Managing Projects with ◉ openSE

Part ③

Table of Content

Project Planning & Scheduling

Typology

2 types of **project schedules**

Master Schedule
~ Summary Schedule
Masterplan
Calendrier directeur

Coordination Schedule
~ "~~PERT~~", Gantt chart
Activity network
Calendrier de coordination

Strategic level
The whole project
Intuitive approach

One page/slide
Can be in the **Project Roadmap**

Tactical level
One or a few phases
Analytical approach

Several pages
Can be in the **PMP**

Master Schedule
When and which effort?

INITIALIZE STUDY DESIGN BUILD COMMISSION FINALIZE

Initiators
Master Schedule preparation

Project Board
Master Schedule (re)validation

Study Team
Master Schedule update

Project Team
Master Schedule updates
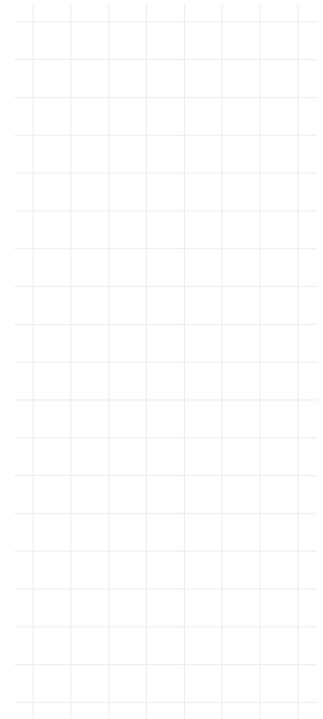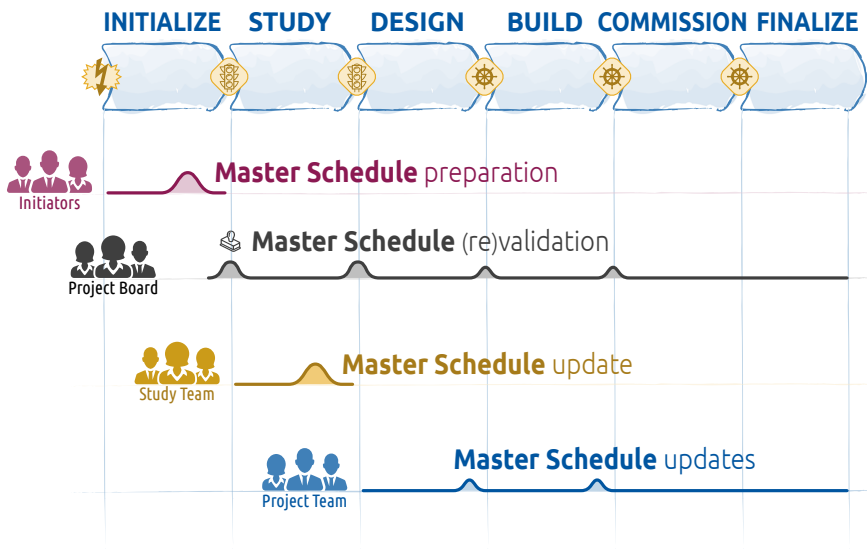
Coordination Schedule
When and which effort?

INITIALIZE STUDY DESIGN BUILD COMMISSION FINALIZE

Study Team
Study Coordination Schedule* preparation (if needed)

Study Team
Project Coordination Schedule* preparation

Project Team
Project Coordination Schedule* updates
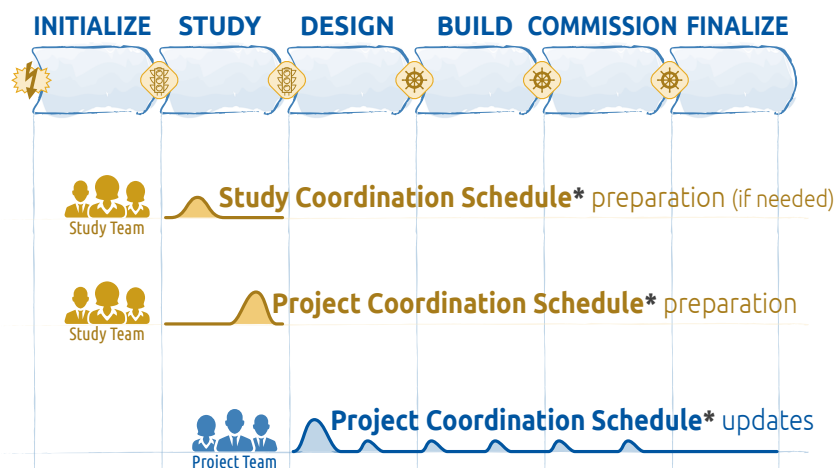
* incl. PBS, WBS, LoA (list of activities), RBS, RACI matrix

Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May

BRZ·KITE project launched

Perform Basic Design 📄 CDR released

Perform Engineering Design   Make & Test Prototype

TDR released   Set Supply Chain

Perform Detailed Design of Manufacturing Facility

Procure Equipment & Tooling

Perform Civil Engineering Works

Instal & Commission Equipment & Tooling

Ramp-up Production 👁

1ˢᵗ batch of
kites shipped

BRZ·KITE
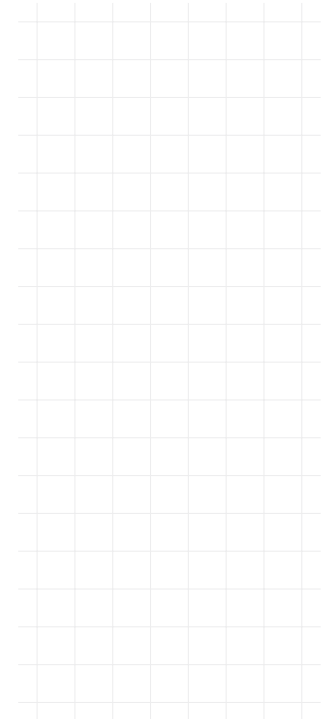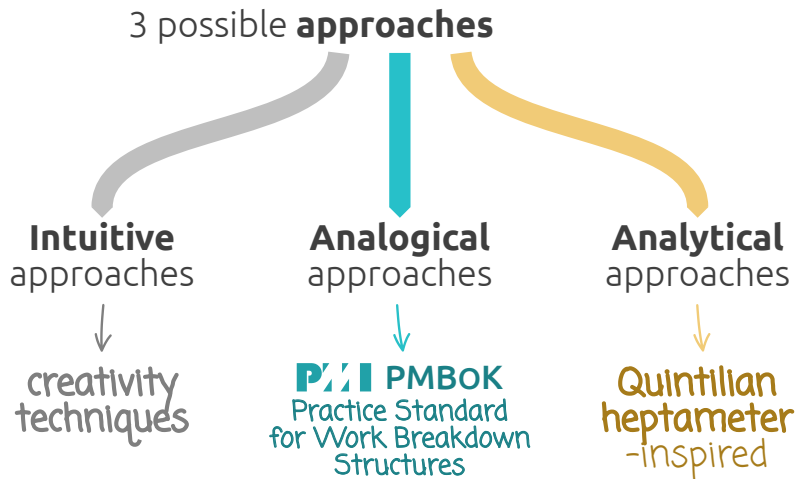
Coordination Planning & Scheduling
A three-step process

1 Identifying the project **activities**

➡ The **Work Breakdown Structure** (**WBS**)

2 Identifying the **resources** available, estimating the **resources** required

➡ The **RACI Matrix**

3 Scheduling the **activities**

➡ The **Coordination Schedule**

a **Gantt chart** → 📄 ProjectWizard® Merlin® Gantt chart

→ Ⓟ Microsoft® Project® Gantt chart

Coordination Planning & Scheduling
1 Identifying the project **activities**

3 possible **approaches**

Intuitive
approaches

↓

creativity
techniques

Analogical
approaches

↓

PMI PMBOK
Practice Standard
for Work Breakdown
Structures

Analytical
approaches

↓

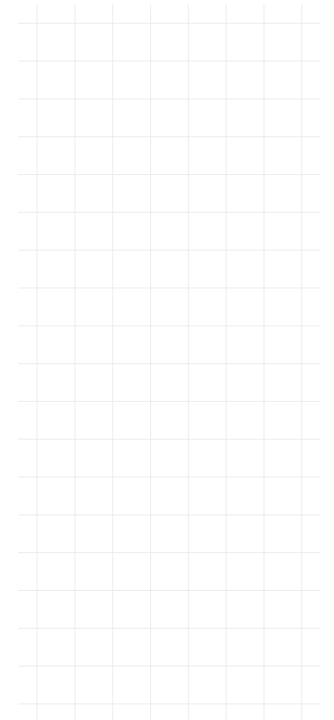Quintilian
heptameter
-inspired

Coordination Planning & Scheduling
1 Identifying the project **activities** → analogical approaches

➔ Approach sold as *systematic*,
but not that much!

