



Project Management Case Study

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SuperB Collaboration Meeting – Roma – 2012-03-22

Purpose

Presenting you CERN's approach to project management
i.e. the approach developed for the **LHC project**
used on the **CNGS project**
in use on the **Linac4 and LIU projects**
implemented on the **NICA project** at Dubna

A project control approach that fully complies
with state-of-the-art practice (even better)

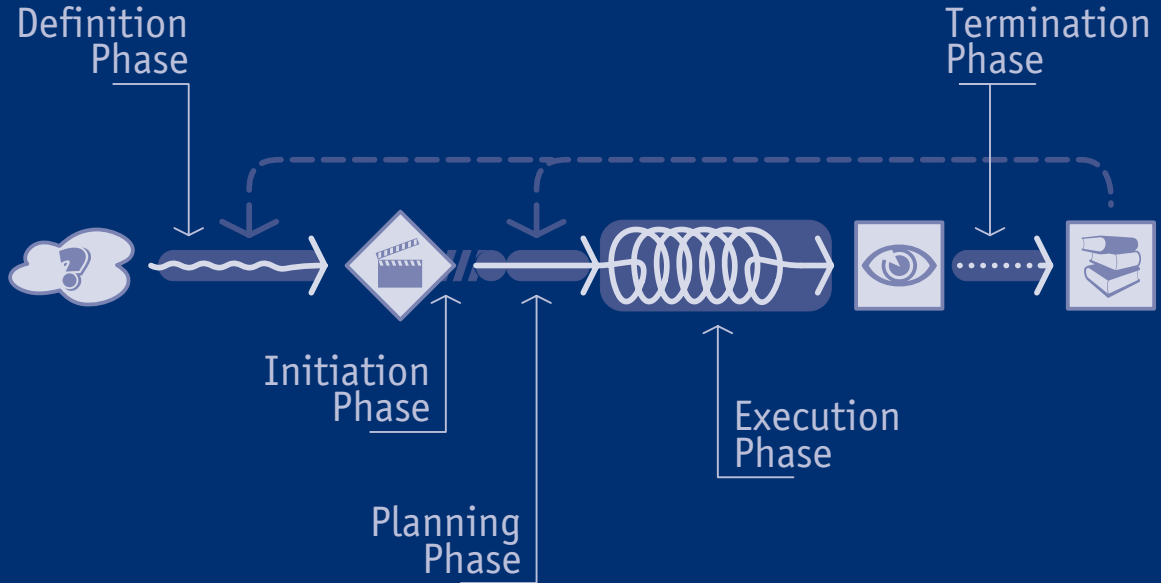
Benoit Daudin → more on the tools used at CERN

Luisella Lari → more on installation planning

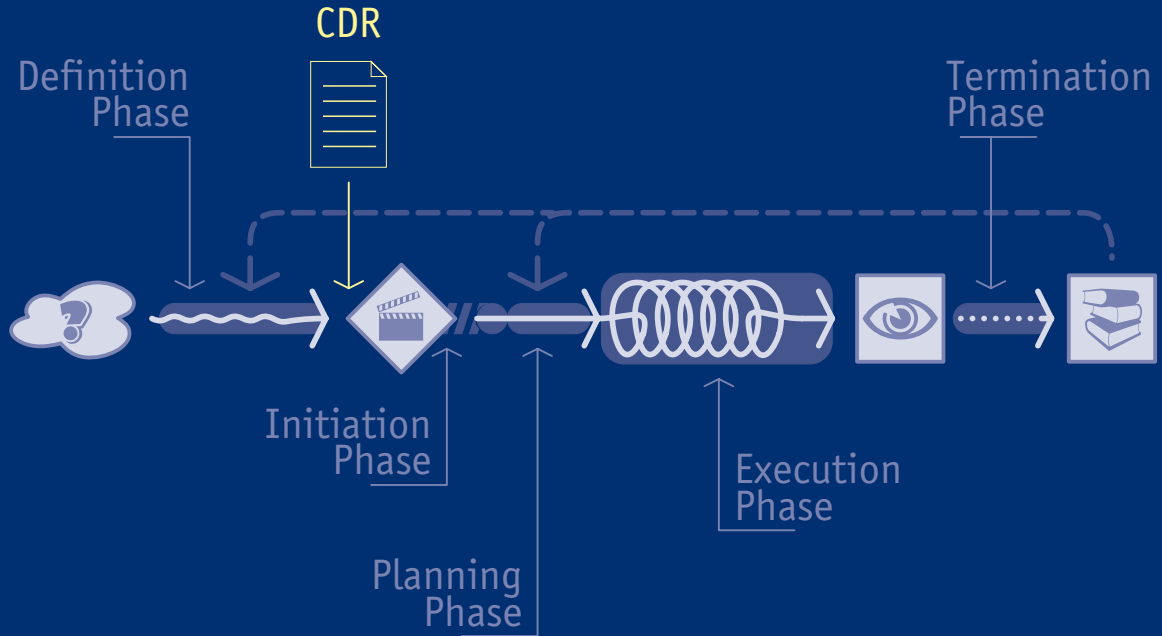
But before starting ...

... let's say a few words
about **Project Life Cycles**.

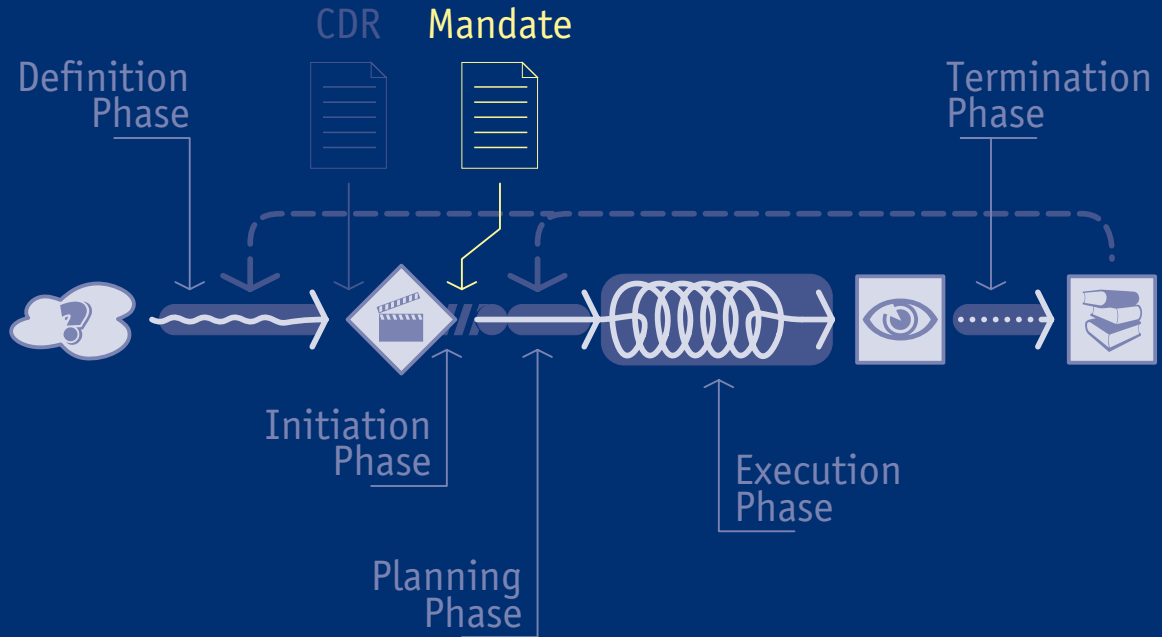
Project Life Cycle.



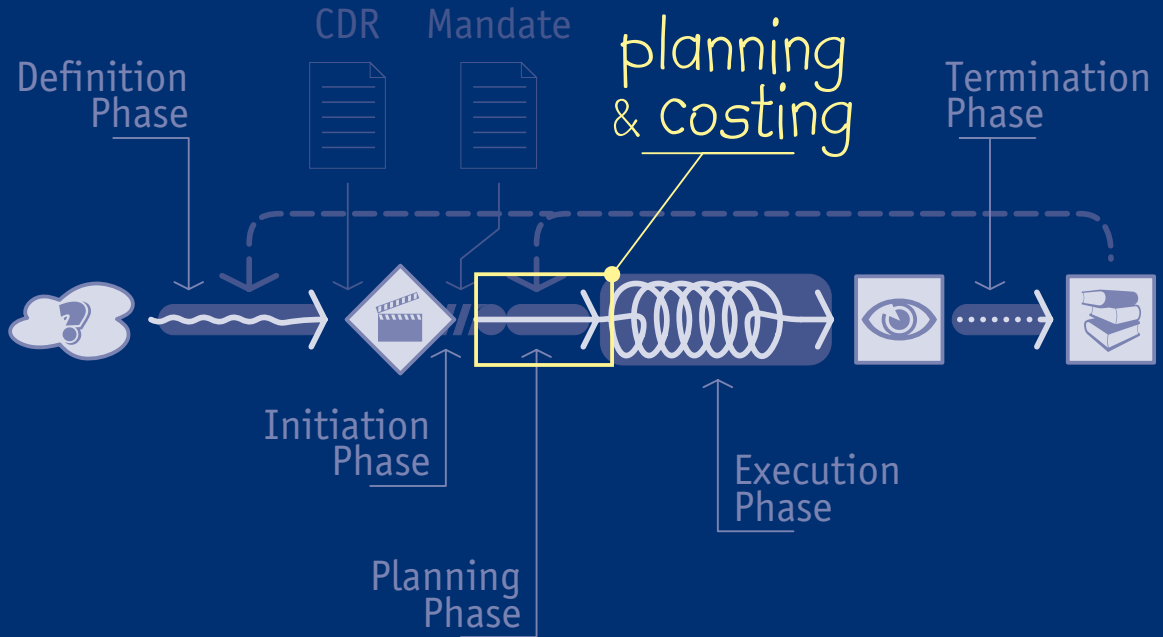
Project Life Cycle.



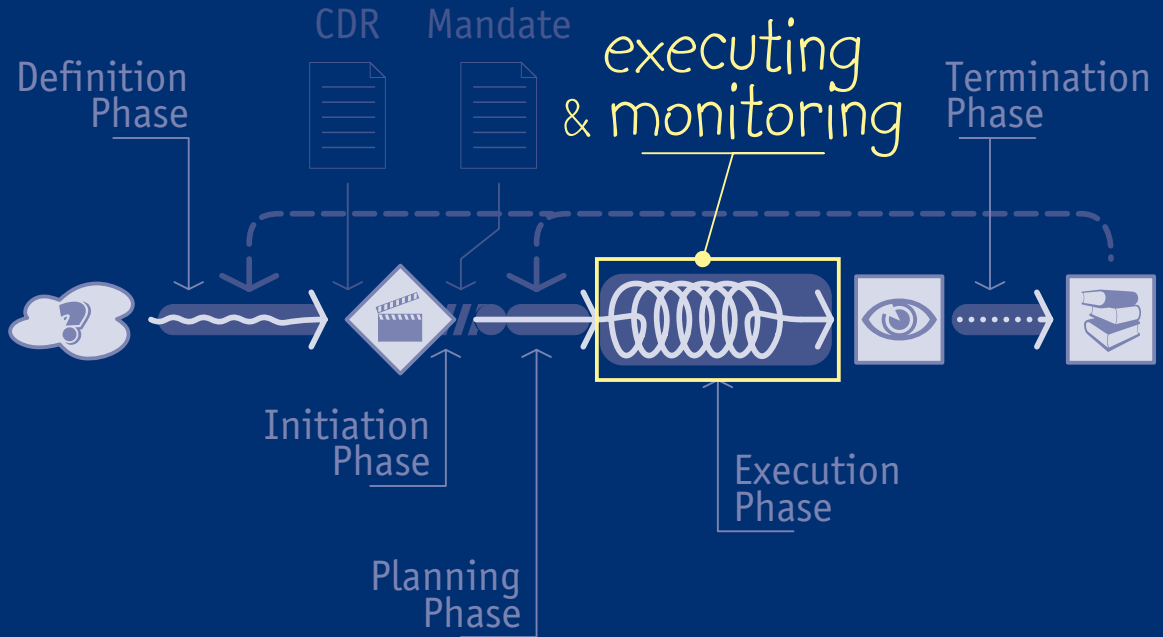
Project Life Cycle.



Project Life Cycle.

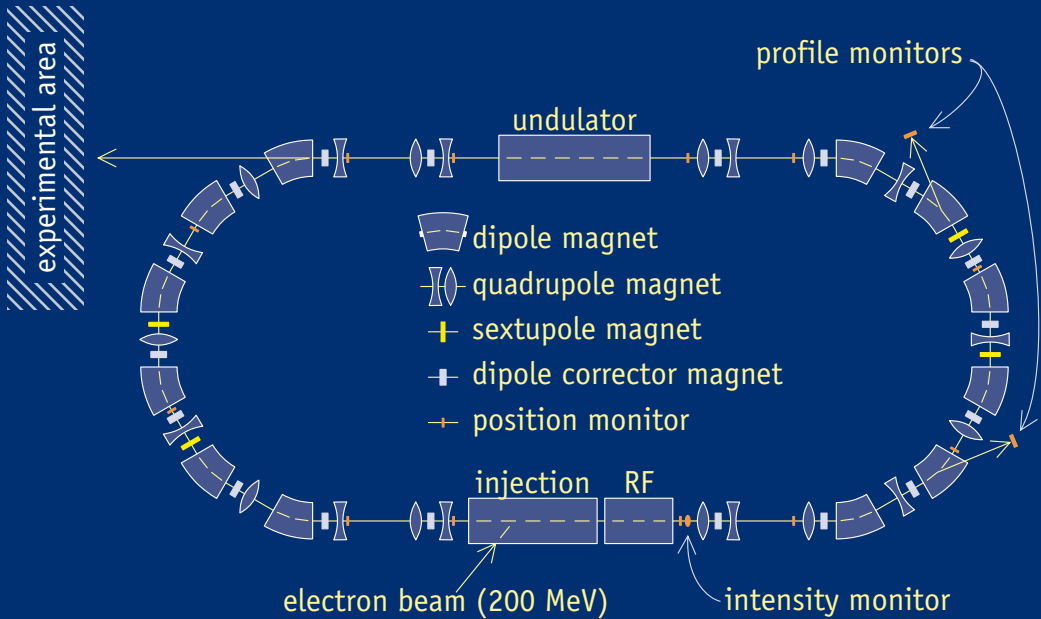


Project Life Cycle.



