Introduction to project management

***Part I** / Concept, methods, resource and time management*

Yves Bellouard

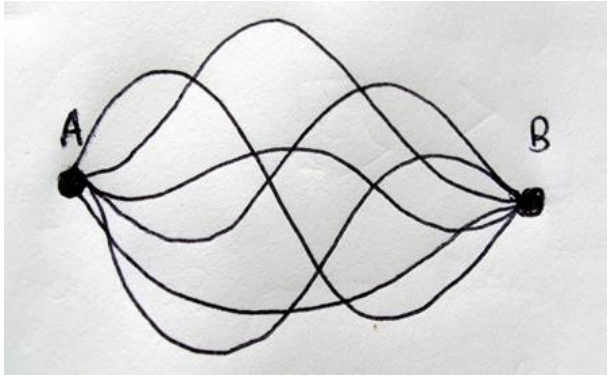
What is a project?

"A project is a temporary endeavor undertaken to create a unique product, service or result.

The temporary nature of projects indicates a definite beginning and end.

The end is reached when the project's objectives have been achieved or when the project is terminated because its objectives will not or cannot be met, or when the need for the project no longer exists."

PMI, PMBOK® Guide



Attributes:
unique, novelty, uncertainty, sponsor and project manager, clear deliverables, limited in time.

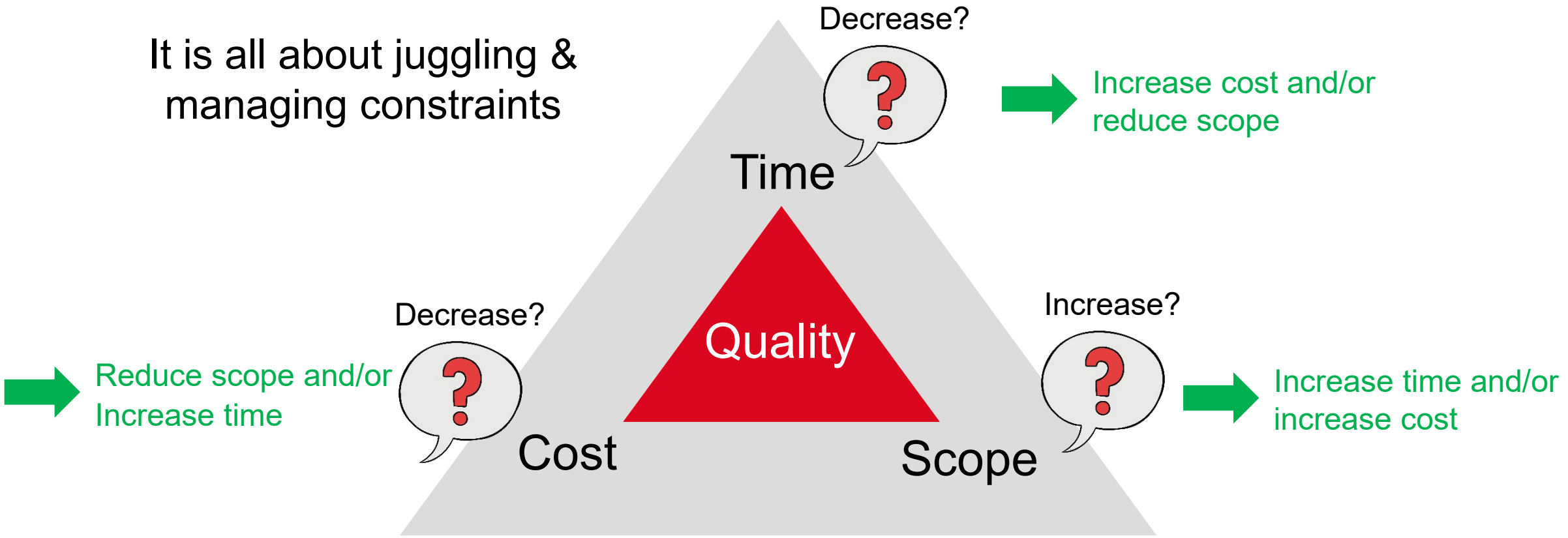
Not a project: repetitive and operational work (e.g. production), tasks.

Product development as a project management: key definitions

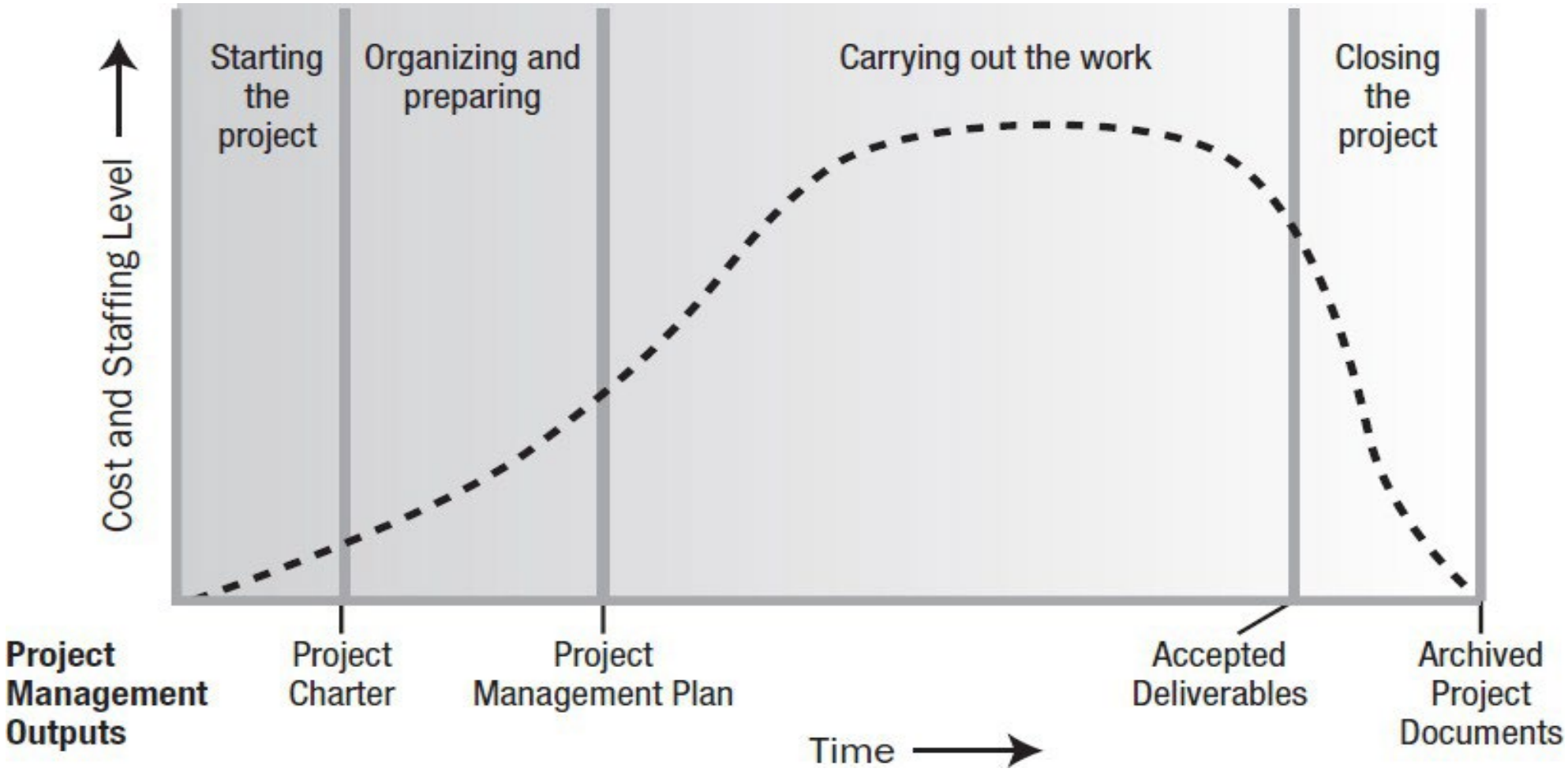
- **Objectives**: statement of scope (project charter), product specification, business case
- **Means** and **resources**: sponsor, project manager, project team,
- **Planning** and **milestones**: delivery dates, release, demonstrations, go-to-market
- **Constraints**: time-to-market, budget, cost target, quality, resources, risks
- **Deliverables**: e.g., design reviews, gates, prototypes, user / service / production / sales documentation, pre-series, series production

