle

Concept introduced by **Barry W. Boehm** (1981)



Verification:

*Are we building
the product right?*

*Are we solving
the equation right?*

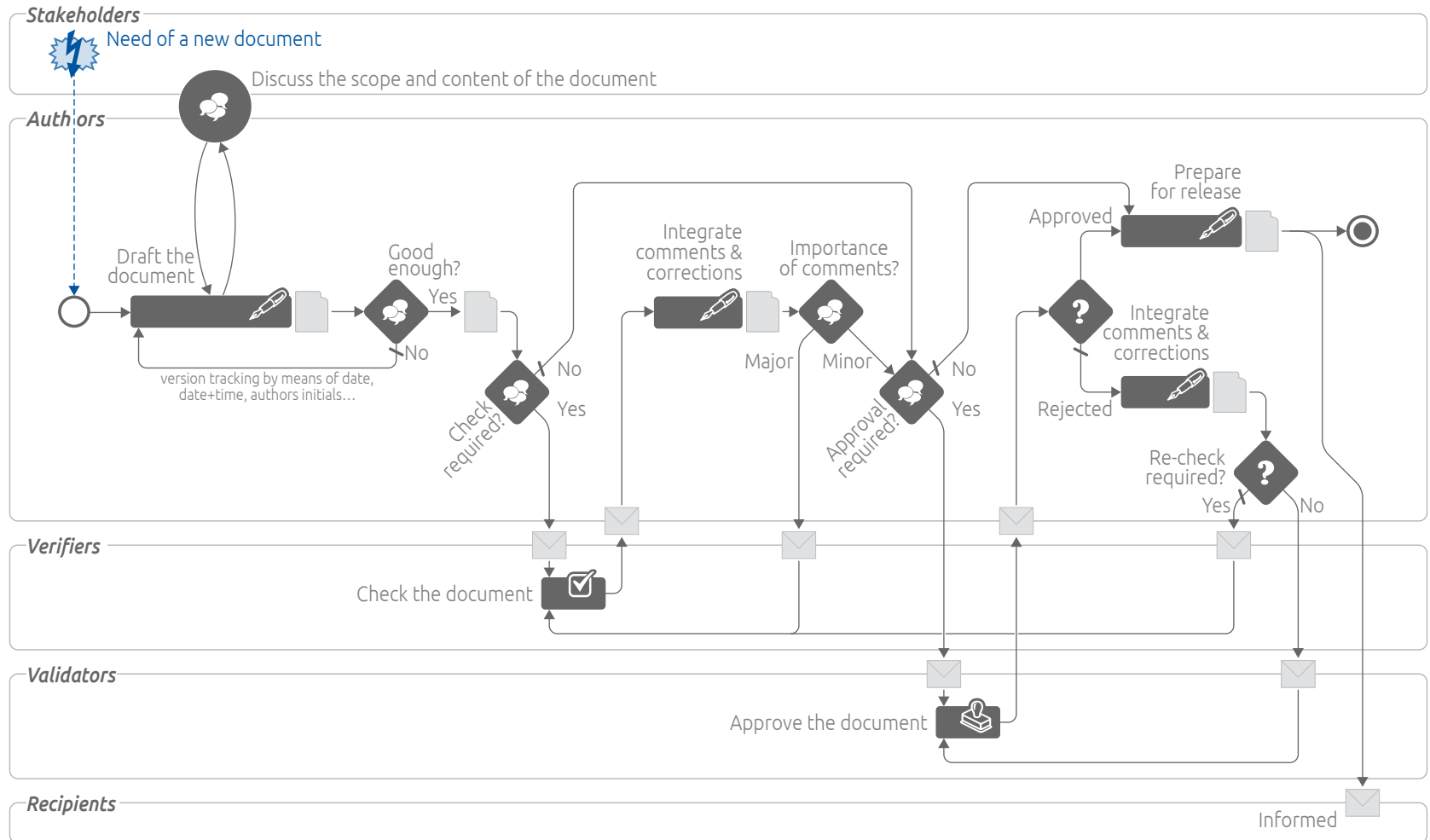
Validation:

*Are we building
the right product?*

*Are we solving
the right equation?*

Document Lifecycle

Document authoring, circulating and versioning





Doct. ID → Should not be problem

To have some means
to refer to a given
version of a given
document without
ambiguity.

Document ID

Version ID

1234 v. 5

Lorem ipsum dolor sit amet,
consectetur adipiscing elit.
Curabitur est purus, facilisis
a pharetra ut mattis sit amet
lacus. Nullam vitae nisi urna,
quis pellentesque nisl.
Nullam sed velit dui. Cras at
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fermentum in vitae libero.



To have some means to refer to a given version of a given document without ambiguity.

Document ID

Version ID

1234 v. 5

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Curabitur est purus, facilisis a pharetra ut, mattis sit amet lacus. Nullam vitae nisi urna, quis pellentesque nisl. Nullam sed velit dui. Cras at elit ut quam vestibulum fermentum in vitae libero.

Doct. ID → Should not be problem

Legal people approach:

First release:

DRAFT

DRAFT *n*

1234

First revision:

1234/DRAFT

1234/DRAFT 2

1234/DRAFT *n*

1234/Rev.

Next revisions:

1234/Rev./DRAFT

1234/Rev./DRAFT 2

1234/Rev./DRAFT *n*

1234/Rev.2 ... *n*



To have some means
to refer to a given
version of a given
document without
ambiguity.

Document ID

Version ID

1234 v. 5

Lorem ipsum dolor sit amet,
consectetur adipiscing elit.
Curabitur est purus, facilisis
a pharetra ut mattis sit amet
lacus. Nullam vitae nisi urna,
quis pellentesque nisl.
Nullam sed velit dui. Cras at
elit ut quam vestibulum
fermentum in vitae libero.

Doct. ID → Should not be problem

Legal people
approach:

First release:

DRAFT

DRAFT *n*

1234

One-digit/letter
approach:

1234 – A DRAFT

1234 – B DRAFT

1234 – C

First revision:

1234/DRAFT

1234/DRAFT 2

1234/DRAFT *n*

1234/Rev.