➔ Global lessons learned collected
by the Project Management Institute

Practice Standard for
WORK BREAKDOWN STRUCTURES

Project Management Institute
Global STANDARD
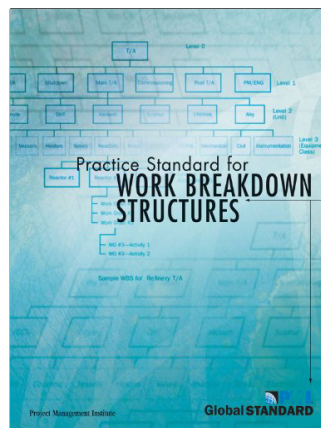
PMI Project Management Institute's Practice Standard to Work Breakdown Structures
NASA's Work Breakdown Structure Handbook (NASA/SP-2010-3404)

Coordination Planning & Scheduling

1 Identifying the project **activities** ➔ analogical approaches

Figure 2-1. WBS Bicycle Example
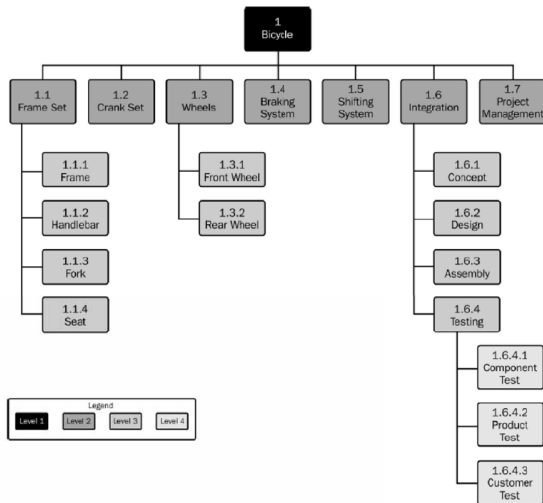
Level	WBS Code	Element Name
1	1	Bicycle WBS
2	1.1	Frame Set
3	1.1.1	Frame
3	1.1.2	Handlebar
3	1.1.3	Fork
3	1.1.4	Seat
2	1.2	Crank Set
2	1.3	Wheels
3	1.3.1	Front Wheel
3	1.3.2	Rear Wheel
2	1.4	Braking System
2	1.5	Shifting System
2	1.6	Integration
3	1.6.1	Concept
3	1.6.2	Design
3	1.6.3	Assembly
3	1.6.4	Testing
4	1.6.4.1	Component Test
4	1.6.4.2	Product Test
4	1.6.4.3	Customer Test
2	1.7	Project Management

■ **P∕I** Project Management Institute's Practice Standard to Work Breakdown Structures

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Coordination Planning & Scheduling

1 Identifying the project **activities** ➔ analytical approach

➔ Inspired from the **Quintilian heptameter**

> **quis** who   **quid** what   **ubi** where   **quibus auxiliis** which means
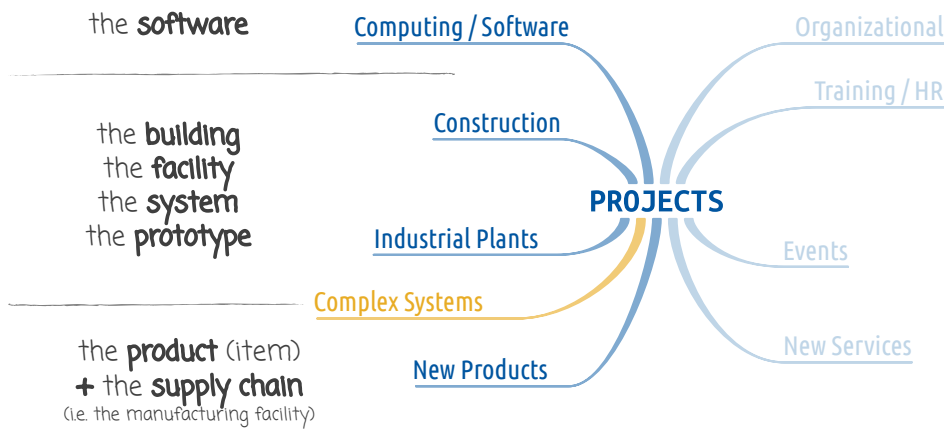>
> **cur** why   **quomodo** how   **quando** when

Marcus Fabius Quintilianus
(c. 35 – c. 100 CE) was a Roman rhetorician from Hispania, widely referred to in medieval schools of rhetoric and in Renaissance writing

1.1 Describing the final **deliverable**(**s**)
  ⇨ The **Product Breakdown Structure** (**PBS**)

1.2 Deriving the **Work Breakdown Structure** (**WBS**) from the PBS
  ⇨ The **WBS** *top nodes*, then the **WBS-matrix**

1.3 Generating the list of **activities** from the **WBS-matrix**
  ⇨ The **activity portfolio**

Coordination Planning & Scheduling

1 Identifying the project **activities** → **analytical** approach

1.1 Describing the final **deliverable**(**s**)

the **software**

Computing / Software

Organizational

Training / HR

the **building**
the **facility**
the **system**
the **prototype**

Construction

PROJECTS

Industrial Plants

Events

Complex Systems

New Services

the **product** (item)
+ the **supply chain**
(i.e. the manufacturing facility)

New Products

⚠ It can become a rather complex mix of "objects"

ID	Component description	Qty	Component specication
01	Wing surface (canopy)	1	1800 mm × 700 mm ; 0.5 m² ; Polyamide 5.5 nylon
02	Nose reinforcement piece	1	Reinforced polyamide nylon
03	Tail reinforcement piece	1	Reinforced polyamide nylon
04	Wisker reinforcement piece		Reinforced polyamide nylon
05	Wing end reinforcement piece	2	Reinforced polyamide nylon
06	Wing side reinforcement piece	2	Reinforced polyamide nylon
07	Wing side yard	2	Ø6 mm × 1100 mm ; carbon rod
08	Rear yard		Ø6 mm × 600 mm ; carbon rod
09	Longitudinal yard		Ø6 mm × 350 mm ; carbon rod
10	Wisker	2	Ø6 mm × 120 mm ; carbon rod
11	Nose yard junction tee	1	Cycolac ABS
12	Central cross	1	Cycolac ABS
13	Wisker junction tee	2	Cycolac ABS
14	Wing side junction tee	2	Cycolac ABS
15	Central tying ring	1	Ø10 mm × 0.4 mm² ; stainless steel
16	Wing end tying ring		Ø10 mm × 0.4 mm² ; stainless steel
17	Wing side tying ring		Ø10 mm × 0.4 mm² ; stainless steel
18	Line attachment ring	2	Ø10 mm × 0.4 mm² ; stainless steel
19	Tie		0.x mm² × ca. 300 mm ; nylon rope
20	Line	2	0.15 mm² × ca. 800 mm ; nylon rope
21	Handle ring	2	Ø20 mm × 1 mm² ; stainless steel
22	Handle	2	20 mm width nylon strap
23	Line winder	1	Cycolac ABS
24	Storage bag		Transparent nylon
25	User's manual		Printed material ; A6 format
26	Safety instructions		Printed material ; A6 format

Fabrics

Carbon rods

Moulded ABS parts

Rings (COTS)