The Project

Deliverable → Undulator Radiation Facility for Photon Chemistry.



2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

2001-11-23

- The Definition Phase is completed.
- The feasibility of the project is demonstrated.
- The Conceptual Design Report is released.

LAMPE

CONCEPTUAL
DESIGN
REPORT

2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

2001-11-28

The **Board** of the Lab has decided to approve the project.

2002

2003

2004

N D J J F M A M J J A S O N D J F M A M J J A S O N D J J F M A M J J A S O N D J

2001-12-06

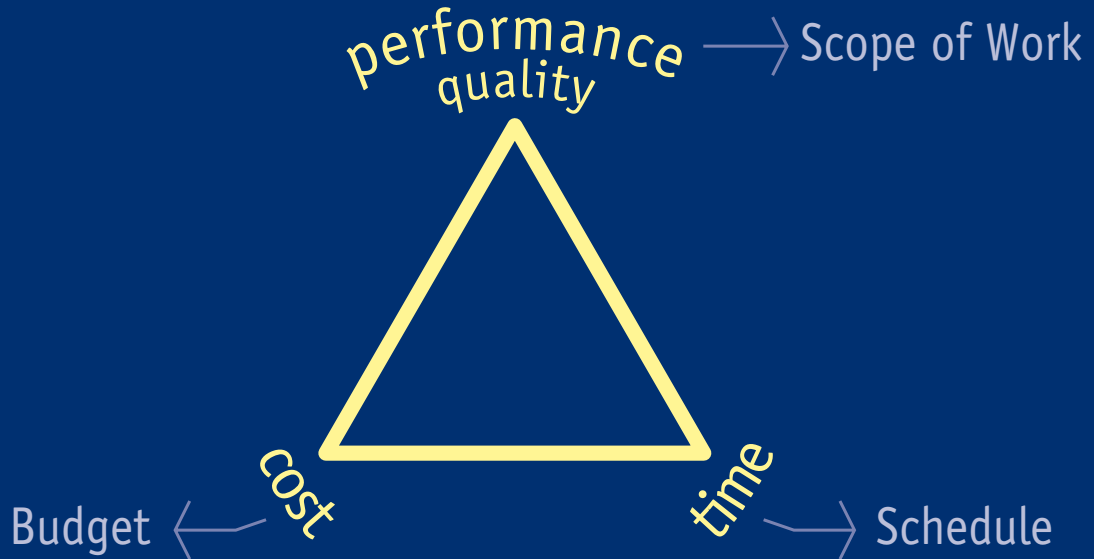
- The Project Mandate is released by **Dizzy**, CEO of the Lab.
- **Bill** was asked and has accepted to become the Project Manager of the LAMPE Project.

LAMPE

Memorandum

**PROJECT
MANDATE**

Project Mandate.



Project Mandate | Scope of Work.

- Infrastructures.
- Electrical services.
- Water cooling.
- Compressed air.
- Magnets & undulator.
- Acceleration (RF cavities).
- Beam instrumentation.
- Vacuum systems.
- Powering.
- Controls.
- Survey.
- Ancillary equipment.
- Installation works.

Project Mandate | Budget & Resources.

Outsourced resources

Material



3'100'000.– CHF

(1.– CHF = .65 EUR)

Insourced resources

Personnel



880 person · weeks

(17.5 person · years)
(5.8 FTEs → 3 years)

Swiss Franc (CHF) → currency of the project.

Project Mandate | Budget & Resources.

Outsourcing through existing contracts (blanket orders...).

Some existing contracts can be used by the project team:

- S01 engineering studies
- S03 vacuum technicians
- S04 RF technicians
- S09 installation team
- F16 logistics support.

Project Mandate | Budget & Resources.

Two in-kind contributions are expected:

- P01 BINP (Russia) → Dipole magnets (except cables).
100 % Russian funding.
- P02 CAT (India) → Undulator.
50 % Indian funding.
50 % Lab funding.

Project Mandate | Budget & Resources.

Purchasing policy:

> 75'000.– CHF



Full procedure
i.e. market survey
call for tender
bidder conference
→ contract.

*Stakeholders want to be
involved in decision making!*

< 75'000.– CHF



Light procedure
i.e. price inquiry
→ order.

Project Mandate | Budget & Resources.

Key resources:

- Oscar Integration / installation studies
- Ben Magnet systems
- Sweet Beam instrumentation
- Max Acceleration
- Billie Vacuum systems
- Ella Power converters
- Cassandra Ring and access control systems
- Gil Mechanical equipment; installation coord.
- Ray Survey
- Pat Electricity and cabling
- Art Cooling and ventilation.

Project Mandate | Budget & Resources.

Key resources:

- **Bill** Project manager
- **Oscar** Head design office & deputy PM
- **Melba** PM assistant
- **Duke** Purchasing officer.

Dealing with Price Escalation...

Three approaches:

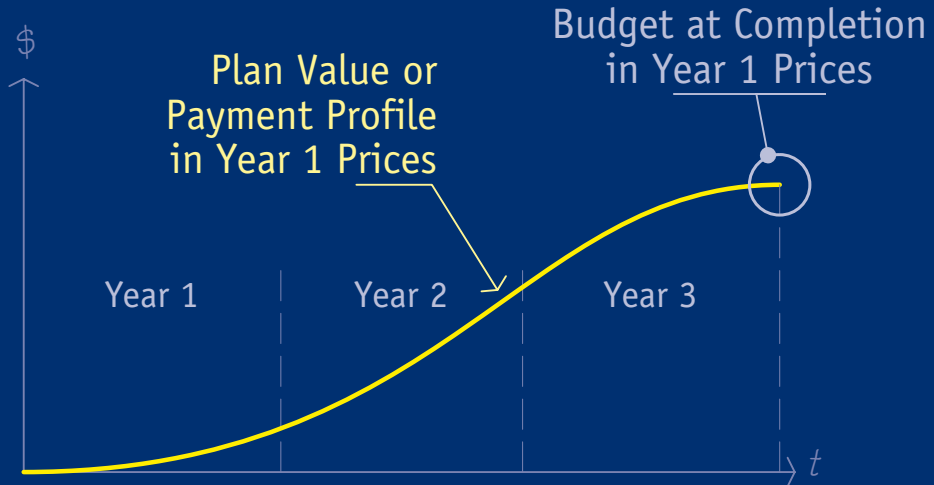
① The **US Government** approach:

Yearly price escalation indices are estimated for the whole duration of the project and considered in budgets.

① Dealing with Price Escalation...

Three approaches:

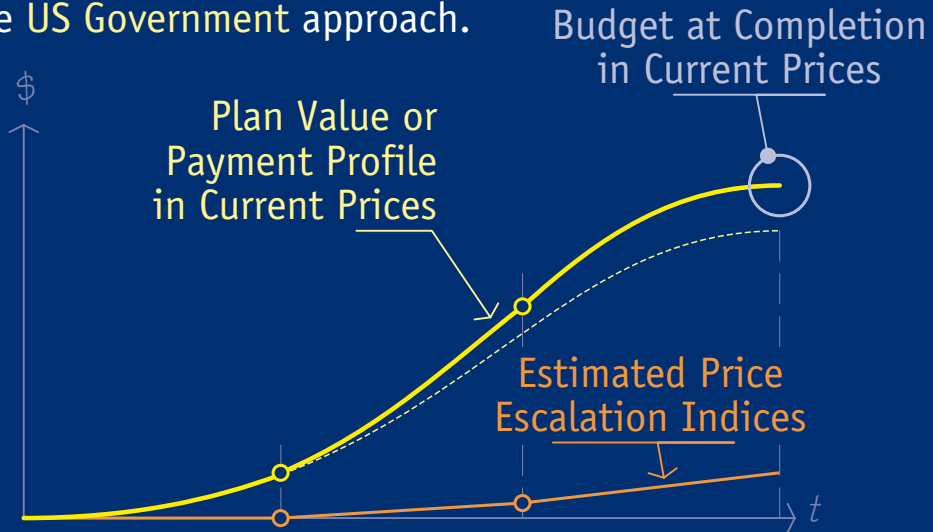
① The US Government approach.



① Dealing with Price Escalation...


Three approaches:

① The US Government approach.



Dealing with Price Escalation...

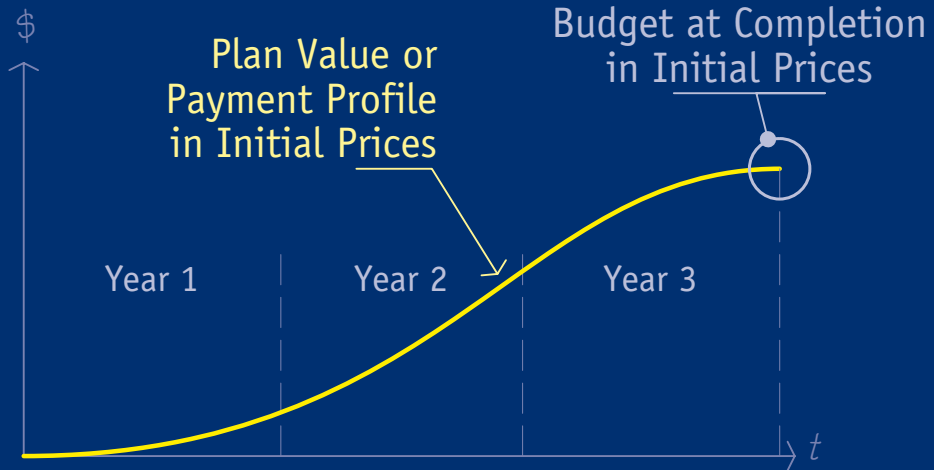
Three approaches:

-  The **Major Engineering Companies** approach:
The whole project is estimated and budgeted in Initial Prices (i.e. Year 1 Prices for instance). Commitments and Actuals are converted in Initial Prices before being compared to corresponding budgets.

① Dealing with Price Escalation...

Three approaches:

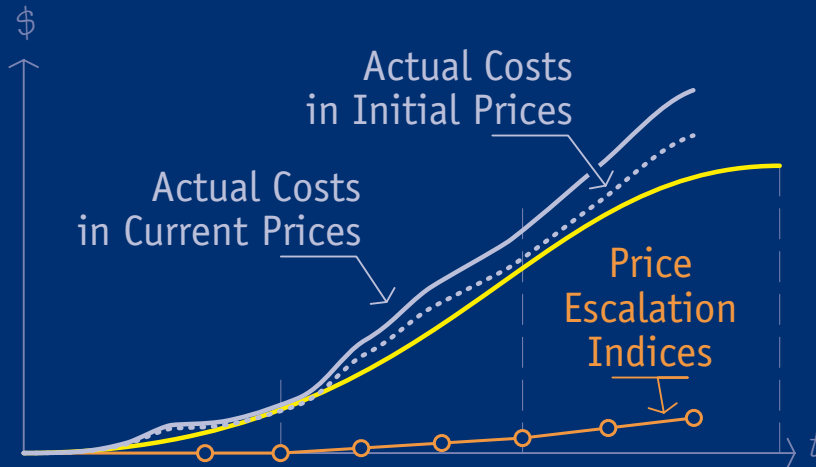
② The Major Engineering Companies approach.



① Dealing with Price Escalation...


Three approaches:

② The Major Engineering Companies approach.



Dealing with Price Escalation...

Three approaches:

-  The **hybrid** approach to project cost engineering:
Budgets associated to non-committed resources are yearly or quarterly recalculated.
As a consequence, budget figures are not constant in time.

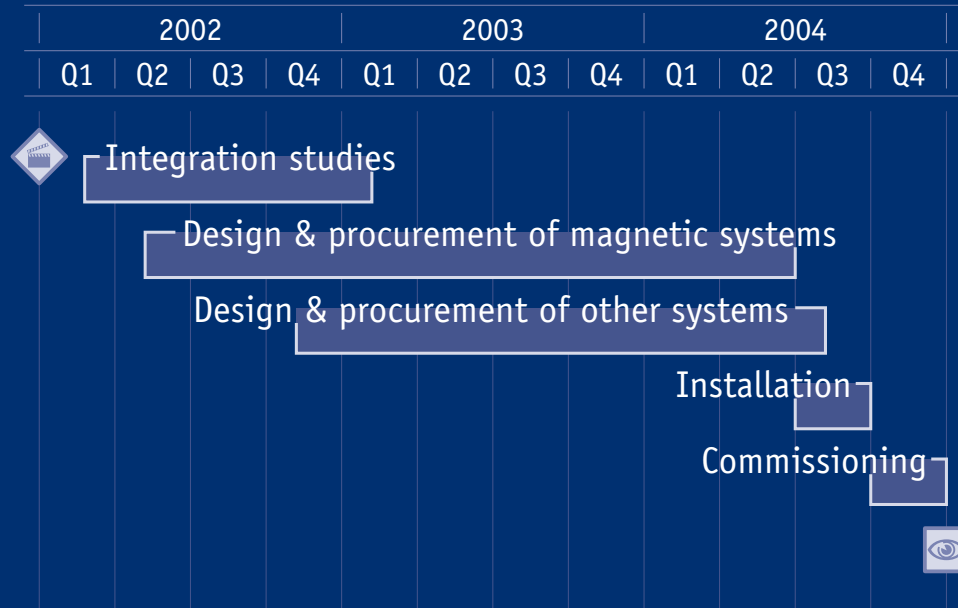
Project Mandate | Budget & Resources.

Cost control policy:

- The **hybrid approach** to project cost engineering is preferred.
- Yearly (estimated) economical index will be applied from 1st January onwards.

Economical and commercial risks are included in the lump sum budget (3.1 MCHF) of the project.

Project Mandate | Master Schedule.



Before continuing ...

... let's say a few words about
our **prefered PM approach.**

Preferred project management approach.

① A Deliverable-oriented approach.

- Historically, project have been managed with a focus on the tasks to carry out ('process-drives-deliverable' approach).
- History has also shown that focusing on managing the processes has failed over and over.
- A more pragmatic approach consists at looking at the (final + intermediate) deliverables ('deliverables-drive-process' approach).

Preferred project management approach.

② A Risk-oriented approach.

- A project is by definition a risky endeavor!
- Possible risks have to be considered all along the Project Life Cycle. It's up to the project team to protect the project from undesirable events.
- These undesirable events can be of several types:
 - technical risks
 - programmatic risks.

Preferred project management approach.

③ An EVM-oriented approach.