1234 – D DRAFT

1234 – E DRAFT

1234 – F DRAFT

1234 – G

Next revisions:

1234/Rev./DRAFT

1234/Rev./DRAFT 2

1234/Rev./DRAFT *n*

1234/Rev.2 ... *n*

1234 – H DRAFT

1234 – J DRAFT

1234 – K DRAFT

1234 – L ... Z, AA



Doct. ID → Should not be a problem

CM M.m

approach:

First release:

1234 v. 0.1 DRAFT

1234 v. 0.2 DRAFT

1234 v. 1.0 RELEASED

First revision:

1234 v. 1.1 DRAFT

1234 v. 1.2 DRAFT

1234 v. 1.3 DRAFT

1234 v. 2.0 RELEASED

Next revision:

1234 v. 2.1 DRAFT

1234 v. 2.2 DRAFT

1234 v. 2.3 DRAFT

1234 v. 3.0 RELEASED

CM M.m.b

approach:

M = major
m = minor
b = built



M = major
m = minor
b = built

Doct. ID → Should not be a problem

CM M.m

approach:

First release:

1234 v. 0.1 DRAFT

1234 v. 0.2 DRAFT

1234 v. 1.0 RELEASED

First revision:

1234 v. 1.1 DRAFT

1234 v. 1.2 DRAFT

1234 v. 1.3 DRAFT

1234 v. 2.0 RELEASED

Next revision:

1234 v. 2.1 DRAFT

1234 v. 2.2 DRAFT

1234 v. 2.3 DRAFT

1234 v. 3.0 RELEASED

CM M.m.b

approach:

1234 v. 0.0.1 DRAFT

1234 v. 0.0.2 DRAFT

1234 v. 0.1 DRAFT

1234 v. 0.2 DRAFT

1234 v. 1.0 RELEASED

1234 v. 1.0.1 DRAFT

1234 v. 1.0.2 DRAFT

1234 v. 1.1 DRAFT

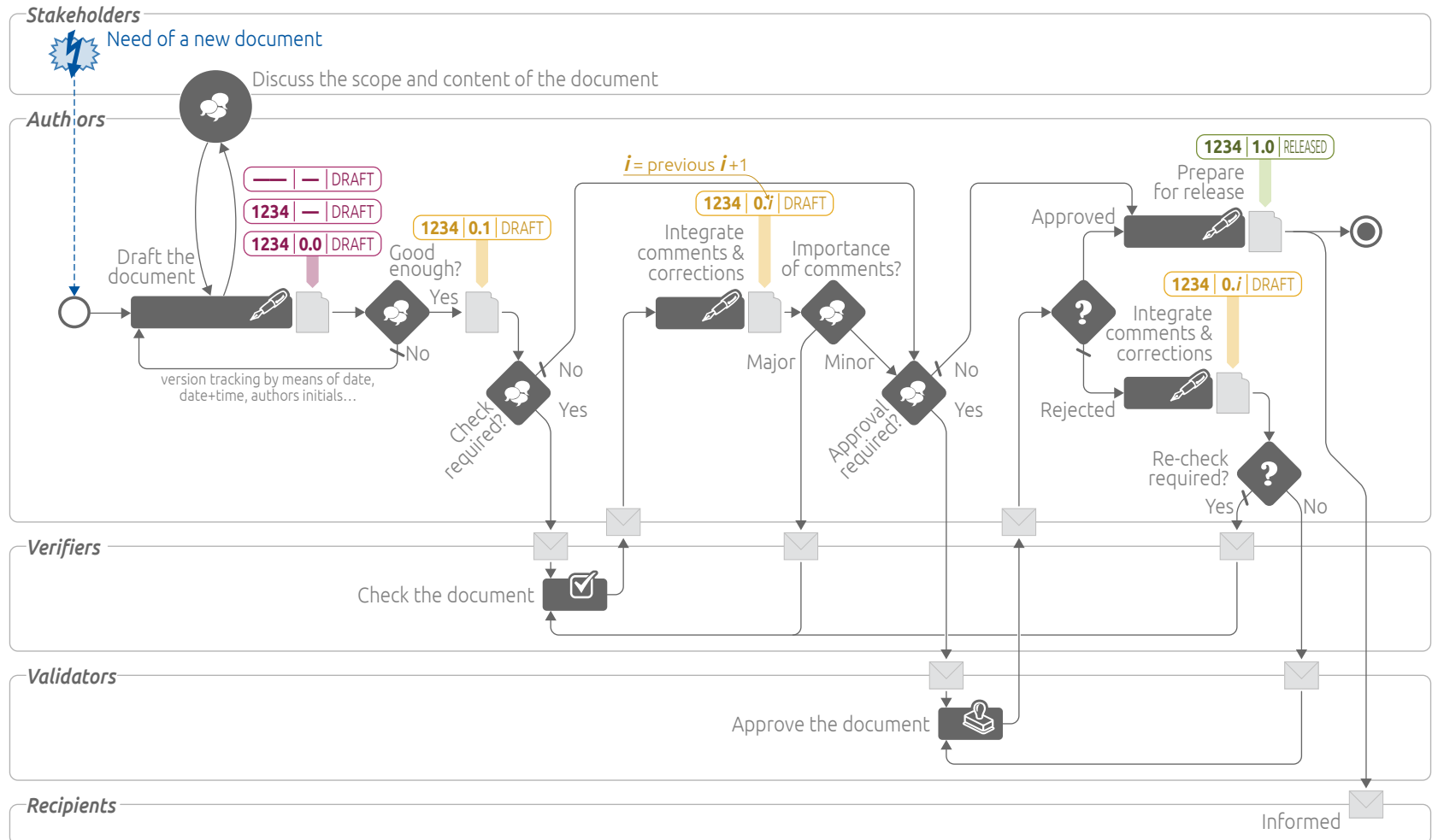
1234 v. 1.2 DRAFT

1234 v. 1.3 DRAFT

1234 v. 2.0 RELEASED

Document Lifecycle

Document authoring, circulating and versioning



Project Document Template



Unique ID	Version	Status	Date
101	0.2	DRAFT	2014-02-22

the whatever project



DOCUMENT TITLE

Authored by:
Alberte
Barnabé

Verified by:
Cyprien
Denise

To be validated by
Ernest

This document is uncontrolled when printed.
Check the Project Document Register to verify
that this is the correct version before use

Document Archival & Retrieval

1234 v. 5

Lorem ipsum dolor sit amet,
consectetur adipiscing elit.
Curabitur est purus, facilisis
a pharetra ut, mattis sit amet
lacus. Nullam vitae nisi urna,
quis pellentesque nisl.
Nullam sed velit dui. Cras at
elit ut quam vestibulum
fermentum in vitae libero.

Two Families of Documents

Documents of personal interest

vs.