Time, Cost, Scope: an interdependent triangle…

It is all about juggling & managing constraints

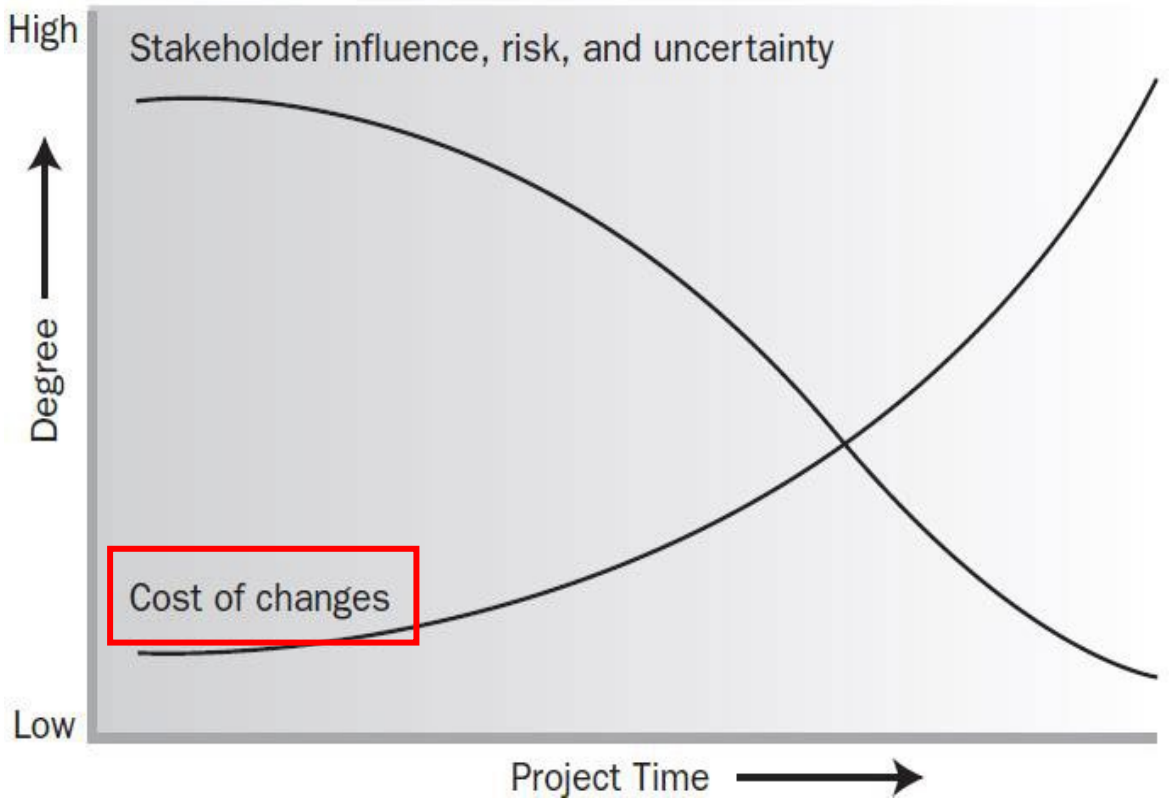


Project will vary in size and complexity during their life-time



Flexibility decrease as cost increase

- Stakeholder influence, risk and uncertainty greatest at project start
- Ability to influence final characteristics of product without significant cost impact is high at project start and decreases drastically with project progress
- Take the opportunity to reduce project risk early to limit cost of changes



Project governance and main roles

Sponsor (senior management, project promoter and facilitator)

appoints Steering Committee, mitigates major conflicts

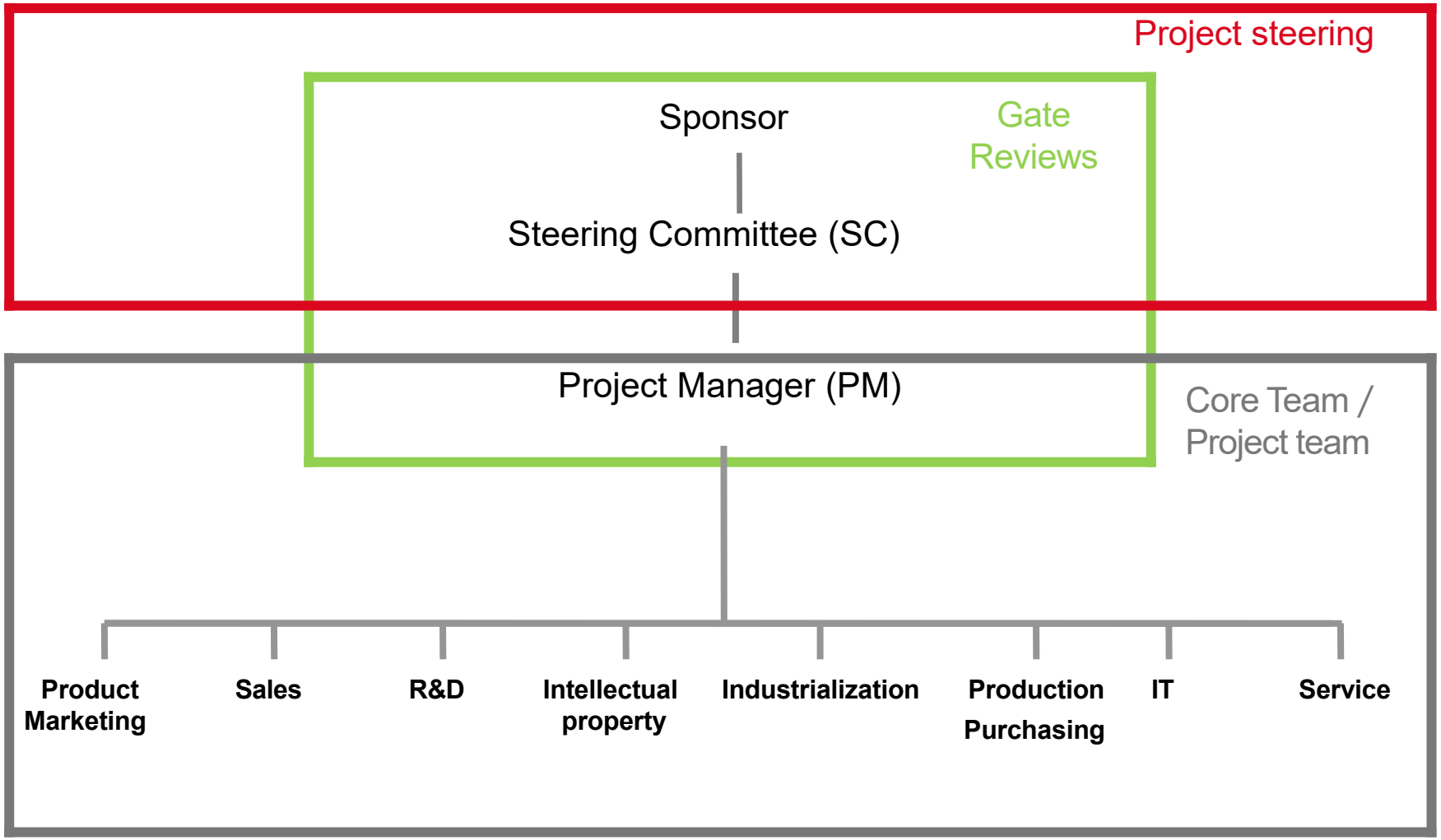
Steering committee:

assigns project team; validates project plan, organization, change of specifications, planning, budget; guarantees periodic project follow-up

Project manager (PM):

defines project organization, plans activities & resources, leads project team, ensures timely release of deliverables within budget, takes care of communication (up & down)

Governance

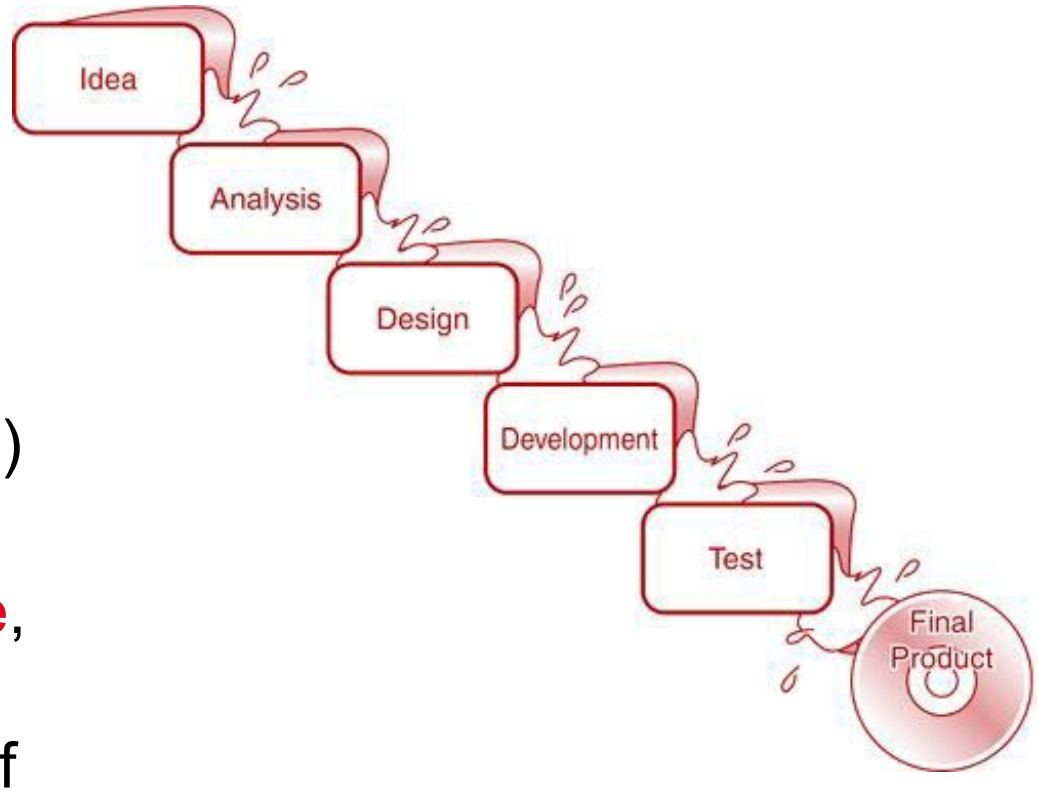

Project steering
Sponsor
Gate Reviews
Steering Committee (SC)
Project Manager (PM)
Core Team / Project team
Product Marketing
Sales
R&D
Intellectual property
Industrialization
Production
Purchasing
IT
Service

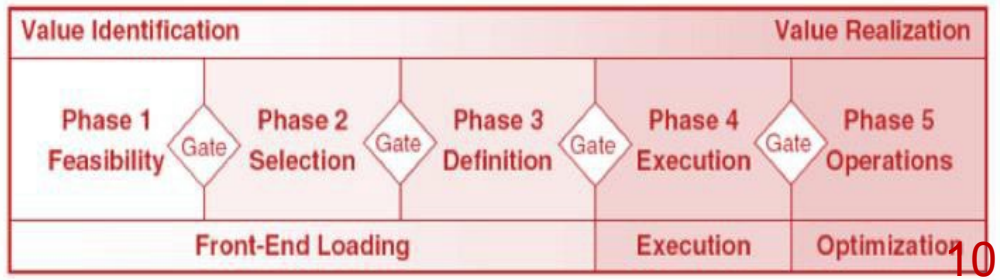
How to get from idea to market ?