- Project stakeholders hates bad surprises!
They require means to appraise objectively the progress of the project.
- The EVM (Earned Value Management) methodology has been promoted to address this requirement.
- This methodology is a model ; i.e. a simplification of the reality. As a consequence, it is required to have the reality 'adapted', so it complies to the model.

Preferred project management approach.

④ A Corporate management-integrated approach.

- Project management is not a stand alone process!
It must be integrated in the corporate management systems: financial & personnel planning, accounting, purchasing, reporting...
- There are organizations that are 'project-oriented': most of their activities are managed as projects.
They must adapt their corporate management systems so projects can be managed easily and efficiently.

2002

2003

2004

N D J J F M A M J J A S O N D J F M A M J J A S O N D J J F M A M J J A S O N D J

early days of January

— Let's start! —

Planning & Costing the Project

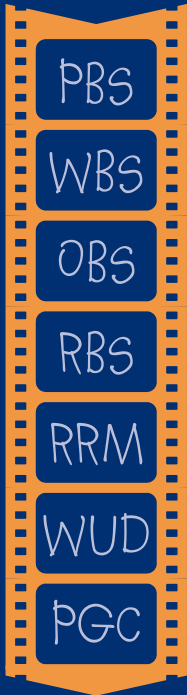
The US approach to project planning...

Refer to:

Project Management Institute. *Practice Standard for Work Breakdown Structures*. PMI, Newtown Square, PA., 2001. ISBN 1-880410-818. www.pmi.org

Gary Sanders. *Planning for Performance Measurement*. Project Science Workshop, Aspen, CO., October 1-5 2003. www.projectscience.org

The European approach...

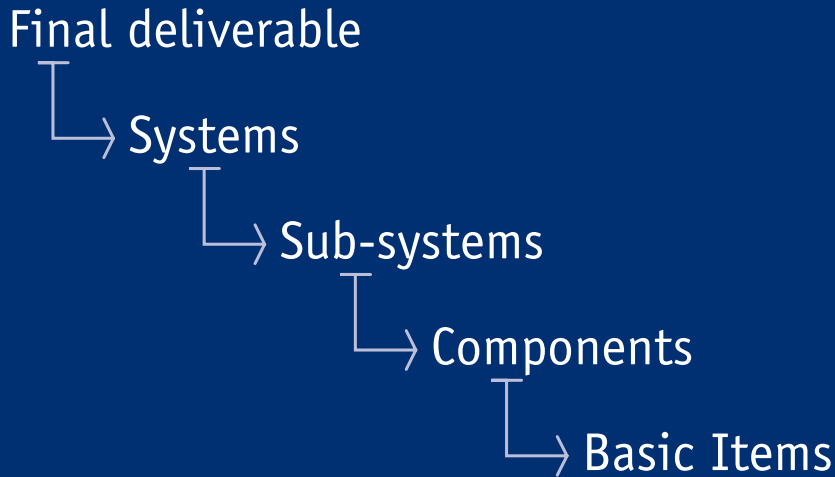


- ① Project / Product Breakdown Structure
- ② Work Breakdown Structure
- ③ Organization Breakdown Structure
- ④ Resource Breakdown Structure
- ⑤ Resource Responsibility Matrix
- ⑥ Work Unit Dictionary
- ⑦ Project Gantt Chart :-)



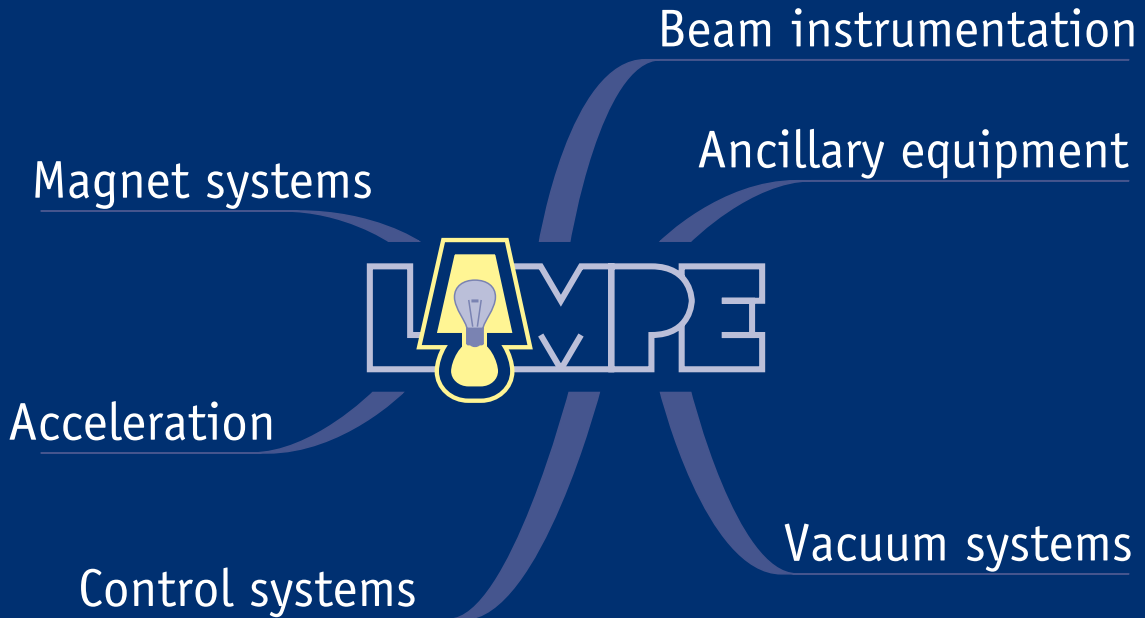
① Project / Product Breakdown Structure.

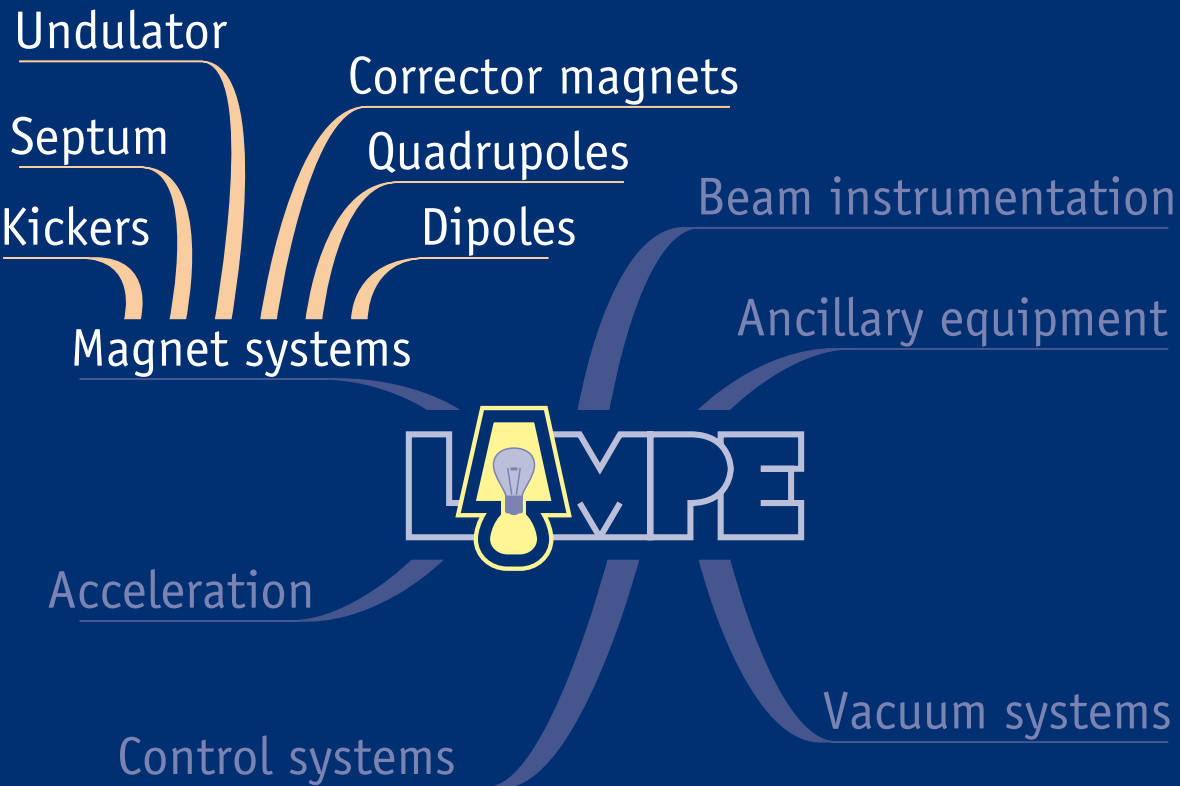
Aim : breaking down the final deliverable into systems...

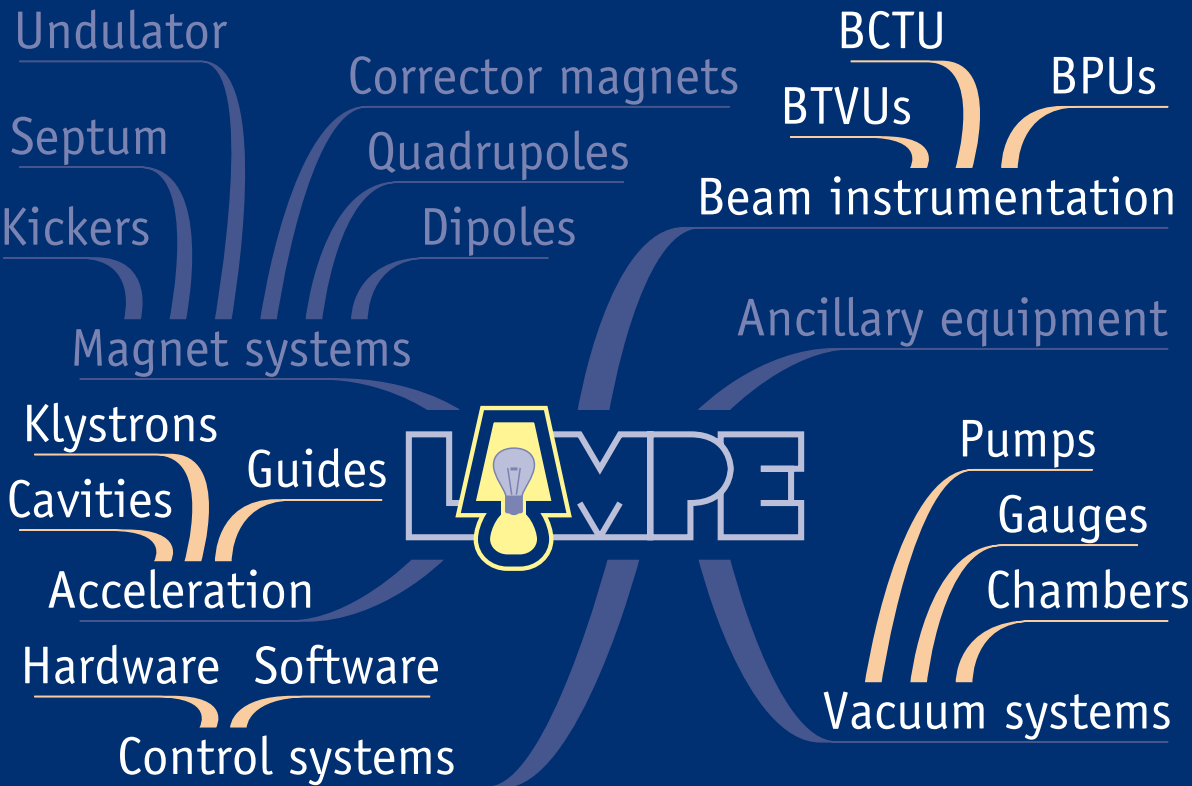




① Project / Product Breakdown Structure.







	A	B	C	D
1	level	code	PBS label	qty
2	1		Magnet systems	
3	2	MBU	Dipole magnets	12
4	3		Insulated copper wire	
5	3		Other components	
6	2	QTU	Quadrupole magnets	22
7	3		Insulated copper wire	
8	3		Other components	
9	2	LSU	Sextupole magnets	4
10	2	MDU	Corrector magnets	18
11	2	MUN	Undulator	1
12	2	MSU	Septum	1
13	2	MKU	Kickers	4
14	1		Beam instrumentation	
15	1		Acceleration	
16	1		Vacuum systems	

	A	B	C	D
1	level	code	PBS label	qty
2	1		Magnet systems	
3	2	MBU	Dipole magnets	12
4	2	QTU	Quadrupole magnets	22
5	2	LSU	Sextupole magnets	4
6	2	MDU	Corrector magnets	18
7	2	MUN	Undulator	1
8	2	MSU	Septum	1
9	2	MKU	Kickers	4
10	1		Beam instrumentation	
11	1		Acceleration	
12	1		Vacuum systems	
13	1		Ancillary equipment	
14	1		Ring & access control systems	
15	1		Power converters	
16	1		Fluids	

	A	B	C	D
1	level	code	PBS label	qty
2	1		Magnet systems	
14	1		Beam instrumentation	
15	2	BPU	Beam position monitors	12
16	2	BTVU	Profile monitors	2
17	2	BCTU	Intensity monitor	1
18	1		Acceleration	
19	1		Vacuum systems	
20	1		Ancillary equipment	
21	1		Ring & access control systems	
22	1		Power converters	
23	1		Fluids	
24	1		Electricity	
25				
26				
27				

2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

2002-01-25

- The Project (Product) Breakdown Structure is released.
- The Project Equipment Coding Convention is also released.