Documents of general interest

Engineering docts.
Safety docts. + **O&M** docts.
Scientific publications

The “5 Roles”

- **Author**

auteur

- **Proofreader**

correcteur

- **Editor**

resp. de collection

- **Publisher**

éditeur

- **Librarian**

bibliothécaire

Authors

“Prepared by”

Checkers

“Checked by” (~ “Verified by”)

Approvers

“Approved by” (~ “Validated by”)

Releaser

“Released by” (the *Appro Leader*)

e-Librarian / Cataloguist

“Cataloged by”

04.7



Document Management System

Project Document Register



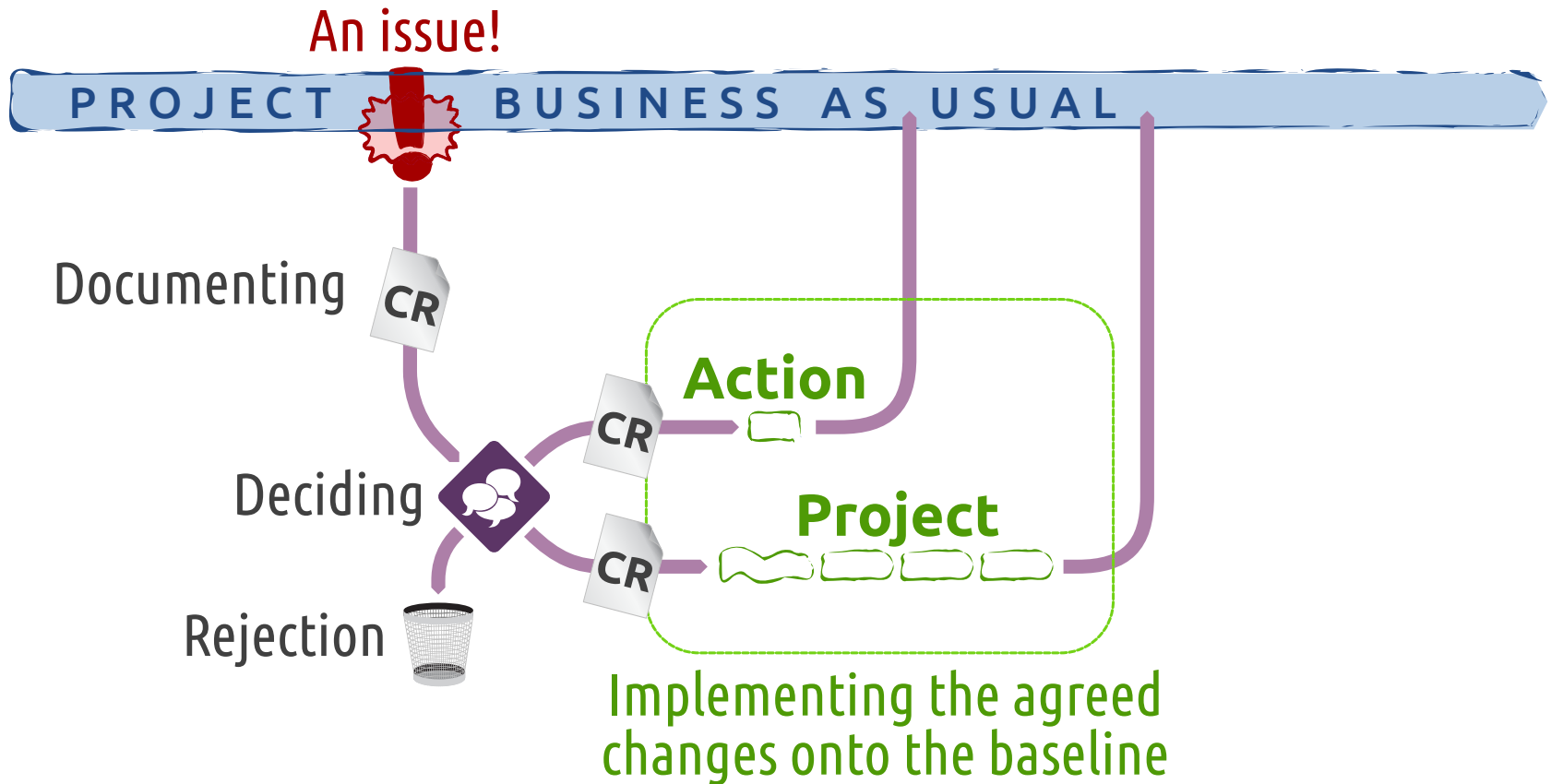
Unique ID	Document title					
		Ver.	Date	Authored by	Verified by	Validated by
100	Project Roadmap					
		⊗ 0.1	2014-01-13	Alberte		
		⊗ 0.2	2014-01-20	—	Ursule, Yvone	
		⊗ 1.0	2014-01-22	—	—	Xavier, Zélie
101	Project Management Plan					
		⊗ 0.1	2014-02-05	Alberte, Barnabé		
102	Project Work Breakdown Structure					
103	Project Cost Estimate					
104	Project Budget					
105	Project Master Schedule					
		⊗ 0.1	2014-02-07	Alberte, Cyprien		
106	Project Coordination Schedule					
107	Project RACI Matrix					
108	Project Risk Register					

