Space Project Management & Project Controlling

A basic introduction and practical guide for start ups and SMEs, targeting ESA projects

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Why this course?

Effective Project Management and Project Control are often ignored by small companies

If the principles are understood and done well, they will **save you time and money** and make you **more competitive**

Issues we aim to address with this course:

- Poorly estimating the effort, time and ultimately cost of a project (as ESA contracts are FFP)
- Insufficient management and control to spot issues early (when they are easy and cheap to correct)
- Not having a system that enables you to apply lessons from one project to the next (especially estimating and planning)
- Thinking that PM and PC are for big companies only and that you don't have the resources (or need) for it.

Throughout this course we discuss PM and PC as separate people/roles. In fact, neither are full time jobs for a small (<2M Euro) project. The same person can do BOTH and still do other work. However – know the function and when you do that role, put on the right hat and switch mindset.

Who is this course for?

The course is aimed at:

- Small, new companies with little experience of PM or PC and who want to do/ improve the management of their (small) contracts/projects with ESA.
- Those wanting a first introduction to project management and control.

- The course is not very suitable for/ not sufficient for:
  - Very large and complex projects
  - Those with multiple years of project management experience
  - Those who already studied business or other project management courses

Course Content List

0 Introduction

1 Project initiation

2 Define Project Objectives

3 Structure the Project [WBS]

4 Estimate Resources & Costs

5 Schedule the Project

6 Finalise the Plan

7 Running the project

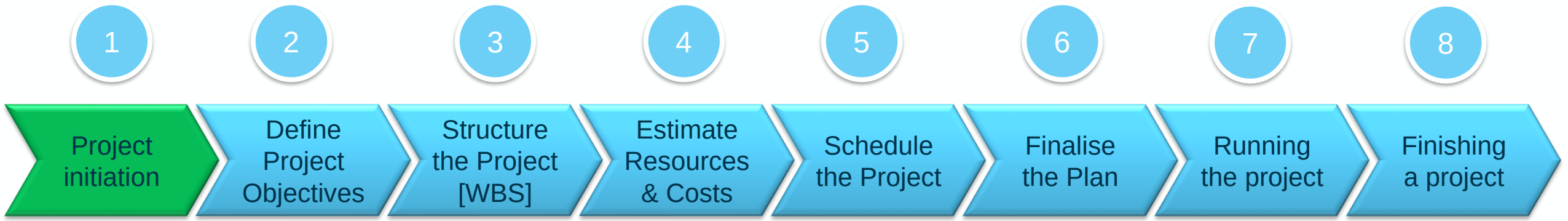
8 Finishing a project

> What are Project Management and Project Control?

This Section covers:

- What is a Project?
- Roles of Project Manager and Project Controller

Project Initiation



What is a PROJECT ?

- An effort or endeavour with a **specific objective**
- Most frequently it is a **unique effort**
- It has specific **start and end** dates
- It can be divided into Project Phases, activities and **tasks**.

A project is defined as **a sequence of tasks that must be completed to attain a certain outcome**. According to the Project Management Institute (PMI), the term Project refers to ” to any temporary endeavour with a definite beginning and end”. Depending on its complexity, it can be managed by a single person or hundreds.

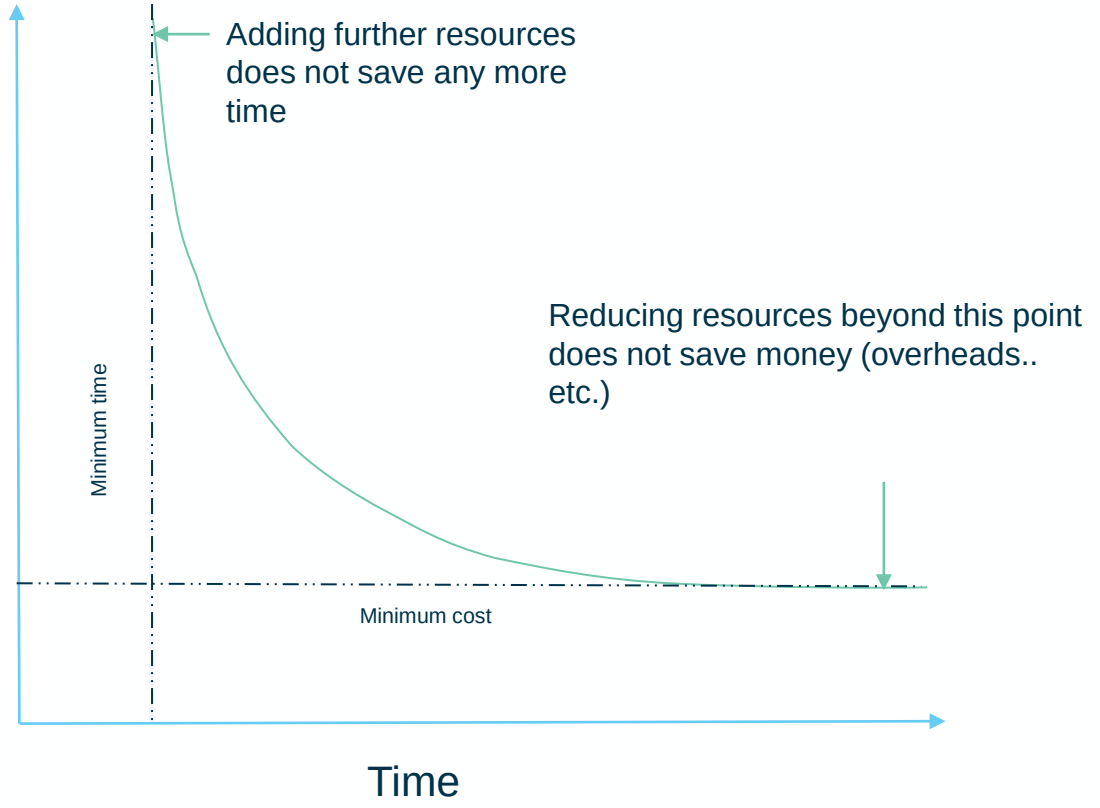
Typically, here we will focus on a project being a contractual activity with ESA, starting with proposal preparation and ending with contract close out.

Project – Balancing Priorities

You can optimise to be Faster and Better, Faster and Cheaper, Cheaper and Better, You cannot be Faster and Better and Cheaper

Expanding the Scope will impact time or cost or both
Decreasing cost will impact the scope, the time or lead to increased risk
Decreasing time will lead to decreased functionality or increased cost

There is typically no magic bullet.



Optimisation has limits...

What is Space Project Management? [ECSS M-Branch]

Definition: Project Management is about **monitoring and controlling** the **scope**, schedule (**time**) and **cost** of a project whilst managing **risk**:

- The Project Manager cannot improve the 4 parameters at the same time but can try to keep them in balance – this is a **constant** need.
- Implementing good management practices and procedures will help your company and all your projects be more efficient, deliver more reliably and be exposed to fewer risks.
- ESA uses the ECSS M-Branch to describe the Project Management requirements. We are taking the key points from these, but for more detailed information, for suggested templates etc. we suggest to read them.

www.ecss.nl

Who is the Project Manager?

Project managers are responsible for the **planning, monitoring** and **execution** of a project, including any procurement.

Project managers in ESA projects are the main point of contact for any issues arising (within their team or from ESA side) and have the authority over all decisions.

Responsibilities

- Developing the **project plans**
- Managing the project **stakeholders** (the team, ESA, sub-contractors, suppliers)
- Managing **communication** (i.e. to all stakeholders)
- Managing the project **team** (setting tasks and priorities, monitoring…)
- Managing the **project risks** (and deciding on actions)

- Managing the project **schedule** (with the project controller)
- Managing the project **budget** (with the project controller)

- Managing the project conflicts
- Contract administration

Project Manager acts as **Captain** of a ship

Who is the Project Controller?

The **project controller** works directly with (and for) the project manager. Their key tasks are to monitor project's actual **budget and schedule** wrt the planning; and recommend actions to improve progress.

Many larger organizations put the project manager and their project controller as part of a centralized project support organization.

Project Controller: The Project Manager's "right hand man"/ "numbers" person

Key Responsibilities

- project **planning and scheduling**
- schedule **monitoring and reporting**
- **budget** estimating
- **cost monitoring** and management
- project and task **reporting**

Project Controller acts as **Navigation Officer** of a ship

At any point in time, the PC should know: Are we on track to finish on time and on budget? What are the key remaining risks to meeting that? In small companies the PC and PM are often the same person

> Project Initiation

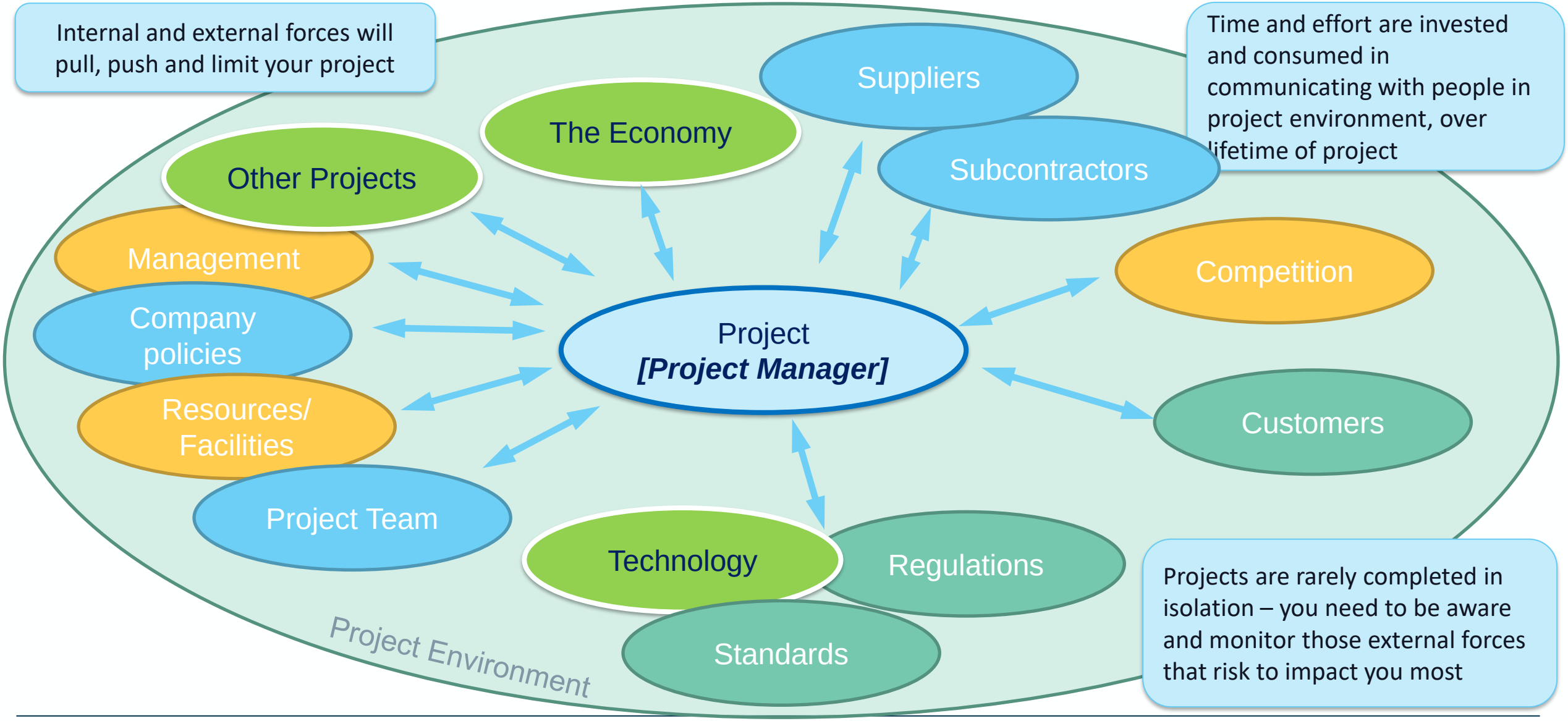
This Section covers:

- **Analyse Project Environment**
- **Stakeholder Management**

Project Environment (Context)

Internal and external forces will pull, push and limit your project

Time and effort are invested and consumed in communicating with people in project environment, over lifetime of project



Projects are rarely completed in isolation – you need to be aware and monitor those external forces that risk to impact you most

Stakeholders

Stakeholders are all those who have an interest or role in the project or who are impacted by the project.

Stakeholder management is the systematic identification, analysis and planning of actions to communicate with, negotiate with and influence stakeholders.