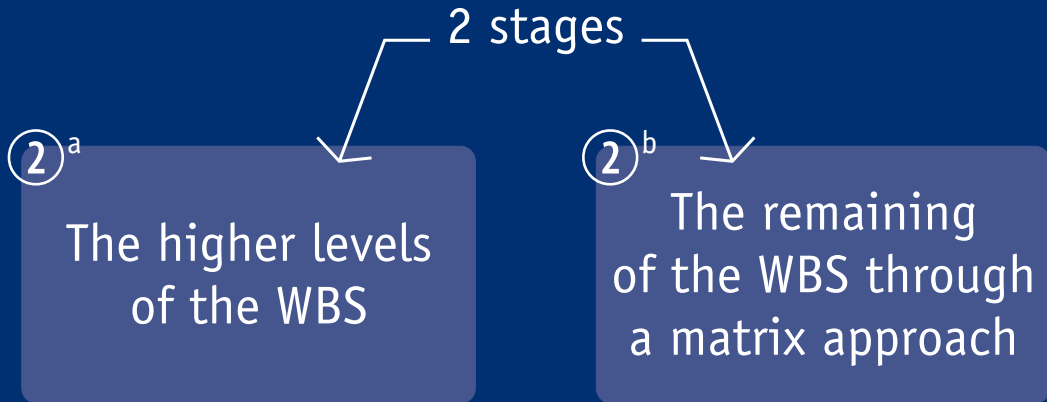
LAMPE

PROJECT
BREAKDOWN
STRUCTURE



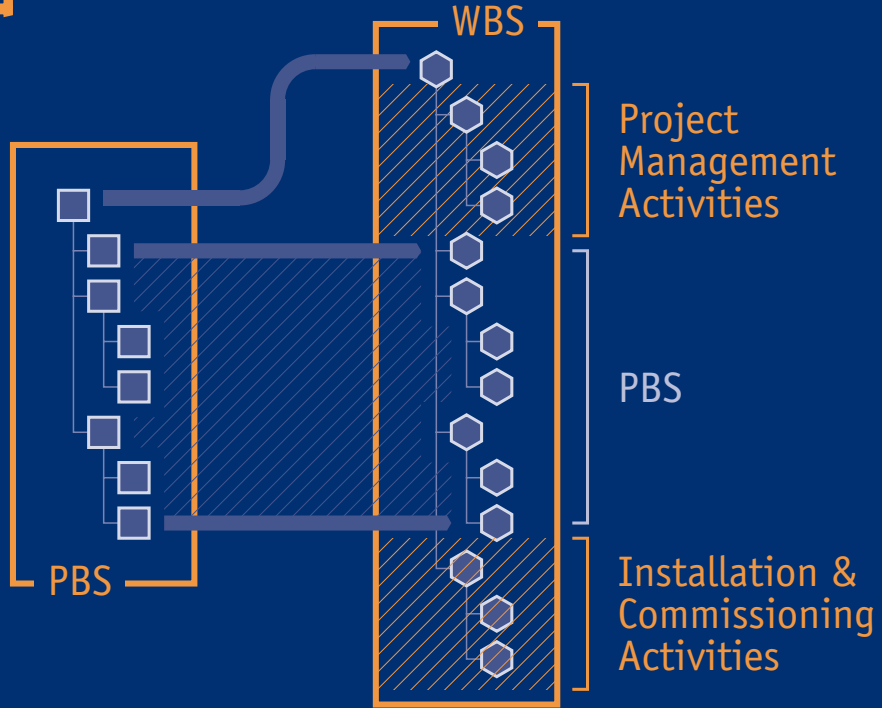
② Work Breakdown Structure.

Aim : identifying the activities, i.e. the Work Units (WU), to be carried out, so all the intermediate deliverables and then the final deliverable are delivered.





② Work Breakdown Structure | higher levels.



	A	B	C
1	level	code	WBS label
2	1	LAMPE.1	Project management and integration
3	1	LAMPE.2	Magnet systems
4	1	LAMPE.3	Beam instrumentation
5	1	LAMPE.4	Acceleration
6	1	LAMPE.5	Vacuum systems
7	1	LAMPE.6	Ancillary equipment
8	1	LAMPE.7	Ring & access control systems
9	1	LAMPE.8	Power converters
10	1	LAMPE.9	Cooling and ventilation
11	1	LAMPE.10	Electricity and cabling
12	1	LAMPE.11	Installation and commissioning
13			
14			
15			
16			

	A	B	C
1	level	code	WBS label
2	1	LAMPE.1	Project management and integration
3	2	LAMPE.1.1	Project management
4	2	LAMPE.1.2	Integration studies
5	1	LAMPE.2	Magnet systems
6	1	LAMPE.3	Beam instrumentation
7	1	LAMPE.4	Acceleration
8	1	LAMPE.5	Vacuum systems
9	1	LAMPE.6	Ancillary equipment
10	1	LAMPE.7	Ring & access control systems
11	1	LAMPE.8	Power converters
12	1	LAMPE.9	Cooling and ventilation
13	1	LAMPE.10	Electricity and cabling
14	1	LAMPE.11	Installation and commissioning
15	2	LAMPE.11.1	Infrastructures
16	2	LAMPE.11.2	Ring equipment and commissioning

	A	B	C
1	level	code	WBS label
2	1	LAMPE.1	Project management and integration
3	2	LAMPE.1.1	Project management
4	2	LAMPE.1.2	Integration studies
5	1	LAMPE.2	Magnet systems
6	2	LAMPE.2.1	Dipole magnets
7	2	LAMPE.2.2	Quadrupole magnets
8	2	LAMPE.2.3	Sextupole magnets
9	2	LAMPE.2.4	Corrector magnets
10	2	LAMPE.2.5	Undulator
11	2	LAMPE.2.6	Septum and kickers
12	2	LAMPE.2.7	Insulated copper wire
13	1	LAMPE.3	Beam instrumentation
14	1	LAMPE.4	Acceleration
15	1	LAMPE.5	Vacuum systems
16	1	LAMPE.6	Ancillary equipment

	A	B	C
1	level	code	WBS label
2	1	LAMPE.1	Project
3	2	LAMPE.1.1	Proje
4	2	LAMPE.1.2	Integ
5	1	LAMPE.2	Magnet
6	2	LAMPE.2.1	Dipo
7	2	LAMPE.2.2	Quad
8	2	LAMPE.2.3	Sextu
9	2	LAMPE.2.4	Corrector magnets
10	2	LAMPE.2.5	Undulator
11	2	LAMPE.2.6	Septum and kickers
12	2	LAMPE.2.7	Insulated copper wire
13	1	LAMPE.3	Beam instrumentation
14	1	LAMPE.4	Acceleration
15	1	LAMPE.5	Vacuum systems
16	1	LAMPE.6	Ancillary equipment

Septum and kickers PBS nodes have been merged into a single WBS node, because these two items will be under the responsibility of the same engineer, and supplied in a single contract.

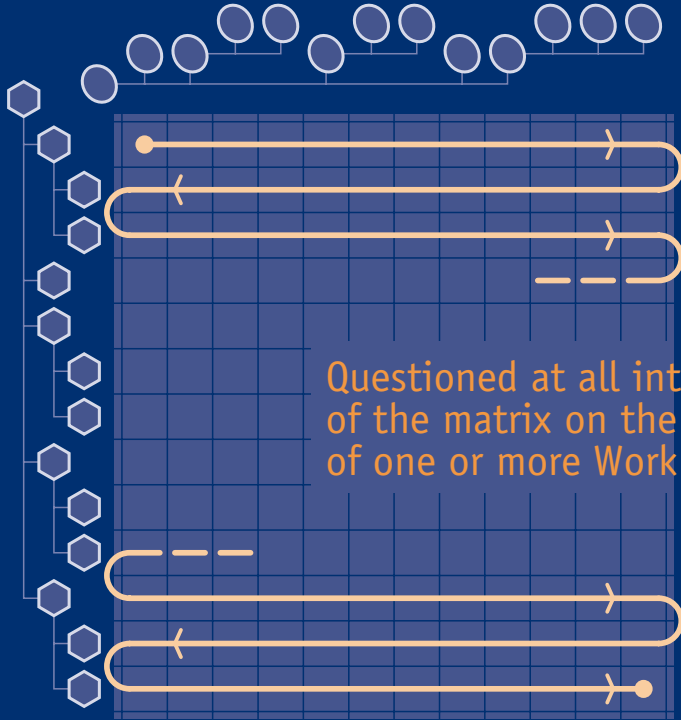
	A	B	C
1	level	code	WBS label
2	1	LAMPE.1	Project management and integration
3	2	LAMPE.1.1	Project
4	2	LAMPE.1.2	Integr
5	1	LAMPE.2	Magnet s
6	2	LAMPE.2.1	Dipole
7	2	LAMPE.2.2	Quadr
8	2	LAMPE.2.3	Sextup
9	2	LAMPE.2.4	Correc
10	2	LAMPE.2.5	Undulator
11	2	LAMPE.2.6	Septum and kickers
12	2	LAMPE.2.7	Insulated copper wire
13	1	LAMPE.3	Beam instrumentation
14	1	LAMPE.4	RF systems
15	1	LAMPE.5	Vacuum systems
16	1	LAMPE.6	Ancillary equipment

Even if it is used in dipole and quadrupole magnets, the supply of insulated copper wire will be done through a single contract, under the responsibility of a different project engineer.

② Work Breakdown Structure.



Higher levels of WBS



Generic activities

Questioned at all intersections of the matrix on the existence of one or more Work Units.



② Work Breakdown Structure.

Higher levels of WBS



Generic activities

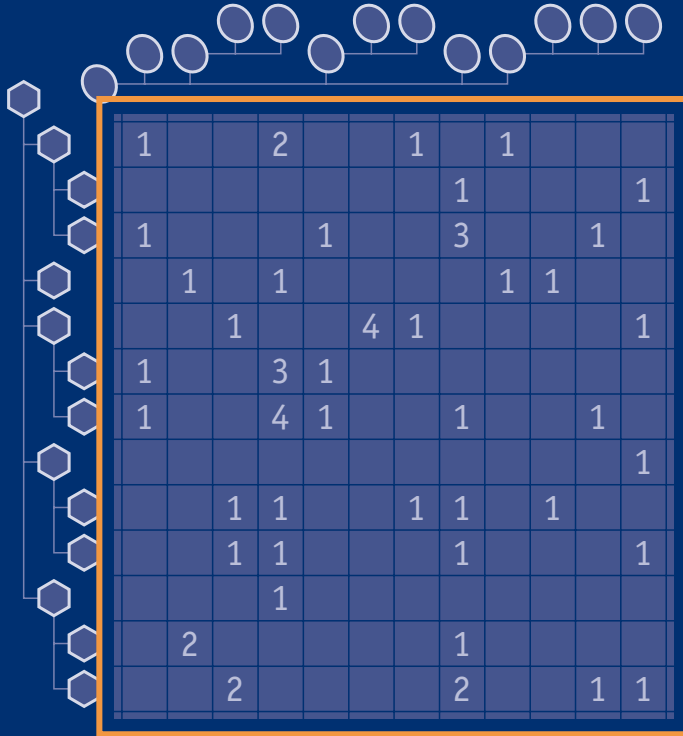
One WU to be created.

Three WUs to be created.



2 Work Breakdown Structure.

Higher levels of WBS



Generic activities

no. of WUs

$$\sum a_{ij} = 53$$

What's a Deliverable ?

A Deliverable is not a Product:

The LAMPE Facility
↳ Product.

👉 What's a Deliverable ?

A Deliverable is not a Product:

The LAMPE Facility
↳ Product.

The LAMPE Facility commissioned
↳ Deliverable.

① What's a Deliverable ?

A Deliverable is not a Product:

Undulator
↳ Product.

👉 What's a Deliverable ?

A Deliverable is not a Product:

Undulator
↳ **Product.**

Undulator designed

Undulator specified

Undulator manufactured

Undulator installed & prov. accepted

Undulator fully tested

↳ **Deliverables.**

What's a Work Unit ?

A Work Unit is an elementary activity that:

- > consumes time
- > consumes resources
- > has a start date and a finish date
- > is assignable to a single person
- > produces deliverable(s)
- > is measurable (to assess its progress).

Work Unit ~ Work Package ~ Activity.

What's a Work Unit ?

A Work Unit is not a Deliverable:

To avoid confusion, several textbooks suggest to label Work Units as follow:

Verb (infinitive tense)

+

Substantive

↑
i.e. an action.

What's a Work Unit ?

Examples of WU labels:

- Manage the project
- Prepare documents
- Perform magnet design
- Refurbish old RF cavities
- Test, validate power converters
- Fabricate intensity monitors
- Install vacuum chambers...

What's a Work Unit ?

A Work Unit is an elementary activity that:

- > consumes time, within some limits!
- > ...
 - > No definitive answer!
 - > No more than 5% – 10% of the project duration.
 - > No more than 13 weeks (long lead projects).
 - > Some 'Level of Effort' Work Units allowed:
[1 ; 1% of no. of WUs]



What's a Generic Activity ?

- Manage the project
- Prepare PM documents
- Perform basic design
- Perform detailed design
- Prepare specifications
- CFT, award contract
- Supply equipment
- Negotiate agreement (order)
- Prepare manufacturing file
- Manufacture, assemble...
- Measure, test, validate...
- Refurbish, maintain...
- Build, install...
- Commission



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		Manage the project	Prepare PM documents	Perform basic design	Perform detailed design	Prepare specifications	CFT, award contract	Supply equipment (order)	Negotiate agreement	Prepare manufacturing file	Manufacture, assemble	Measure, test, validate	Refurbish, maintain	Build, install	Commission
2	Project management...														
3	Project management	1	1												
4	Integration studies			2											
5	Magnet systems														
6	Dipole magnets														
7	Quadrupole magnets														
8	Sextupole magnets														
9	Corrector magnets														

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		Manage the project	Prepare PM documents	Perform basic design	Perform detailed design	Prepare specifications	CFT, award contract	Supply equipment (order)	Negotiate agreement	Prepare manufacturing file	Manufacture, assemble	Measure, test, validate	Refurbish, maintain	Build, install	Commission
5	Magnet systems														
6	Dipole magnets					1			1	1	4	1			
7	Quadrupole magnets														
8	Sextupole magnets														
9	Corrector magnets														
10	Undulator														
11	Septum and kickers														
12	Insulated copper wire														

(8)

Typical Life Cycle of a component that is supplied in the framework of a collaboration (in-kind contribution).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		Manage the project	Prepare PM documents	Perform basic design	Perform detailed design	Prepare specifications	CFT, award contract	Supply equipment (order)	Negotiate agreement	Prepare manufacturing file	Manufacture, assemble	Measure, test, validate	Refurbish, maintain	Build, install	Commission
5	Magnet systems														
6	Dipole magnets					1			1	1	4	1			
7	Quadrupole magnets				1	1	1			1	6	1			
8	Sextupole magnets														
9	Corrector magnets														
10	Undulator														
11	Septum and kickers														
12	Insulated copper wire														

(11)

Typical Life Cycle of a component that is supplied in the framework of a contract with a industrial firm.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		Manage the project	Prepare PM documents	Perform basic design	Perform detailed design	Prepare specifications	CFT, award contract	Supply equipment (order)	Negotiate agreement	Prepare manufacturing file	Manufacture, assemble	Measure, test, validate	Refurbish, maintain	Build, install	Commission
5	Magnet systems														
6	Dipole magnets					1			1	1	4	1			
7	Quadrupole magnets				1	1	1			1	6	1			
8	Sextupole magnets				1	1	1			1	1				
9	Corrector magnets				1	1	1			1	6				
10	Undulator				1	1			1	1	1				
11	Septum and kickers				2	2	1			1	2				
12	Insulated copper wire					1	1			1	5				

(55)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		Manage the project	Prepare PM documents	Perform basic design	Perform detailed design	Prepare specifications	CFT, award contract	Supply equipment (order)	Negotiate agreement	Prepare manufacturing file	Manufacture, assemble	Measure, test, validate	Refurbish, maintain	Build, install	Commission
13	Beam instrumentation	/	/	/										/	/
14	Beam position monitors	/	/	/	1					1	2	1		/	/
15	Profile monitors	/	/	/	1					1	1	1		/	/
16	Intensity monitor	/	/	/	1					1	1	1		/	/
17	Acceleration	/	/	/	1						1		2	/	/
18	Vacuum systems	/	/	/										/	/
19	Vacuum chambers	/	/	/		1					7			/	/
20	Pumps and gauges	/	/	/				1						/	/

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		Manage the project	Prepare PM documents	Perform basic design	Perform detailed design	Prepare specifications	CFT, award contract	Supply equipment (order)	Negotiate agreement	Prepare manufacturing file	Manufacture, assemble	Measure, test, validate	Refurbish, maintain	Build, install	Commission
21	Ancillary equipment												3		
22	Ring and access control...														
23	Hardware							2							
24	Software					1		1				1			
25	Power converters				1	1	1			1	6				
26	Cooling and ventilation				1	1	1			1			1		
27	Electricity and cabling				1	1	1						2		
28	Installation and commis...														