Rope & strap

Bag

Printed material

BoM

PBS

Product
Breakdown
Structure

BRZ·KITE

Coordination Planning & Scheduling

1 Identifying the project **activities** ➜ **analytical** approach

1.1 Describing the final **deliverable**(**s**)

Product Breakdown Structure

☐ **BRZ·KITE**
- ☐ **Fabrics**
- ☐ **Carbon rods**
- ☐ **Moulded ABS parts**
- ☐ **Rings** (COTS)
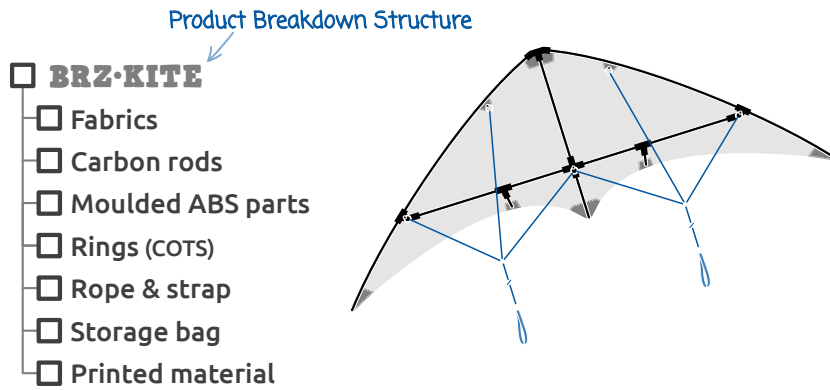- ☐ **Rope & strap**
- ☐ **Storage bag**
- ☐ **Printed material**

BRZ·KITE

Coordination Planning & Scheduling

1 Identifying the project **activities** ➜ **analytical** approach

1.1 Describing the final **deliverable**(**s**)

moniteurs de profil

zone expérimentale

Onduleur

aimant dipolaire
aimants quadripolaires
aimant sextupolaire
aimant correcteur dipolaire
moniteur de position

Injection **RF**

faisceau d'électrons

moniteur d'intensité

Projet LAMPE

Coordination Planning & Scheduling

1 Identifying the project **activities** → **analytical** approach

1.1 Describing the final **deliverable**(**s**)

Chambres
Jauges
Pompes

Onduleur
Septum
Kickers

Correcteurs
Sextupôles
Quadripôles
Dipôles

Bâtiments
Système vide
Éléments magnétiques

Services électriques
Hydraulique
Aéraulique
Convertisseurs de puissance

Infrastructures
Guides d'ondes
Cavités
Klystron

Matériel
Logiciel
Système d'accélération

Supervision centrale
Automates programmables
LAMPE

Systèmes de supervision
moniteurs de position
moniteurs de prof I
moniteur d'intensité

Équipements ancillaires
Instrumentation du faisceau

Coordination Planning & Scheduling

1 Identifying the project **activities** → **analytical** approach

? What is an **activity**?

▶ ≠ deliverable!   *a.k.a.* **work unit**

To avoid confusion, clever professional practices (e.g. MIL-HDBK-245B + appendix A) and several textbooks suggest to label activities as follow:

▶   **action verb** (infinitive tense) **+ noun**

An **activity**:

▶ consumes **time**

▶ consumes **resources**

▶ has **start** and **end** dates

▶ creates (a) **deliverable**(**s**)

▶ is **measurable**   *and only one!*

▶ is **assignable** to one project participant

Some examples:
Manage the project
Prepare PM documents
Perform detail design of wing surface
Supply rope & straps
CFT for moulded ABS parts

Coordination Planning & Scheduling

1 Identifying the project **activities** → **analytical** approach
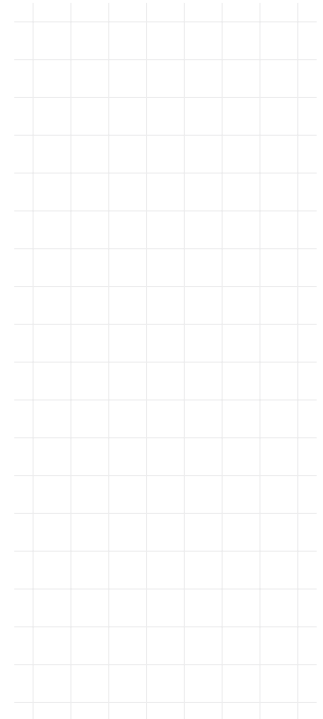
? What is an **activity**?

An **activity**:

▶ consumes **time** ⚠ Yes, but within certain limits!

What is the maximum duration?

▶ No definitive answer!

▶ No more than **5%** to **10%** of the project duration

▶ No more than **13 weeks** (long lead projects)

▶ One or up to 1% of **level-of-effort** activities

And how many activities on a coordination schedule?

▶ No definitive answer!

activities vs. *planned activities* **ANSI** *#748*

▶ But not more than **400 activities**, otherwise difficult to manage

---

Coordination Planning & Scheduling

1 Identifying the project **activities** → **analytical** approach

? What is a **deliverable**?

▶ ≠ activity! *a.k.a. result*

▶ ≠ product! *e.g. the brz-kite*

▶ **noun** + **verb** at past participle tense

Some examples:
bzh-kite designed
bzh-kite specified
bzh-kite prototype tested
bzh-kite manuf. facility commissioned
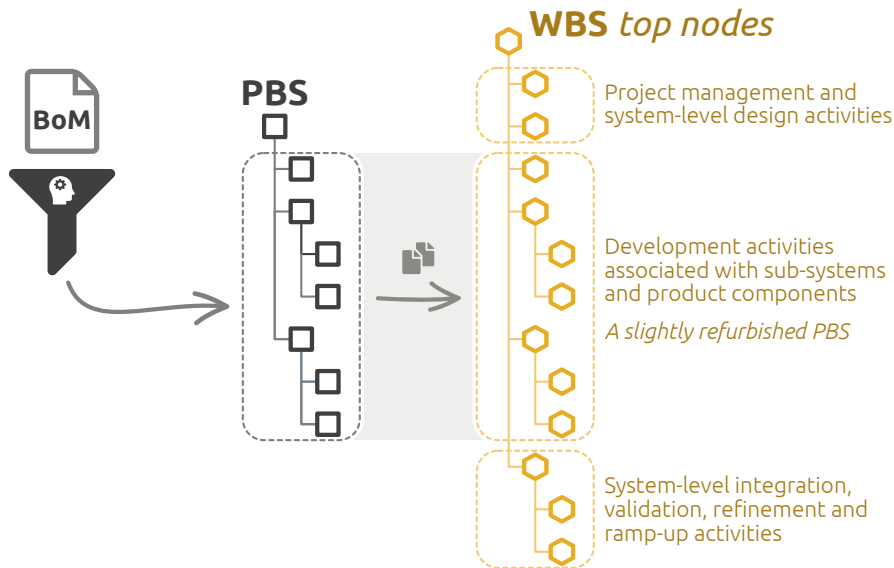
▶ ≠ milestone!