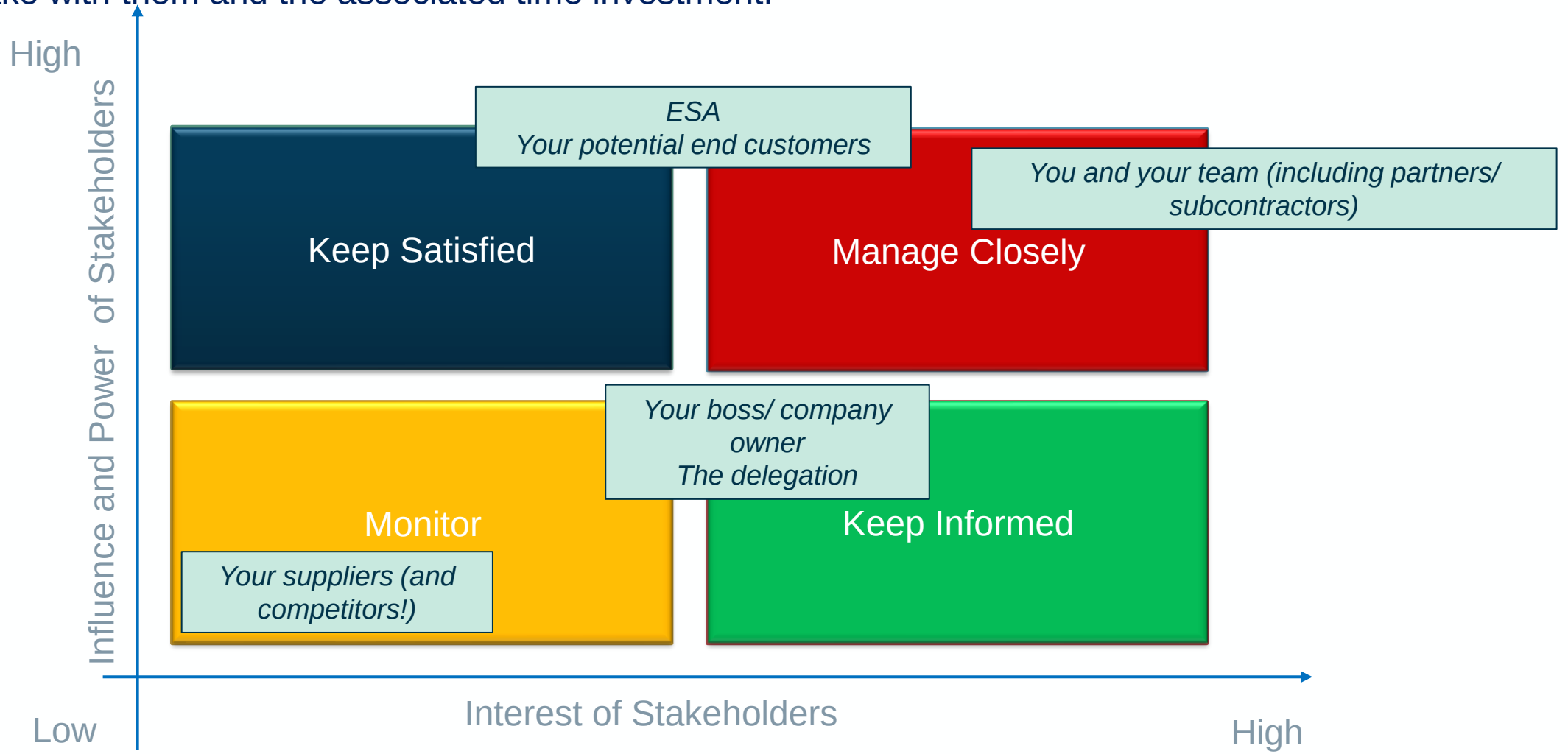
- Stakeholders interest and power to influence the project should be considered from the start
- Stakeholders should be identified and their power to influence the success of the project should be understood
- Stakeholders need to be managed too!

For ESA projects your stakeholders will most likely be:

- *ESA*
- *You and your team (including partners/subcontractors/suppliers)*
- *Your boss/ company owner*
- *The delegation*
- *Your potential end customers*

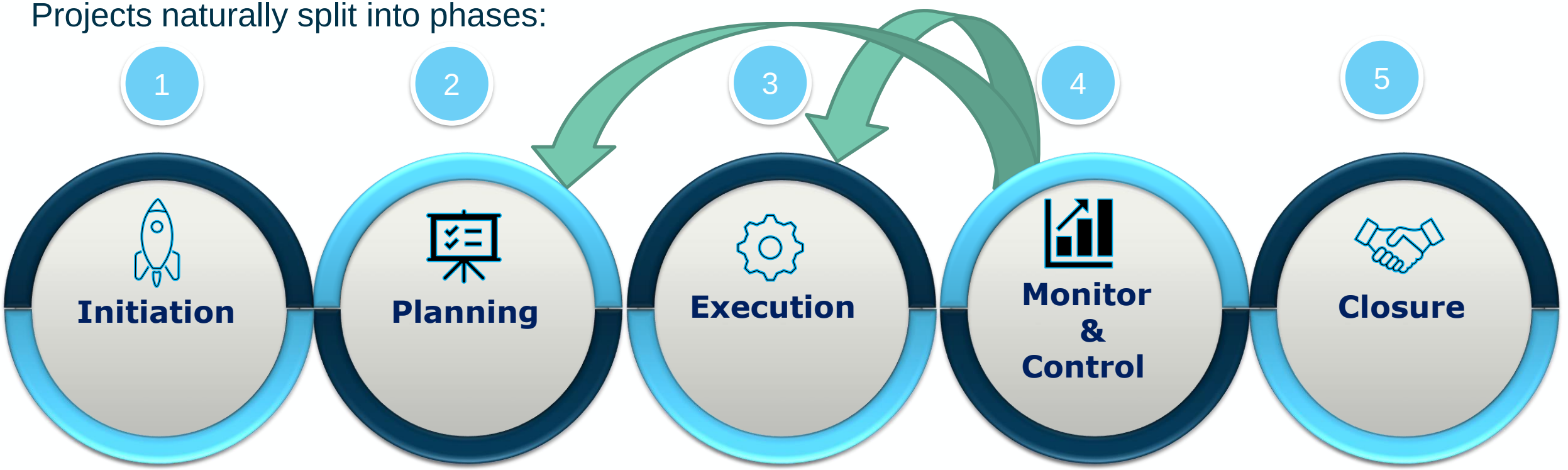
Stakeholder Management

A Stakeholder analysis: The position that you allocate to a stakeholder on the grid shows you the actions you need to take with them and the associated time investment.



Project Phases (ESA activities – PM perspective)

Projects naturally split into phases:



Proposal Phase

Running Contract

Final Presentation

Establish Project Objectives

Define Work Scope, Schedule Work & Resources

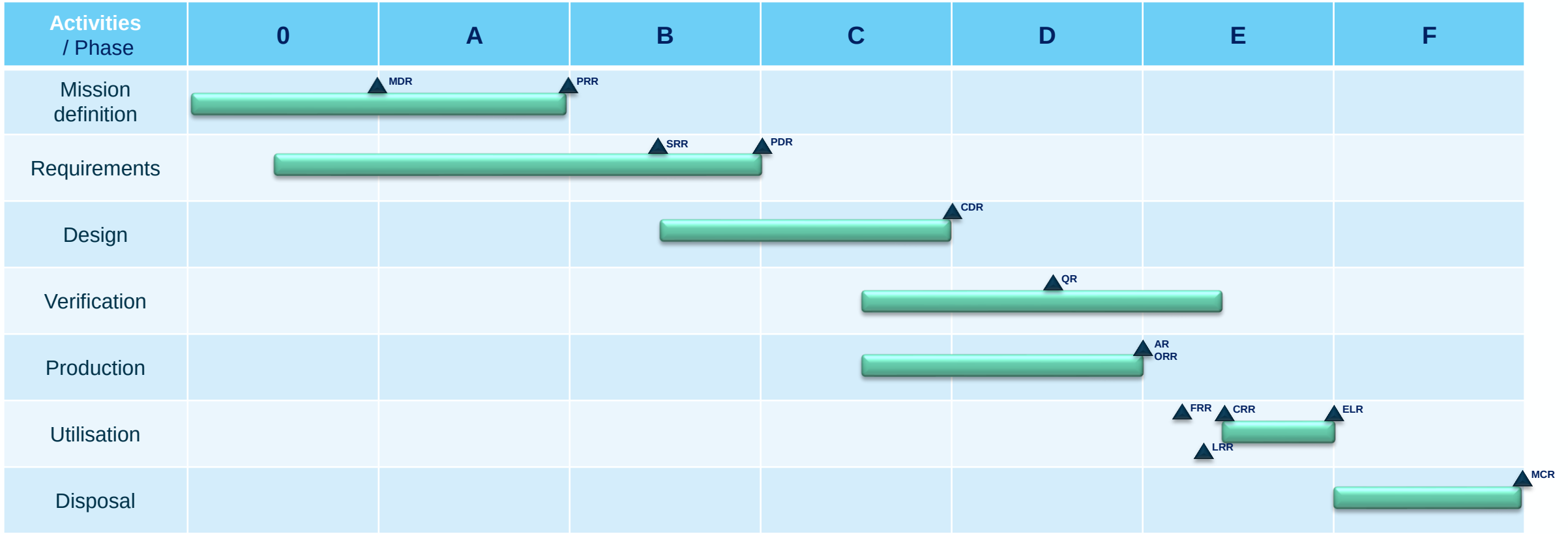
Perform Work
Provide Reports

Track cost/schedule
Analyse Progress
Replan as required

Lessons learnt
Future planning
Disposal and storage

Sidebar: Spacecraft Development Project Phases

For info: The life cycle of **spacecraft** development is typically divided into seven phases, as follows:

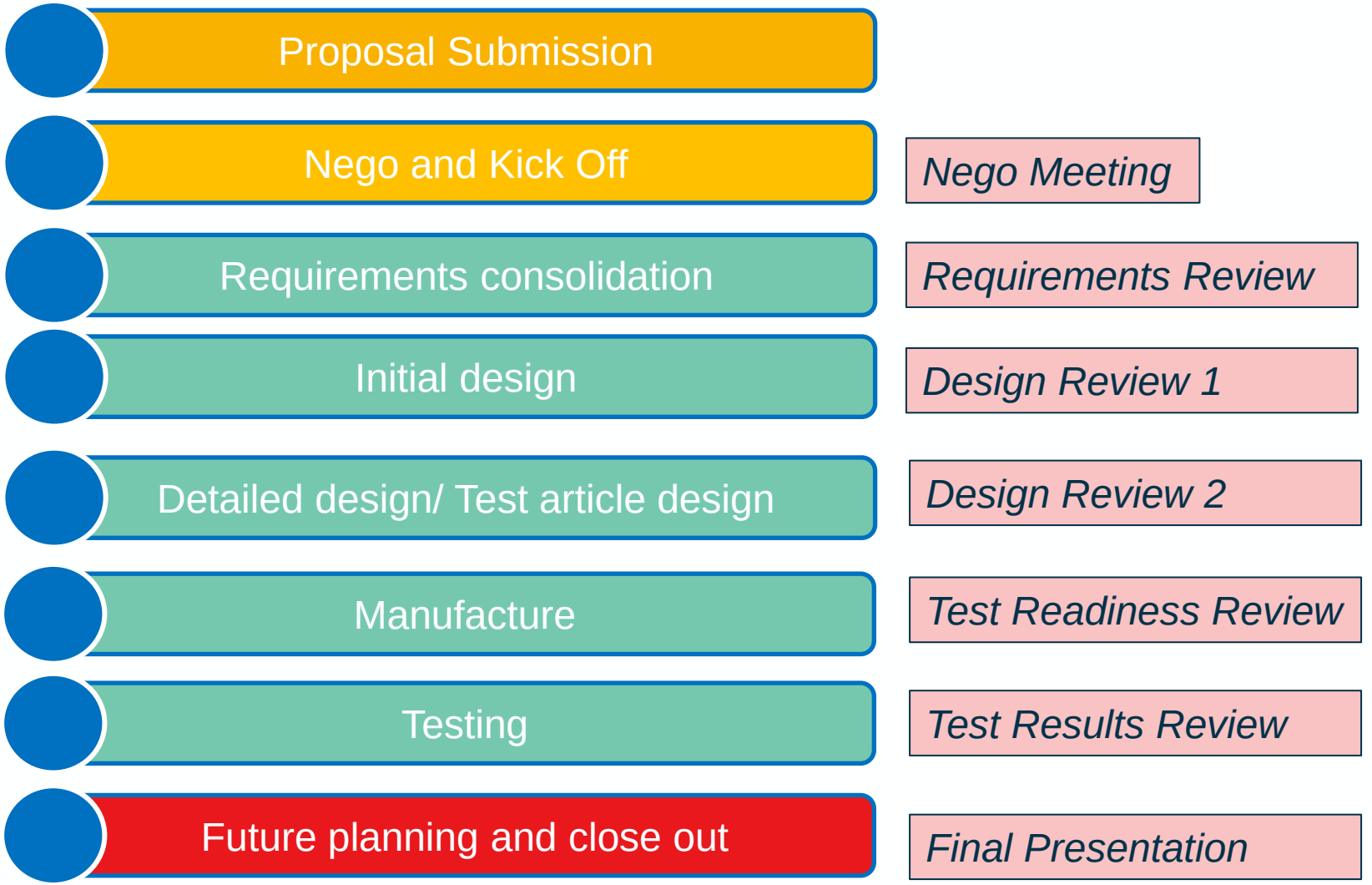


REVIEWS

MDR=Mission Definition PRR=Preliminary req. SRR=System req. PDR=Preliminary design CDR=Critical design	QR=Qualification AR=Acceptance ORR=Operational readiness FRR=Flight readiness LRR=Launch readiness	CRR=Commissioning result ELR=End-of-life MCR=Mission close-out

Ref.: ECSS-M-ST-10C Rev.1

ESA (Generic) Technology Development Project Phases



Ref.: ECSS-M-ST-10C Rev.1

This is a typical (generic) project phasing for ESA technology development activities.

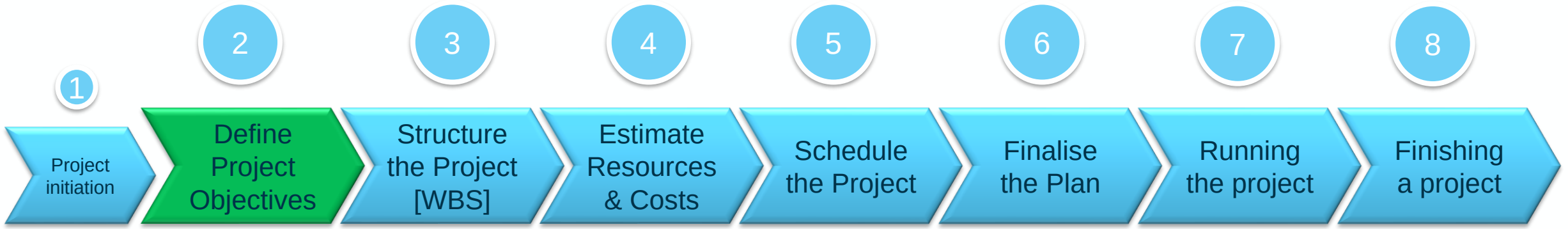
Each review essentially enforces a minimum of project management from ESA side: Reporting and reviewing progress, assessing risks, identifying changes, replanning and moving forward.