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		Manage the project	Prepare PM documents	Perform basic design	Perform detailed design	Prepare specifications	CFT, award contract	Supply equipment (order)	Negotiate agreement	Prepare manufacturing file	Manufacture, assemble	Measure, test, validate	Refurbish, maintain	Build, install	Commission
28	Installation and commis...														
29	Infrastructures													7	
30	Ring equipment													4	
31	Commissioning														1
32															

$\sum a_{ij} = 125$ WUs needed
for managing this project.

Work Unit vs. Planned Unit.

- It is not mandatory to identify all the WUs of the project with the same level of accuracy!
- WUs that are scheduled to be carried out at the early stage of the project should be defined more precisely than the ones scheduled to be performed at the end of the project.
- Practically, this means that the content or the breakdown of long lead WUs can be reviewed.



② Work Breakdown Structure | list of WUs.

The procedure is straightforward: the list of WUs is generated from the WBS Matrix by scanning all its intersections.

1 or n Work Units are appended to the list according to the number that has been specified at the intersection.

2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

2002-01-25

- The Work Breakdown Structure of the project is released.
This document includes the list of Work Units.

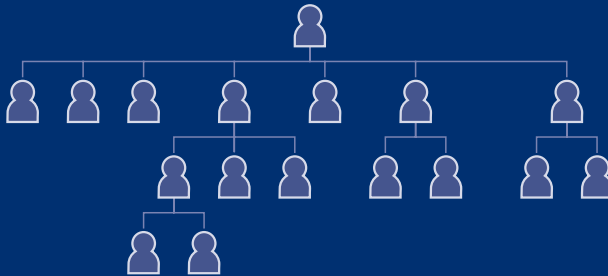
LAMPE

WORK
BREAKDOWN
STRUCTURE



③ Organization Breakdown Structure.

It is no more than the organization chart of the project.



2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

2002-01-25

- The Organization Breakdown Structure is released.

LAMPE

ORGANIZATION
BREAKDOWN
STRUCTURE

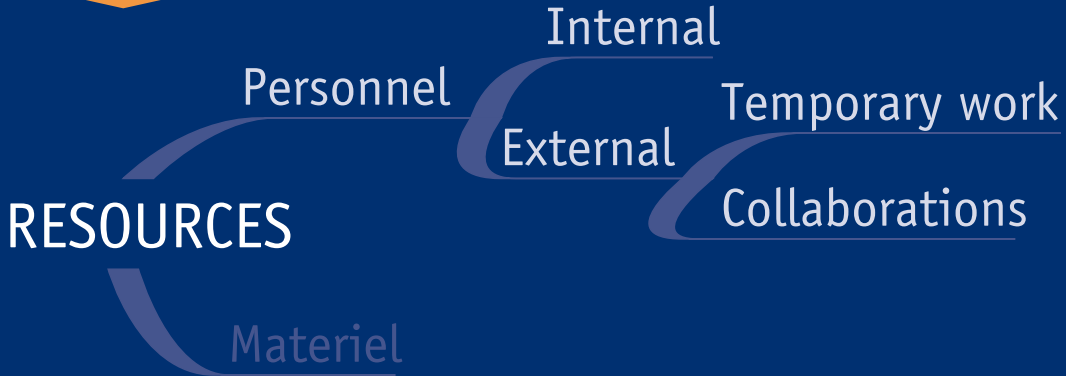


④ Resource Breakdown Structure.





④ Resource Breakdown Structure.





④ Resource Breakdown Structure.





④ Resource Breakdown Structure.





④ Resource Breakdown Structure.





④ Resource Breakdown Structure.





④ Resource Breakdown Structure.

Non-renewable RESOURCES

Personnel

Internal

Temporary work

External

Collaborations M3

Materiel

Stores & orders

Contracts

Logistics

Energies

Others

Space

Duty travels

Tools

Quality control



④ Resource Breakdown Structure.

	A	B
1	type	name of the resource
2	L1	Art > lead engineer, cooling & ventilation
3	L1	Ben > lead engineer, magnet systems
4	L1	Bill > project manager
5	L1	Billie > lead engineer, vacuum systems
6	L1	Bud > engineer, intensity monitor
7	L1	Carla > engineer, beam position monitors
8	L1	Cassandra > lead engineer, controls
9	L1	Chet > engineer, sextupole magnets
10	L1	Count > engineer, dipole magnets
11	L1	Django > engineer, insulated copper wire
12	L1	Ella > lead engineer, power converters



④ Resource Breakdown Structure.

	A	B
1	type	name of the resource
13	L1	Errol > engineer, undulator
14	L1	Fats > engineer, septum & kickers
15	L1	Gil > lead engineer, mechanical & installation coord.
16	L1	Helen > engineer, dipole corrector magnets
17	L1	Jacky > engineer, controls
18	L1	Joshua > designer, magnet systems
19	L1	Lester > designer, integration studies
20	L1	Max > lead engineer, acceleration
21	L1	Melba > PM assistant
22	L1	Nina > engineer, profile monitors
23	L1	Oscar > head design office, deputy PM



④ Resource Breakdown Structure.

	A	B
1	type	name of the resource
24	L1	Pat > lead engineer, electricity & cabling
25	L1	Ray > surveyor
26	L1	Sarah > engineer, quadrupole magnets
27	L1	Sonny > technician, magnet systems
28	L1	Sweet > lead engineer, beam instrumentation
29	L1	Tools > technician, beam instrumentation
30	L1	Waine > technician, mechanical & installation coord.
31	L2	S02 - Designers
32	L2	S03 - Vacuum technicians
33	L2	S04 - RF technicians
34	L2	S09 - Installation team



④ Resource Breakdown Structure.

	A	B
1	type	name of the resource
35	M1	F02 - Supply and installation of cooling network
36	M1	F06 - Supply of quadrupole magnets
37	M1	F07 - Supply of vacuum chambers
38	M1	F09 - Supply of septum and kicker magnets
39	M1	F10 - Supply of insulated copper wire
40	M1	F11 - Supply of power converters
41	M1	F12 - Supply of sextupole magnets
42	M1	F13 - Supply of corector magnets
43	0	F16 - Logistics
44	M1	F19 - Electrical Works
45	M2	Off-the-shelf components COTS



④ Resource Breakdown Structure.

	A	B
1	type	name of the resource
46	M2	P02 - CAT Protocol (50% funded by the Lab)
47	M3	P02 - CAT Protocol (50% funded by CAT)
48	M3	P01 - BINP Protocol (100% funded by BINP)
49	0	Duty travels
50		
51		
52		
53		
54		
55		
56		

2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

2002-01-25

- The Resource Breakdown Structure of the project is released.

This document includes the list of Budget Codes.

LAMPE

RESOURCE
BREAKDOWN
STRUCTURE



⑤ Resource Responsibility Matrix.

The Resource Responsibility Matrix

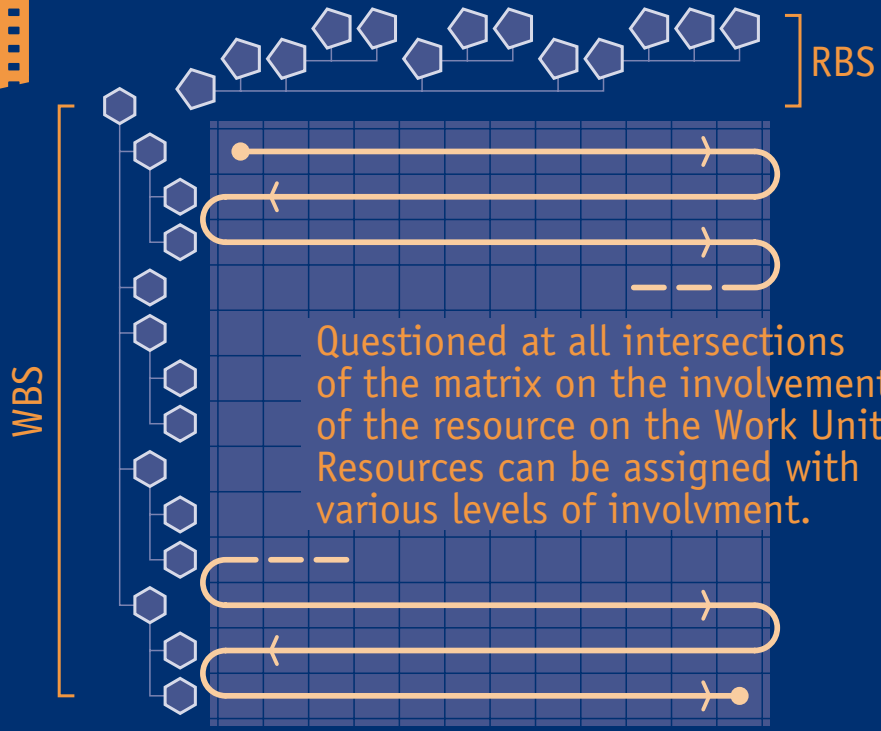
(a.k.a. Resource Assignment Matrix in some textbooks)

has basically two purposes:

- The identification of all the **resources required** to carry out all the Work Units that have been identified.
- The clarification of all the **communication processes** within the project.

5

Resource Responsibility Matrix.





⑤ Resource Responsibility Matrix.

The different levels of involvement:

X → eXecutes the work.



⑤ Resource Responsibility Matrix.

The different levels of involvement:

X → e**X**ecutes the work.

R → **R**eviews the work done.



⑤ Resource Responsibility Matrix.

The different levels of involvement:

X → e**X**ecutes the work.

R → **R**eviews the work done.

I → must be **I**nformed.



⑤ Resource Responsibility Matrix.

The different levels of involvement:

- X** → e**X**ecutes the work.
- R** → **R**eviews the work done.
- I** → must be **I**nformed.
- H** → provides **H**elp or tuitions.



⑤ Resource Responsibility Matrix.

The different levels of involvement:

- X** → e**X**ecutes the work.
- R** → **R**eviews the work done.
- I** → must be **I**nformed.
- H** → provides **H**elp or tuitions.
- N** → is **N**eeded to complete the work.



⑤ Resource Responsibility Matrix.

The different levels of involvement:

- X → eXecutes the work.
- R → Reviews the work done.
- I → must be Informed.
- H → provides Help or tuitions.
- N → is Needed to complete the work.

Dark b.g.
or circled



leads the WU and monitor its progress.



⑤ Resource Responsibility Matrix.

The different levels of involvement:

- X → eXecutes the work.
- R → Reviews the work done.
- I → must be Informed.
- H → provides Help or tuitions.
- N → is Needed to complete the work.

leads the WU and monitor its progress.

contributes to decision making w.r.t. the WU.

Dark b.g.
or circled

X	ⓧ
R	Ⓜ

Grey b.g.
or underscore

X	<u>X</u>
R	<u>R</u>
I	<u>I</u>
H	<u>H</u>

	A	B	C	D	E	F	G	H	I	T	U	AU	AV	AW
1		Bill	Melba	Oscar	Lester	S01	Ben	Helen	F13	Joshua	Sonny	COTS	Travels	Logistics
2	Manage the LAMPE Project	(X)												
3	Issue PM documents	(X)		R			X	R						
4	Perform integration studies general services	R		(X)	X	X	R	I						
5	Perform integration studies ring equipment	R		(X)	X	X	R	R						
30	Perform detailed design of MDUs	R		I			R	(X)		X				
31	Prepare specification for MDUs	R		I			R	(X)		X				
32	Call for tender & award contract for MDUs	R	X				R	(X)	N					
33	Prepare MDU manufacturing files	R		I			R	(X)	X	I				
34	Assemble & deliver pre-series MDUs (x2)	I		I			R	(R)	X		X		N	
35	Assemble & deliver series MDUs (x4)	I		I			R	(R)	X		X		N	
36	Assemble & deliver series MDUs (x4)	I		I			R	(R)	X		X		N	
37	Assemble & deliver series MDUs (x4)	I		I			R	(R)	X		X		N	
38	Assemble & deliver series MDUs (x4)	I		I			R	(R)	X		X		N	
39	Assemble & deliver MDU spare coils (x2)	I		I			R	(R)	X		X		N	

2002

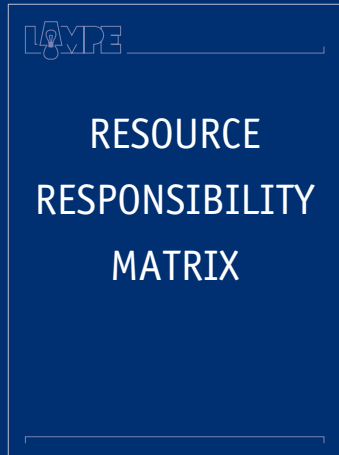
2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

2002-01-25

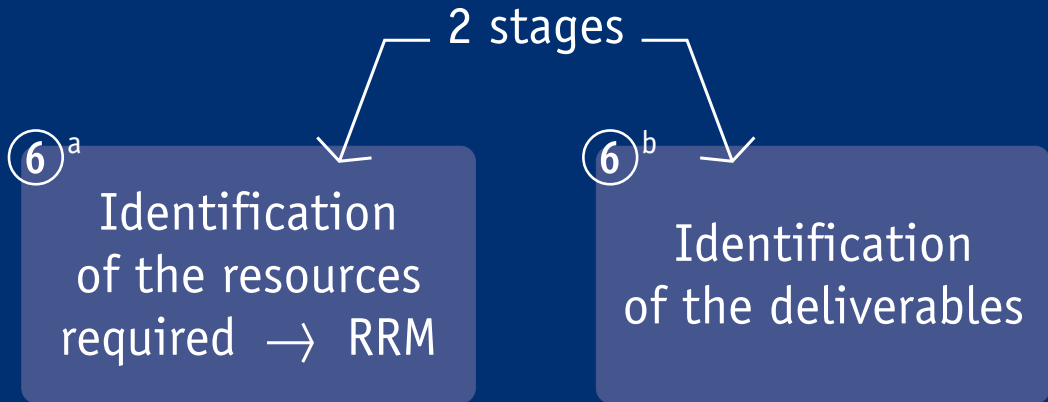
- The Resource Responsibility Matrix of the project is released.