Handling Issues



Managing Issues

Change Records (**CR**) featuring requests and orders

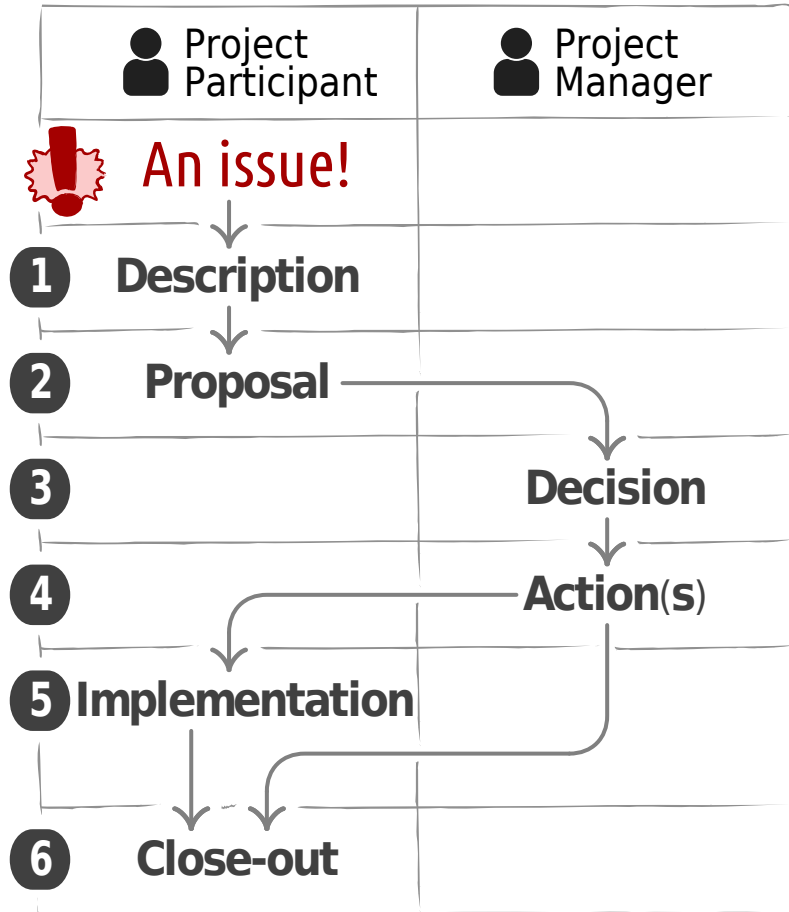


05.1



Issue Management System

Change Record



Unique ID	Version	Status	Date
234	0.1	DRAFT	2014-02-26

CHANGE RECORD

- Description
- Proposal
- | Decision | Comments |
|---|----------|
| <input type="checkbox"/> Rejection
<input type="checkbox"/> Action(s)
<input type="checkbox"/> Project(s) | |
- | Action(s) | Resp. | Date | 5 Done |
|-----------|-------|------|--------|
| | | | |
- Close-out

Handling Requirements



Requirement Engineering / Management



The process of documenting, analyzing, tracing, prioritizing and agreeing on requirements and then controlling change and communicating to relevant stakeholders

- Software Engineering → capturing **users requirements**
- New Product Development → gathering **customers needs** and translating them into (product) **specifications** or specification items
- Systems Engineering → identifying **users** vs. **functional** vs. **non-functional requirements**
- Quality Management → **QFD** (Quality Function Deployment) and the ***House of Quality***
- Procurement and Purchasing → **technical specification** writing

A few years ago



Now: **e-Tendering**



Tomorrow:
Requirements Engineering



ReqIF



STEP



High/good quality
products/services

AIRFRANCE 

Low/affordable cost
products/services

 **BLACKLIST
AIRWAYS**

Competitive advantage ➡ They can choose their customers
Well organized ➡ They prefer well organized customers
Have adopted or adopting requirements engineering tools



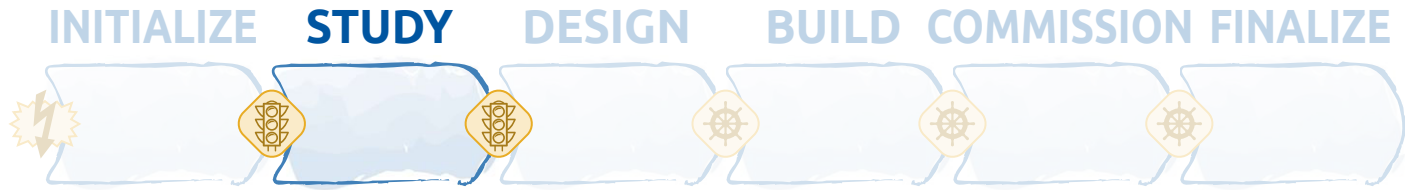
Competitive advantage ➡ They can choose their customers
Well organized ➡ They prefer well organized customers
Have adopted or adopting requirements engineering tools

06.1

Gathering Needs and Defining Requirements



Identifying Needs



- 1 Identifying **needs**
- 2 Setting **target requirements**
- 3 Generating, selecting and testing **concepts**
- 4 Setting **final requirements**

Identifying customer needs in 4 steps

Step 1: *Gather raw data from customers.*

What to ask to elicit customer needs...

- ➔ When and why do you use this type of product?
- ➔ Walk us through a typical usage of the product.
- ➔ What do you like about the existing products?
- ➔ What do you dislike about the existing products?
- ➔ What issues do you consider when purchasing the product?
- ➔ What improvements would you make to the product?

Identifying customer needs in 4 steps

Step 1: *Gather raw data from customers.*

To be efficient, use the *Customer needs data gathering* template!



Customer needs gathering data sheet

Interviewee :	NPD Project :	QA matters :
	Interviewer(s) :	
	Currently uses :	
	Willing to do follow up?		Type of user :
Question	Customer statement	Interpreted need
When and why do you use this type of product? Walk us through a typical usage of the product. What do you like about the existing products? What do you dislike about the existing products? What issues do you consider when purchasing the product? What improvements would you make to the product?		

Customer needs gathering data sheet

Interviewee : Ignatius Reilly Constantinople Street New-Orleans 314 159 2742		NPD Project : cordless screwdriver	QA matters : # 06-137 v. 1.0 2006-11-22
		Interviewer(s) : Robichaux & Mancuso	
		Currently uses : Triton PDA100 18V	
Willing to do follow up? yes		Type of user : Handy person (frequent user)	
Question	Customer statement	Interpreted need	
X	I need to drive screws fast, faster than by hand.		
X	I sometimes do duct work; use sheet metal screws.		
X	A lot of electrical; switch covers, outlets, fans, kitchen appliances.		
When and why do you use this type of product?	I like the pistol grip; it feels the best.		
Walk us through a typical usage of the product.	I like the magnetized tip.		
What do you like about the existing product?	I don't like it when the tip slips off the screw.		
What do you dislike about the existing products?	I would like to be able to lock it so I can use it with a dead battery.		
What issues do you consider when purchasing the product?	Can't drive screws into hard wood.		
What improvements would you make to the product?	Sometimes I strip tough screws.		
	An attachment to allow me to reach down skinny holes.		
	A point so I can scrape paint off of screws.		
X	Would be nice if it could punch a pilot hole.		

Identifying customer needs in 4 steps

Step 1: *Gather raw data from customers.*

Hints for effective data gathering...

- ➔ Go with the flow
(don't worry about answering all the questions
if you're getting great data from one question)
- ➔ Use visual stimuli / props
(existing products, related products, early prototypes)
- ➔ Have customer demonstrate product use
(this invariably reveals new information)
- ➔ Be alert for surprises and expression of latent needs
(if something surprising comes up... ask follow-up questions).