Deliverable is a term used [...] to describe a tangible or intangible object produced as a result of the project that is intended to be delivered to a customer (either internal or external). A deliverable could be a **report**, a **document** [...] or any other **building block** of an overall project.
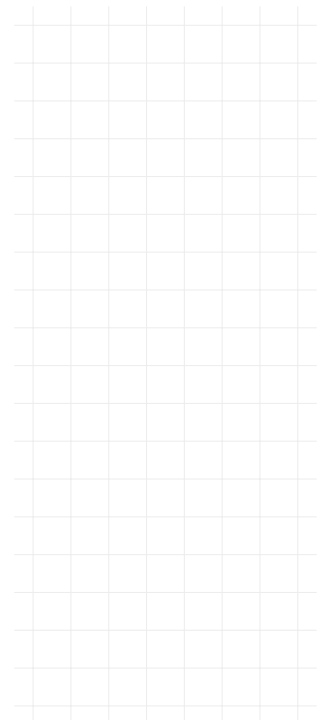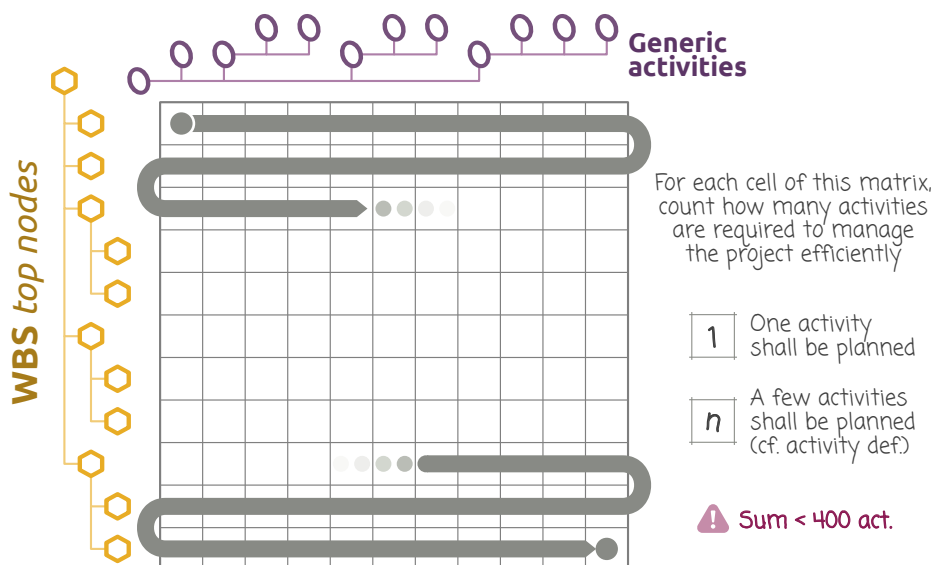
W en.Wikipedia.org

Coordination Planning & Scheduling

1 Identifying the project **activities** → **analytical** approach

1.2 Deriving the **Work Breakdown Structure** (**WBS**) from the PBS

WBS *top nodes*

BoM

PBS

Project management and system-level design activities

Development activities associated with sub-systems and product components

A slightly refurbished PBS

System-level integration, validation, refinement and ramp-up activities

---

Coordination Planning & Scheduling

1 Identifying the project **activities** → **analytical** approach

1.3 Generating the list of **activities** from the **WBS-matrix**

Generic activities

WBS *top nodes*

For each cell of this matrix, count how many activities are required to manage the project efficiently

| 1 | One activity shall be planned |

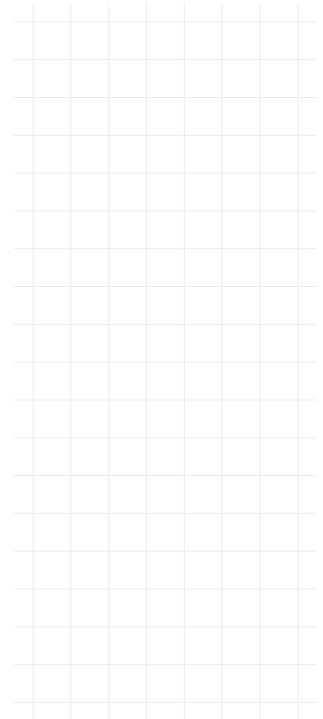| n | A few activities shall be planned (cf. activity def.) |

⚠ Sum < 400 act.

Coordination Planning & Scheduling

① Identifying the project **activities** → **analytical** approach

1.3 Generating the list of **activities** from the **WBS-matrix**

ⓘ Generic activities suited to a **construction project**

Manage the project
Prepare PM documents
Perform basic design
Perform detail design
Prepare specification
CFT and award contract
Supply equipment
Negotiate agreement
Prepare construction
Do earthworks
Pour concrete
Do 2ndary works
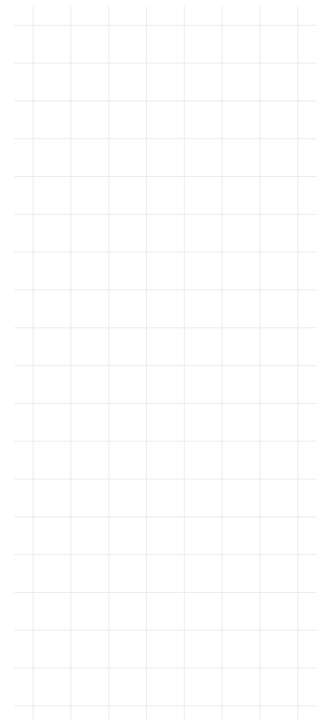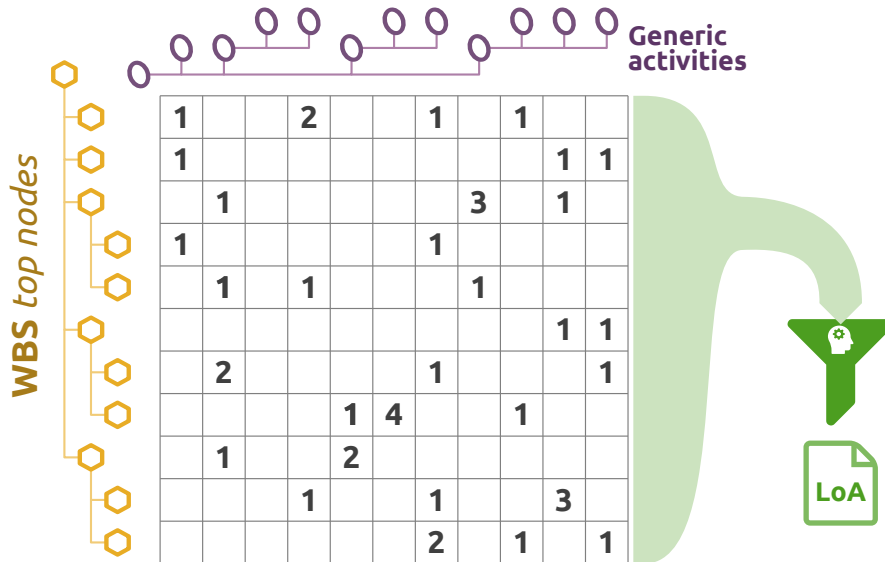Control, survey
Do last finishings
Transfer to owner

Coordination Planning & Scheduling

① Identifying the project **activities** → **analytical** approach

1.3 Generating the list of **activities** from the **WBS-matrix**

ⓘ Generic activities suited to a **NPD project**

Manage the project
Prepare PM documents
Perform marketing/sales activities
Perform IP / patent related activities
Perform system-level design
Perform detail design
Design and set the supply chain
Prepare procurement specs / order
CFT and award contracts / place order
Prepare making
Make, assemble...
Verify, validate...
Refurbish...
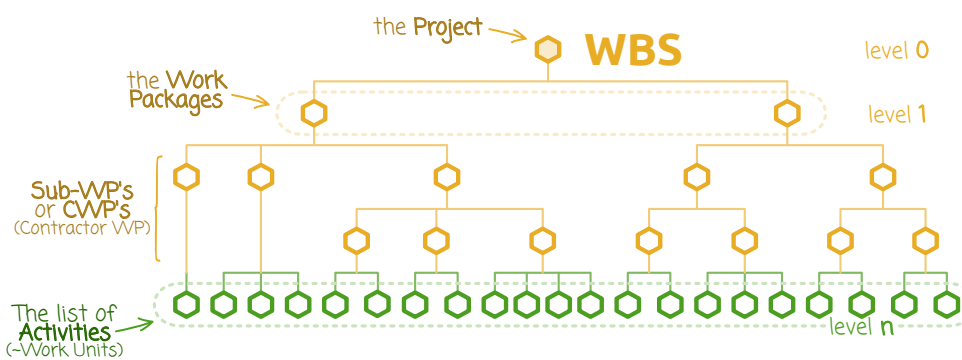Construct, install...
Commission, ramp-up...