Each step typically is more expensive than the last or involves actions making it more difficult to correct issues arising.

> Defining project objectives

Preparing a project: Idea to Contract Signature

Project Planning



First Step: The mission statement

Without an objective (Goal) to be reached, there is no project.

Having a clear objective to be achieved (and a clear understanding of why) is the only way to ensure that project can be properly planned.

The goal should be defined clearly in the Mission Statement before any other work is done. Any project should have only ONE mission statement.

A good Mission Statement: *States, clearly and in simple terms, what must be achieved at the end of the project.*

A good Mission Statement: *Enables a competent PM and engineer to derive all requirements, needs and constraints and plan the project logically.*

A good Mission Statement: *Does **NOT** list the work to be done or steps to be taken – only the highest level result to be achieved and key constraints.*

Goal, Objective and Mission Statement are used synonymously here.

Example Goal Statement

"I believe that this nation should commit itself to achieving the goal, before this decade out, of landing a man on the moon and returning him safely to the earth."

President John F. Kennedy, Congress on May 25, 1961

Exercise 1: Mission Statement – Make your own !

You and your guests are thirsty, they want a hot beverage. Write a mission statement for this mini-project. You have 5 minutes

Exercise 1

www.menti.com

Exercise 1: Mission Statement – A possible answer

You and your guests are thirsty, they want a hot beverage. Write a mission statement for this mini-project. You have 5 minutes.

Our attempt:

Each guest shall be provided with the hot beverage of their choice within 5 minutes of being asked.

The Project Plan: A Tool

The project plan, also called project management plan, answers the who, what, where, why, how and when of the project.

For ESA technology activities, the proposal requires a short summary of this – it is partially to show you have done the proper project planning

The purpose of a project plan is to guide the execution and control project phases.

A means of modelling, communicating, measuring progress, anticipating and avoiding problems

The plan is NOT the project

The Plan: A model of what you want the people to do

PM gets everyone to stick to the plan

The Project: people doing those things in the real world

PC gives feedback leading to adapt the plan

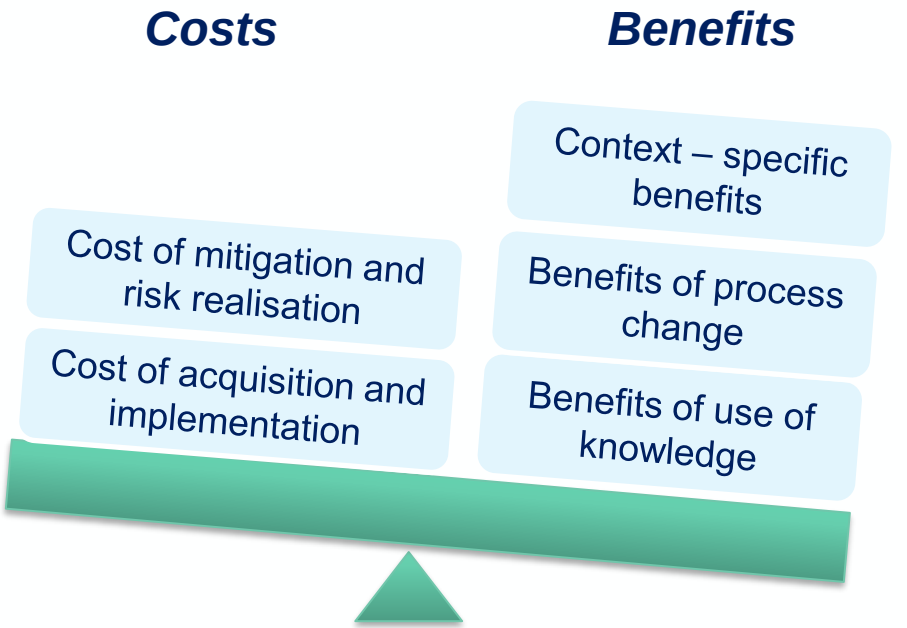
Analysing the “new” Project – Key Questions

1. **The Source of the Project**
   - Is the Goal/ Idea/ Mission Statement Clear?
   - Who is it for?
2. **Project Requirements**
   - What is really needed to meet the objective? Do you know them all?
   - Are the technical requirements clear? Are they measurable?
3. **Project Constraints**
   - Limits and trade-offs between scope, cost and time: Which is the driver?
   - Are there fixed constraints, geographical constraints, etc?
4. **Resources**
   - Type of resources needed (human, tools, facilities)
   - Do you have them available? Who will pay for what?
   - Will the resource be available when needed?
   - Will human resources have the correct experience?
   - Will training be needed?

Cost/Benefit assessment

Feasibility and costs of project should be assessed before project proceeds:

- Technical knowledge and tools
- Organisational and human resources
- Regulatory
- Scheduling
- Investment needs (tools, infrastructure)



Benefit of a project should also be assessed

- Income and profit
- **Knowledge and experience gained**
- **Products and IPR**
- Secondary effects (**customer contacts**, networking, future opportunities)

Cost/ Benefit Analysis is key business decisions: Some projects should never proceed beyond this point !

Project Requirements Documents

Project requirements documents are essential to a successfully planned and managed project.

For ESA activities these are either an integral part of an ITT (Invitation to Tender), or you need to define them yourself as part of your proposal (e.g. Call for ideas/proposals)

A typical ITT will have:

- A Statement of Work (SoW)
  - Management Requirements
  - Standards to be followed (e.g. ECSS)
- Technical Requirements Specifications*
  - Engineering Requirements and standards
- Product Assurance Requirements and standards
- Programmatic Requirements and Constraints

In a typical Call for ideas/proposals you will be guided to develop and provide many of these yourselves as part of the proposal template.

Ref.: ECSS-M-ST-10C Rev.1, Section 4.1.10

*see separate training on requirements

Review Strategic Risks and Assumptions

Start Risk management already at this early stage of the project

- Risk analysis seeks to identify the major uncertainties and assumptions that may affect the project and its environment
- Continuously Monitor and Review all strategic risks throughout the lifetime of project
- A checklist (below) can be used to produce a risk statement very early in the project lifecycle

Strategic Risk Analysis Checklist

- ✓ Project size
- ✓ Technology expertise/dependency
- ✓ Requirements definition/structure/stability
- ✓ Special quality requirements
- ✓ Complexity of the project
- ✓ Organisational issues
- ✓ Project team
- ✓ Third party / contractors / suppliers
- ✓ Customer acceptance
- ✓ Long lead items and inflation

How to analyse the Project Environment for Risk

1. *Identify all the factors that might have an impact on the project (Cost, Schedule, Quality)*
2. *Analyse each factor that you have identified by listing*
   - *What is the impact on the project*
   - *How likely is it to happen*
3. *List the actions needed to manage any impact these factors may have on the project*

Risks are further developed under their own section here

Exercise 2: Cost/benefit

Continuing our beverage project for our guests… Perform the following tasks, you have 10 minutes:

- Task: Identify a cost, and a benefit for your project

Exercise 2

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Exercise 2: Cost/benefit – A possible answer

Continuing our beverage project for our guests… Perform the following tasks, you have 10 minutes:

Task: What is the cost/benefit here?

Each guest shall have the hot beverage of their choice within 5 minutes of being asked.

COST

- *Investment in raw materials*
- *Investment in equipment*
- *Time away from your guests*

BENEFIT

- *Income*
- *Profit made*
- *Happy guests*

Exercise 3: Key risks

Continuing our beverage project for our guests… Perform the following tasks, you have 5 minutes:

- Task: Identify key risks for your project

Exercise 3 (key risks)

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Exercise 3: Key risks – A possible answer

Continuing our beverage project for our guests… Perform the following tasks, you have 5 minutes:

Task: Identify key risks

Risk of people getting burnt

Risk of not having what people want – disappointing them

Order is taking too long

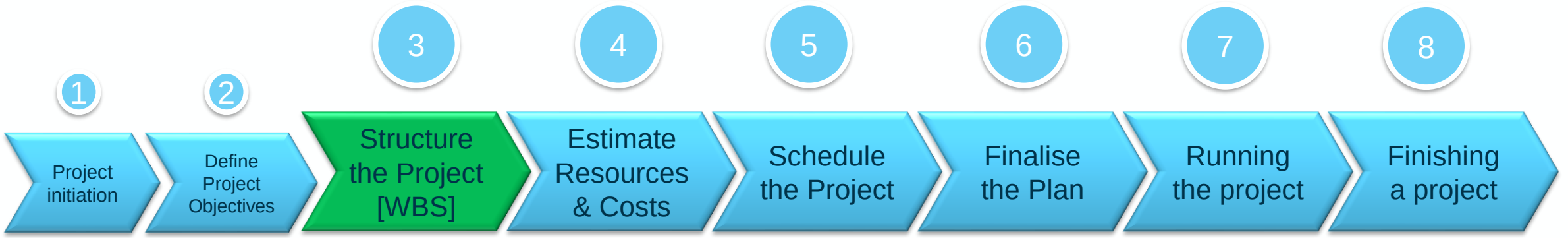
Malfunctioning of equipment

Other risks?

> Structuring the project

The steps in writing a proposal to ESA: See also our proposal writing course

Structuring the project



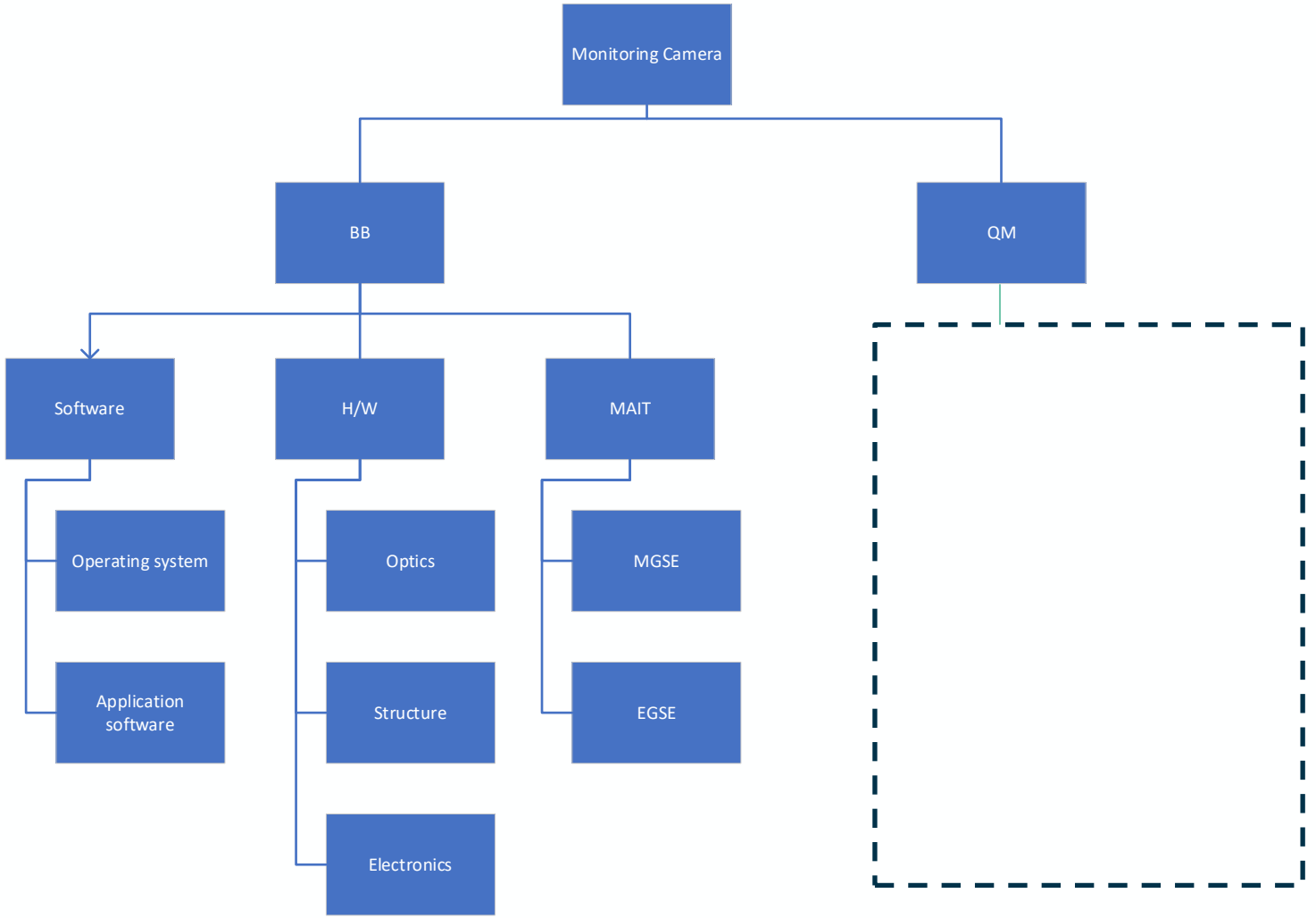
Planning Step 2 - Structuring The Project

ECSS Standard ECSS-M-10C describes different breakdown trees:

- Functional Tree – The function tree is the breakdown of the system into functions. Each function is split further into sub-functions. (can help in the design)
- Specification Tree – The specification tree defines the hierarchical relationship of all technical requirements specifications (needed for larger projects and sub-contracts)
- **Product Tree – The product tree is the breakdown of the project into successive levels of hardware and software products or elements. The product tree includes: the development models, the Ground Support Equipment (GSE), the integration tools and test equipment, and anything else needed.**

The product tree forms the basis for the project work breakdown structure. For many ESA technology development activities you can just focus on this.

Example Product Tree



High level example for a camera

A product tree helps to ensure you don't forget anything!

It also helps you to determine the people and skills you will need

It can form the inputs to a make/ buy plan

In next level you examine what you need to do to produce each box and form your Work Breakdown.

The Work Breakdown Structure (WBS)

The WBS (and associated Work Package Descriptions) is the principal structure used in managing a project and provides a framework for:

- Estimating and managing cost,
- Estimating and monitoring schedule
- Determining teams and responsibilities
- The technical content and deliverables.