Identifying customer needs in 4 steps

Step 2: *Interpret raw data in term of customer needs.*

Customer needs gathering data sheet

Interviewee :		NPD Project : Interviewer(s) : Currently uses : Type of user :	QA matters :
Willing to do follow up?			
Question	Customer statement	Interpreted need	
When and why do you use this type of product? Walk us through a typical usage of the product. What do you like about the existing products? What do you dislike about the existing products? What issues do you consider when purchasing the product? What improvements would you make to the product?	<div style="text-align: center; font-size: 2em;">Customer statement</div>	<div style="text-align: center; font-size: 2em;">Interpreted need</div>	

Customer needs gathering data sheet

Interviewee : Ignatius Reilly Constantinople Street New-Orleans 314 159 2742		NPD Project : cordless screwdriver	QA matters : # 06-137 v. 1.0 2006-11-22
		Interviewer(s) : Robichaux & Mancuso	
		Currently uses : Triton PDA100 18V	
Willing to do follow up? yes		Type of user : Handy person (frequent user)	
Question	Customer statement	Interpreted need	
X	I need to drive screws fast, faster than by hand.	The SD drives screws faster than by hand.	
X	I sometimes do duct work; use sheet metal screws.	The SD drives sheet metal screws into metal duct work.	
X	A lot of electrical; switch covers, outlets, fans, kitchen appliances.	The SD can be used for screws on electrical devices.	
X	I like the pistol grip; it feels the best.	The SD is comfortable to grip.	
X	I like the magnetized tip.	The SD tip retains the screw before it is driven.	
X	I don't like it when the tip slips off the screw.	The SD tip remains aligned with the screw head without slipping.	
X	I would like to be able to lock it so I can use it with a dead battery.	The user can apply torque manually to the SD to drive a screw. (!)	
X	Can't drive screws into hard wood.	The SD can drive screws into hard wood.	
X	Sometimes I strip tough screws.	The SD does not strip screw heads.	
X	An attachment to allow me to reach down skinny holes.	The SD can access screws at the end of deep, narrow holes.	
X	A point so I can scrape paint off of screws.	The SD allows the user to work with screws that have been painted over.	
X	Would be nice if it could punch a pilot hole.	The SD can be used to create a pilot hole. (!)	

Identifying customer needs in 4 steps

Step 2: *Interpret raw data in term of customer needs.*

	Customer statement	Need statement RIGHT	Need statement WRONG
What not how	"Why don't you put protective shields around the battery contacts?"	The screwdriver battery is protected from accidental shorting.	The screwdriver battery contacts are covered by a plastic sliding door.
Specificity	"I drop my screwdriver all the time."	The screwdriver operates normally after repeated dropping.	The screwdriver is rugged.
Positive not negative	"It doesn't matter if it's raining; I still need to work outside on Saturdays."	The screwdriver operates normally in the rain.	The screwdriver is not disabled by the rain.
An attribute of the product	"I'd like to charge my battery from my cigarette lighter."	The screwdriver battery can be charged from an automobile cigarette lighter.	An automobile cigarette lighter adapter can charge the screwdriver battery.
Avoid <i>must</i> and <i>should</i>	"I hate it when I don't know how much juice is left in the batteries of my cordless tools."	The screwdriver provides an indication of the energy level of the battery.	The screwdriver should provide an indication of the energy level of the battery.

Identifying customer needs in 4 steps

Step 3: *Organize the needs into a hierarchy.*

The result should be **50 to 300 need statements**.

These should be distilled into **primary needs & secondary needs**.

- ➔ Write each statement on separate card
- ➔ Eliminate redundant statements
- ➔ Group cards according to the similarity of the needs they express
- ➔ For each group choose label (general statement).

Identifying customer needs in 4 steps

Step 3: *Organize the need into a hierarchy.*



SD provides plenty of power to drive screws.

- * The SD maintains power for several hours of heavy use.
- ** The SD can drive screws into hardwood.
The SD drives sheet metal screws into metal ductwork.
- *** The SD drives screws faster than by hand.

The SD makes it easy to start a screw.

- * The SD retains the screw before it is driven.
- *! The SD can be used to create a pilot hole.

The SD works with a variety of screws.

- ** The SD can turn Phillips, Torx, socket, and hex head screws.
- ** The SD can turn many sizes of screws.

The SD can access most screws.

- The SD can be maneuvered in tight areas.
- ** The SD can access screws at the end of deep, narrow holes.

The SD turns screws that are in poor condition.

The SD can be used to remove grease and dirt from screws.
The SD allows the user to work with painted screws.

The SD feels good in the user's hand.

- *** The SD is comfortable when the user pushes on it.
- *** The SD is comfortable when the user resists twisting.
- * The SD is balanced in the user's hand.
- ! The SD is equally easy to use in right or left hands.
The SD weight is just right.
The SD is warm to touch in cold weather.
The SD remains comfortable when left in the sun.

The SD is easy to control while turning screws.

- *** The user can easily push on the SD.
- *** The user can easily resist the SD twisting.
The SD can be locked on.
- ***! The SD speed can be controlled by the user while turning a screw.
- * The SD remains aligned with the screw head without slipping.
- ** The user can easily see where the screw is.
- * The SD does not strip screw heads.
- * The SD is easily reversible.

Identifying customer needs in 4 steps

Step 3: *Organize the need into a hierarchy.*



The SD is easy to set up and use.

- * The SD is easy to turn on.
- * The SD prevents inadvertent switching off.
- * The user can set the maximum torque of the SD.
- *! The SD provides ready access to bits or accessories.
- * The SD can be attached to the user for temporary storage.

The SD power is convenient.

- * The SD is easy to recharge.
The SD can be used while recharging.
- *** The SD recharges quickly.
The SD batteries are ready to use when new.
- **! The user can apply torque manually to the SD to drive a screw.

The SD lasts a long time.

- ** The SD tip survives heavy use.
The SD can be hammered.
- * The SD can be dropped from a ladder without damage.

The SD is easy to store.

- * The SD fits in a toolbox easily.
- ** The SD can be charged while in storage.
The SD resists corrosion when left outside or in damp places.
- *! The SD maintains its charge after long periods of storage.
The SD maintains its charge when wet.

The SD prevents damage to the work.

- * The SD prevents damage to the screw head.
The SD prevents scratching of finished surfaces.

The SD has a pleasant sound when in use.

The SD looks like a professional quality tool.

The SD is safe.

- The SD can be used on electrical devices.
- *** The SD does not cut the user's hands.

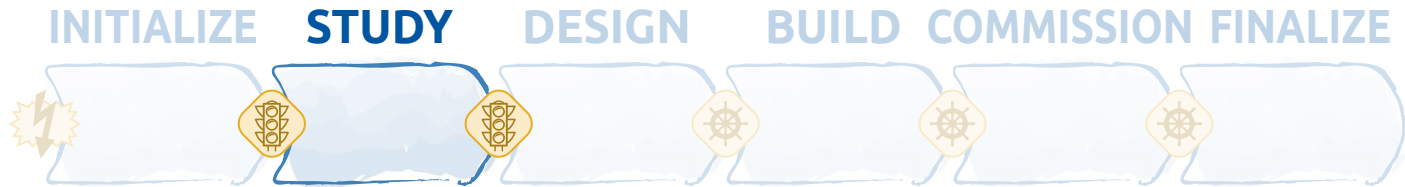
Identifying customer needs in 4 steps

Step 4: Establish the relative importance of the needs.