Coordination Planning & Scheduling

1 Identifying the project **activities** → **analytical** approach

1.3 Generating the list of **activities** from the **WBS-matrix**

Generic activities

WBS *top nodes*								
1		**2**		**1**		**1**		
1							**1**	**1**
	1				**3**		**1**	
1				**1**				
	1	**1**			**1**			
							1	**1**
	2			**1**				**1**
		1	**4**		**1**			
	1	**2**						
		1		**1**		**3**		
				2	**1**		**1**	

LoA

Coordination Planning & Scheduling

1 Identifying the project **activities** → **analytical** approach

the Project → **WBS** level **0**

the Work Packages → level **1**

Sub-WP's or CWP's (Contractor WP)

The list of **Activities** (~Work Units) → level **n**

➡ **Work packages** = level 1 of the Work Breakdown Structure

➡ **Activities** = the *leaves* (🌿) of the WBS (from level 2 to level 6 max.)

➡ There is no requirement to have all activities at a same level!

Coordination Planning & Scheduling

1 Identifying the project **activities** ➜ **analytical** approach

OBS

Bill of Materials

PBS

Generic Activities

WBS

RBS

BoM

Organisational
Breakdown
Structure

Product
Breakdown
Structure

Work
Breakdown
Structure

List of
Activities

Resource
Breakdown
Structure

CBS

Project Breakdown Structure

to be moved to facility, item and/or asset management systems after the project is completed

Cost
Breakdown
Structure
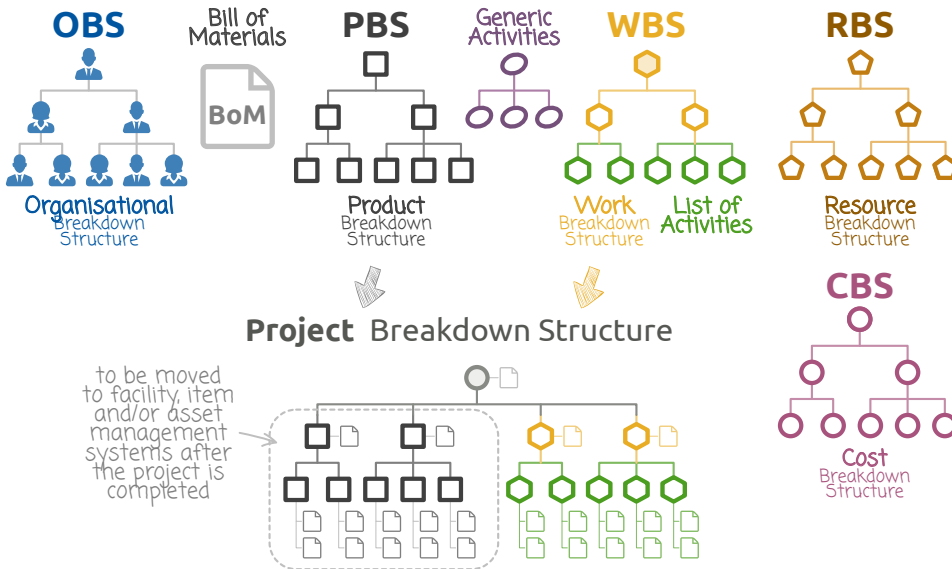
Coordination Planning & Scheduling

2 Identifying the **resources** available, estimating the **resources** required

2 types of **resources**

Renewable
resources

Non-renewable
resources

2.1 Identifying the **resources** that are **available**

➮ The **Resource Breakdown Structure** (**RBS**)

2.2 Estimating the **resources** that are **required**

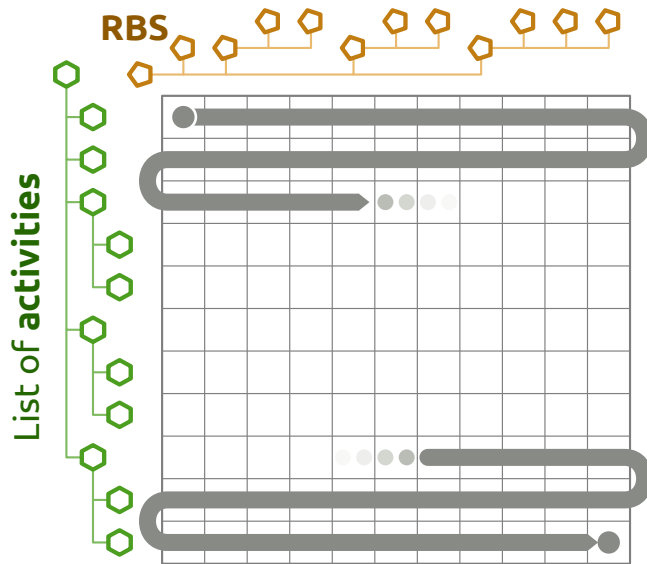*See section dedicated to Project Costing*

2.3 Assigning **resources** to **activities**

➮ The **RACI Matrix**
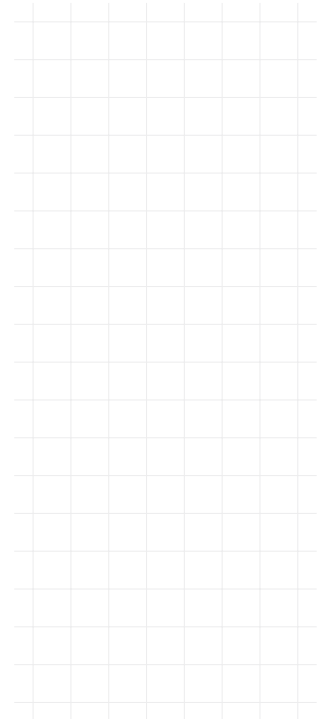
Coordination Planning & Scheduling

2 Identifying the **resources** available, estimating the **resources** required

2.3 Assigning **resources** to **activities** → **RACI Matrix**

RBS

List of **activities**

for each cell of
the matrix, resource
implication is elicited

Executes — **X**

Follows up — **F**

Is informed — **I**

Provide help — **H**

Is required — **R**

Coordination Planning & Scheduling

2 Identifying the **resources** available, estimating the **resources** required

2.3 Assigning **resources** to **activities** → **RACI Matrix**

Executes — **X**

Follows up — **F**

Is informed — **I**

Provide help — **H**

Is required — **R**

Is responsible — Ⓧ **X** Ⓧ / Ⓕ **F** Ⓕ

⚠ Only one per row!

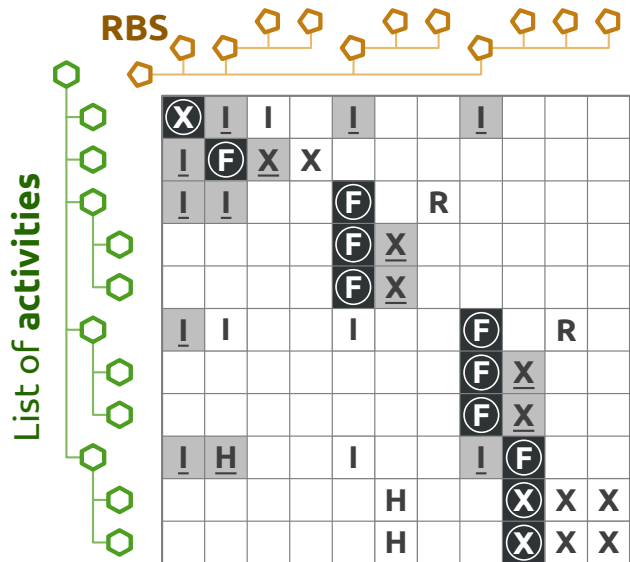**Participate to decisions** — **X X X** / **F F F** / **I I I** / **H H H**
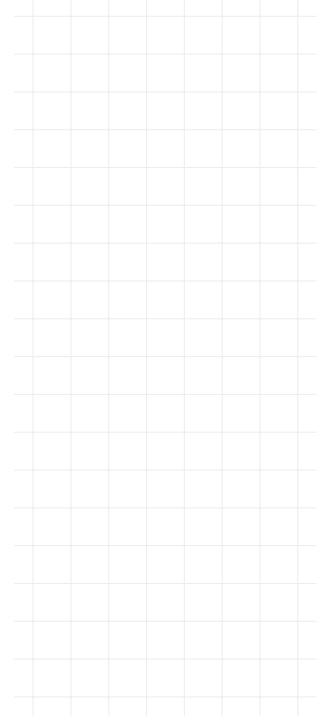
Coordination Planning & Scheduling