- A WBS divides the project into manageable work packages, organized by the nature of the work. It is iterated by further breaking down the total work to be performed into increasing levels of detail until it is at manageable chunks.

The WBS can be derived from the product tree, selected elements of which are extended to include support functions (i.e. management, engineering, product assurance) and associated services (e.g. test facilities).'

The Work Breakdown Structure is the KEY project management element

The Work Breakdown Structure (WBS)

- The WBS breaks the project down by levels into its component parts
- Each level must give an expanded amount of detail (of the level above).
- The lowest level work package gives the individual tasks, to be performed by individuals, teams or contractors. With clear responsibilities for that work.
- Have a consistent degree of detail horizontally where possible
- Each WP and Task identifier must be unique

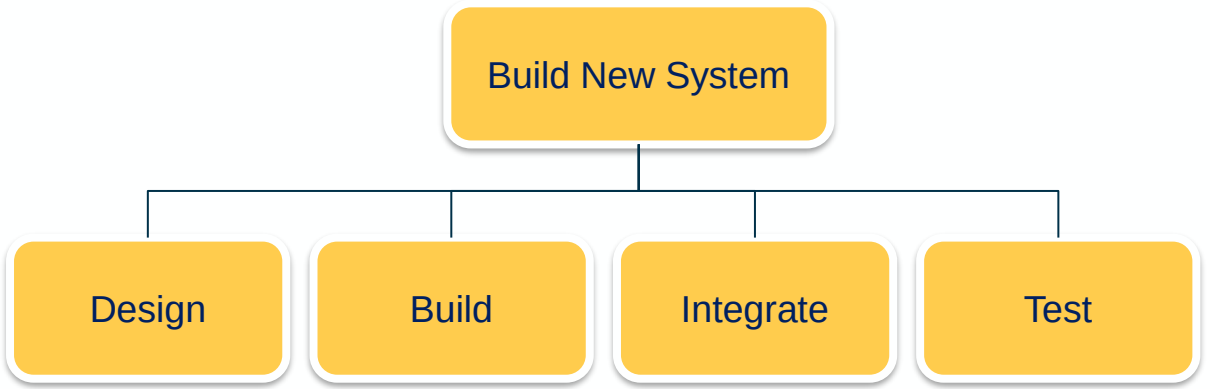
Notes:

Tasks are not put into sequence at this stage. There is no timing implied in the WBS

You will need a higher level of WBS detail for your project planning and management than you show in the ESA proposal.

Creating a new WBS

- Start the process by creating a two- or three-level WBS for the project following the major steps/phases
- Brainstorm ideas for tasks under each heading



Ideas for tasks

…..

…..

…..

…..

…..

Some will be ***discarded***

Some will be ***Tasks***

Some will be ***Sub-Tasks***

Some will be ***activities***

Brainstorming

- Some guidelines:
  - Include as many experienced people as is practical
  - Remind everyone of the objective/ mission statement
  - Do not get into too much detail at this stage
  - Brainstorm down the WBS branches
  - Have a time limit, (Two hours maximum)
- Brainstorming involves the team and provides a sense of **ownership** and avoids forgetting potentially key elements
- Group ideas after to make the next level of Work Packages and repeat if needed

Putting the WBS to work for you…

A structure for the cost estimation

A Cost Breakdown Structure (CBS) is used to estimate the costs.

Easiest manner:

Take the WBS

- *For each Work Package, split out to Task level*
- *For each Task assign cost elements for Manpower, Procurements, Travel*
- *Estimate each separately and add (see later slides for estimation methods)*
- *For each tasks: What are the deliverables expected, inputs needed to produce the deliverables, tangible measures for assessing he performance*

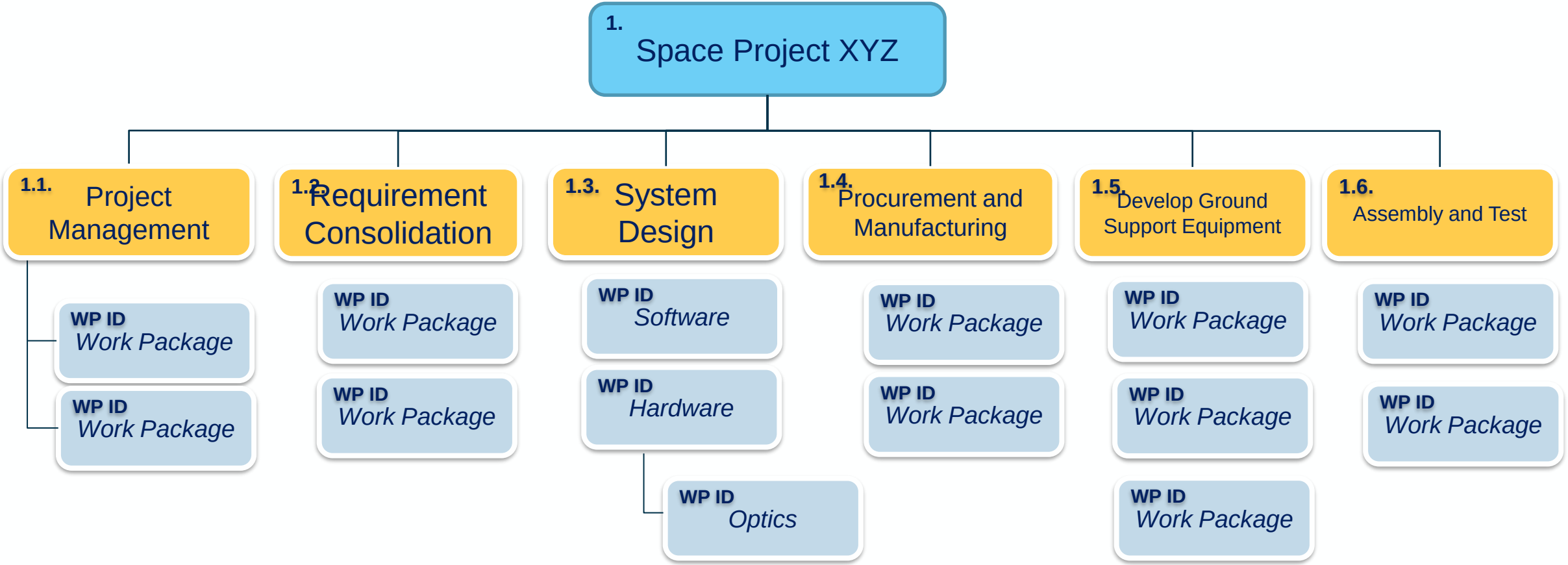
Defining the needed Team

- For each WP: What are the skills and knowledge needed to lead it?
- E.g. The Project Manager needs to:
  - Match experience and ability to tasks
  - Match tasks and availability of people
  - Opportunity for motivation and clear delegation
- Decide **who** is responsible for each WP based on identified needs

Ensuring Manageability

- For each WP:
- What are the dependencies to start or finish the work (e.g. other WP, procurements being delivered…)
- What are the deliverables/outputs expected?
- Are any review points needed?

Example of WBS with single design/build/test cycle



The Work Breakdown Structure establishes clear roles and responsibilities, and allows precise deliverables to be defined in all project domains

Delegating Tasks

- The PM delegates Work Packages to a WP lead. The WP lead is responsible for ensuring all the Tasks of the WP are completed and are correct and on-time and is also responsible for reporting issues, problems and progress to the PM.
- Further, the WP lead should carefully delegate each Task to the most suitable individuals or teams.
- This delegation process should take the form of a "Task Contract". Ideally it should be documented!
- The task should be fully defined. Requirements, budgets, measures should all be established before the work starts so that everyone is clear and knows what is expected of them. They should do no more and no less than what is in the detailed Task description*

- * Note this level of WBS and Task description you need internally but you will need to summarise it in the proposal to ESA.

Exercise 4: Work Breakdown Structure – create your own

Draw up a WBS for the Hot Beverage Project (for the chosen mission statement for).

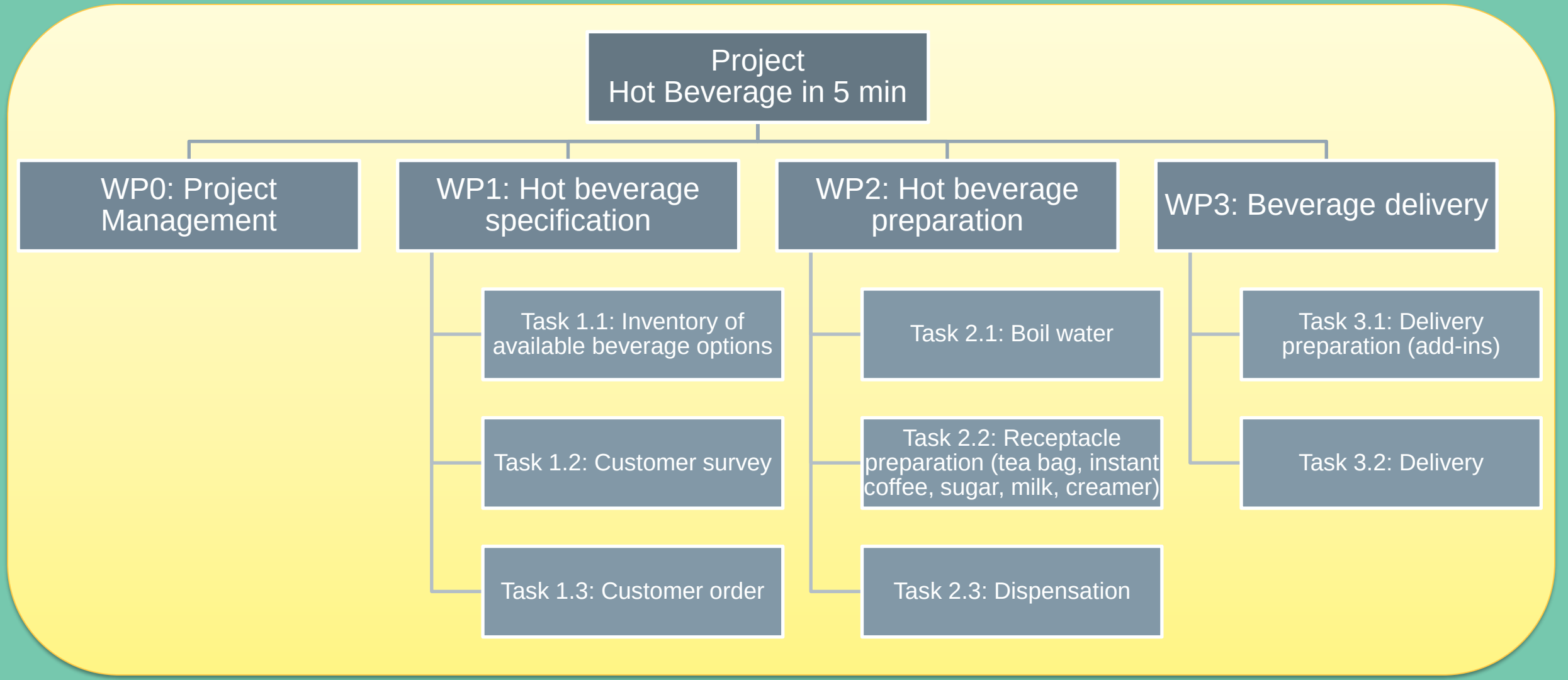
Take it all the way down to individual task level.

Please use provided paper.

Note: You will be using this for later exercises for Planning, Costing and resource allocation, bear that in mind now.

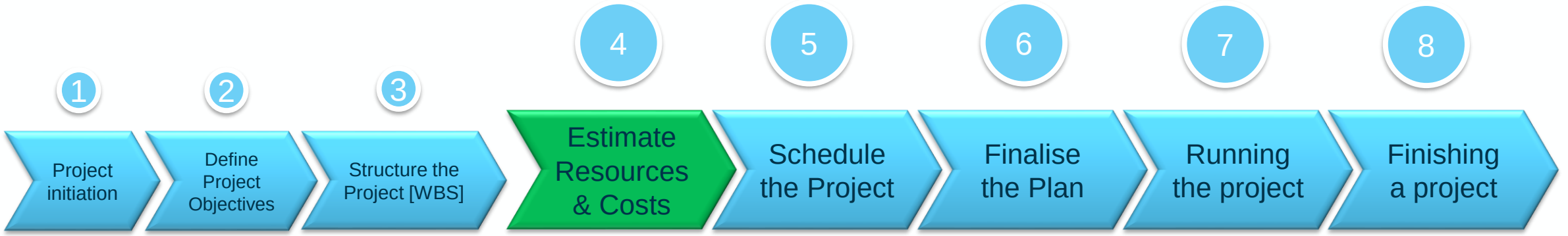
You have 15 minutes.

Exercise 4: WBS - A possible answer



> Estimating Resources & Cost

> Estimating Resources & Cost



The Approach to Estimating

Estimating is a key element in project planning.

It is the stage where many projects set themselves up for failure!

If estimates are done badly, it is not clear whether the implementation failed or whether the estimate was wrong.

Estimating needs good methods and good management

Managing Estimating:

- Be clear about what you are estimating:
  - Duration (May be elapsed time or workdays)
  - Effort (Usually measured in person-hours)
  - Costs (Usually Effort + procurements)

ESA contracts will typically be FFP (firm fixed price) – bad estimation leads to more risk for you

Which Estimating Methodologies do you know?