Customer needs survey form

NPD Project : <i>cordless screwdriver</i>	Reviewer : <i>Ignatius Reilly Constantinople Street New-Orleans 314 159 2742</i>	QA matters : <i># 06-258 2006-11-22</i>														
<p>For each of the following features, please indicate on a scale of 1 to 5 how important the feature is to you. Please use the following scale :</p> <ol style="list-style-type: none">1. Feature is undesirable. I would not consider a product with this feature.2. Feature is not important, but I would not mind having it.3. Feature would be nice to have, but is not necessary.4. Feature is highly desirable, but I would consider a product without it.5. Feature is critical. I would not consider a product without this feature. <p>Also indicate by checking the box if you feel that the feature is unique, exciting and or unexpected.</p>																
<table border="1"><thead><tr><th>Importance of the feature</th><th>Interpreted need</th></tr><tr><td>LOW HIGH</td><td></td></tr></thead><tbody><tr><td>1 2 3 4 5</td><td><input type="checkbox"/> The SD drives screws faster than by hand.</td></tr><tr><td>1 2 3 4 5</td><td><input type="checkbox"/> The SD drives sheet metal screws into metal duct work.</td></tr><tr><td>1 2 3 4 5</td><td><input type="checkbox"/> The SD can be used for screws on electrical devices.</td></tr><tr><td>1 2 3 4 5</td><td><input type="checkbox"/> The SD is comfortable to grip.</td></tr><tr><td>1 2 3 4 5</td><td><input type="checkbox"/> The SD tip retains the screw before it is driven. a</td></tr></tbody></table>			Importance of the feature	Interpreted need	LOW HIGH		1 2 3 4 5	<input type="checkbox"/> The SD drives screws faster than by hand.	1 2 3 4 5	<input type="checkbox"/> The SD drives sheet metal screws into metal duct work.	1 2 3 4 5	<input type="checkbox"/> The SD can be used for screws on electrical devices.	1 2 3 4 5	<input type="checkbox"/> The SD is comfortable to grip.	1 2 3 4 5	<input type="checkbox"/> The SD tip retains the screw before it is driven. a
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1 2 3 4 5	<input type="checkbox"/> The SD is comfortable to grip.															
1 2 3 4 5	<input type="checkbox"/> The SD tip retains the screw before it is driven. a															

Setting Requirements



- 1 Identifying **needs**
- 2 Setting **target requirements**
- 3 Generating, selecting and testing **concepts**
- 4 Setting **final requirements**

Product Specification

The issue:

Customer needs are generally expressed in the language of the customers, i.e. it leaves too much space for subjective interpretation.

Customer needs → *mountain bike suspension fork.*

No.	Need	Imp.
1	The suspension reduces vibration to the hands.	3
2	The suspension allows easy traversal of slow, difficult terrain.	2
3	The suspension enables high-speed descents on bumpy trails.	5
4	The suspension allows sensitivity adjustment.	3
5	The suspension preserves the steering characteristics of the bike.	4
6	The suspension remains rigid during hard cornering.	4
7	The suspension is lightweight.	4
8	The suspension provides stiff mounting points for the brakes.	2
9	The suspension fits a wide variety of bikes, wheels, and tires.	5
10	The suspension is easy to install.	1
11	The suspension works with fenders.	1
12	The suspension instills pride.	5
13	The suspension is affordable for an amateur enthusiast.	5
14	The suspension is not contaminated by water.	5
15	The suspension is not contaminated by grunge.	5
16	The suspension can be easily accessed for maintenance.	3
17	The suspension allows easy replacement of worn parts.	1
18	The suspension can be maintained with readily available tools.	3
19	The suspension lasts a long time.	5
20	The suspension is safe in a crash.	5



Product Specification

For this very reason, product development teams usually expressed these customer needs statements in term of specification, which spell out in precise and measurable detail what customers expect from the product.

The product specifications do not address the **how** the product will satisfy the customer needs, but the **what** it has to do.

Target specifications vs. final specifications

Target product specification

1. Prepare a list of **metrics**
2. Collect **competitive benchmarking** information
3. Set ideal and marginally acceptable **target values**.

Target product specification

Step 1: *Prepare a list of metrics.*

An efficient approach consists to contemplate each need in turn and (to try) to consider what precise and measurable characteristic of the product can be used.

The ideal case is a one to one mapping between needs and metrics. In practice this is not always the case. A needs-metrics matrix can represent visually the relationship between needs and matrix. This matrix is part of the so-called *House of quality* used in QFD.

Metrics ❖ *mountain bike suspension fork.*

Metric No.	Need No.	Metric	Imp.	Units
1	1, 3	Attenuation from dropout to handlebar at 10Hz	3	dB
2	2, 6	Spring preload	3	N
3	1, 3	Maximum value from the Monster	5	g
4	1, 3	Minimum descent time on test track	5	s
5	4	Damping coefficient adjustment range	3	N-s/m
6	5	Maximum travel (26-in. wheel)	3	mm
7	5	Rake offset	3	mm
8	6	Lateral stiffness at the tip	3	kN/m
9	7	Total mass	4	kg
10	8	Lateral stiffness at brake pivots	2	kN/m
11	9	Headset sizes	5	in.
12	9	Steertube length	5	mm
13	9	Wheel sizes	5	List



Metrics ❖ *mountain bike suspension fork.*

Metric No.	Need No.	Metric	Imp.	Units
14	9	Maximum tire width	5	in.
15	10	Time to assemble to frame	1	s
16	11	Fender compatibility	1	List
17	12	Instils pride	5	Subj.
18	13	Unit manufacturing cost	5	US\$
19	14	Time in spray chamber without water entry	5	s
20	15	Cycles in mud chamber without contamination	5	k-cycles
21	16, 17	Time to disassemble/assemble for maintenance	3	s
22	17, 18	Special tools required for maintenance	3	List
23	19	UV test duration to degrade rubber parts	5	hr
24	19	Monster cycles to failure	5	cycles
25	20	Japan Industrial Standards test	5	binary
26	20	Bending strength (frontal loading)	5	kN



Needs-metrics matrix

20 needs

26 metrics

[illegible]

Target product specification

Guidelines to be considered when constructing the **list of metrics**:

- ➔ Metrics should be **complete**: at least a metric per identified customer need
- ➔ Metrics should be **dependant variables**, answering preferably the **what** question and not the **how** question: e.g. specifying a light material for a weight is non dependant while giving a weight metrics in kilograms for instance is dependant
- ➔ Metrics should be **practical**, i.e. measurable with usual measurement means
- ➔ Some metrics cannot be translated into quantifiable metrics, i.e. colour, aesthetic consideration... → specify "**Subj.**" as a unit!
- ➔ Metrics may also include **popular comparison criteria**.