2 Identifying the **resources** available, estimating the **resources** required

2.3 Assigning **resources** to **activities** → **RACI Matrix**

RBS

List of **activities**

The purpose of this RACI matrix is twofold:

1. identifying the required resources ('**X**','**R**' and sometimes '**F**' and '**H**')

2. organizing information circulation (mailing lists)

→ Microsoft® Excel® spreadsheet

Coordination Planning & Scheduling

3 Scheduling the **activities**

3.1 Estimating the **duration** of the activities

3.2 Defining **technical constraints** between activities

3.3 If required, getting rid of **loops**
⇛ **DSM** (Design Structure Matrix)

3.4 If required, defining **temporal constraints**

3.5 Calculating earliest/latest start/finish **dates**, **floats** + **critical path**(**s**)
⇛ **PDM** (Precedence Diagramming Method) + **Gantt Chart**

3.6 If required, defining **resource constraints**

3.7 Calculating (earliest) start/finish **dates** and **floats**
⇛ **RCPS** (Resource-Constrained Project Scheduling) + **Gantt Chart**
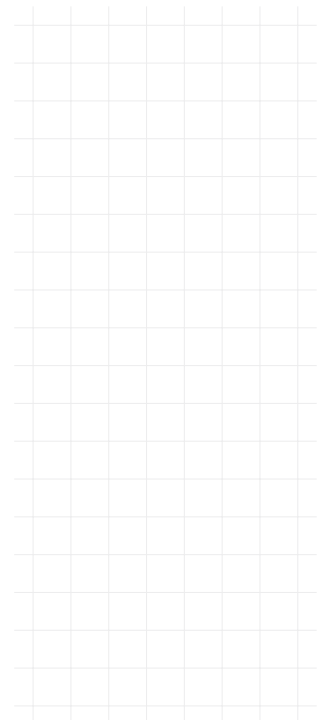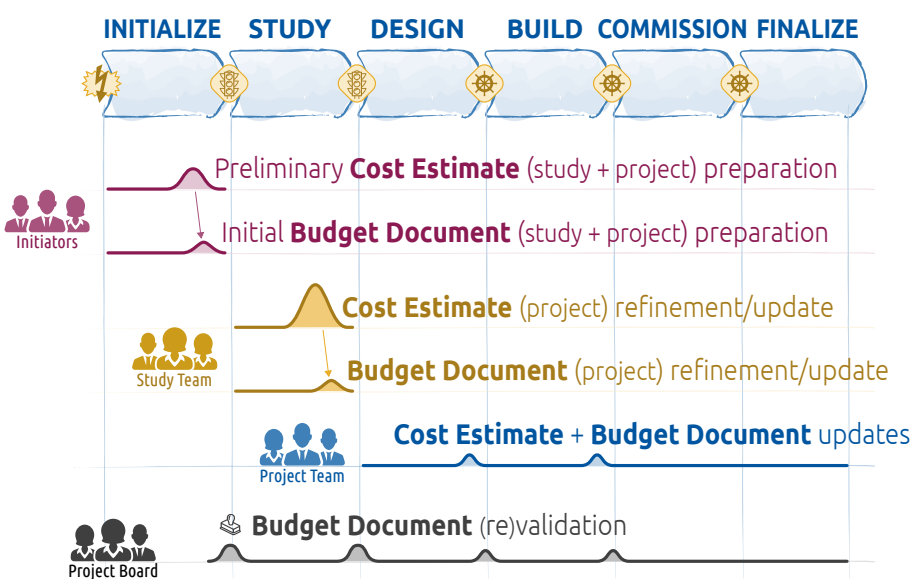
Project Costing

Project Costing
A three-step process

① **Estimating** the resources required to perform the project

⇨ The (project) **Cost Estimate**

② **Budgeting** the resources allocated to the project

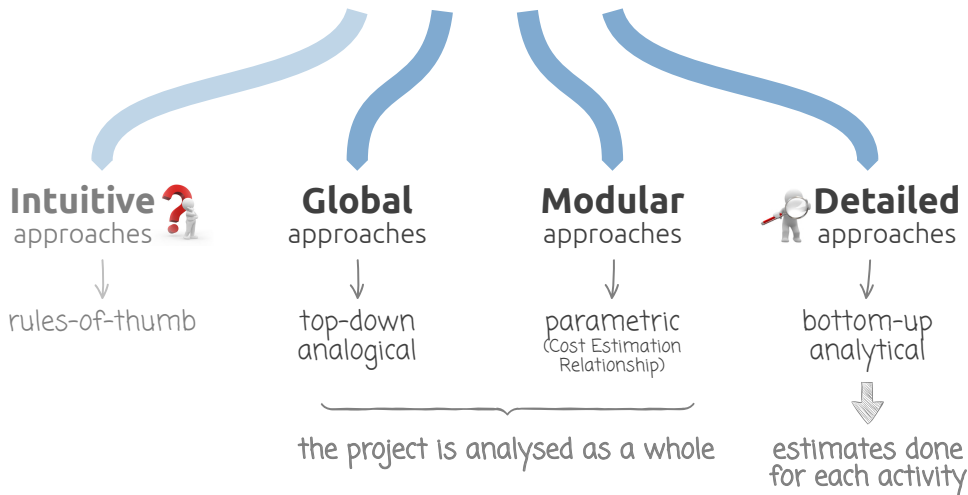⇨ The (project) **Budget Document**
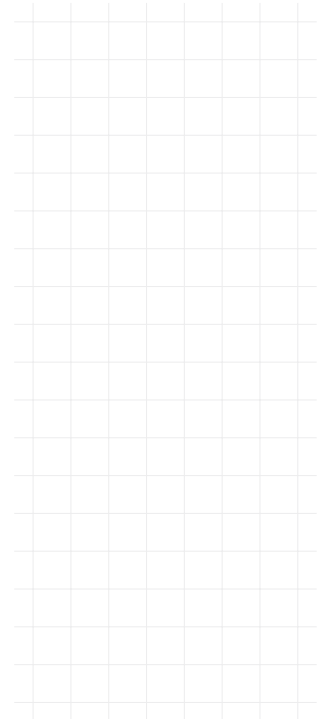
Project Costing
When and which effort?

Project Costing

1 **Estimating** the resources required to perform the project

4 families of **cost estimating** approaches

Intuitive approaches

↓

rules-of-thumb

Global approaches

↓

top-down
analogical

Modular approaches

↓

parametric
(Cost Estimation
Relationship)

Detailed approaches

↓

bottom-up
analytical

⇩

estimates done
for each activity

the project is analysed as a whole

Project Costing

1 **Estimating** the resources required to perform the project

? Which **costs** (and incomes) to take into account?