1. Collect & **identify ideas** (customers, technicians, sales & marketing, R&D, etc.)
2. Select & **prioritize ideas**
3. Analyze **market needs**, business opportunities
4. Define **customer requirements**, product scope
5. Identify & verify **technical solutions** (prototypes)
6. Do **planning**, workload, time, resources
7. Develop **general concept, detail design**, production concept
8. On **pre-series**: validate solution, ensure quality, industrialize
9. Set-up & launch **production**, sales & services

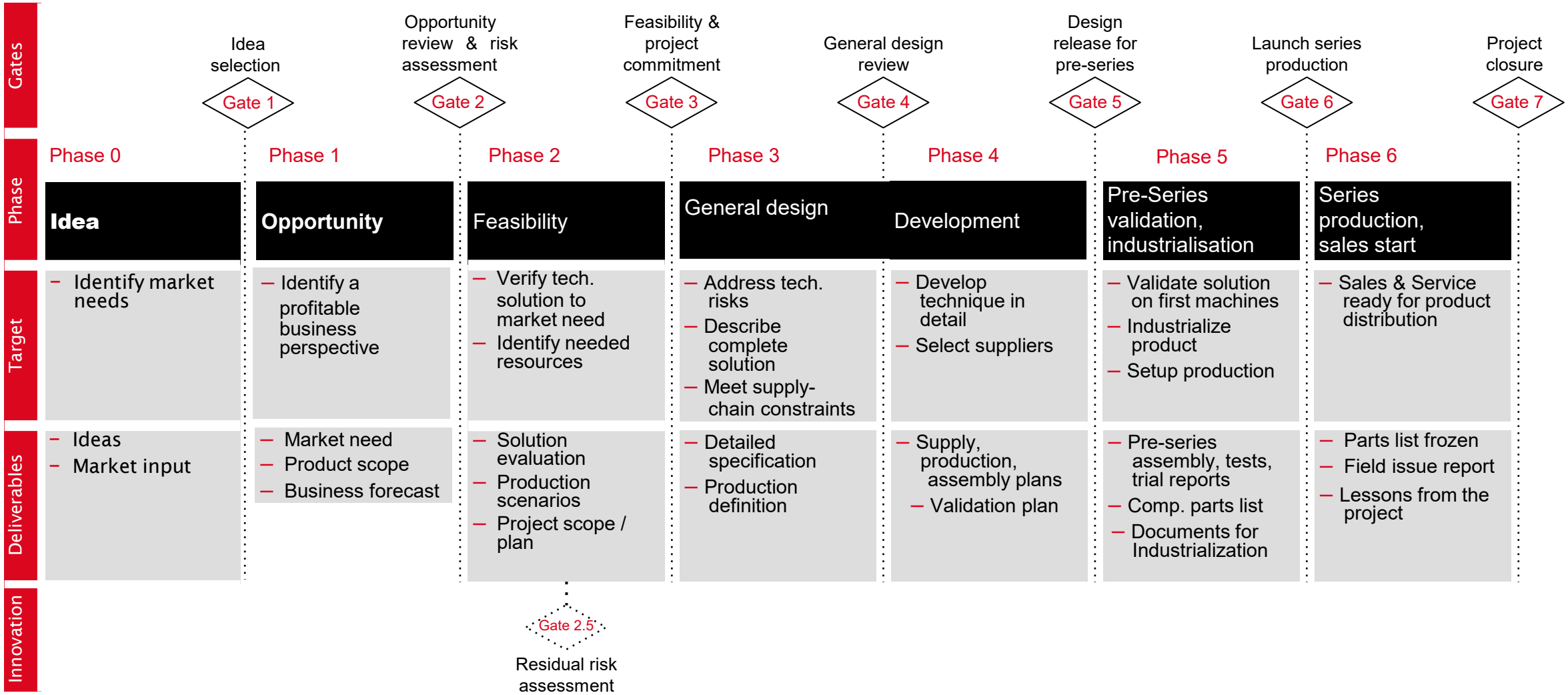
Phase and Gate or waterfall model

- Product Development Process is usually based on Phase and Gate model (also called waterfall)
- Project is divided into stages or phases, separated by formal Gates (Sponsor, SC, PM)
- At each Gate, a Steering Committee decides if project shall continue to next phase, based on available information, including business case, risk analysis and availability of necessary resources





Example of Product Development Process



Small vs large companies

Small companies

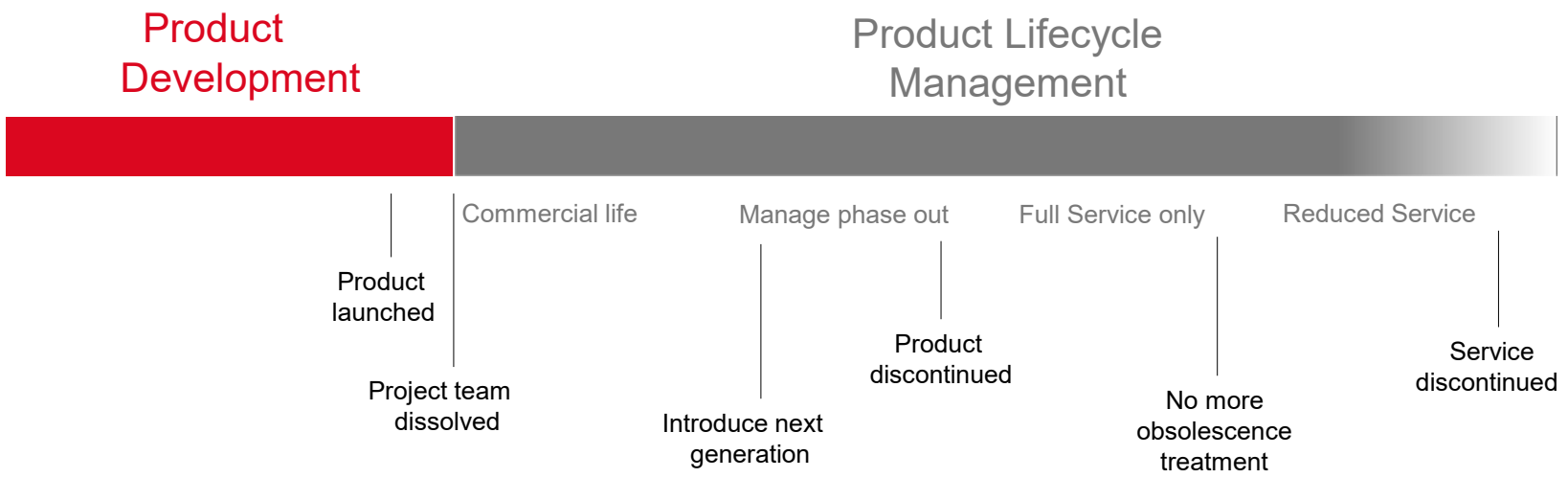
- Start-up and SMEs usually have little if no formal process to guide them through product development
- Organizations are very fast in decision making process but unstructured and face changing priorities

Large companies

- Rely on internal framework and process to guide NPD and describe how new product ideas are brought to market
- Organizations are well structured, priorities change less frequently, but tend to be slower in decision-making process as more people are involved

What after the project ?

- Product development process covers only development phase until product is launched and stable
- Product development process is followed by Product Lifecycle Management during commercial life, until service is fully discontinued

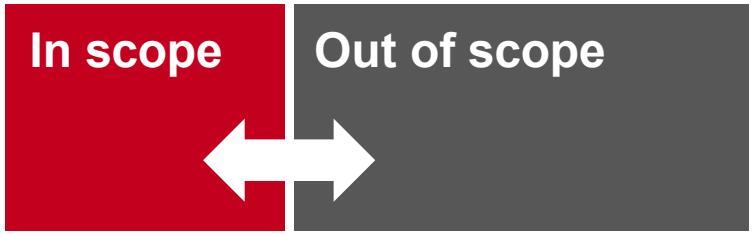


Scope management

Success factor

Project success depends a lot on relevance of project objectives definition

- Be sure to aim at the right target!
- Be critical to extensively define project perimeter (in-scope, out of scope)
- Do not freeze ideas to quickly, keep different options in mind



Scope management: Methodology

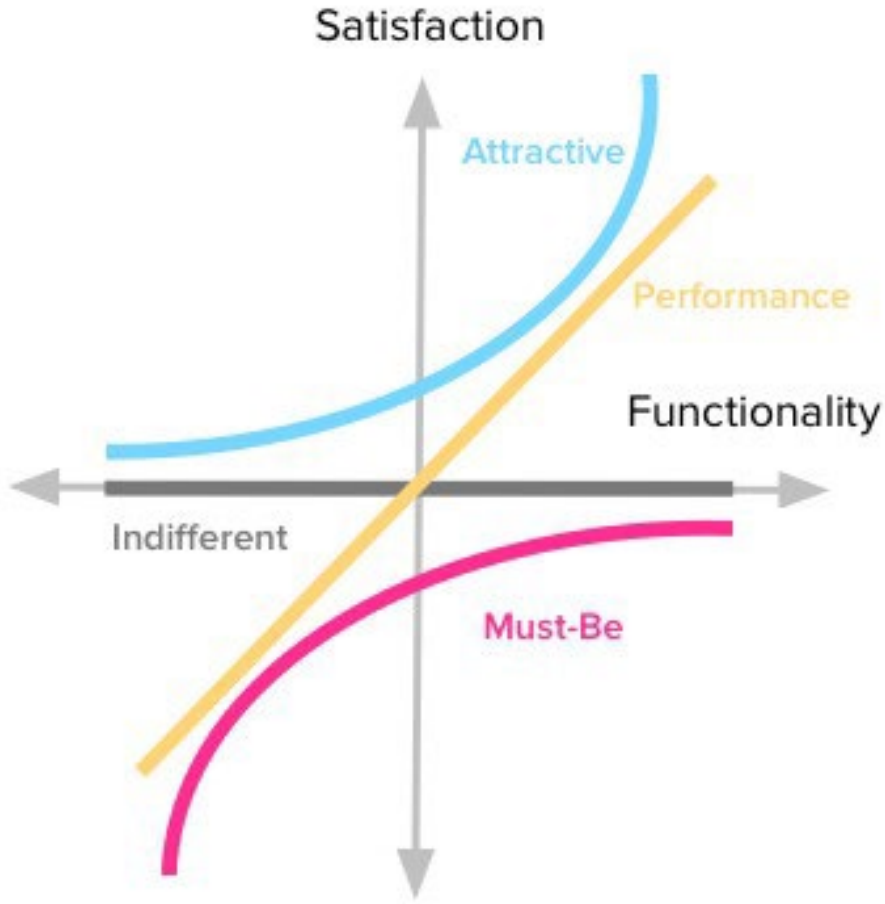
A **project scope ('product development')** is defined using following sequence and later validated by major company's stakeholders (e.g. marketing, sales, R&D, production, service) and possibly by customer(s):