⑥ Work Unit Dictionary.

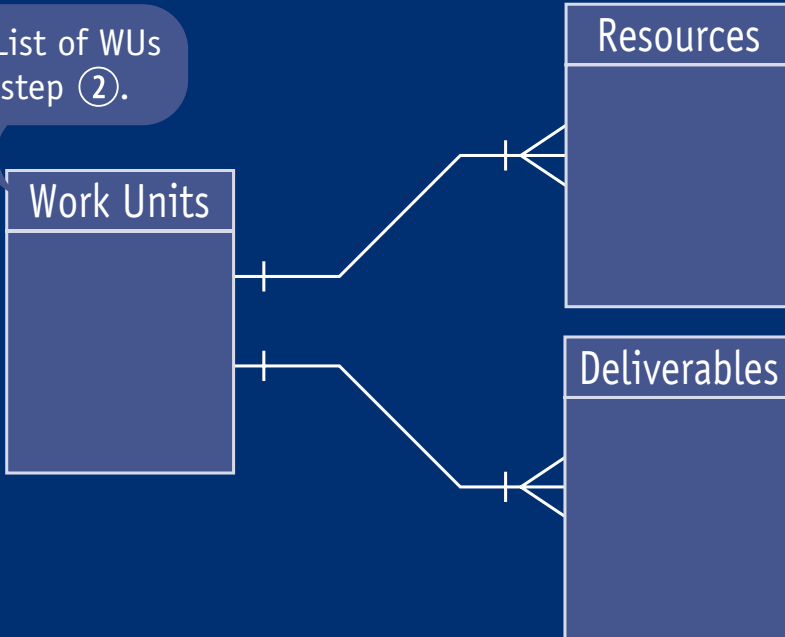
Aim : listing all the Work Units of the project, and for each of them: specifying which are the resources required, and what are the deliverables expected.





⑥ Work Unit Dictionary.

The List of WUs
of step ②.





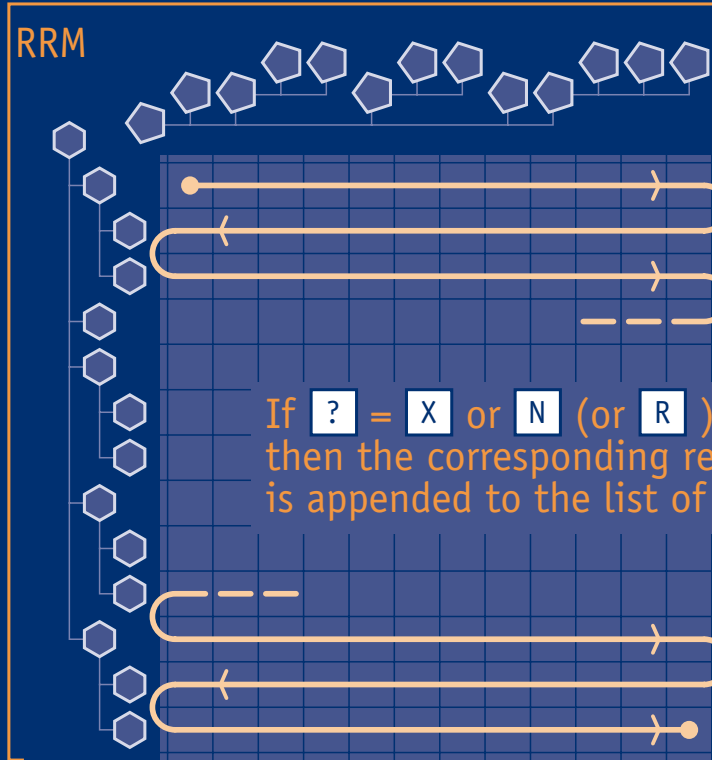
⑥ Work Unit Dictionary | resources.

⑥^a Identification
of the resources
required → RRM

Only those that are substantially
involved in the execution of the WUs,
i.e.:

- > The resources that execute the work. —————→ **X**
- > The resources that are needed. —————→ **N**
- > The resources that are substantially
involved in decision making processes. —————→ **R**

6 Work Unit Dictionary | resources.



	A	B	C	D	E	F	G	H
1	WU	WUID	type	status	Work Unit label	WU Holder	Pld Start	Pld Finish
2	type	WUID	#		Resource description	BAC	Unit	Budget Code
3								
4	Black lines → Work Units				Red lines → Resources assigned			
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								

	A	B	C	D	E	F	G	H	I	T	U	AU	AV	AW
1		Bill	Melha	Oscar	Lester	S01	Ben	Helen	F13	Joshua	Sonny	COTS	Travels	Logistics
25	Manage the LAMPE Project	(X)	X											
26	Issue PM documents	(X)	X	R			X	R						
27	Perform integration studies general services	R		(X)	X	X	R	I						
28	Perform integration studies ring equipment	R		(X)	X	X	R	R						
29														

	A	B	C	D	E	F	G	H
1	WU	WUID	type	status	Work Unit label	Holder	Pld Start	Pld Finish
2	type	WUID	#		Resource description	BAC	Unit	Budget Code
23	WU	103	E	PL	Perform integration studies ring equip	er@Lab.org	28-Jan-02	01-Nov-02
24	L1	103	1		Oscar@lab.org	7	M.WK	
25	L1	103	2		Lester@lab.org	15	M.WK	
26	L2	103	3		S01 - Designers	20'925	CHF	13705
27								

	A	B	C	D	E	L	M	T	U	AA	AF	AO	AV	AW
1		Bill	Melba	Oscar	Ren	Chet	Eliz	Joshua	Sonny	Sweet	Billie	Ella	Travels	Logistics
25	Perform detailed design of LSUs	R	X	I	R	(X)	(X)	X	I	R	R			
26	Prepare specification for LSUs	R		I	R	(X)	(X)	X	I	R				
27	CFT and award contract for LSUs	R	X		R	(X)							N	
28	Prepare LSU manufacturing files	R		I	R	(X)		I						
29	Assemble and deliver LSUs (x4)	I		I	R	(R)			X				N	

	A	B	C	D	E		G	H
1	WU	WUID	type	status	Work Unit label	WU Ho	Pld Start	Pld Finish
2	type	WUID	#		Resource description		Unit	Budget Code
123	WU	123	E	PL	Perform detailed design of LSUs	Chet@lab.org	02-Dec-02	21-Feb-03
124	L1	123	1		Chet@lab.org		2	M.WK
125	L1	123	2		Joshua@lab.org		5	M.WK
126								
127								

	A	B	C	D	E	L	M	T	U	AA	AF	AO	AV	AW
1		Bill	Melba	Oscar	Ren	Chet	Eliz	Joshua	Sonny	Sweet	Billie	Ella	Travels	Logistics
25	Perform detailed design of LSUs	R		I	R	(X)		(X)		I	R	R		
26	Prepare specification for LSUs	R		I	R	(X)		(X)		I	R			
27	CFT and award contract for LSUs	R	X		R	(X)							N	
28	Prepare LSU manufacturing files	R		I	R	(X)		I						
29	Assemble and deliver LSUs (x4)	I		I	R	(R)			X				N	

	A	B	C	D	E			G		H
1	WU	WUID	type	status	Work Unit label			WU Ho	Pld Start	Pld Finish
2	type	WUID	#		Resource description			C	Unit	Budget Code
126	WU	124	E	PL	Prepare specification for LSUs			Chet@lab.org	10-Feb-03	02-May-03
127	L1	124	1		Chet@lab.org			2	M.WK	
128	L1	124	2		Joshua@lab.org			5	M.WK	
129										
130										

	A	B	C	D	E	L	M	T	U	AA	AF	AO	AV	AW
1		Bill	Melba	Uscar	Ren	Chet	F12	Josnua	Sonny	Sweet	Billie	Filla	Travels	Logistics
25	Perform detailed design of LSUs	R		I	R	(X)		X		I	R	R		
26	Prepare specification for LSUs	R		I	R	(X)		X		I	R			
27	CFT and award contract for LSUs	R	X		R	(X)	N						N	
28	Prepare LSU manufacturing files	R		I	R	(X)		I						
29	Assemble and deliver LSUs (x4)	I		I	R	(X)			X				N	

	A	B	C	D	E	F	G	H
1	WU	WUID	type	status	Work Unit label	WU	Pld Start	Pld Finish
2	type	WUID	#		Resource description	AC	Unit	Budget Code
125	WU	125	E	PL	CFT and award contract for LSUs	Chet@lab.org	16-May-03	11-Jul-03
130	L1	125	1		Chet@lab.org	1	M.WK	
131	L1	125	2		Melba@lab.org	1	M.WK	
132	M1	125	3		F12 - Supply of sextupole magnets	5'000	CHF	13713
133	0	125	4		Duty travels	2'775	CHF	13713

	A	B	C	D	E	L	M	T	U	AA	AF	AO	AV	AW
1		Bill	Melba	Oscar	Ren	Chet	F12	Josnua	Sonny	Sweet	Billie	Ella	Travels	Logistics
25	Perform detailed design of LSUs	R		I	R	(X)		X		I	R	R		
26	Prepare specification for LSUs	R		I	R	(X)		X		I	R			
27	CFT and award contract for LSUs	R	X		R	(X)	N						N	
28	Prepare LSU manufacturing files	R		I	R	(X)	X	I						
29	Assemble and deliver LSUs (x4)	I		I	R	(X)			X				N	

	A	B	C	D	E			G		H
1	WU	WUID	type	status	Work Unit label			WU	Pld Start	Pld Finish
2	type	WUID	#		Resource description			AC	Unit	Budget Code
134	WU	126	E	PL	Prepare LSU manufacturing files			Chet@lab.org	19-Sep-03	19-Sep-03
135	L1	126	1		Chet@lab.org			1	M.WK	
136	M1	126	2		F12 - Supply of sextupole magnets			10'025	CHF	13713
137										
138										

	A	B	C	D	E	L	M	T	U	AA	AF	AO	AV	AW
1		Bill	Melba	Oscar	Ben	Chet	F12	Virginia	Sonny	Sweet	Billie	Filla	Travels	Logistics
25	Perform detailed design of LSUs	R		I	R	(X)	X		I	R				
26	Prepare specification for LSUs	R		I	R	(X)	X		I	R				
27	CFT and award contract for LSUs	R	X		R	(X)	N						N	
28	Prepare LSU manufacturing files	R		I	R	(X)	X	I						
29	Assemble and deliver LSUs (x4)	I		I	R	(R)	X		X				N	

	A	B	C	D	E	F	G	H
1	WU	WUID	type	status	Work Unit label	WU Holder	Pld Start	Pld Finish
2	type	WUID	#		Resource description	Unit		Budget Code
137	WU	127	E	PL	Assemble and deliver LSUs (x4)	Chet(12-Mar-04	12-Mar-04
138	L1	127	1		Sonny@lab.org	0.5	M.WK	
139	M1	127	2		F12 - Supply of sextupole magnets	5'150	CHF	13713
140	0	127	3		Duty travels	2'775	CHF	13713
141								



⑥ Work Unit Dictionary | deliverables.