INITIALIZE STUDY DESIGN BUILD COMMISSION OPERATE & MAINTAIN DECOMMISSION

FINALIZE

incomes

t

expenses

project
front-end
costs

development costs

operations and
maintenance
costs

dism.
costs
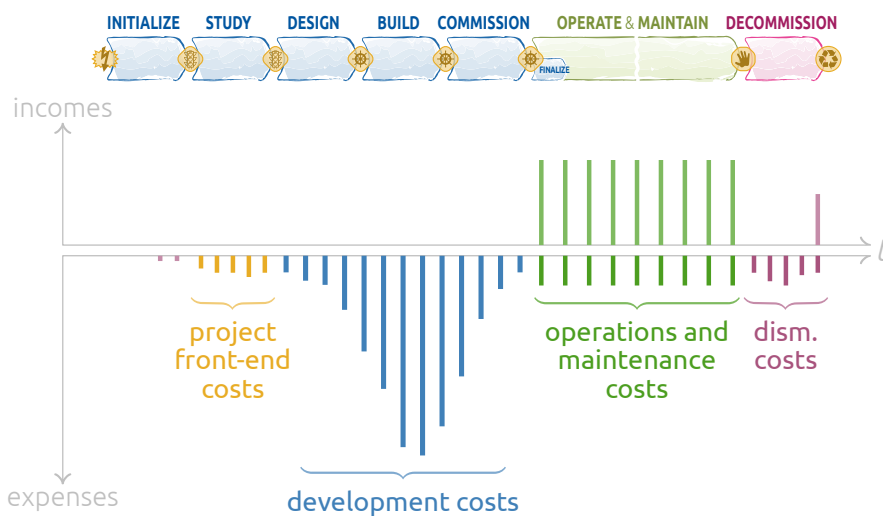
Project Costing

① **Estimating** the resources required to perform the project

(?) Which **costs** to take into account?
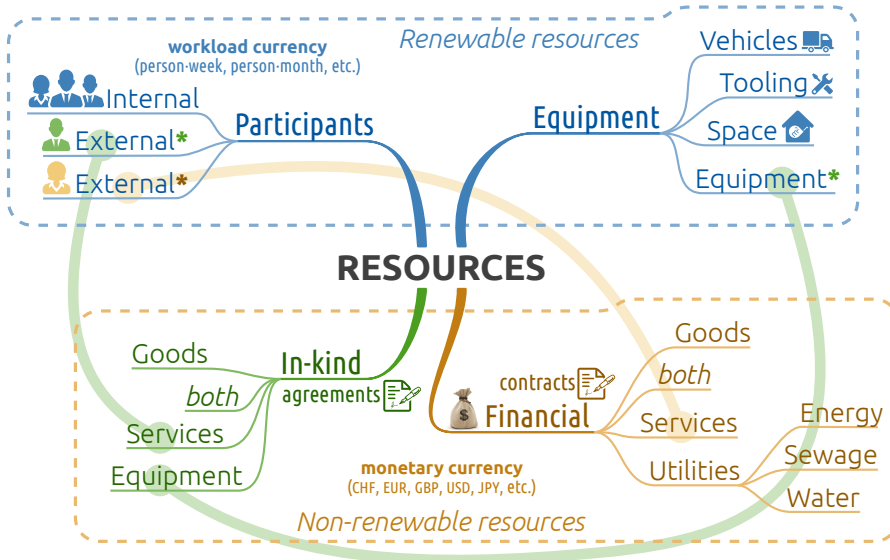
Renewable resources

workload currency
(person·week, person·month, etc.)

👥 Internal
🧑 External *****
🧑 External *****

Participants

Equipment

Vehicles 🚚
Tooling 🔧
Space 🏠
Equipment *****

RESOURCES

Goods
both
Services
Equipment

In-kind
agreements 📝

💰 **Financial**
contracts 📝

Goods
both
Services
Utilities

Energy
Sewage
Water

monetary currency
(CHF, EUR, GBP, USD, JPY, etc.)

Non-renewable resources

Project Costing

① **Estimating** the resources required to perform the project

(?) Which **costs** (and incomes) to take into account?

▶ Only **chargeable costs** shall be considered !

▶ Cash flows that are **distorded** (i.e. suppressed or modified)

▶ Cash flows that are **generated** by the project

$$\begin{array}{c}\text{Cash flows}\\\text{of the project}\end{array} = \begin{array}{c}\text{Cash flows}\\\text{of the organisation}\\\textbf{with}\text{ the project}\end{array} - \begin{array}{c}\text{Cash flows}\\\text{of the organisation}\\\textbf{without}\text{ the project}\end{array}$$

▶ Past or irrecoverable costs: no! ← These costs will exist whatever the decision

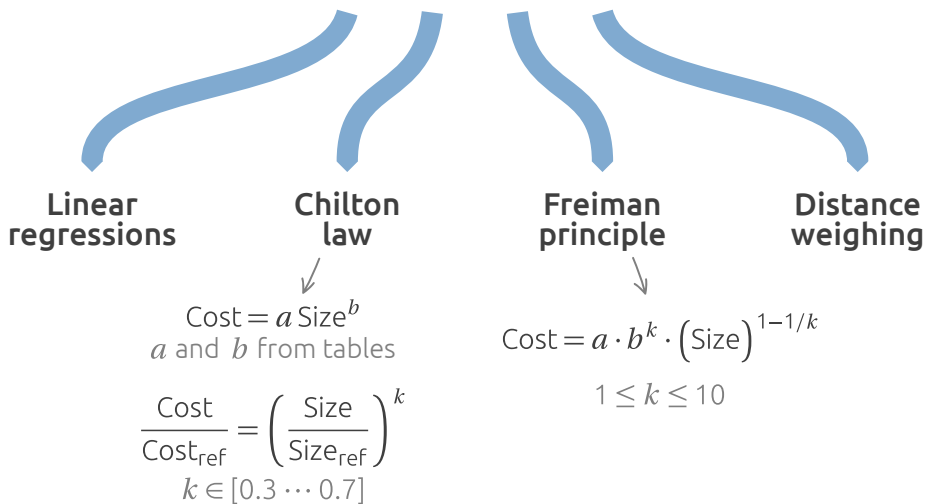▶ Renunciation costs: yes! ← E.g. the consequence of stopping a project that is already on-going

▶ Unquantifiable costs: no! ← **Benefits** sometimes replace incomes

Project Costing

1 **Estimating** the resources required to perform the project

1.1 Estimating with **global approaches**

Global approaches

| Linear regressions | Chilton law | Freiman principle | Distance weighing |

$$\text{Cost} = a\,\text{Size}^{b}$$
a and b from tables

$$\text{Cost} = a \cdot b^{k} \cdot \left(\text{Size}\right)^{1-1/k}$$

$$1 \leq k \leq 10$$

$$\frac{\text{Cost}}{\text{Cost}_{\text{ref}}} = \left(\frac{\text{Size}}{\text{Size}_{\text{ref}}}\right)^{k}$$

$$k \in [0.3 \cdots 0.7]$$

Project Costing

1 **Estimating** the resources required to perform the project

? Dealing with **price escalation**

$$\text{Cost}_{\text{now}} = \text{Cost}_{\text{past}} \cdot \left(\sum_{i=1}^{n} \omega_{i}\, \frac{\text{EI}_{i\,\text{now}}}{\text{EI}_{i\,\text{past}}} \right)$$

where

$\omega_{i} \longrightarrow$ weighing coefficients so that: $\sum_{i=1}^{n} \omega_{i} = 1$

$\text{EI}_{i \cdot t} \longrightarrow$ appropriate economical indices

Project Costing

1 **Estimating** the resources required to perform the project

1.2 Estimating with **modular approaches**

Project cost as a function of several sizing parameters:

$$\text{Cost} = f(p_1, p_2, \ldots, p_n)$$

where p_i are the sizing parameters

Software:

→ TruePlanning® [PRICE System] (www.pricesystems.com)

→ Cost+ [3f] (www.3f-fr.com)

→ COCOMO for IT projects (csse.usc.edu)

Handbook:

📕 **ISPA** (International Society of Parametric Analysts) **Parametric Estimating Handbook** (www.ispa-cost.org)
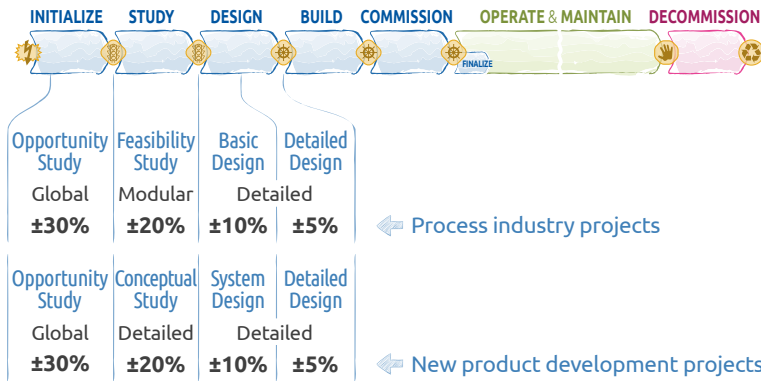
Project Costing