1. **Capture customer needs**, e.g. with **Voice of Customer**
2. **Define what product will do** with **Product requirements**
3. **Define project contours** with **Project Scope Statement**
4. **Decompose project** into smaller parts with **Work Breakdown Structure**

Voice Of the Customer – Kano model for products features

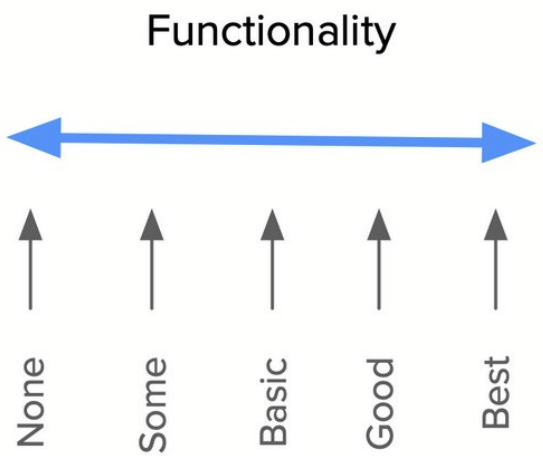
狩野紀昭 *Kanō Noriaki*

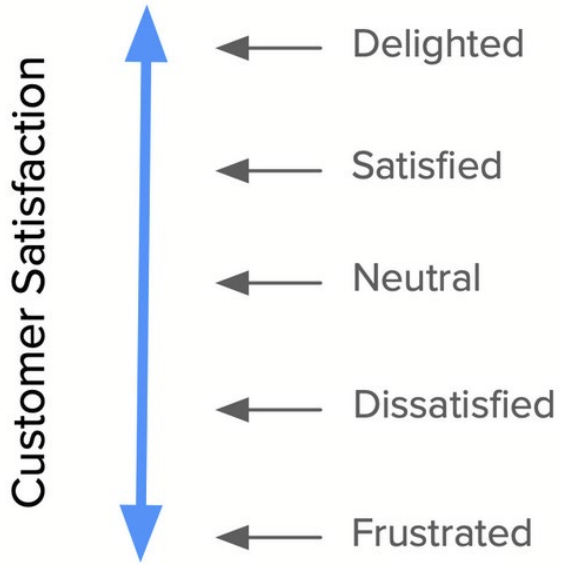
- Indifferent: features towards customers feel indifferent, independently of the functionality. Don't lose time developing them
- Performance: features which behave intuitively as satisfaction is a linear function of functionality
- Must be: so basic that customers fail to mention them, until they are not performed. Highly dissatisfying if missing functionalities
- Attractive: unexpected features difficult to discover as they go beyond customer's expectations. Their absence doesn't dissatisfy, their presence excites

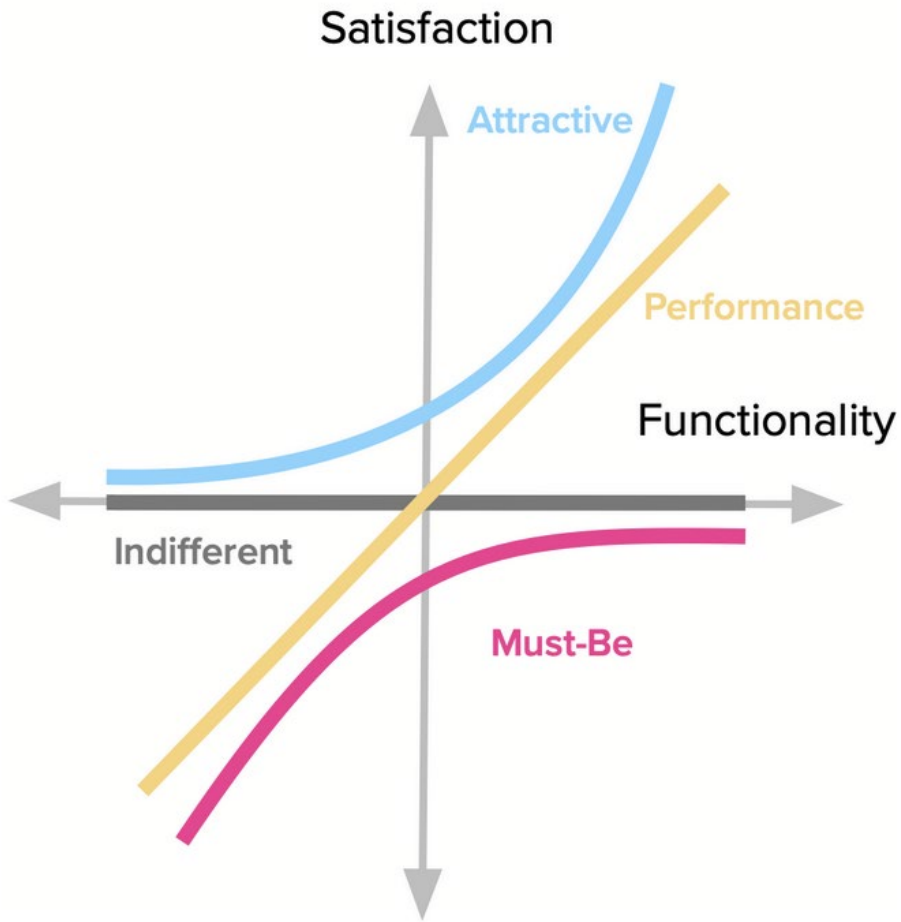


https://foldingburritos.com/kano-model/

Kano's model

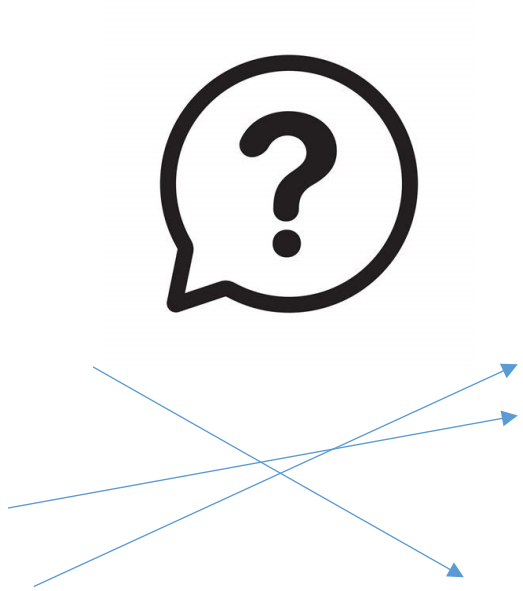

Functionality
None
Some
Basic
Good
Best


Customer Satisfaction
Delighted
Satisfied
Neutral
Dissatisfied
Frustrated


Satisfaction
Attractive
Performance
Functionality
Indifferent
Must-Be

Let’s try! Which category would you classify these product features?

- Dishwashing liquid color
- Smartphone battery
- Bluetooth compatibility
- First iPhone touchscreen
- Internet speed
- Gift in hotel
- Water in hotel room
- Car door noise



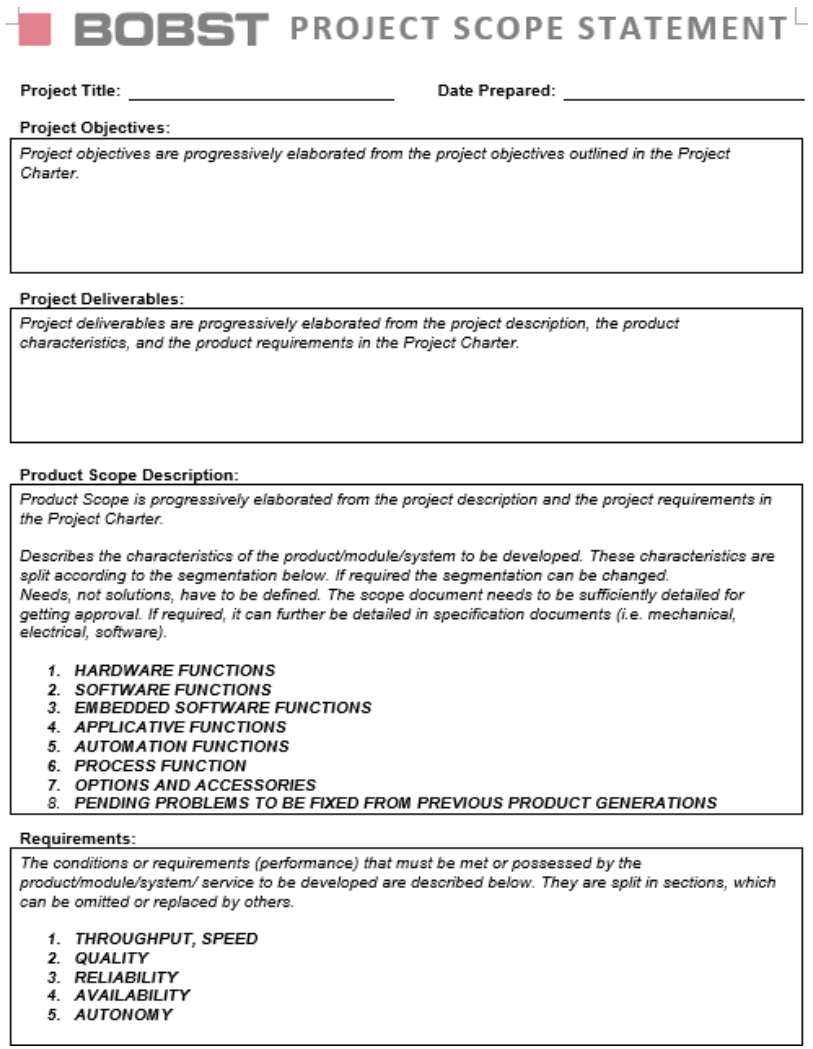
- Indifferent
- Performance
- Must be
- Attractive

Product **requirements** (‘Cahier des charges’)

Consulting all company departments, define functional product specification by listing:

- Product **functions** with targetted **performance levels**
- **Marketing attributes**
  1. D = differentiator (goes beyond what competition is offering)
  2. P = parity (performance at par with competition)
  3. B = basic (expected requirements)
- **Priority**
  1. M = must have (key differentiators that enable business case)
  2. N = nice to have (can be descoped is needed or sold as options)
  3. F = future product evolutions (out of scope)

Scope Statement



BOBST PROJECT SCOPE STATEMENT

Project Title: _____ Date Prepared: _____

Project Objectives:

Project objectives are progressively elaborated from the project objectives outlined in the Project Charter.