1. Top-down estimate
2. Bottom-up estimate
3. Expert judgment
4. Comparative or analogous estimation
5. Parametric model estimating
6. **Three-point estimating**

Common Problems in Estimating

- Attitude that projects "always overrun"
- Acceptance by Managers of poor estimating !
- **Estimating for too large a task (insufficient breakdown)**
- **Missing steps/ tasks**
- Top down estimation instead of bottom up
- Failing to account for risk
- Estimates can become a self fulfilling prophecy
- Parkinsons law…
- Not accounting for team structure
- Not accounting for reporting/ documenting
- Not accounting for actions from reviews

Include the Effects of Project Conditions

- The ideal case:
- Small project team (< 7) *[vs large team/ many sub-contracts]*
- Working in the same room *[vs multi site/ teleworking]*
- Working full time on one project *[vs multi-tasking]*
- Clearly defined and challenging project *[vs unclear objective]*
- No sharing of resources/facilities *[vs. Renting test facilities]*
- No procurements *[vs. Multiple procurements of long lead items]*
- No uncontrolled changes *[vs. Dynamic customer environment]*
- Project "protected" by effective sponsor *[vs. Management with other priorities]*
- Rapid decision making process *[vs. Layers of beaurocracy]*
- Team involved in planning and well informed *[vs. Working in the dark]*

Example: multi-site working: - Factors

» *Different time zones*

» *Cultural/ language differences*

» *Different working practises*

» *Shipping and customs logistics*

» *Public holidays / work hours*

» *Sick leave policies*

» *"Not invented here" syndrome*

» *Time and cost of travelling*

» *Keeping people in many locations informed*

Any variation from these conditions must be accounted for, adding uncertainty

Estimating Tools: Why 3-point estimation?

Task	Duration (hr)	Resource (project role)	Rate (EUR)	Total (EUR)
Design	180	Design engineer	€35.00	€6,300.00
Build	250	Manufacturing engineer	€35.00	€8,750.00
Test 1	30	Junior test engineer	€25.00	€750.00
Test 2	60	Senior test engineer	€40.00	€2,400.00
Sign off	10	Project manager	€45.00	€450.00
			TOTAL	**€18,650.00**

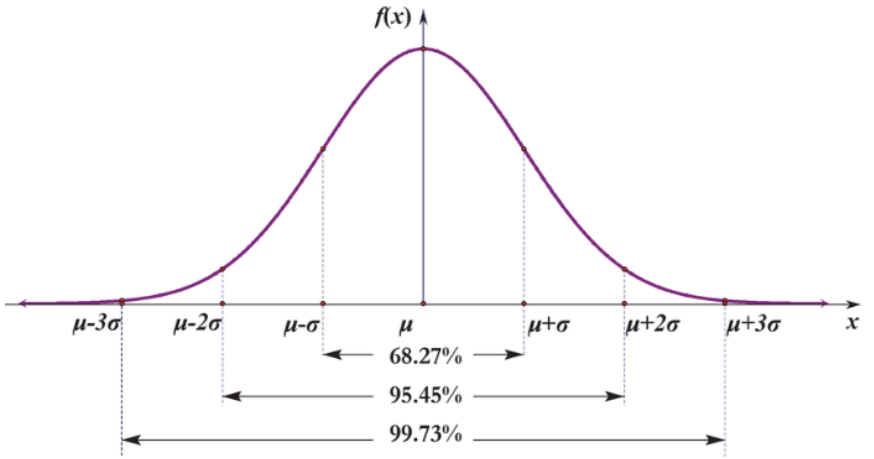
Example of single point estimation

Estimating using ranges:

- A single point estimate is almost certain to be wrong. It is better to determine a "most likely" figure and then to estimate the smallest and largest figure for each task. This also helps with risk
- The more the tasks are broken into small chunks, the easier it is to estimate each element.
- Estimates showing a wide range, or spread, between the smallest and largest figure indicate estimates with a large degree of uncertainty and/or a high risk factor
- These tasks can be targeted to see if the uncertainty can be reduced in any way. For example, the task may be too large and should be broken down further, but a 3-point estimation will help to 'smooth' out such uncertainties.

Three Point Estimate Method (1/2)

1. **Estimate each task**
   - a= smallest
   - m= most likely
   - b= largest
2. **Calculate for each task**
   - $e=\frac{a+4m+b}{6}$
   - $s=\frac{b-a}{6}$
3. **Compute for the whole project**
   - $E=\sum_i e_i$
   - $S=\sqrt{\sum_i (s_i)^2}$



Step 1: You make 3 estimates for each task: Your nominal value, your 'best case' value and your 'worst case' value.
Step 2: The 'expected' value (e) for the task estimate is calculated as the weighted average. The variation is a pseudo sigma value (s).
Step 3: Sum all of the expected values of each task – this is now your overall estimate taking the uncertainties into account. Sum square the sigmas to get the overall estimated variation.

Three Point Estimate Method – Example and handling contingency

Example: Number of hours for Work Package 1 which has 4 Tasks

WP# 1					
Task ID	Best Case	Nominal	Worst Cas	Expected	Sigma
1	35	40	60	*42.5*	*4.2*
2	12	16	32	*18.0*	*3.3*
3	8	8	24	*10.7*	*2.7*
4	100	120	160	*123.3*	*10.0*
			Total	**194.5**	***11.6***
			Best	**182.9**	
			Worst	**206.1**	

This method can be used for costs and for effort. The duration depends on the scheduling of the work – which we will deal with next.

Including Contingency (safety net for unforeseen events)

Technique 1.

- Decide on the contingency needed for each WP. Depending on the perceived risk you can increase or decrease the expected value within the +/- 1 sigma range to arrive at your final value for your estimation.

Technique 2.

- Decide on the total contingency needed and distribute this back across the entire project.

Exercise – Estimation – Make your own

1. *Use the provided excel sheet and the 3-point method to estimate the number of hours for each task in each Work Package of Hot Beverage project.*

2. *Estimate the overall number of hours for each work package and for the entire project.*

3. *Decide on your contingency method and apply it.*

4. *Using an hourly rate of 20 Euro – calculate the expected, maximum and minimum cost.*

We will grab a coffee and take 20 minutes for this exercise

Exercise 5: Effort and Cost Estimation – Make your own

Effort estimation summary and example work package

Workpackage	Total expected	Overall variation	Used value*
xx1	0.0	0.0	
xx2	0.0	0.0	
xx3	0.0	0.0	
xx4	0.0	0.0	
		Total	0.0

Workpackage number	xx1
Title	abc
Estimating	seconds

	Best case	Most likely	Worst case	Expected	psuedo sigma	
Task	*a*	*m*	*b*	*e*	*s*	*s^2*
Task 1.1				0.0	0.0	0.0
Task 1.2				0.0	0.0	0.0
Task 1.3				0.0	0.0	0.0
Task 1.4				0.0	0.0	0.0
		Total expected		0.0		
		Overall variation		0.0		

Exercise 5: Effort and Cost Estimation – Make your own

Cost estimation: total costs, costs per work package and procurement costs summary and example work package

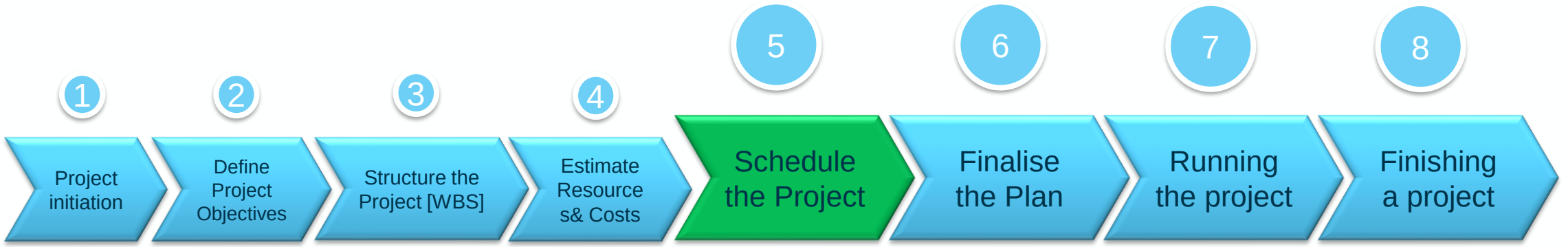
Costs	Total expected
Effort	€0.00
Procurement	€0.00
Total	€0.00

Workpackage	Total expected	Overall variation	Used value*	Cost
xx1	0.0	0.0	0.0	
xx2	0.0	0.0	0.0	
xx3	0.0	0.0	0.0	
xx4	0.0	0.0	0.0	
			Total	€0.00

	Item	Cost per piece	Number	Total cost
1				€0.00
2				€0.00
3				€0.00
4				€0.00
5				€0.00
6				€0.00
7				€0.00
8				€0.00
9				€0.00
10				€0.00
11				€0.00
12				€0.00
13				€0.00
14				€0.00
15				€0.00
			Total	€0.00

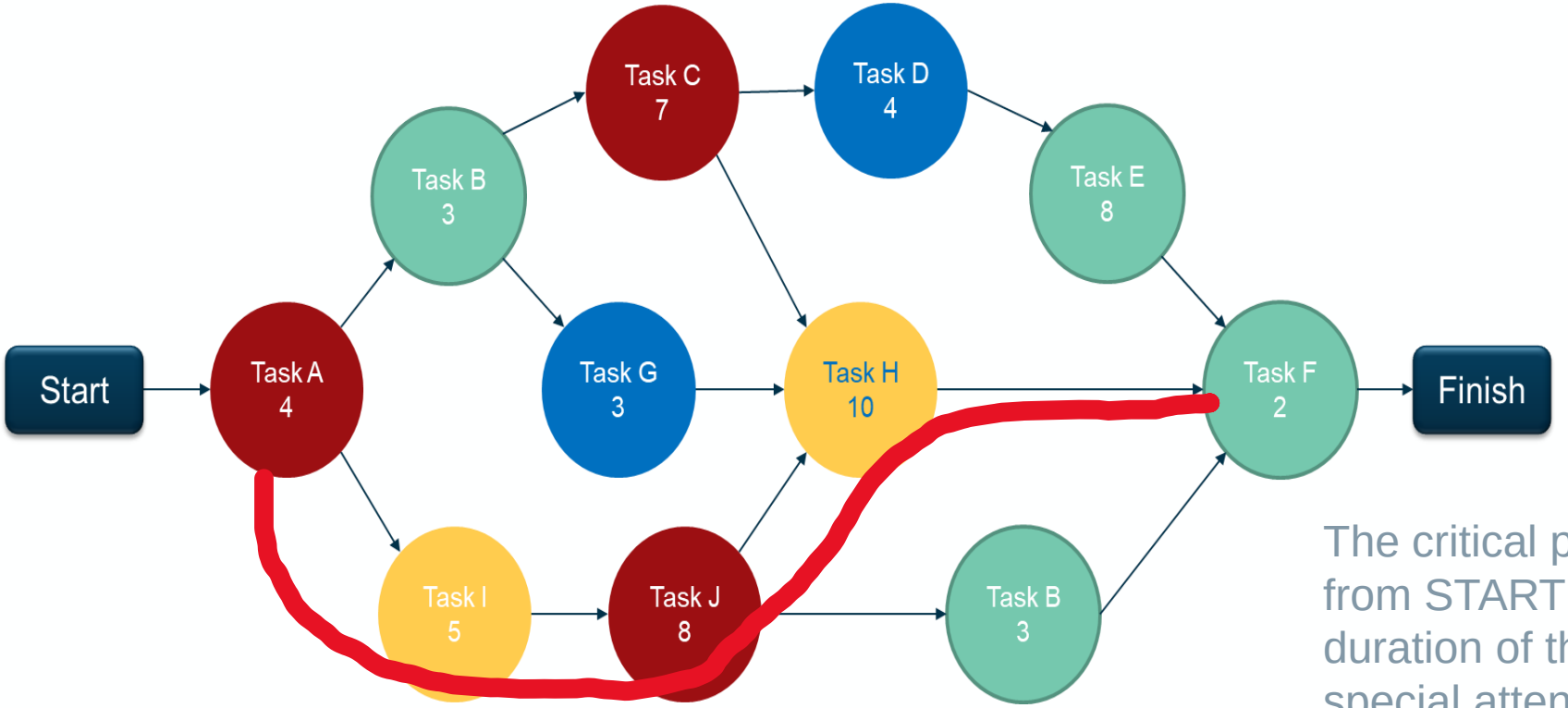
> Project Scheduling & Resource Allocation

> Project Scheduling & Resource Allocation



Network Analysis – PERT diagrams

A PERT diagram takes all the Tasks from the WBS and puts them in a logical sequential order by identifying each tasks dependencies and dependants (predecessors and successors)



The PERT diagram allows the GANTT chart to be assembled, ensures that no steps have been missed and enables to easily find the critical path

The critical path is the longest duration path from START to FINISH. This drives the duration of the project and should get special attention.

(*) PERT – Program Evaluation Review Technique

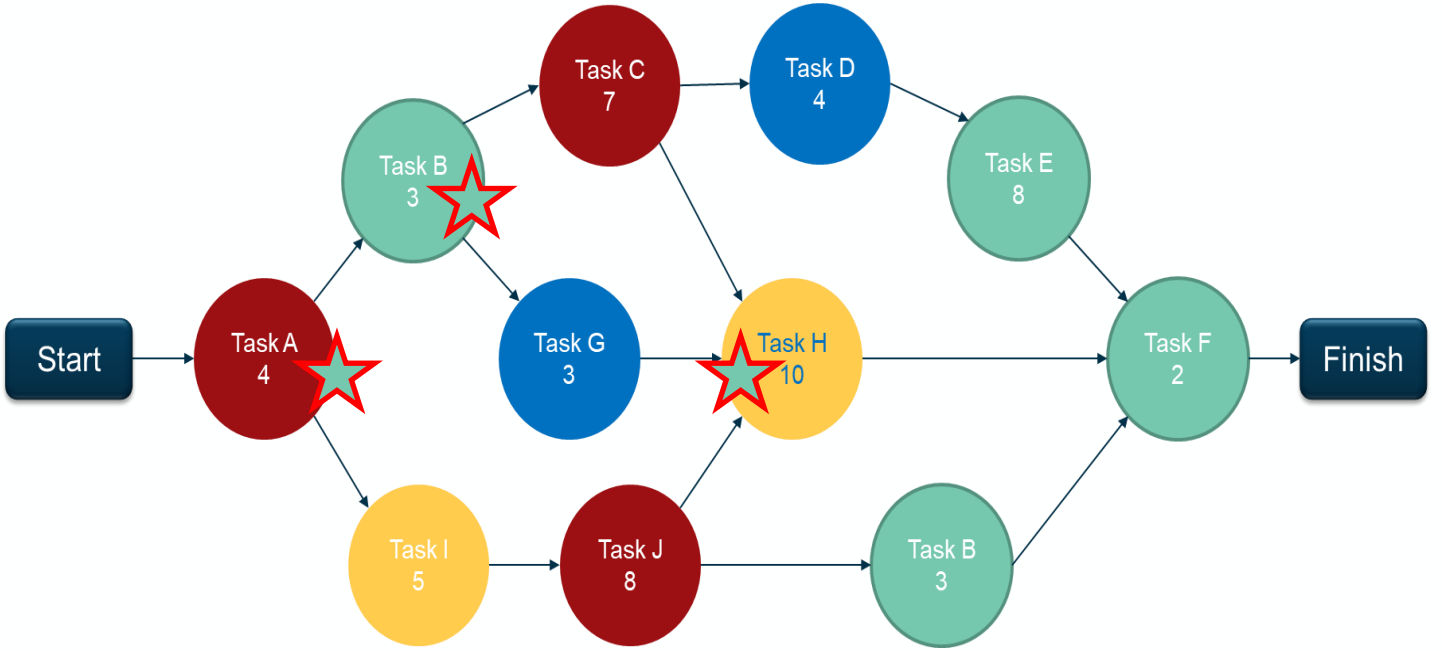
Milestones

The Network diagram should be updated to include a number of Milestones which can be used to evaluate project progress. These can be formal reviews with ESA (e.g. PDR, CDR….) or can be internal milestones marking key points in the project.