Target product specification

Step 2: *Collect competitive benchmarking information.*

Collecting competitive benchmarking information is a rather simple, tough, but rather simple! The investment is in general very valuable.

Competitive benchmarking



1	Attenuation from dropout to handlebar at 10Hz	3	dB	8	15	10	15	9	13
2	Spring preload	3	N	550	760	500	710	480	680
3	Maximum value from the Monster	5	g	3.6	3.2	3.7	3.3	3.7	3.4
4	Minimum descent time on test track	5	s	13	11.3	12.6	11.2	13.2	11
5	Damping coefficient adjustment range	3	N-s/m	0	0	0	200	0	0
6	Maximum travel (26-in. wheel)	3	mm	28	48	43	46	33	38
7	Rake offset	3	mm	41.5	39	38	38	43.2	39
8	Lateral stiffness at the tip	3	kN/m	59	110	85	85	65	130
9	Total mass	4	kg	1.409	1.385	1.409	1.364	1.222	1.100

Competitive benchmarking



10	Lateral stiffness at brake pivots	2	kN/m	295	550	425	425	325	650
11	Headset sizes	5	in.	1.000 1.125	1.000 1.125 1.250	1.000 1.125	1.000 1.125 1.250	1.000 1.125	NA
12	Steertube length	5	mm	150 180 210 230 255	140 165 190 215	150 170 190 210	150 170 190 210 230	150 190 210 220	NA
13	Wheel sizes	5	List	26 in.	26 in.	26 in.	26 in. 700 cm	26 in.	26 in.
14	Maximum tire width	5	in.	1.5	1.75	1.5	1.75	1.5	1.5
15	Time to assemble to frame	1	s	35	35	45	45	35	85
16	Fender compatibility	1	List	Zefaf	None	None	None	None	All
17	Instils pride	5	Subj.	1	4	3	5	3	5

Competitive benchmarking



18	Unit manufacturing cost	5	US\$	65	105	85	115	80	100
19	Time in spray chamber without water entry	5	s	1300	2900	>3600	>3600	2300	>3600
20	Cycles in mud chamber without contamination	5	k -cycles	15	19	15	25	18	35
21	Time to disassemble/assemble for maintenance	3	s	160	245	215	245	200	425
22	Special tools required for maintenance	3	List	Hex	Hex	Hex	Hex	Long hex	Hex, pin wrench
23	UV test duration to degrade rubber parts	5	hr	400+	250	400+	400+	400+	250
24	Monster cycles to failure	5	Cycles	500k+	500k+	500k+	480k	500k+	330k
25	Japan Industrial Standards test	5	Binary	Pass	Pass	Pass	Pass	Pass	Pass
26	Bending strength (frontal loading)	5	kN	5.5	8.9	7.5	7.5	6.2	10.2

Competitive benchmarking



1	The suspension reduces vibration to the hands.	3	•	••••	••	•••••	••	•••
2	The suspension allows easy traversal of slow, difficult terrain.	2	••	••••	•••	•••••	•••	•••••
3	The suspension enables high-speed descents on bumpy trails.	5	•	•••••	••	•••••	••	•••
4	The suspension allows sensitivity adjustment.	3	•	••••	••	•••••	••	•••
5	The suspension preserves the steering characteristics of the bike.	4	••••	••	•	••	•••••	•••••
6	The suspension remains rigid during hard cornering.	4	•	•••	•	•••••	•	•••••
7	The suspension is lightweight.	4	•	•••	•	•••	••••	•••••
8	The suspension provides stiff mounting points for the brakes.	2	•	••••	•••	•••	•••••	••
9	The suspension fits a wide variety of bikes, wheels, and tires.	5	••••	•••••	•••	•••••	•••	•
10	The suspension is easy to install.	1	••••	•••••	••••	••••	•••••	•

Competitive benchmarking



11	The suspension works with fenders.	1	...	.	.	.	.	.....
12	The suspension instills pride.	5	.	....	...	.....	...	.....
13	The suspension is affordable for an amateur enthusiast.	5	.....	.	...	.	...	..
14	The suspension is not contaminated by water.	5	.	...	....	....	..	.....
15	The suspension is not contaminated by grunge.	5	.	...	.	....	..	.....
16	The suspension can be easily accessed for maintenance.	3	....	.....	....	....	.....	.
17	The suspension allows easy replacement of worn parts.	1	....	.....	....	....	.....	.
18	The suspension can be maintained with readily available tools.	3	.....	.....	.....	.....	..	.
19	The suspension lasts a long time.	5	.....	.....	.....	...	.....	.
20	The suspension is safe in a crash.	5	.....	.....	.....	.....	.....	.....

Target product specification

Step 3: *Set ideal and marginally acceptable target values.*

There are five ways to express a value of the metrics:

- ➔ *At least X* , i.e. a bound or the higher value the better
- ➔ *At most X* , i.e. a upper bound or the smaller value the better
- ➔ *Between X and Y* , i.e. a lower and upper bounds
- ➔ *Exactly X* , a particular value of a metric
- ➔ *Discrete values.*

The set of valued metrics of the target product specification is obtained after some iterations.

Final product specification

1. Develop **technical models** of the product
2. Develop a **cost model** of the product
3. Refine the specification, make **trade-offs** if necessary
4. Flow down the specification.

More difficult because of some trade-offs: stringent specifications have a cost! Inverse relationships between two or more specifications, e.g. weight and strength.