⑥^b

Identification
of the deliverables

From a deliverable point of view,
Work Units can be of 3 types:

2 deliverables

Standard WUs

WORK UNIT

1 deliverable

'Result-oriented' WUs
i.e. outsourced WUs

multi-deliverables

	A	B	C	D	E	F	G	H
1	WU	WUID	type	status	Work Unit label	WU Holder	Pld Start	Pld Finish
2	type	WUID	#		Resource description	BAC	Unit	Budget Code
3	DE	WUID	#	weight	Deliverable description	Pld Qty	Unit	Pld Date
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								

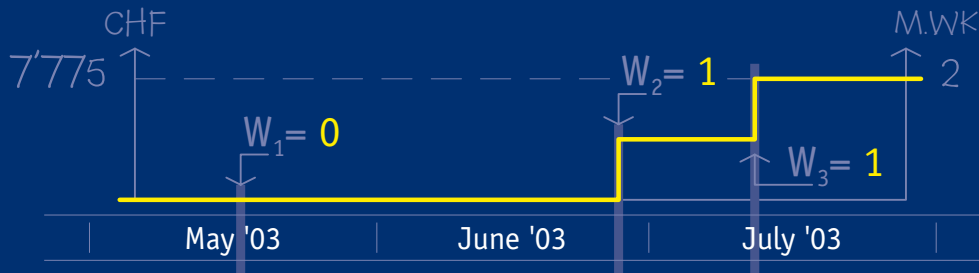
Black lines → Work Units

Red lines → Resources assigned

Green lines → Deliverables

	A	B	C	D	E	F	G	H
1	WU	WUID	type	status	Work Unit label	WU Holder	Pld Start	Pld Finish
2	type	WUID	#		Resource description	BAC	Unit	Budget Code
3	DE	WUID	#	weight	Deliverable description	Pld Qty	Unit	Pld Date
137	WU	127	E	PL	Assemble and deliver LSUs (x4)	Chet@Lab.org	12-Mar-04	12-Mar-04
138	L1	127	1		Sonny@lab.org	0.5	M.WK	
139	M1	127	2		F12 - Supply of sextupole magnets	35'150	CHF	13713
140	0	127	3		Duty travels	2'775	CHF	13713
141	DE	127	1	0	LSUs assembled and delivered to the Lab	4	U	12-Mar-04
142					Date at which the 4 th LSU magnet is planned to be delivered.			
143								
144								
145								
146								
147								
148								
149								
150								

	A	B	C	D	E	F	G	H
1	WU	WUID	type	status	Work Unit label	WU Holder	Pld Start	Pld Finish
2	type	WUID	#		Resource description	BAC	Unit	Budget Code
3	DE	WUID	#	weight	Deliverable description	Pld Qty	Unit	Pld Date
129	WU	125	E	PL	CFT and award contract for LSUs	Chet@Lab.org	16-May-03	11-Jul-03
130	L1	125	1		Chet@lab.org	1	M.WK	
131	L1	125	2		Melba@lab.org	1	M.WK	
132	M1	125	3		F12 - Supply of sextupole magnets	5'000	CHF	13713
133	0	125	4		Duty travels	2'775	CHF	13713
134	DE	125	1	0	CFT for LSUs issued	1	U	16-May-03
135	DE	125	2	1	Contract for LSUs awarded	1	U	27-Jun-03
136	DE	125	3	1	Downpayment to LSU manufacturer done	1	U	11-Jul-03



2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

2002-01-25

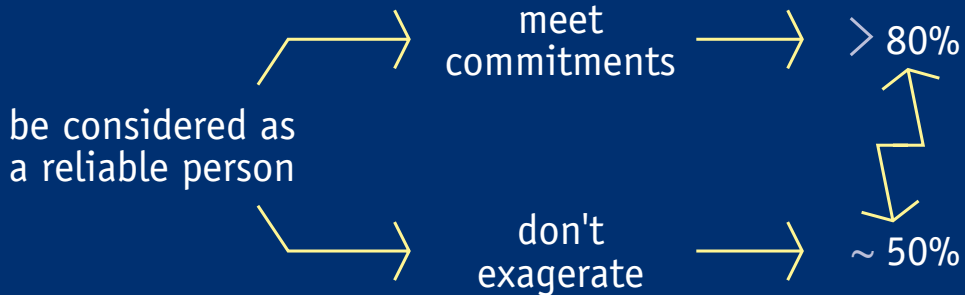
- The Work Unit Dictionary of the project is released.

LAMPE

WORK UNIT
DICTIONARY

👏 Estimating vs. budgeting...

The Goldratt's dilemma:



Eliyahu M. Goldratt. *Necessary and sufficient. Vol. 4: a look into the rules of project management.* Goldratt's Marketing Group. 2002 www.TOC-Goldratt.com

Estimating vs. budgeting...

Within the project, budgets (i.e. commitments) shall be set up at system level (i.e. budget codes) and not at Work Unit level.

↳ This is the purpose of budget codes!

Every system owner must then contribute to the setting up of the Project Management Reserve.

↳ ~ 10% of the system budget.

no Project Management Reserve ⇒ no Project Management!



Estimating vs. budgeting...

The Project Management Reserve aims at:

- covering the technical and programmatic risks:
system forgotten or underestimated, rework,
delays, technical difficulties;
- covering the commercial and economical risks:
bids are always higher or lower w.r.t. the initial estimates!
bankrupt, price escalation, FX...

2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

2002-01-25

- The Budget of the project is released.



2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

2002-01-25

- The Coordination Schedule of the project is released.

LAMPE

COORDINATION
SCHEDULE

2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

end of January

The Planning & Costing Phase

of the  Project
is completed.

2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

early days of February

— Let's continue! —

Executing & Monitoring the Project

Before continuing ...

... let's say a few words about
Earned Value Management.

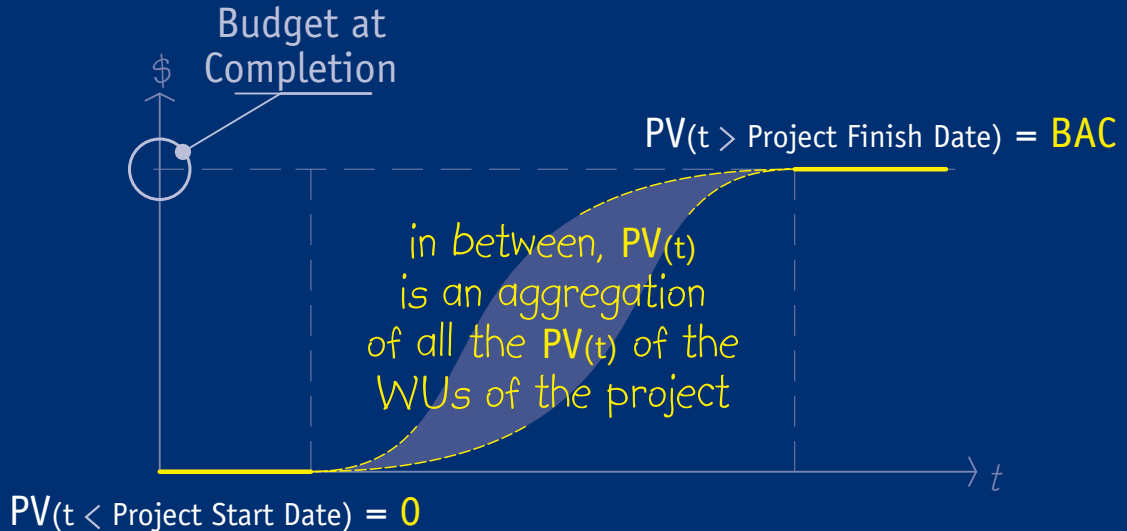
Earned Value Management Basics.

The Earned Value Criteria is a methodology developed by the US DoD in the late '60s. At that time it was known as the C/SCSC (Cost/Schedule Control System Criteria).

This methodology is now managed by ANSI, under standard #748.

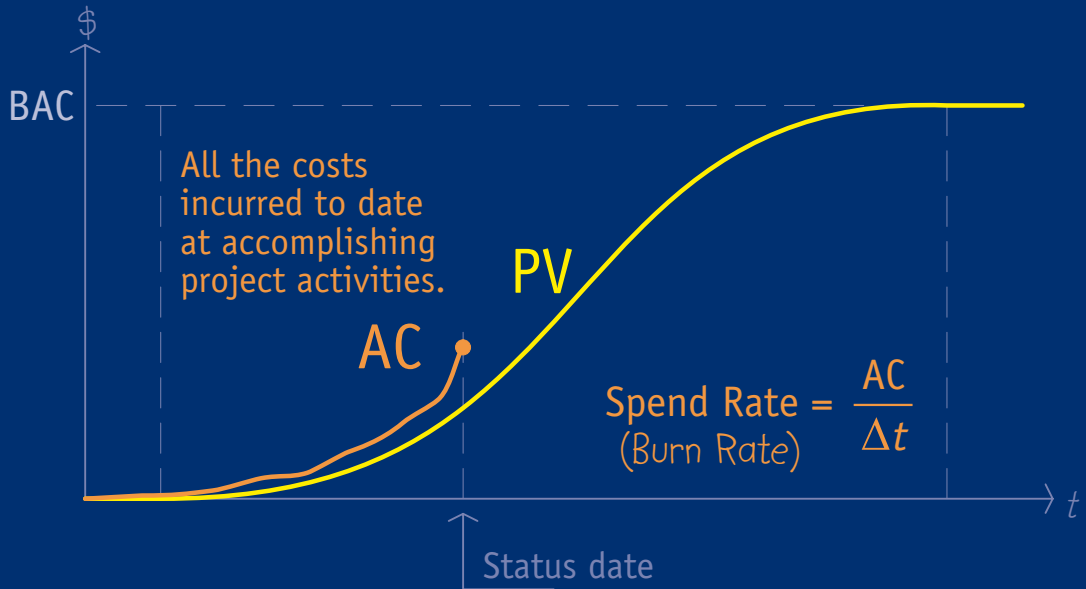
Earned Value Management Basics.

- ① Setting up the Planned Value curve of the project.



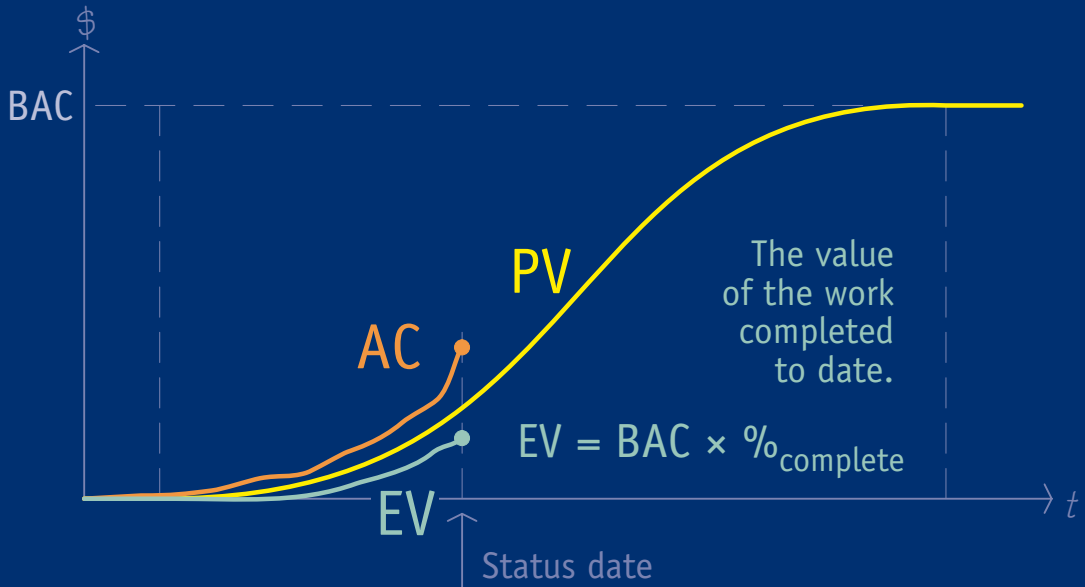
Earned Value Management Basics.

③ Recording the Actual Costs of the project.



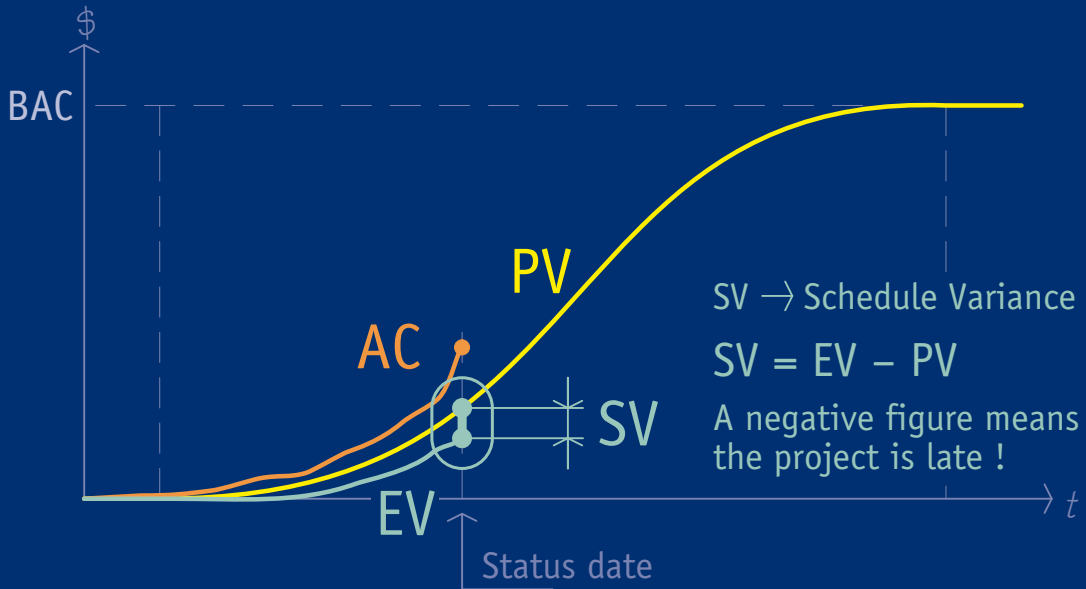
Earned Value Management Basics.

④ Calculating the Earned Value of the project.



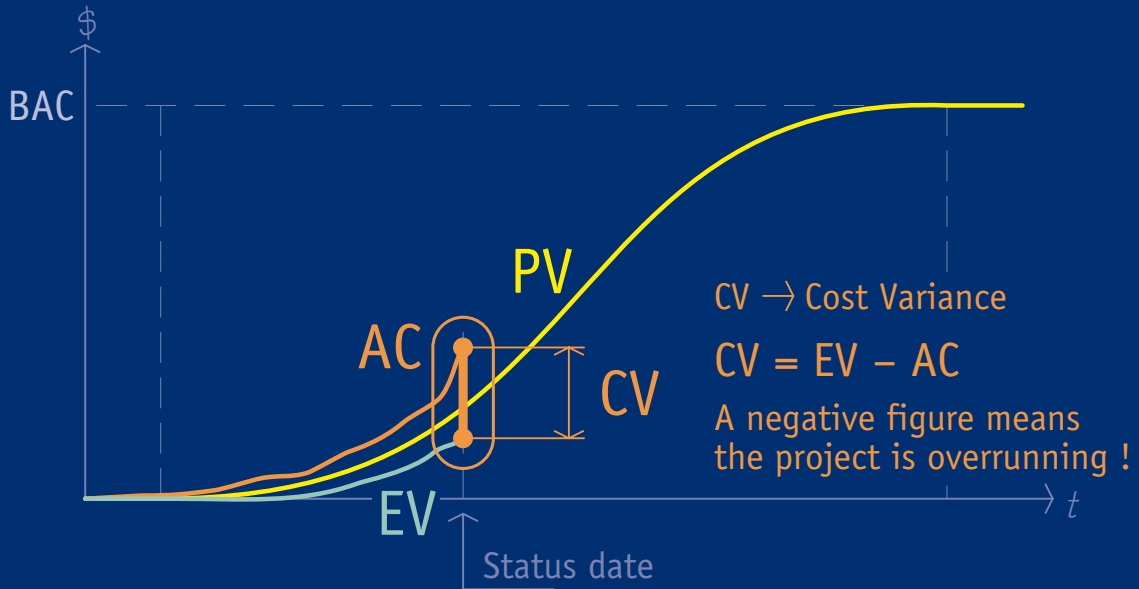
Earned Value Management Basics.

⑤ Calculating variances and performance indices.