Milestones are not only important psychological targets for the project team. They act as early warning markers for the Project Manager to show if progress is on schedule.

Tips for Milestone setting:

- All formal reviews
- Where multiple tasks converge
- Where multiple tasks are dependent on a single previous task
- Attached to a certain deliverable
- End of a WorkPackage
- Start/ End of a project Phase
- Have sufficient that you are never more than 2 months from a milestone or the team's focus will drift.



Exercise – PERT and the Critical Path – Make your own

NOTE: All paths on the PERT will have a certain amount of "float" or "slack“ Float is how long an activity can be delayed without putting off the project completion date and this can be used to ensure a balanced workload for the team.

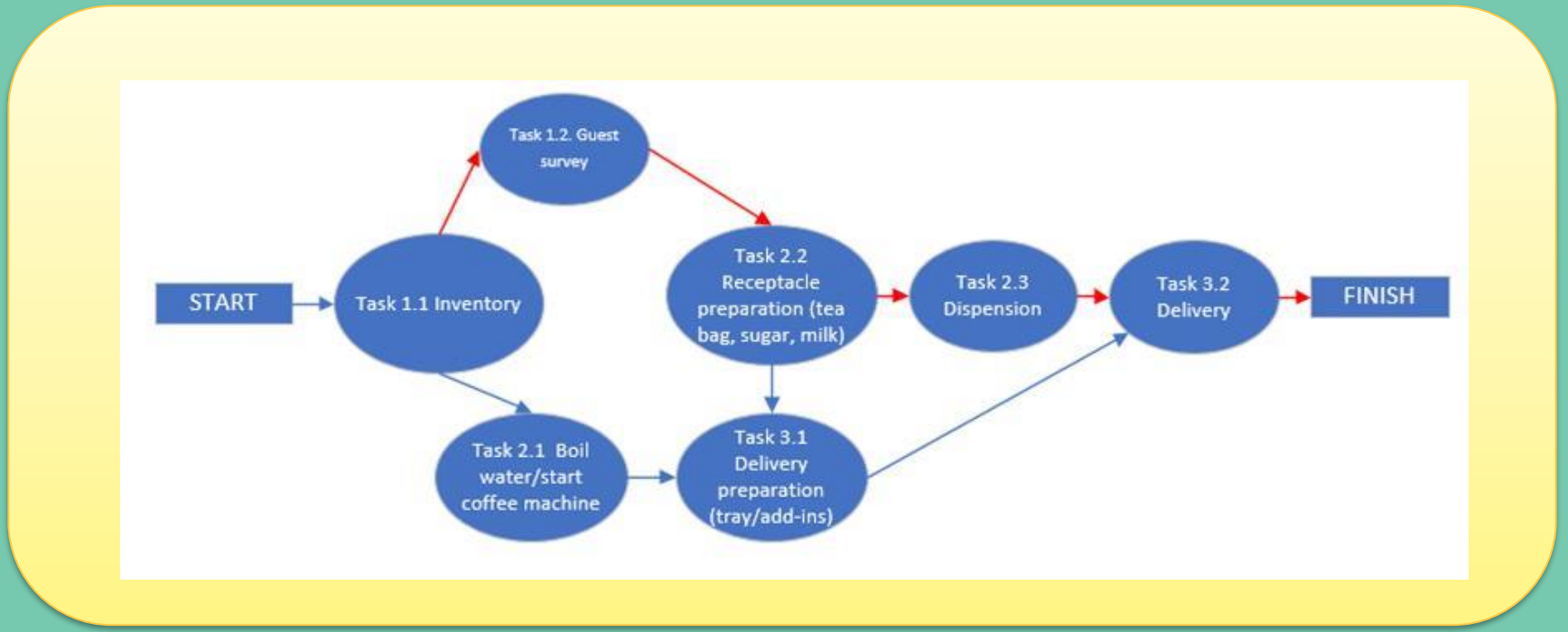
*Use chosen **WBS** from the Hot Beverage project to:*

- *Create a PERT diagram*
- *Determine the Critical Path*

You have 10 minutes to complete the task

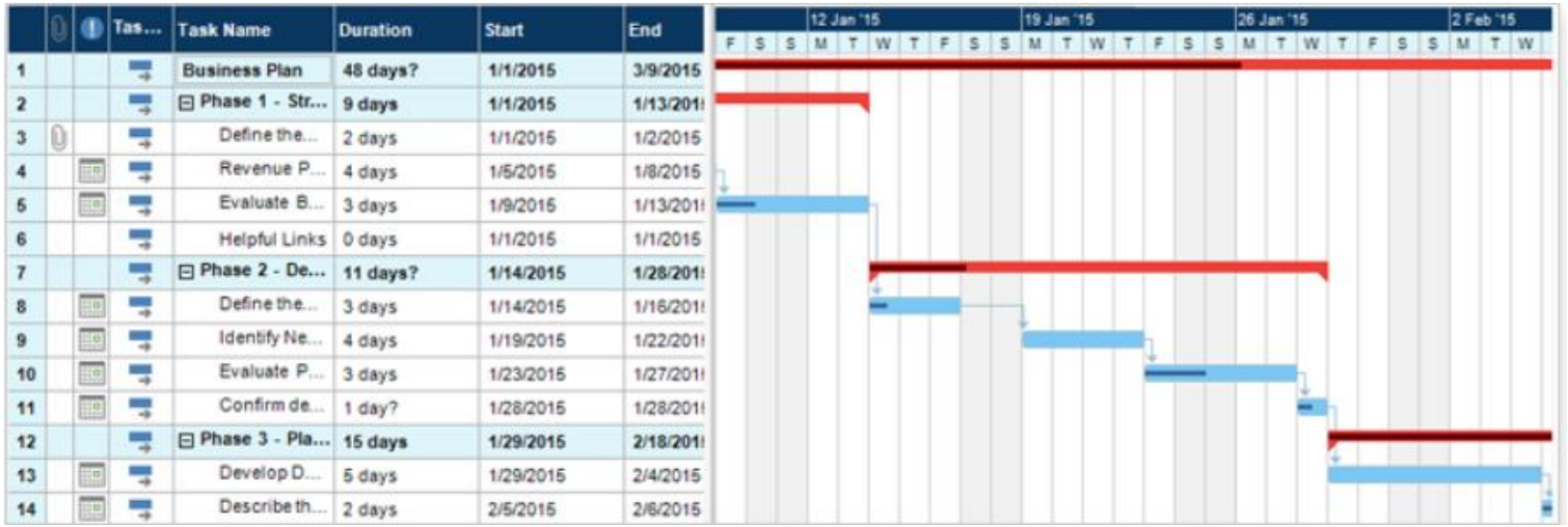
Exercise – PERT and the Critical Path – A possible answer

NOTE: All paths on the PERT will have a certain amount of "float" or "slack“ Float is how long an activity can be delayed without putting off the project completion date and this can be used to ensure a balanced workload for the team.



The GANTT Chart

- The GANTT Chart provides the main way of showing and reporting a schedule.
- Construct your GANTT from your WBS and PERT chart
- The GANTT Chart is the best format for passing information to customers and management.
- Use a specialised tool for this (e.g. MS Project) do not be tempted to think Excel is sufficient.
- Once constructed, save a Baseline and then use the same tool to record (and report) the actual progress
- TIP: in professional tools you enter the data only once and can automatically switch between views for PERT, GANTT, Resource management etc. You can therefore use these tools to build the WBS, PERT and GANTT simultaneously



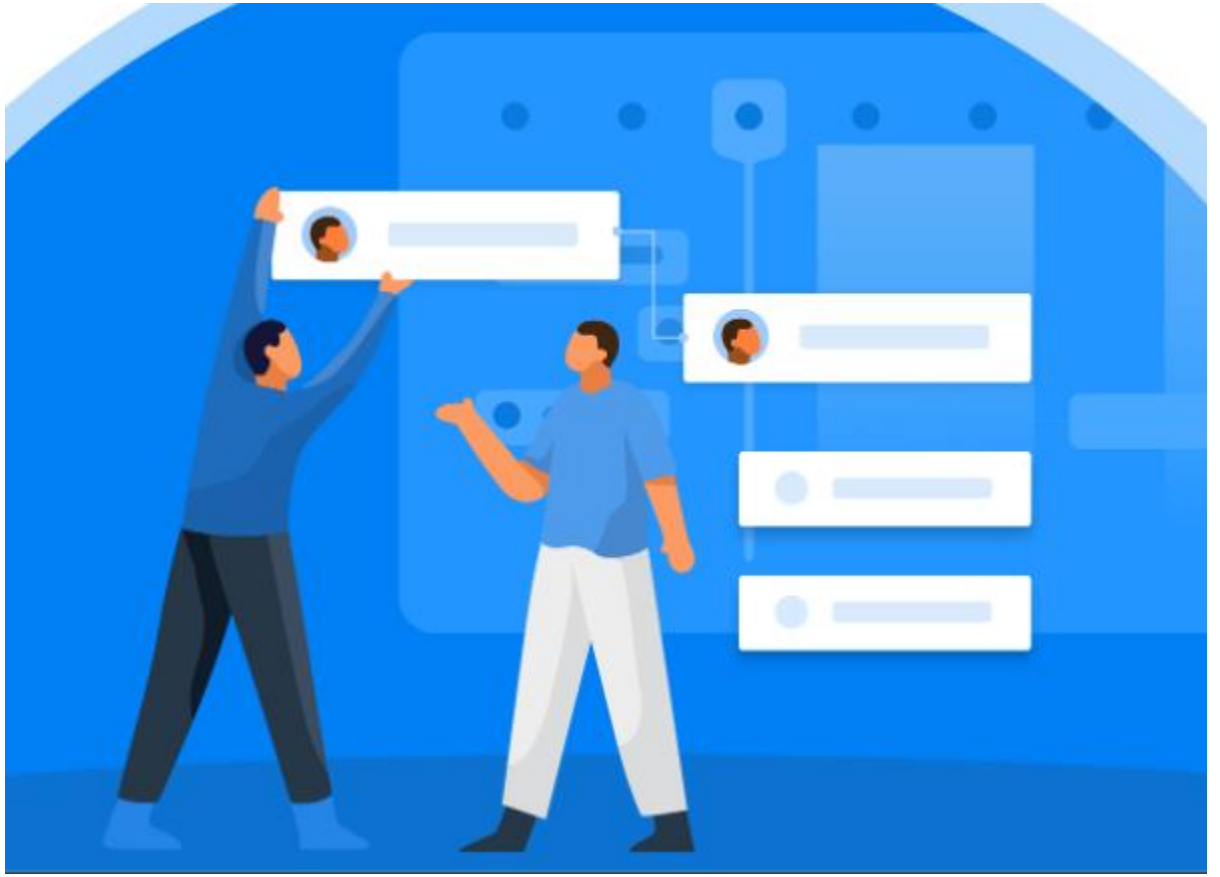
	Tas...	Task Name	Duration	Start	End
1		Business Plan	48 days?	1/1/2015	3/9/2015
2		⊟ Phase 1 - Str...	9 days	1/1/2015	1/13/201
3		Define the...	2 days	1/1/2015	1/2/2015
4		Revenue P...	4 days	1/5/2015	1/8/2015
5		Evaluate B...	3 days	1/9/2015	1/13/201
6		Helpful Links	0 days	1/1/2015	1/1/2015
7		⊟ Phase 2 - De...	11 days?	1/14/2015	1/28/201
8		Define the...	3 days	1/14/2015	1/16/201
9		Identify Ne...	4 days	1/19/2015	1/22/201
10		Evaluate P...	3 days	1/23/2015	1/27/201
11		Confirm de...	1 day?	1/28/2015	1/28/201
12		⊟ Phase 3 - Pla...	15 days	1/29/2015	2/18/201
13		Develop D...	5 days	1/29/2015	2/4/2015
14		Describe th...	2 days	2/5/2015	2/6/2015

Assigning Resources

The Project Manager's job is to make the best fit between the available resources and the project tasks.

When assigning staff consider:

- Availability
- Level of Experience
- Productivity
- Cost
- Past track record



It is important to allocate resources to Tasks and do resource planning. If you do not, you can easily temporarily overload one person – which will then drive the schedule – or leave people with nothing to do as they are just waiting for inputs.

Planning for costs and cash flow

It is very important when planning your project to consider your cash flow needs, a good idea and a good team are very important but always remember that poor/wrong cash flow will fail a project or a company.