Project Deliverables:

Project deliverables are progressively elaborated from the project description, the product characteristics, and the product requirements in the Project Charter.

Product Scope Description:

Product Scope is progressively elaborated from the project description and the project requirements in the Project Charter.

Describes the characteristics of the product/module/system to be developed. These characteristics are split according to the segmentation below. If required the segmentation can be changed. Needs, not solutions, have to be defined. The scope document needs to be sufficiently detailed for getting approval. If required, it can further be detailed in specification documents (i.e. mechanical, electrical, software).

1. *HARDWARE FUNCTIONS*
2. *SOFTWARE FUNCTIONS*
3. *EMBEDDED SOFTWARE FUNCTIONS*
4. *APPLICATIVE FUNCTIONS*
5. *AUTOMATION FUNCTIONS*
6. *PROCESS FUNCTION*
7. *OPTIONS AND ACCESSORIES*
8. *PENDING PROBLEMS TO BE FIXED FROM PREVIOUS PRODUCT GENERATIONS*

Requirements:

The conditions or requirements (performance) that must be met or possessed by the product/module/system/ service to be developed are described below. They are split in sections, which can be omitted or replaced by others.

1. *THROUGHPUT, SPEED*
2. *QUALITY*
3. *RELIABILITY*
4. *AVAILABILITY*
5. *AUTONOMY*

Project Scope Statement clearly and succinctly describes what **a project is** and **is not** intended to accomplish

- Product scope description
- Project assumptions
- Project deliverables
- Project acceptance criteria
- Project constraints
- Project exclusions
- Project rules and process

Work Breakdown Structure (WBS)

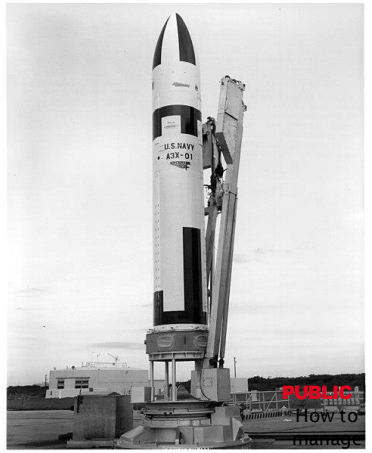
- The WBS is a deliverable-oriented hierarchical decomposition of a project into smaller components
- The WBS is used to turn complex projects into manageable entities
- The WBS is designed to help break to estimate and supervise projects deliverables
- Allow to then define dependencies diagram, then schedule

Advantages

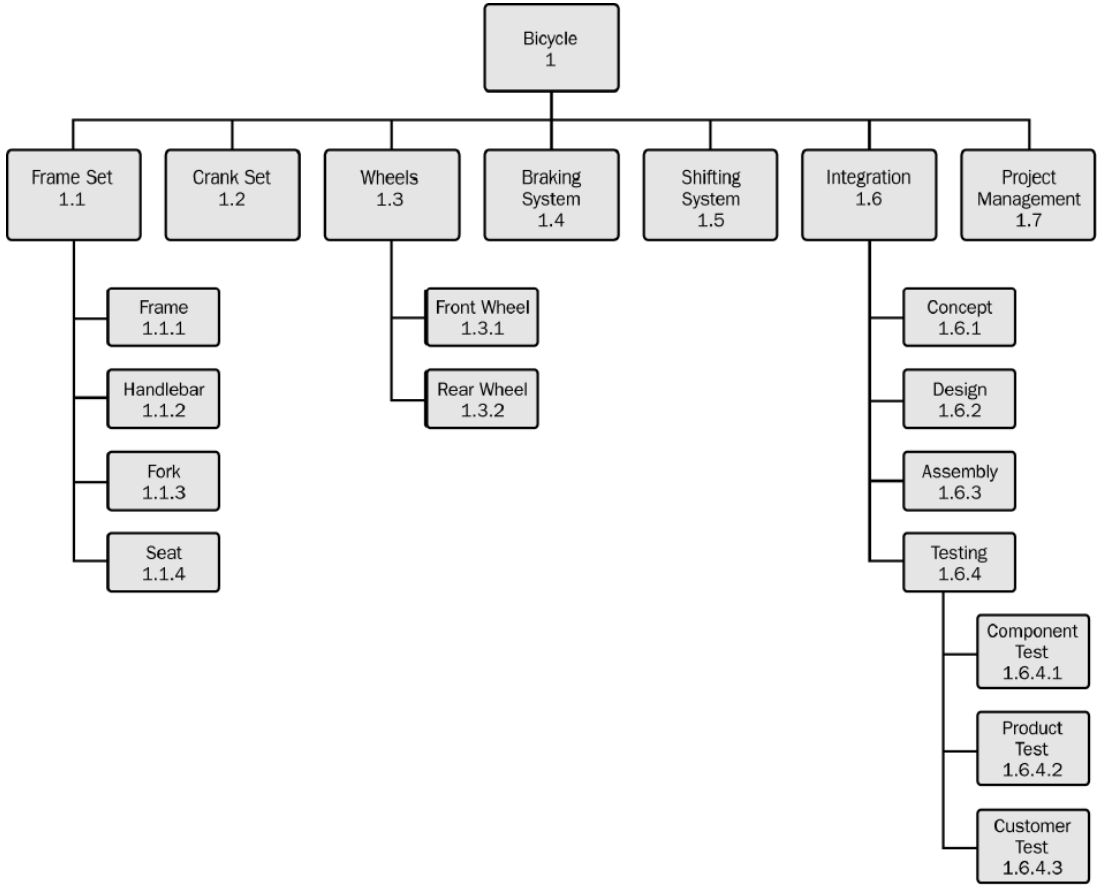
- Assists with accurate project organization
- Helps assigning responsibilities
- Helps defining deliverables
- Allows for more accurate estimation of cost, risk and time
- Helps explain the project scope and status to stakeholders

History

- Introduced by the US Navy in 1957 to support the development of the Polaris missile program
- Described since 1987 by PMI for non-defense applications