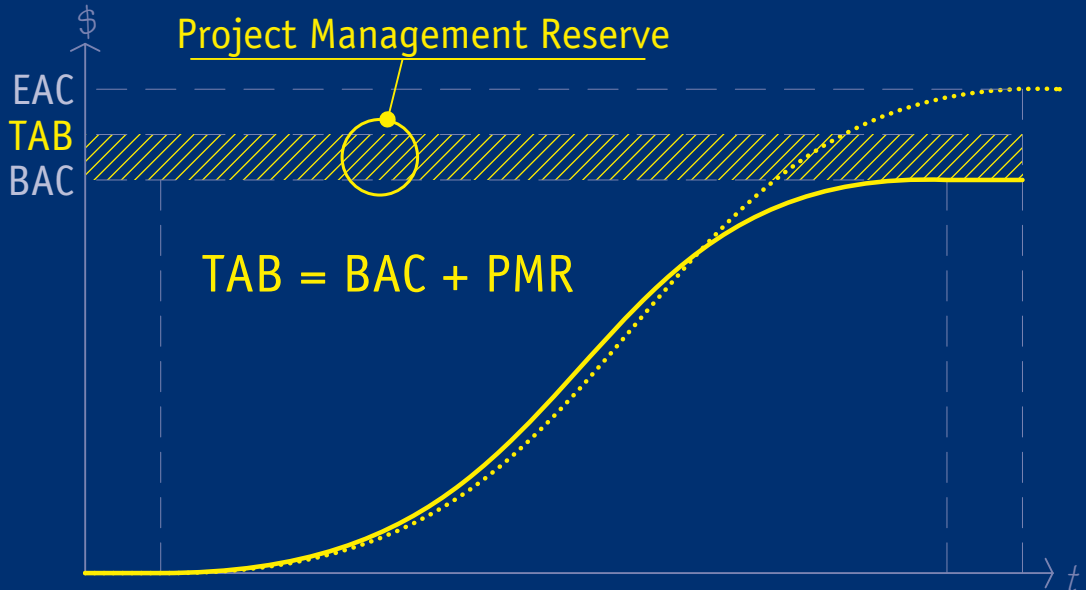
Earned Value Management Basics.

⑤ Calculating variances and performance indices.



Earned Value Management Basics.

Budget at Completion vs. **Total Allocated Budget** vs. EAC.



2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J J F M A M J J A S O N D J

Jan.–Mar. & Apr.–June 2002 reporting periods

- The project started in the early days of January as scheduled.
- Project contributors have recorded the time they have spent on completed or on-going Work Units (personnel Actual Costs).
- Some (material) Actual Costs have been recorded in the Lab accounting database, and charged on Budget Codes.
- The first unforeseen event occurred:

4 DMUs (dipole corrector magnets) have been forgotten in the preliminary design.

⇒ Change Record.

2002

2003

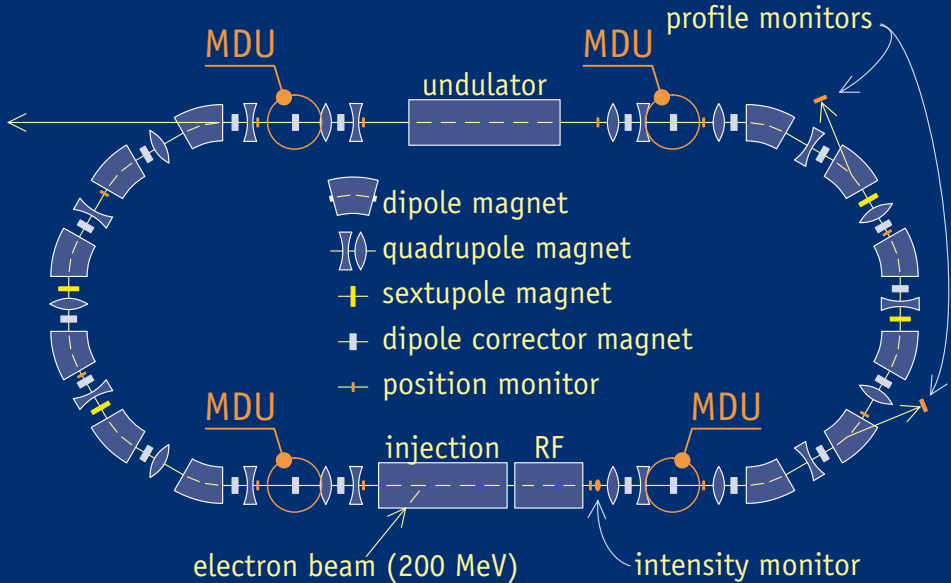
2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J



CR L101

experimental area



2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J



CR L101

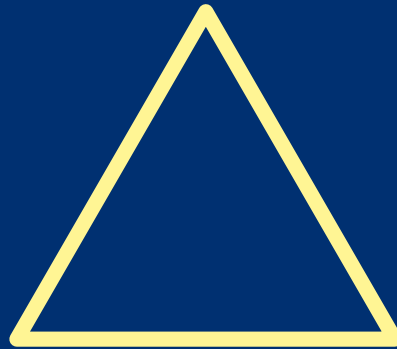
performance
quality

→ Scope of Work



4 more DMUs

4 power converters



37'500.- CHF



Budget

Cost

time

no impact



Schedule

2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

CR L101

WUs impacted:

130 131 133 134 135 136
4 DMUs

198 199
4 PCs

	A	B	C	D	E	F	G	H
1	WU	WUID	type	status	Work Unit label	WU Holder	Pld Start	Pld Finish
2	type	WUID	#		Resource description	BAC	Unit	Budget Code
3	DE	WUID	#	weight	Deliverable description	Pld Qty	Unit	Pld Date
211	WU	133	F	PL	Assemble and deliver series DMUs (x5)	Bill@Lab.org	24-Oct-03	24-Oct-03
212	L1	133	1		Helen@Lab.org	5	M.WK	
213	M1	133	2		F13 - Supply of DMUs	27'100	CHF	13714
214	M1	133	4		F13 - Supply of DMUs	6'775	CHF	13714
215	O	133	3		Duty travels	2'500	CHF	13714
216	DE	133	1	1	Series DMUs assembled & delivered	5	U	24-Oct-03
217								

2002

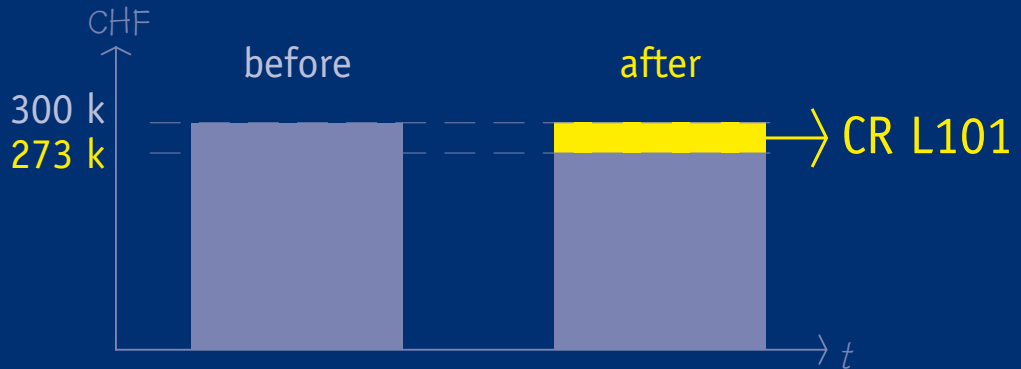
2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J J F M A M J J A S O N D J

CR L101

How this change is funded? → Management Reserve!



grazie mille

<https://edms.cern.ch/document/1156884/2004>

<http://campus.hesge.ch/bonnalp/LAMPE/01/LAMPE.html>

Pierre.Bonnal@cern.ch

Change Record Life Cycle.



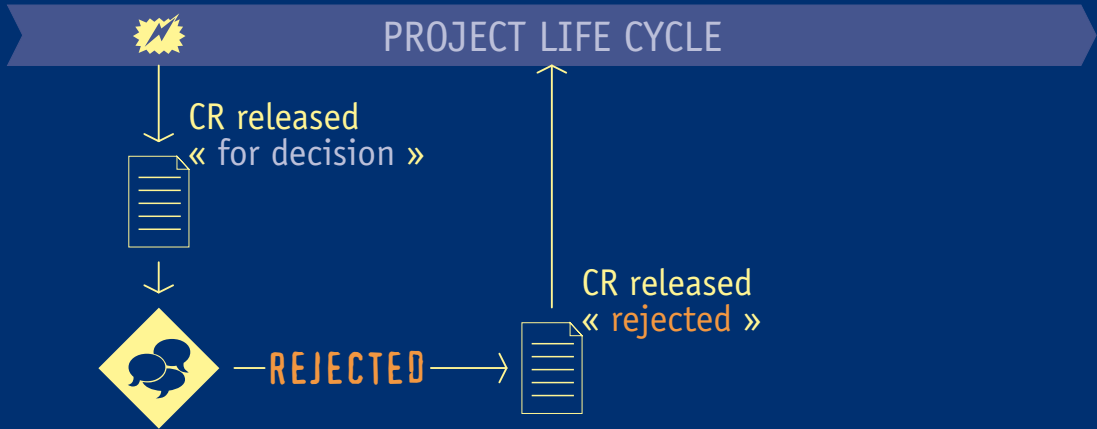
PROJECT LIFE CYCLE



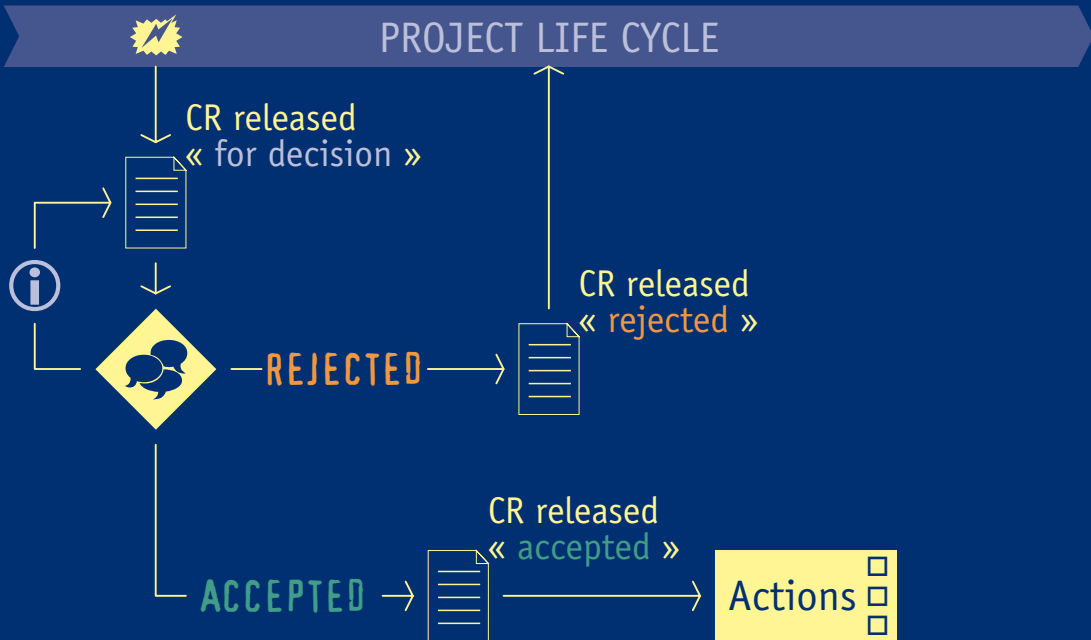
CR released
« for decision »



Change Record Life Cycle.



Change Record Life Cycle.



Change Record Life Cycle.

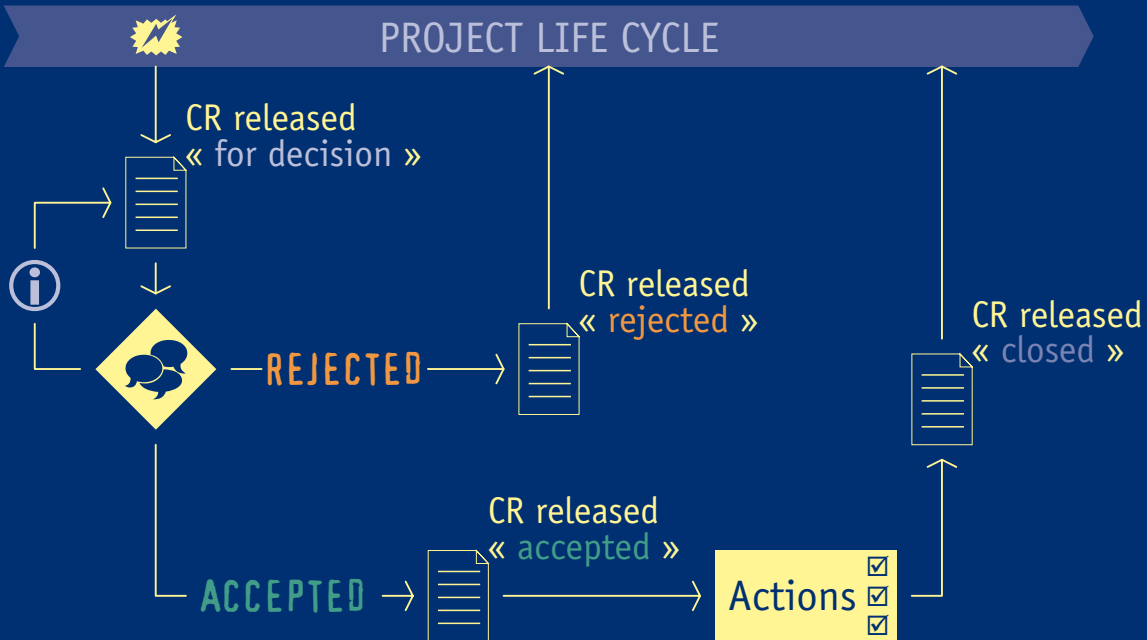
Quality \Rightarrow All actions are supported by documents.

Clever strategy towards changes:

Integration of all the consequences of the change into the project databases so the change record doesn't need to be handled as such.

Change traceability is done through the project databases.

Change Record Life Cycle.



2002

2003

2004

N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J

CR L101



0.1

2002-03-14

CHANGE
RECORD

FOR DECISION



1.0

2002-04-26

CHANGE
RECORD

ACCEPTED



2.0

2002-05-10

CHANGE
RECORD

CLOSED