Use the PSSA forms to detail your costs (We also provide a proposal writing and a PSS form course)

Ensure milestones payments and advance payments are in line with your cash flow needs so that all your costs are covered at the right time. You get paid when the deliverables are accepted by ESA not when they are delivered.

During the project always check the planned costs vs the actual costs. How much does the plan say we should have spent on the work we have actually done? Compare the actual cost of the work done with the planned cost of work done.

Deviations between actual costs and planned costs for a task will show problems earlier and will make solutions easier or cheaper to implement. More information on ways to achieve this are under the chapter on “running the project”

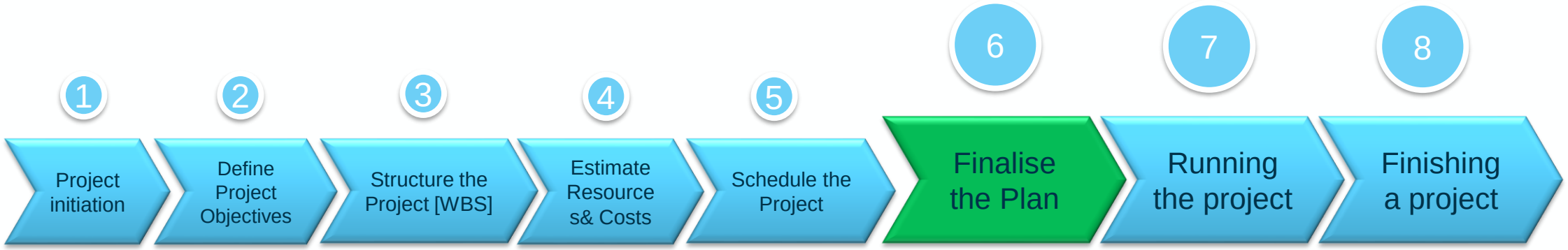
Exercise 7: Gantt chart – Make your own

Use the WPs including their allocated times, together with the PERT diagram to construct the Gantt chart. Pay attention to the dependencies and when each subsequent WP or task may only initiate after completion of the dependent previous WP/task.

You have 10 minutes to complete the task

> Finalise the Plan

> Finalise the plan



Reviewing & Finalising The Plan

When the plan is assembled, it can be reviewed and finalised:

- Which tasks are on the critical path?
- How much float is there on non critical tasks
- Are all the resources available?
- How does the project fit in with other work!
- Can it be completed on time?
- Can it be optimised further?

Check everything is consistent and then re-assess the risks, new ones will have appeared

Risks & Assumptions

All planning involves assumptions, with the risk that the assumption is wrong.

It is vital to identify assumptions and analyse what the risks are and what is the alternative strategy should the risk occur.

Risk Analysis Methodology

Discuss the plan by phases with the team

Key questions to ask for each major task:

- What are the external dependencies? (information from other tasks, subcontractors, deliveries from suppliers, information from the customer etc.)
- What are the internal dependencies? (key staff, facility availability, training etc.)
- What can go wrong in each case?
- What is the probability of it happening?
  - If it does go wrong what is the impact!
  - What is your backup plan/ what are the alternatives?

Specific Risks To Watch For:

- Too many new concepts, or new technologies being implemented at once
- Complex project being developed from zero [better to build up stepwise]
- External dependencies without tight contracts
- Procurements with long delivery times

Risk categorization matrix

Assess each risk:

- Likelihood of occurring (1-5)
  - 1: Never
  - 2: Unlikely
  - 3: Possible
  - 4: Likely
  - 5: Almost Certain
- Impact (severity) on project if it occurs (1-5)
  - 1: No impact
  - 2: Minor Cost or Schedule impact
  - 3: Cost and/or Schedule impact and/or Scope impact
  - 4: Significant Cost/Schedule and/or Scope impact
  - 5: Catastrophic (unable to complete the project)

Very useful way to assess risks:

RED – Don't do it! Find another way

ORANGE – Have a credible backup plan worked out and ready to go, monitor closely and often

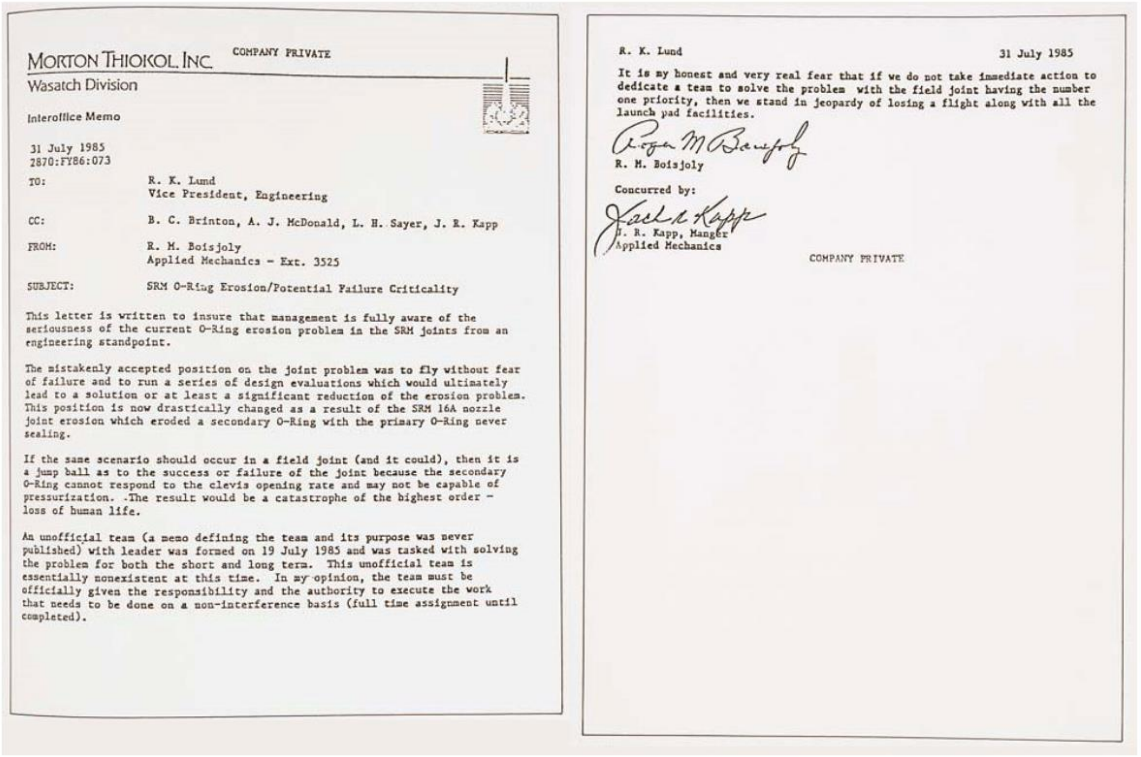
YELLOW – Have thought about alternatives, monitor at reviews

LIGHT GREEN – Reassess at reviews

DARK GREEN – No special measures

L/I	1	2	3	4	5
1					
2					
3					
4					
5					

Importance of Risk Management



MORTON THIOKOL, INC. COMPANY PRIVATE
Wasatch Division

Interoffice Memo

31 July 1985
2870:FY86:073

TO: R. K. Lund
Vice President, Engineering

CC: B. C. Brinton, A. J. McDonald, L. H. Sayer, J. R. Kapp

FROM: R. M. Boisjoly
Applied Mechanics - Ext. 3525

SUBJECT: SRM O-Ring Erosion/Potential Failure Criticality

This letter is written to insure that management is fully aware of the seriousness of the current O-Ring erosion problem in the SRM joints from an engineering standpoint.

The mistakenly accepted position on the joint problem was to fly without fear of failure and to run a series of design evaluations which would ultimately lead to a solution or at least a significant reduction of the erosion problem. This position is now drastically changed as a result of the SRM 16A nozzle joint erosion which eroded a secondary O-Ring with the primary O-Ring never sealing.

If the same scenario should occur in a field joint (and it could), then it is a jump ball as to the success or failure of the joint because the secondary O-Ring cannot respond to the clevis opening rate and may not be capable of pressurization. The result would be a catastrophe of the highest order - loss of human life.

An unofficial team (a memo defining the team and its purpose was never published) with leader was formed on 19 July 1985 and was tasked with solving the problem for both the short and long term. This unofficial team is essentially nonexistent at this time. In my opinion, the team must be officially given the responsibility and the authority to execute the work that needs to be done on a non-interference basis (full time assignment until completed).

R. K. Lund 31 July 1985

It is my honest and very real fear that if we do not take immediate action to dedicate a team to solve the problem with the field joint having the number one priority, then we stand in jeopardy of losing a flight along with all the launch pad facilities.

R. M. Boisjoly

Concurred by:

R. R. Kapp, Manager
Applied Mechanics

COMPANY PRIVATE

Letter from employee to the company's vice president, highlighting the issue and anticipating the disaster in July 1985.

Space Shuttle Challenger before and shortly after explosion, January 1986

Exercise 8: Risks

Continuing our beverage project for our guests… Perform the following tasks, you have 10 minutes:

Identify risks, categorize them and identify appropriate actions

Very useful way to assess risks:

RED – Don't do it! Find another way

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YELLOW – Have thought about alternatives, monitor at reviews

LIGHT GREEN – Reassess at reviews

DARK GREEN – No special measures

L/I	1	2	3	4	5
1					
2					
3					
4					
5					

Exercise 8: Risks – A possible answer

Continuing our beverage project for our guests… Perform the following tasks, you have 10 minutes:

Identify risks, categorize them and identify appropriate actions

L1/I5 if it's too fast people can get burnt

L4/I1 It might increase the caffeine addiction and increase overall cost of coffee procurement

Very useful way to assess risks:

RED – Don't do it! Find another way

ORANGE – Have a credible backup plan worked out and ready to go, monitor closely and often

YELLOW – Have thought about alternatives, monitor at reviews

LIGHT GREEN – Reassess at reviews

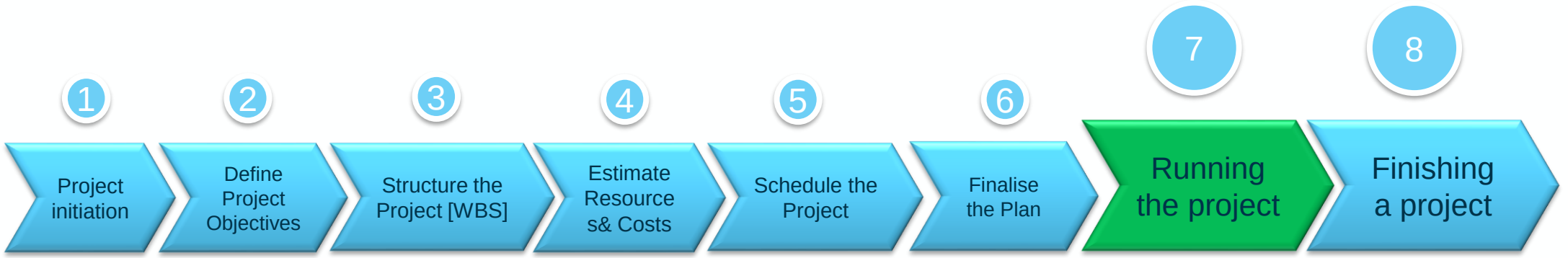
DARK GREEN – No special measures

L/I	1	2	3	4	5
1					
2					
3					
4					
5					

> Running the Project & Managing the Change

Delivering what you promised, on time and on cost. Not delivering more.

> Finalise the plan

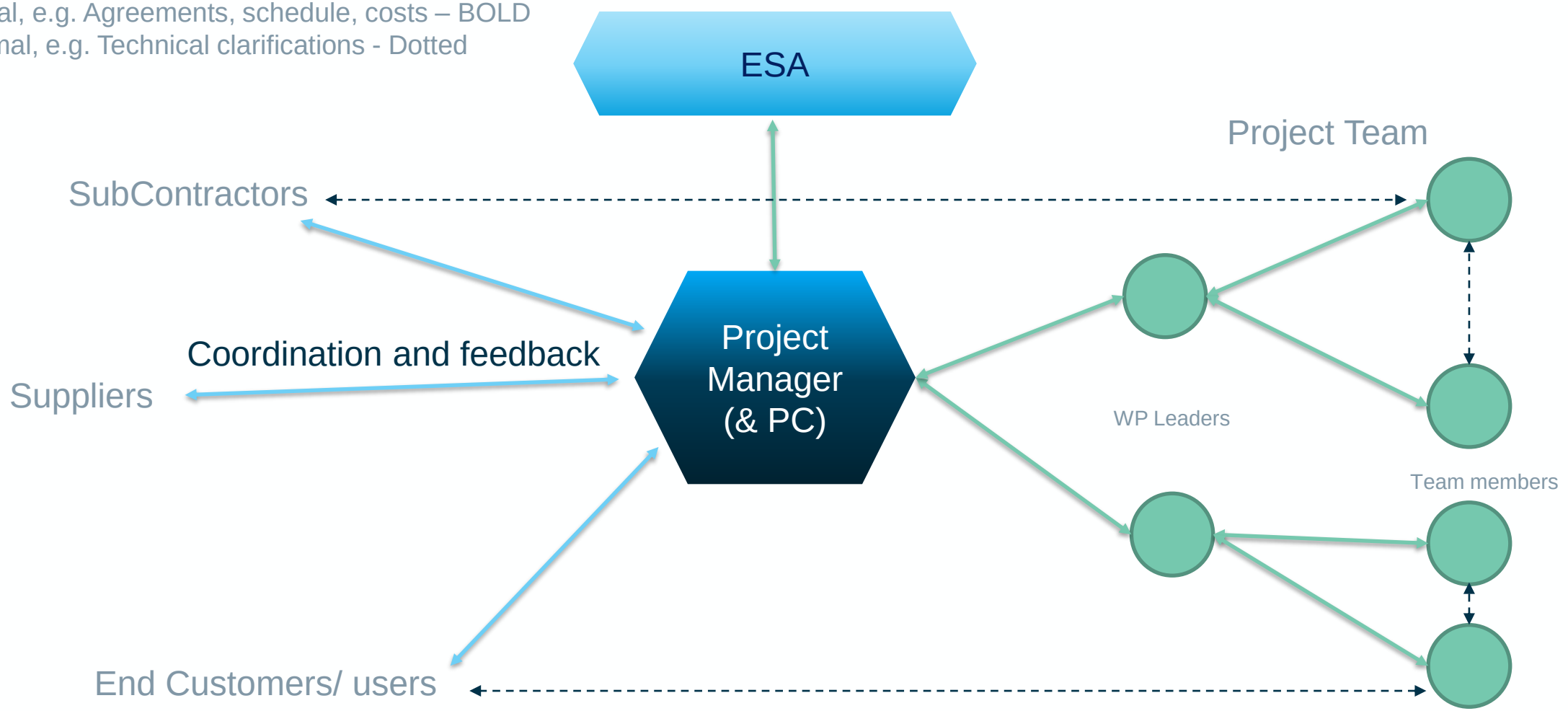


Important tasks in running a project

- Coordinating
- Reporting
- Monitoring
- Problem solving
- Managing changes

Coordinating - Project Information Flows

Formal, e.g. Agreements, schedule, costs – BOLD
Informal, e.g. Technical clarifications - Dotted



Coordinating

The project manager should ensure that work package managers do the tasks in the right order with the right priorities.