WBS structure example for a bike development

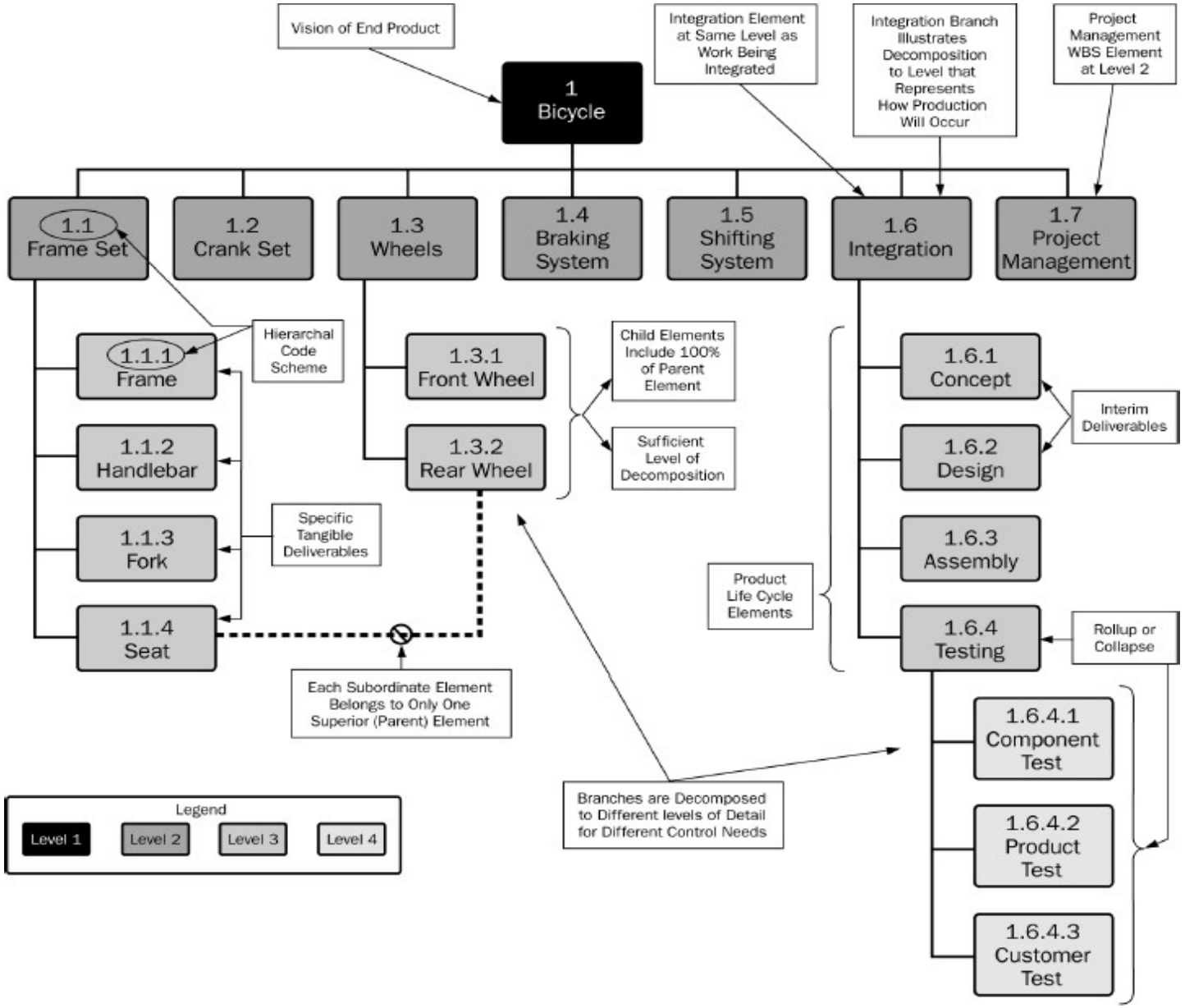


- At lowest level are work packages describing deliverables or work components

Rules to follow when creating a WBS

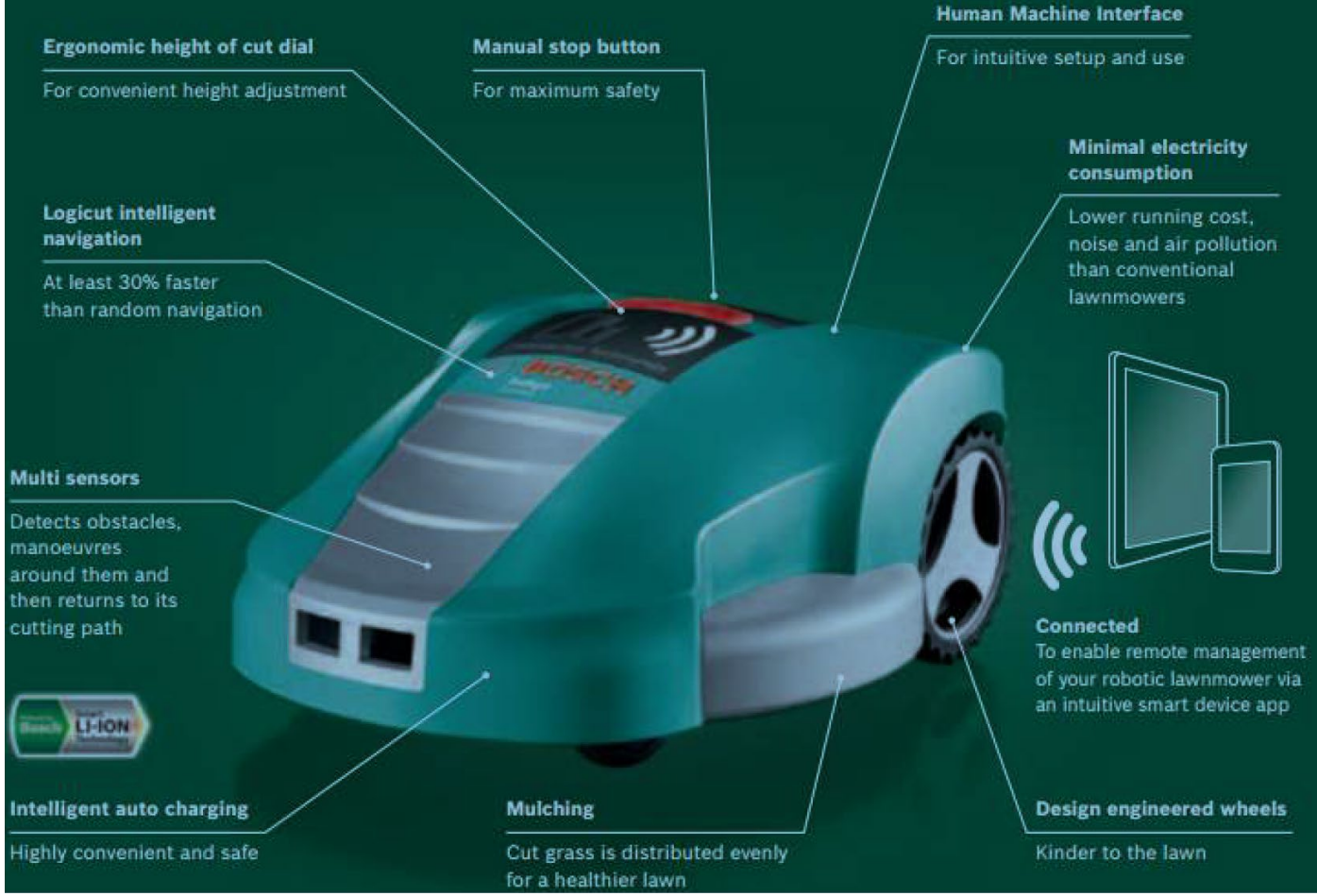
- Lowest level of WBS are work packages describing deliverables. A work package groups all activities where work to achieve the deliverable can be estimated, scheduled and monitored
- 100% rule - WBS must include 100% of work defined by the project scope and must capture all deliverables – internal, external, interim – in terms of the work to be completed, including project management
- Mutual exclusivity - no overlap in scope definition between different elements of the work breakdown structure
- Plan outcomes or results, not actions
- Use coding scheme - reused in project planning tool

In detail how does it looks like ?



Exercise

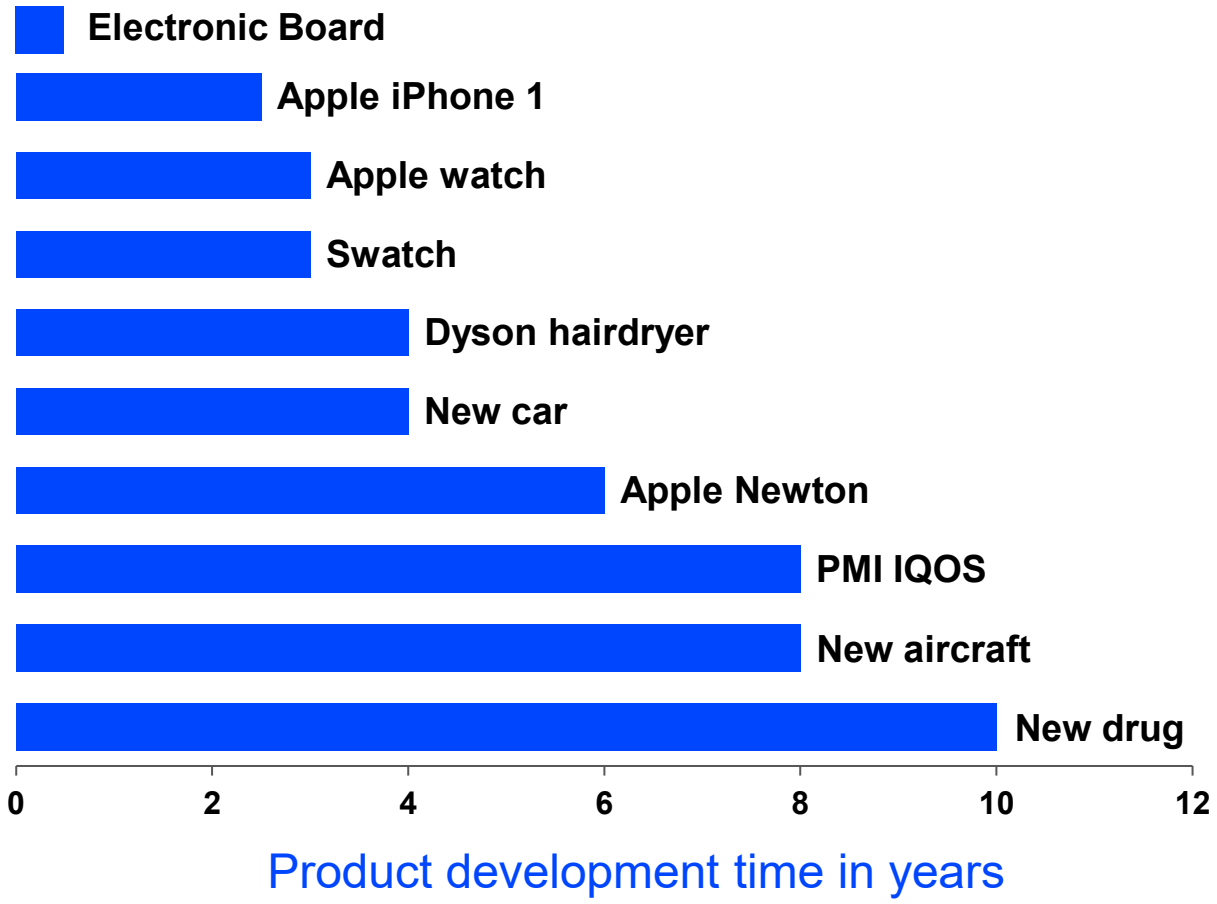
Your company plans to release new generation of connected autonomous electric lawn mower. As a project manager, you have received the following functional specifications from Marketing. Now you need to **define project WBS**



Time management

Introduction

- Product development time depends on the type of industry
- Projects with longer development time are more difficult to manage
- Time-to-market being critical for companies, development time tends to decrease



Methodology for planning creation

- Use **WBS structure** to create planning structure, starting from project deliverables contained at lowest level of WBS
- For **each deliverable**, as described in WBS dictionary, project team identifies all activities required to produce that deliverable and estimates effort. Organize interactive session to investigate alternatives, detect potential risks, assess team's level of confidence
- Sequence activities in **logical order** (activity sequencing). Certain activities can only be started when others have been completed
- **Assign resources** to each activity; in case of conflict, change sequence
- **Determine critical path**, include project buffer after risk analysis, estimate project duration

Main standard certifications and institutes

PMI - Project Management Institute, USA based professional organization, now recognized worldwide with 250 chapters in over 70 countries

- CAPM, Certified Associate in Project Management
- PMP, Project Management Professional
- PgMP, Program Management
- Management Professional

IPMA - International Project Management Association. Based in Switzerland, its members are national project management organizations such as AFITEP in France, GPM in Germany, APM in the UK, SMP and SPM in Switzerland

- Level D: Certified Project Management Associate
- Level C: Certified Project Manager
- Level B: Certified Senior Project Manager
- Level A: Certified Projects Director

APMG - Association for Project Management Group (UK)

- PRINCE2 Foundation
- PRINCE2 Practitioner

Time management: estimate an activity

- For each work package, estimate effort for each task (e.g. using 3-point estimates (PERT)
- Identify and keep track of assumptions made during activity estimation