06.2

Requirements Engineering



Requirements Engineering

INCOSE Systems Engineering Handbook - a guide for system life cycle processes and activities, version 3.2.1 January 2011, INCOSE-TP-2003-002-03.2.1 (374 pages)
www.incose.org

ISO/IEC 15288:2008, Systems and software engineering – System life cycle processes



Guide to the Systems Engineering Body of Knowledge (SEBoK), version 1.2, 2013 (816 pages)
http://www.sebokwiki.org/pdf/SEBoKv1.2_full.pdf

NASA Systems Engineering Handbook, NASA/SP-2007-6105 Rev1, December 2007 (360 pages)
http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20080008301_2008008500.pdf

Space Engineering – Verification, European Cooperation for Space Standardization ECSS-E-ST-10-02C, March 2009 (45 pages) www.ecss.nl

A Glossary of Requirements Engineering Terminology, IREB, v1.5, May 2013 (116 pages)
www.ireb.org



Get It Right The First Time: Writing Better Requirements, IBM Rational DOORS, 2011 (68 pages),
http://publib.boulder.ibm.com/infocenter/rsdp/v1r0m0/topic/com.ibm.help.download.doors.doc/pdf92/get_it_right_the_rst_time.pdf

Requirements Engineering

The Systems Engineering approach

- ① Gathering **UR**'s (user/stakeholders requirements), i.e. **needs**
- ② Searching for **solutions** that may satisfy the UR's
- ③ **Benchmarking** the solutions w.r.t. the UR's; elimination those that do not match UR's
- ④ Translating the UR's into **FR**'s (functional requirements) and **¬FR**'s (non-functional requirements)
- ⑤ **Verifying** and **validating** the portfolio of requirements prior UR's, FR's and ¬FR's become "released/planned"
- ⑥ **Implementing** the preferred solution, and by the way the requirements
- ⑦ **Qualifying** the requirement after they have been implemented

06.3



Requirements Register

Requirements Register



It is a structured list of requirements

- ➔ Rqt. **ID** and a short description
- ➔ So-called "***shall statement***"
- ➔ Category or **type**, e.g. UR, FR or ¬FR
- ➔ **Compliance** to solutions, and per solution:
 - ➔ Compliant (C)
 - ➔ Partially compliant (PC)
 - ➔ Not compliant (¬C or NC)
 - ➔ Compliance not applicable (NA)
 - ➔ Compliance to be defined (TBD)
- ➔ **Deviation** request(s) and decision(s)

Requirements Register (cont'd)



It is a structured list of requirements

- Rqt. **ID** and a short description
- So-called "**shall statement**"
- Category or **type**, e.g. UR, FR or \neg FR
- **Compliance** to solutions
- **Deviation** request(s) and decision(s)

→ **Qualification** method:

- **Tests** (T), destructive on samples or not destructive
- **Analyses** (A)
- **Inspections** (I)
- **Reviews** (R), design reviews, etc.

→ **Qualification** procedure(s), report(s) and status

→ **Non conformance** report(s) and decision(s)

→ Editorial quality control: comments, V&V, traceability, rqt. status

Requirements Engineering

IBM Software
Requirements management

IBM Rational DOORS

*Requirements management for complex
and embedded systems*



Highlights

- Supports collaborative, intuitive and scalable management of requirement specifications
- Helps enable simpler creation of links and powerful traceability views across requirement specifications, designs and tests
- Provides automatic notification of changes that can impact related requirements, designs and tests
- Helps integrate requirements into the lifecycle as a core component of the IBM® Rational® solution for systems

Effective requirements management practices have a positive impact on the success of systems and product development.

IBM Rational DOORS® software is designed to capture, trace, analyze and manage changes to requirements and helps you comply with industry standards.

Intuitive, collaborative and scalable requirements management

Successful management of requirements starts by documenting them in a way that's easy to interpret and navigate. In Rational DOORS, the hierarchical organization of requirements—in a familiar, document-style list—shows each individual requirement in context, while a convenient navigation tree reveals the structure of the information set. A tabular view of the requirements helps you view and assign additional information to them with an unlimited number of your own attributes. Rational DOORS is designed for managing small to large requirement documents,

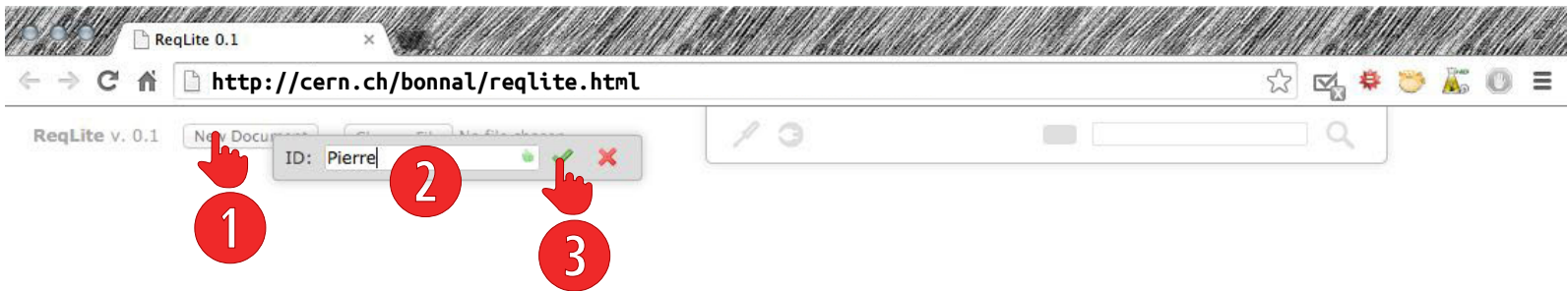
PizzaExpress

Consegna a domicilio da drone

Your lab is invited to design and develop a remotely operated **drone** for pizza delivery by the air.

Your 3rd task: gathering **UR**'s and translating them into **FR**'s and **¬FR**'s





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✎ ↻ Pierre

LC



▼ [ID] ✎

PROJECT REQUIREMENT REGISTER ✎



Project Name

4

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Abstract

[Document abstract] ✎

Contributors



Pierre ✎



Lead Contributor/Editor



DOCUMENT SUMMARY

5

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- Export XML as...
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- Expand/Collapse

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Project Name: [Project Name]

Abstract: [Document abstract]

Contributors: + Pierre -

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DOCUMENT SUMMARY

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▼ **[ID]** ✎ **PROJECT REQUIREMENT REGISTER** ✎ ✎

Project Name **[Project Name]** ✎

Abstract [Document abstract] ✎

Contributors + Pierre ✎ 🔒 ▼ Lead Contributor/Editor ✎

▼ **1** ✎ 🔒 **7** [Requirement Short Description] ✎

Description [Longer description of the requirement] ✎

✎ ✎

DOCUMENT SUMMARY



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[Project Name] ✎

Abstract

[Document abstract] ✎

Contributors

+ Pierre ✎ 👤

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▼ 1 ✎ 👤

[Requirement Short Description] ✎



Description

[Longer description of the requirement] ✎

DOCUMENT SUMMARY

- Add rqt. **status**
- Add rqt. **type**
- Add **links** to other rqts.
- Add **compliance** assessment
- Add **qualification method**
- Add **qualification procedure(s)**
- Add **qualification report(s)**
- Add **qualification status**
- Add **comment** (rqt. item level)



06.3

Quality Control