1 **Estimating** the resources required to perform the project

1.3 Estimating with **detailed approaches**
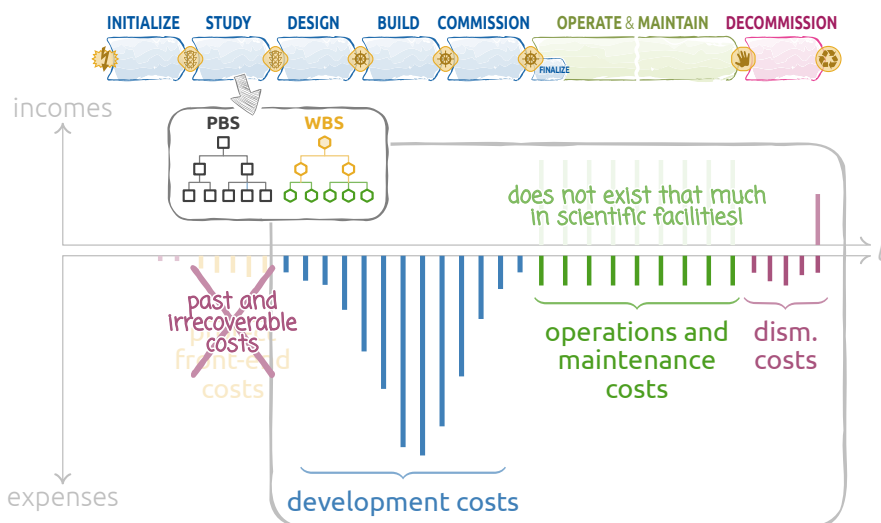
Project Costing

① **Estimating** the resources required to perform the project

(?) Which **accuracy** can be obtained?

INITIALIZE   STUDY   DESIGN   BUILD   COMMISSION   OPERATE & MAINTAIN   DECOMMISSION

Opportunity Study	Feasibility Study	Basic Design	Detailed Design
Global	Modular	Detailed	
±30%	**±20%**	**±10%**	**±5%**

⇐ Process industry projects

Opportunity Study	Conceptual Study	System Design	Detailed Design
Global	Detailed	Detailed	
±30%	**±20%**	**±10%**	**±5%**

⇐ New product development projects

⚠ imprecision ≠ uncertainty**!**

deterministic nature   probabilistic nature

Project Costing

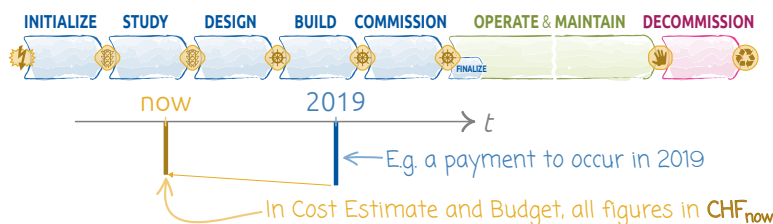**①** **Estimating** the resources required to perform the project

(?) How to deal with **interest rates** and future **price escalation**?

⚠ cost of money ≠ price escalation**!**

interest rates (financial concept)   inflation (economical concept)

▶ **All CF's** shall be set as if they were paid **now**!

INITIALIZE   STUDY   DESIGN   BUILD   COMMISSION   OPERATE & MAINTAIN   DECOMMISSION

now   2019   → t

← E.g. a payment to occur in 2019
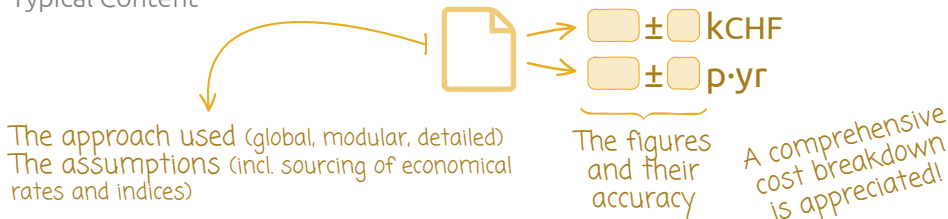
In Cost Estimate and Budget, all figures in CHF_{now}
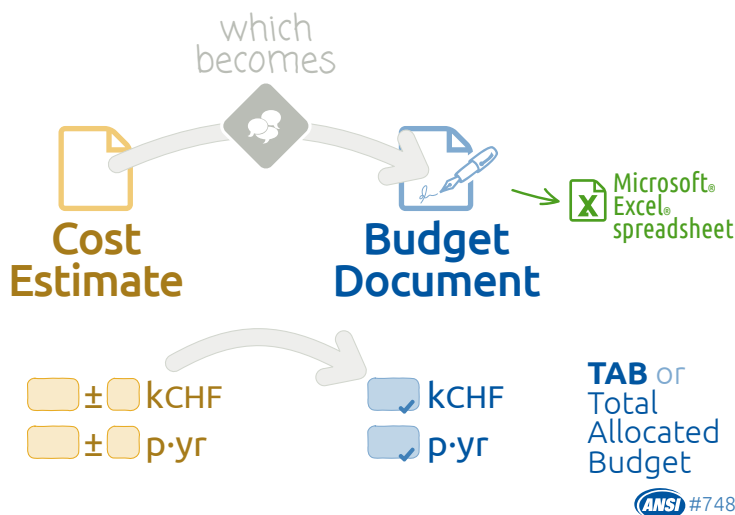
Cost Estimate
Editorial Process

➡ **Authoring:** Study (or Project) Manager
+ a few Key Study (or Project) Participants

➡ **Verification:** Some other Key Study (or Project) Participants
+ some experts in the fields

➡ **Validation:** **Study** (or Project) **Manager**

Typical Content

☐ ± ☐ kCHF

☐ ± ☐ p·yr

The approach used (global, modular, detailed)
The assumptions (incl. sourcing of economical rates and indices)

The figures and their accuracy

A comprehensive cost breakdown is appreciated!

Project Costing

② **Budgeting** the resources allocated to the project

which becomes

Cost Estimate → Budget Document → Microsoft® Excel® spreadsheet

☐ ± ☐ kCHF
☐ ± ☐ p·yr

☐✓ kCHF
☐✓ p·yr

TAB or Total Allocated Budget

(ANSI) #748

⚠ Logically: ☐ − ☐ ≤ ☐✓ ≤ ☐ + ☐

Project Costing

2 **Budgeting** the resources allocated to the project

WBS

CBS Cost Breakdown Structure

or

Budget Document

BAC or Budget at Completion

☑ kCHF
☑ p·yr

TAB or Total Allocated Budget

(ANSI) #748

PMR or Project Management Reserve
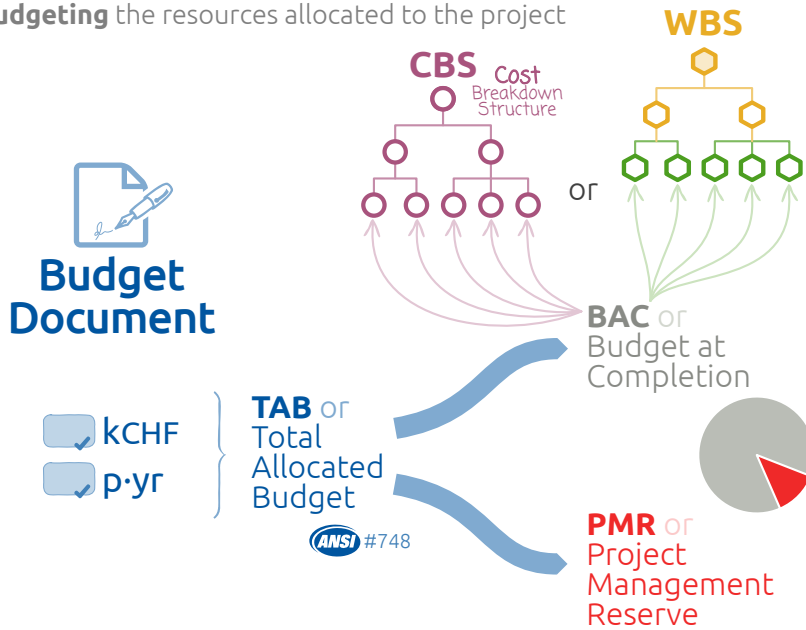
Budget Document

Editorial Process

➡ **Authoring:**   Study (or Project) Manager
+ a few Key Study (or Project) Participants

➡ **Verification:**   Some other Key Study (or Project) participants
+ some experts in the field

Project Board

➡ **Validation:**   **Study Manager**

Project Manager

at Work Package level

at Cost Center level