Mechanical support 1.3

WP 1.3 Mechanical support ACTIVITY	MOYEN 50%	OPTIMISTE 20%	PESSIMISTE 80%	(4+1+1)/6	Cash-out	Fait par	Estimé par	Remarque
P3 sous-total P2								
Lighting module								
• Définir forme et composants mécanique Lighting Module	6	4	12	7		MTR	MLY/MTR	
• vérifier aspects dilatation thermique	6	4	12	7		FPI	MLY/MTR	
Miroirs & Vitre								
• Calculer la forme et les tolérances pour les miroirs	80	80	80	80		FPI	MLY/MTR	
• Définir fixation miroir	8	8	8	8		MTR	MLY/MTR	
• Rechercher fournisseurs injection & métallisation	16	4	32	17		MTR	MLY/MTR	
Thermal dissipation (air cooling)								
• Recherche partenaire et analyse concept global	12	8	24	13		FPI	MLY/MTR	
nir forme du radiateur, débit wr circuit d'air après étude thermique du partenaire	12	8	24	13		FPI	MLY/MTR	
finir température de travail du radiateur	4	2	8	4		FPI	MLY/MTR	
isir ventilateur et définir sa fixation	4	2	8	4		MTR	MLY/MTR	
ign interface entre les deux PCBs et le radiateur	8	4	16	9		MTR	MLY/MTR	
ure mécanique de base								
inir atructure mécanique de modules qui porte cartes, miroirs, glass, radiateurs	40	40	80	47		MTR	MLY/MTR	
liser étude pour miroirs	16	8	32	17		MTR	MLY/MTR	
• Realiser étude pour refroidisseur	16	8	24	16		MTR	MLY/MTR	
• Créer dessins de détails	60	40	100	63		MTR	MLY/MTR	
P4 sous-total P4								
• Suivi fabrication pièces pour Lighting module	8	8	8	8		MTR	MLY/MTR	
• Suivi fabrication miroirs et vitre	8	8	8	8	CHF 10'000.00	MTR	MLY/MTR	Moule à réaliser
• Suivi fabrication refroidisseurs	8	8	8	8	CHF 2'000.00	MTR	MLY/MTR	
• Assemblage général	16	8	24	16		MTR	MLY/MTR	Assemblage d'un système à 10 modules
• Corriger les dessins (structure, miroirs et vitre, refroidisseurs)	20	15	40	23		MTR	MLY/MTR	
P5 sous-total P5								
• Suivi fabrication et corriger pièces pour Lighting module	8	4	16	9		MTR	MLY/MTR	
• Au besoin correction miroirs et vitre	6	4	12	7		MTR	MLY/MTR	
• Suivi fabrication et correction refroidisseurs	6	4	12	7		MTR	MLY/MTR	
• Assembler le tout	24	8	32	23	CHF 3'000.00	MTR	MLY/MTR	Prix des retouches
• Corriger les dessins (structure qui tient le tout, miroirs et vitre, refroidisseurs)	20	15	40	23		MTR	MLY/MTR	
Suivi première serie	20	15	40	23		MTR	MLY/MTR	
• Documentation & introduire dans SAP	24	16	40	25		MTR	MLY/MTR	
Total	456	333	740	483	CHF 15'000.00			

Activity estimation techniques

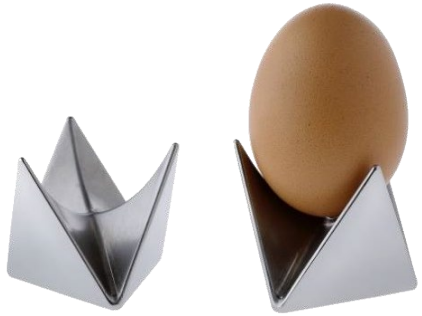
- Expert judgment (top-down) use knowledge from people who have performed similar activities, *e.g. colleagues, experts, outsourcing firm*
- Analogous estimating (top-down) use estimates from previous similar projects to estimate duration and cost of given activity or entire project (*e.g. 800-1200h for new electronic board*)
- Parametric estimating (top-down) – linear extrapolation, finding metrics in activity (*e.g. 10 new parts to design, on average 3 drawing per part and 10 hrs per study, total 300 hrs*)
- 3-point estimates (PERT) (bottom-up) from engineers who will perform the work

Note: Top-down estimations best suited in early project phase
Bottom-up (cross-checked with top-down) estimates better suited later in project lifecycle
Group Decision Making techniques is useful for improving duration estimates

Estimated an activity

Complexity depends with number of parts, so compare similar products !

- **Airbus A380**: 4 million parts, with 2.5 million parts numbers produced by 1,500 companies from 30 countries
- **Car**: 1’800 large-level parts, total of about 30’000 parts
- **Bike**: 890 parts
- **ROLEX caliber 1570**: 150 parts
- **SWATCH**: 51 parts
- **ALESSI Roost egg cup:** 1 part



The 3-point estimate (PERT) method

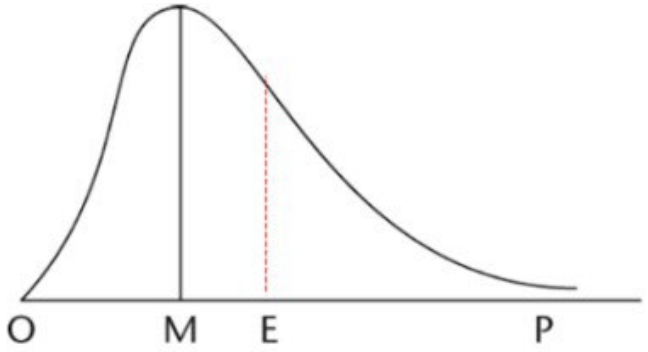
Illustration (for a simple task): how long will it take to drive from Lausanne to Geneva airport (60 km)?

- Best case: no traffic, 40 minutes
- Realistic: moderate traffic, 50 minutes
- Worst case*: heavy traffic, need to fill in car tank, 80 minutes

Risk analysis *will consider additional potential problems:*

- *flat tire (low probability, impact 30' delay and extra cost 100$)*
- *accident ahead (moderate probability, impact 30'-60' delay)*
- *car crash (low probability, impact 3hrs delay, extra cost 5'000$)*

PERT method:



- Ask resources for **Optimistic** (O), **Most likely** (M) and **Pessimistic** (P) task durations

O: Optimistic
P: Pessimistic
M: Most Likely

$$E = \frac{O + 4M + P}{6}$$

- **Estimated Activity Duration**
  EAD = (P + 4M + O) / 6
- **Enter EAD or 3 values** (O, M, P) in project planning tool
- Standard deviation SD = (P – O) / 6
- Variance VA = SD^2
- *Geneva example: O = 40', M = 50', P = 80',* => ***EAD = 54'***

Activity estimation

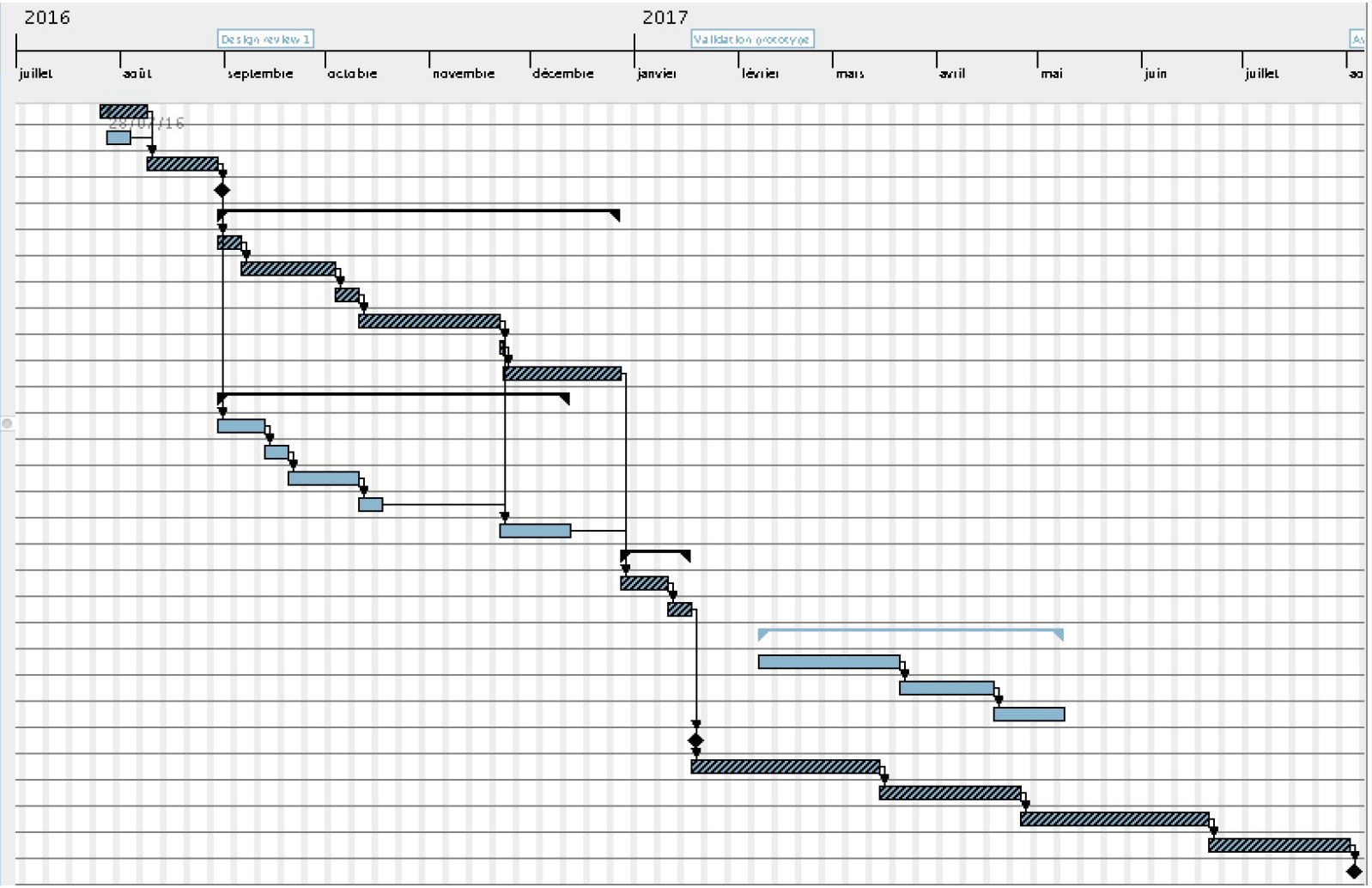
After a first iteration, ***challenge*** estimations given by project team members:

- Activities **sufficiently** well understood?
- **Clear** deliverables?
- **Unnecessary padding** (= extra buffers) included?
- **Technical solutions** selected?
- **Missing** activities or work packages?
- **Risks** identified and communicated?

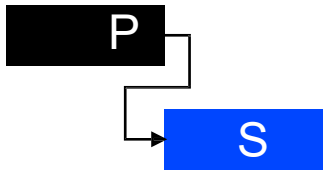
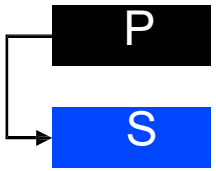
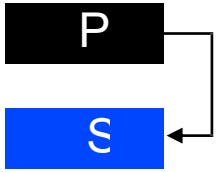
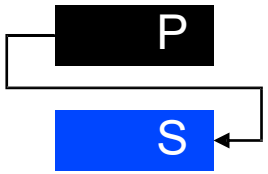
Gantt diagram

Must be done with the WBS! (use same reference)

Nom	Date de début	Date de fin
Product specification definition	26/07/16	08/08/16
Intellectual property analysis	28/07/16	03/08/16
Conceptual design	09/08/16	29/08/16
Design review 1	30/08/16	30/08/16
Electronic board	30/08/16	27/12/16
Electrical schematic	30/08/16	05/09/16
Routing PCB	06/09/16	03/10/16
Bill of Material definition	04/10/16	10/10/16
Procurement and assembly	11/10/16	21/11/16
Board testing	22/11/16	22/11/16
VHDL code and tests	23/11/16	27/12/16
Mechanical assembly	30/08/16	12/12/16
Design CAD	30/08/16	12/09/16
Bill of Material definition	13/09/16	19/09/16
Purchasing and procurement	20/09/16	10/10/16
Assembly casing	11/10/16	17/10/16
Assembly casing and board	22/11/16	12/12/16
Prototype testing	28/12/16	17/01/17
Functional testing	28/12/16	10/01/17
EMC testing	11/01/17	17/01/17
Product documentation	07/02/17	08/05/17
User documentation	07/02/17	20/03/17
Production documentation	21/03/17	17/04/17
Service documentation	18/04/17	08/05/17
Validation prototype	18/01/17	18/01/17
Industrialization	18/01/17	14/03/17
Pre-series procurement	15/03/17	25/04/17
Pre-series assembly and testing	26/04/17	20/06/17
Buffer	21/06/17	01/08/17
Availability pre-series for sale	02/08/17	02/08/17



How to sequence activities using dependencies?

Diagram	Ab.	Name	Definition	Example
	FS	Finish to start	Predecessor must finish before Successor can start	*You must finish cooking before that the dinner can start*
	SS	Star to start	Predecessor must start before Successor can start	*Actor start playing after that the camera started recording*
	FF	Finish to finish	Predecessor must finish before Successor can finish	*Integration test must be finished to finish the acceptance test*
	SF	Start to finish	Predecessor must start before Successor can finish	*Road excavating must start before line painting can be completed*

Resource allocation

- Determine what **resources** are required (**people**, **equipment**, **material**)
- Define which **competencies** are required (type, skill, previous experience, languages, affinities with other team members) and match with **available resources**
- Check **resources availability** (work on other projects or activities, vacation, number of projects per resource) and **motivation**
- Fix **availability** level (e.g. maximum 80%). Without vacation and holidays, a 100% availability level corresponds to about 2000h / year. At 70% availability it gives 1’400h/year/resource

Schedule optimization / Progress tracking

- **Define** and **communicate** milestones to help team focus on clear objectives } *During the Friday weekly meeting!*
- Save initial baseline in planning tool to monitor delays over time
- Perform frequent resource leveling to avoid peaks } *During the Friday weekly meeting!*
- **Identify critical path**, or sequence of activities that determines project duration = *'the longest sequence of tasks in project plan that must be completed to meet deadline'*. Any delay on critical path will cause project to be delayed

Resource allocation

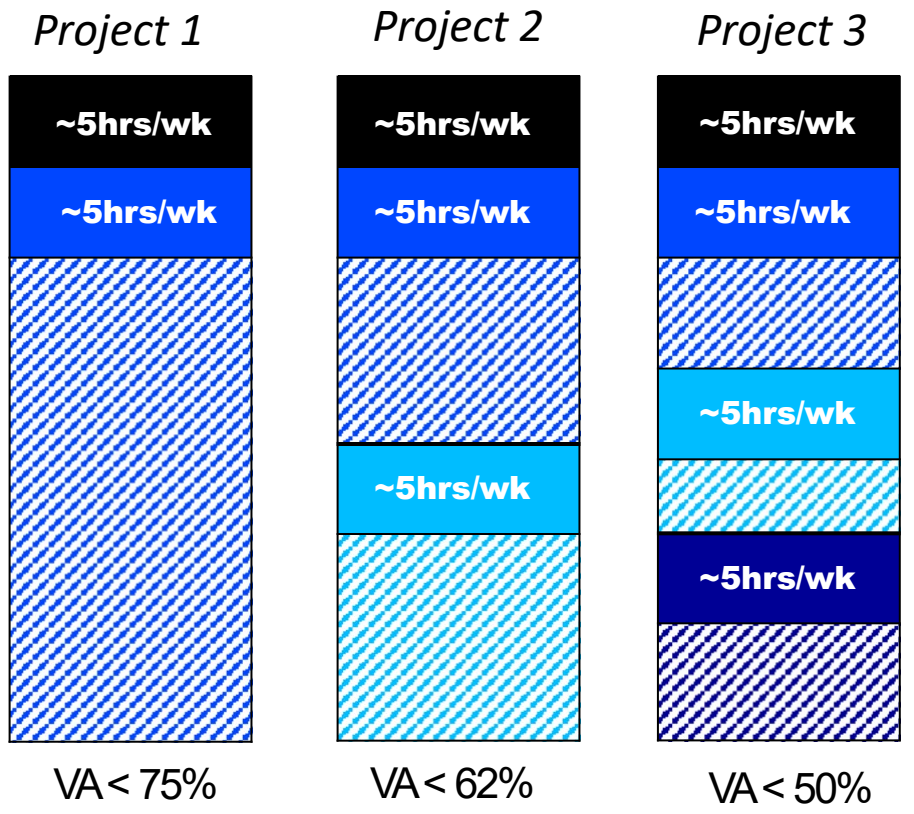
Maximum 2 major or 3 minor projects per staff member because ‘multi-tasking between projects introduces additional efficiency waste!

Non value-added time on general activities
(Admin, general meetings, support, interruptions, coffee breaks, …)

Non value-added time on project
(Status meetings, schedule updates, project-related emails, interactions with team members, …)

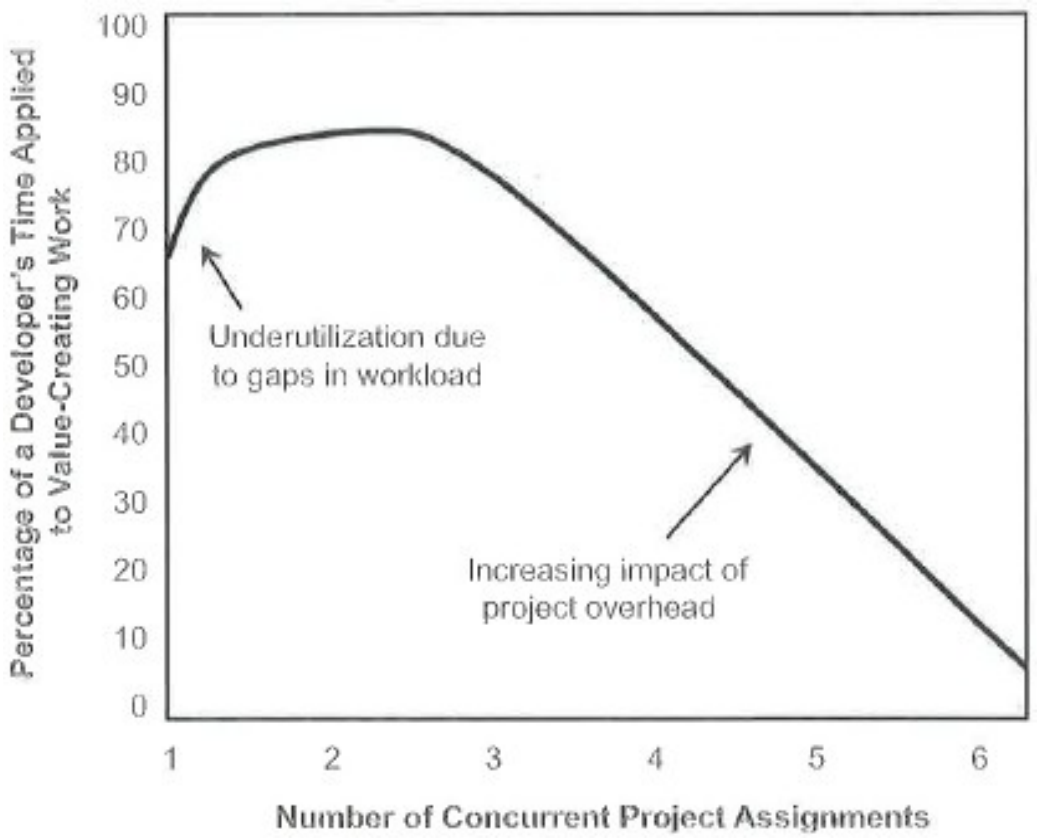
Value-added time on project
(Development activities)

Resource time capacity



Resource allocation

- Maximum 2 major or 3 minor projects per developer
- 1 project / resource offers fastest option, but not always most optimum capacity (resource may sit idle waiting for teammates inputs)
- Large and complex projects allow for some internal level-loading of resources, while smaller projects must be externally level-loaded



Schedule optimization

- **Update** project schedule on regular basis (e.g. monthly / In this course: weekly!).
- **Monitor** deviations and correct them with schedule compression techniques
  i. **Crashing:** add additional/more experienced resources (internal or external) on an activity
  ii. **Fast tracking:** parallelize activities. It adds risk to project, as some work may have to be redone.
  iii. **Descope project by removing content**, e.g., nice-to-have features.
  iv. **Outsource activities** or subproject to external supplier (cash out increase)
  v. **Plan overtime** or postpone vacation, but only on exceptional basis. Use it as a possible risk Response.
- Major deviations, if unavoidable, shall be communicated to steering committee

Credits

- PMI management principles
- Slides adapted from Alexandre Pauchard lectures