The work package managers make sure the staff know their daily tasks, priorities and deadlines.

Give priority to what is on the critical path (see project scheduling)

Fit tasks that have float around the priority tasks.

Internal reporting:

Reporting back from staff and work package managers may lead to changes in work packages or priorities.

Progress Reporting

Progress reporting is at 2 levels: Regular formal reporting to ESA and Internal reporting. Internal reporting should be sufficient for the PM and PC to be able to monitor:

- Is the schedule being maintained, in advance or delayed
- Have any unforeseen/ unplanned events taken place
- Are the costs in line with expectations
- Are there any technical issues arising that might affect cost, planning or scope
- Have any of the foreseen risks materialised or removed, are there any new risks

Don't shoot the person who brings bad news …if you shoot anyone, shoot the person who doesn't bring the bad news!

PM needs all bad news – and FAST. The faster you react the less the impact.

PC needs regular statistics and statuses

Progress reporting does not need to be a big overhead – fit the type and frequency to the project

- Written reports on a fixed period (e.g. Weekly, monthly – see next slide)
- Written reports triggered by events (e.g. unexpected problem)
- Oral reports during scheduled progress meetings
- Informal over coffee (try to avoid relying on this!)

The project team is responsible for continuous monitoring and control of progress

Reporting - Keeping The Customer Informed

- The Project Manager must keep the customer informed of progress
- Avoid announcing late surprises on delays or costs – inform early!
- Withholding information prevents the customer from rescheduling resources and activities
- Withholding information damages relationships!
- Customers may have to be persuaded to attend progress meetings

Reporting tips

Internal regular written progress reports – set up an easy to use template e.g. :

- Status per task (Red, Amber, Green)
- Progress vs. planned (deviations only – more or less + why)
- Tasks next Period
- Issues / Concerns/ Risks arising (e.g. waiting for info, X is none responsive, equipment X broke, idea didn't work…)
- Procurement status and costs
- Save all in a central place for PC and for reference.

Reporting to ESA

- Have formal written regular (e.g. monthly) report to ESA with agreed contents
- Inform ASAP about unexpected issues arising that may affect scope, cost or schedule. This brings customer on-board the decision process and can help share risk. ESA is an understanding and helpful (usually!) customer if involved early.

Internal progress meetings

- Have clear purpose of the meeting and clear agenda
- Keep them short and to the point
- Can be useful to unblock communication issues and align priorities of WP managers
- Write Minutes to record all decisions and key information – save in central place for PC.
- Ensure resulting actions are acted upon and inform of the outcomes (use an action list tool)

Event driven and Ad-hoc reporting

- Have a clear process – what events/ issues should generate an ad-hoc report and at which level
- Keep verbal first
- If impacting cost, scope or schedule or needing customer notification – write it up.
- The ECSS NCR process can be a useful reference for this and very effective tool

Reporting - Organization and conduct of reviews

ECSS-M-ST-10-01C – Organization and conduct of reviews

This Standard provides means for preparing for and running project reviews. It provides a **check–list** of activities and information required for each of the project reviews identified in the ECSS Management Standards.

Plan for the reviews:

- Document delivery 2 weeks before
- Receive ESA Review Item Discrepancies (RIDS = Comments!)
- Read and reply to the comments
- Hold the review, discuss comments and replies, agree on actions (extra work, document updates, re-work)
- Ensure all is captured in Minutes of Meeting and they are signed
- Perform the actions
- Close out the review

Many people forget to budget time and effort for reviews – it is not just one day. Deliverables (and the review) have to be accepted by ESA as being Complete and Correct BEFORE you can be paid.

Most actions will be considered normal work. But some actions may result in additional work outside your current contract – ask for a CCN for this

Typical Reviews in a development activity

RR = Requirements Review
CR = Concept Review
PDR = Preliminary Design Review
CDR = Critical Design Review
TRR = Test Readiness Review
TRB = Test Review Board
FR = Final Review

Project Deliverables

- **Deliverables to the customer (ESA)** by the project:
  - **During the project:**
    - **Documentation for reviews** (design descriptions, Technical analysis, Interface control document etc..)
    - **Progress reports**
    - **At the end of the project** (Final reports, presentations and HW/SW)

The list of project deliverables should be carefully defined and documented. It forms a key part of the contract with your customer

- **Deliverables internal to your company** (Progress reports, Technical exchange documents)
- **Deliverables provided by subcontractors or suppliers**: This list may include:
  - Parts
  - Equipment
  - Software
  - Documentation

Maintain a document list **up to date** to reflect the status of each document (delivered ?, Version ?, accepted ?)

Monitoring

- This is where project controller and project manager work is intertwined
- Monitor your planned costs, currently predicted costs vs your actual costs
- Monitor the planned duration, currently predicted duration vs the actual duration of tasks
- Monitor planned, currently predicted and actual dates of milestones
- Monitor completed tasks, remaining efforts and remaining tasks

Based on the reporting the project controller constantly updates the predicted costs, duration and planning to be able to alert the project manager.

Consequently the project manager should reassess the impacts in the priorities of the upcoming work.

Doing this regularly will help you run the project smoother and solve issues faster and/or cheaper.

Monitoring - Why is Project Control important during a project?

The project controller will focus on a project's budget and schedule. They will:

- Help with estimates
- Monitor and assess progress reported against the work schedules
- Ensure a system to book hours to WPs/ Tasks and monitor all spend/costs of the project
- Raise warnings to the PM on schedule and cost trends (or any deviation/anomaly).
- Ensure bills are paid and invoices raised (and paid)

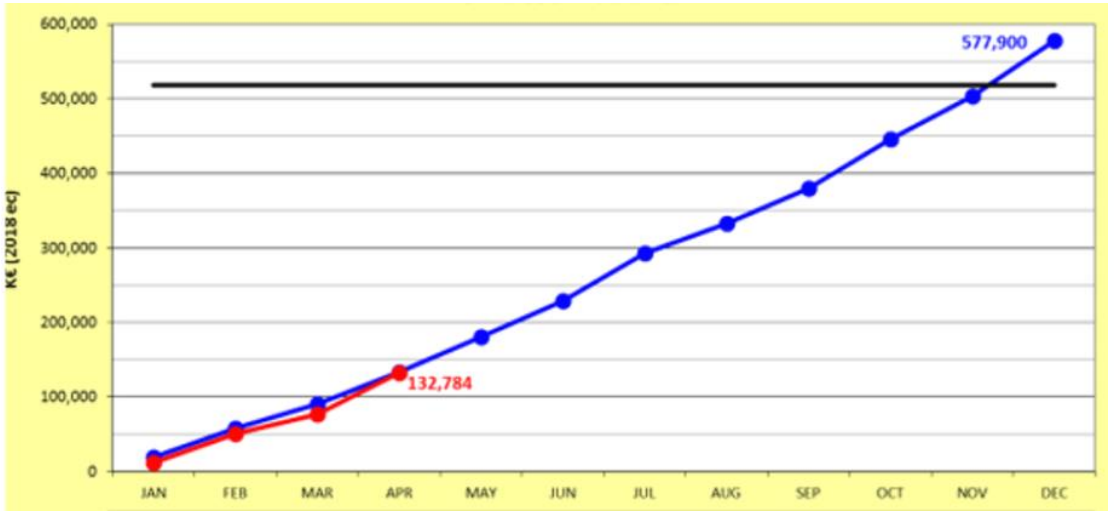
KEY Points:

1. Project control is essential to achieve a project on cost and on time
2. Project control will analyse processes and improve them to be more efficient
3. Project control is in charge of a unified reporting on overall budget, costs control and schedule

A good project controller will gather the data from each task of each project and this will enable you to make better cost and schedule estimates in the future. THIS IS KEY TO SURVIVING.

Monitoring - Comparing Planned & Actual Costs

Planned and Actual Costs should be tracked and variance monitored



Cumulative Planned Cost
Cumulative Actual Cost

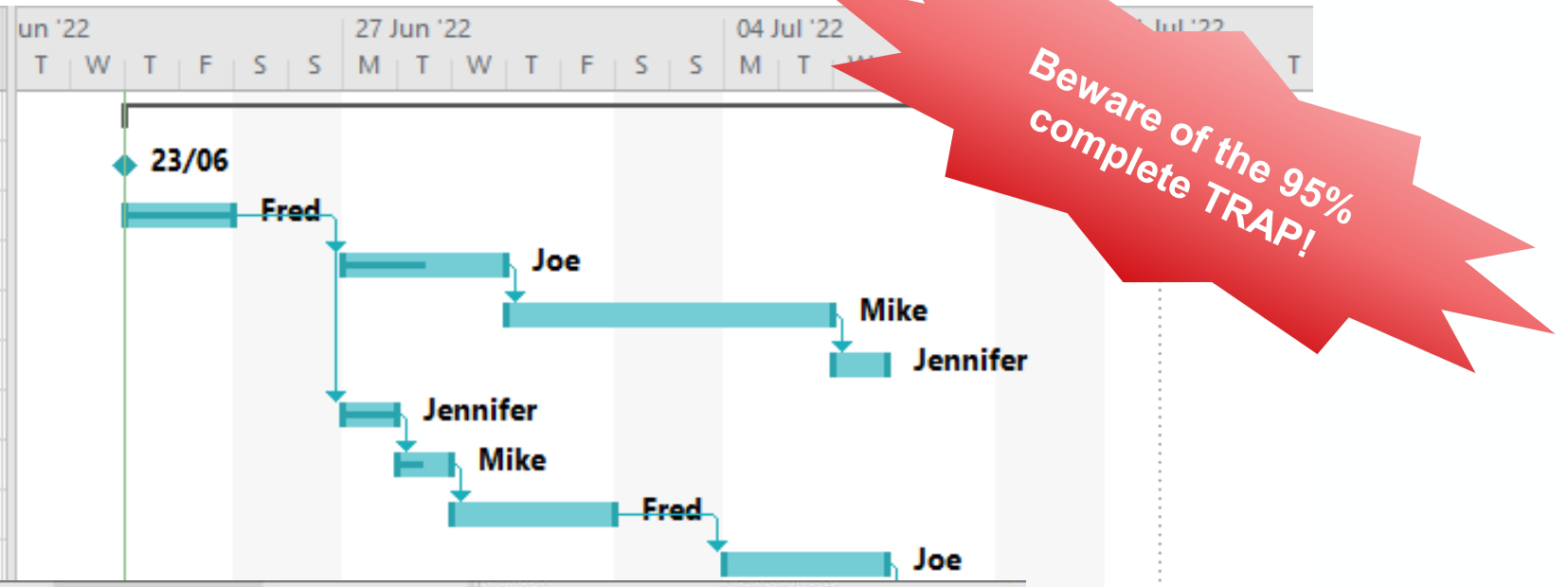
Monthly costs typically peak in the middle of the project
Cumulative costs then follow an “S” curve
This enables the Project Manager to predict when resources will be heavily utilised

This is very important as it will avoid you running into cash flow issues ! Many technically successful companies fail due to cash flow issues

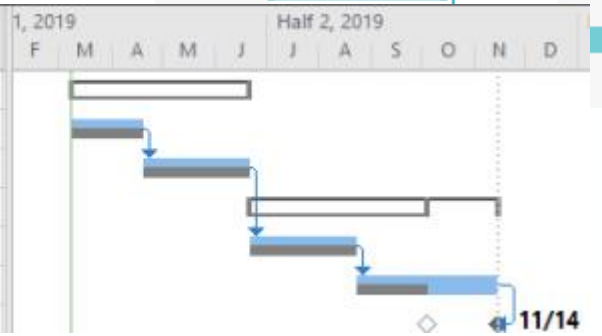
Monitoring - Comparing Planned & Actual Task Duration

Using a good tool (e.g. MS Project) makes the job significantly easier. The percentage completion for a task can be entered and displayed to show actual progress as the project develops

	Task Name	Duration
1	SAMPLE	13 days
2	Start	0 days
3	Task 1	2 days
4	Task 2	3 days
5	Task 3	4 days
6	Task 4	1 day
7	Task 5	1 day
8	Task 6	1 day
9	Task 7	3 days
10	Task 8	3 days



Task Name	Duration	Start	Finish	Baseline Start	Baseline Finish
Phase 1	75 days	3/8/2019	6/20/2019	3/8/2019	6/20/2019
Task A	30 days	3/8/2019	4/18/2019	3/8/2019	4/18/2019
Task B	45 days	4/19/2019	6/20/2019	4/19/2019	6/20/2019
Phase 2	105 days	6/21/2019	11/14/2019	6/21/2019	10/3/2019
Task C	45 days	6/21/2019	8/22/2019	6/21/2019	8/22/2019
Task D	60 days	8/23/2019	11/14/2019	8/23/2019	10/3/2019
Milestone E	0 days	11/14/2019	11/14/2019	10/3/2019	10/3/2019



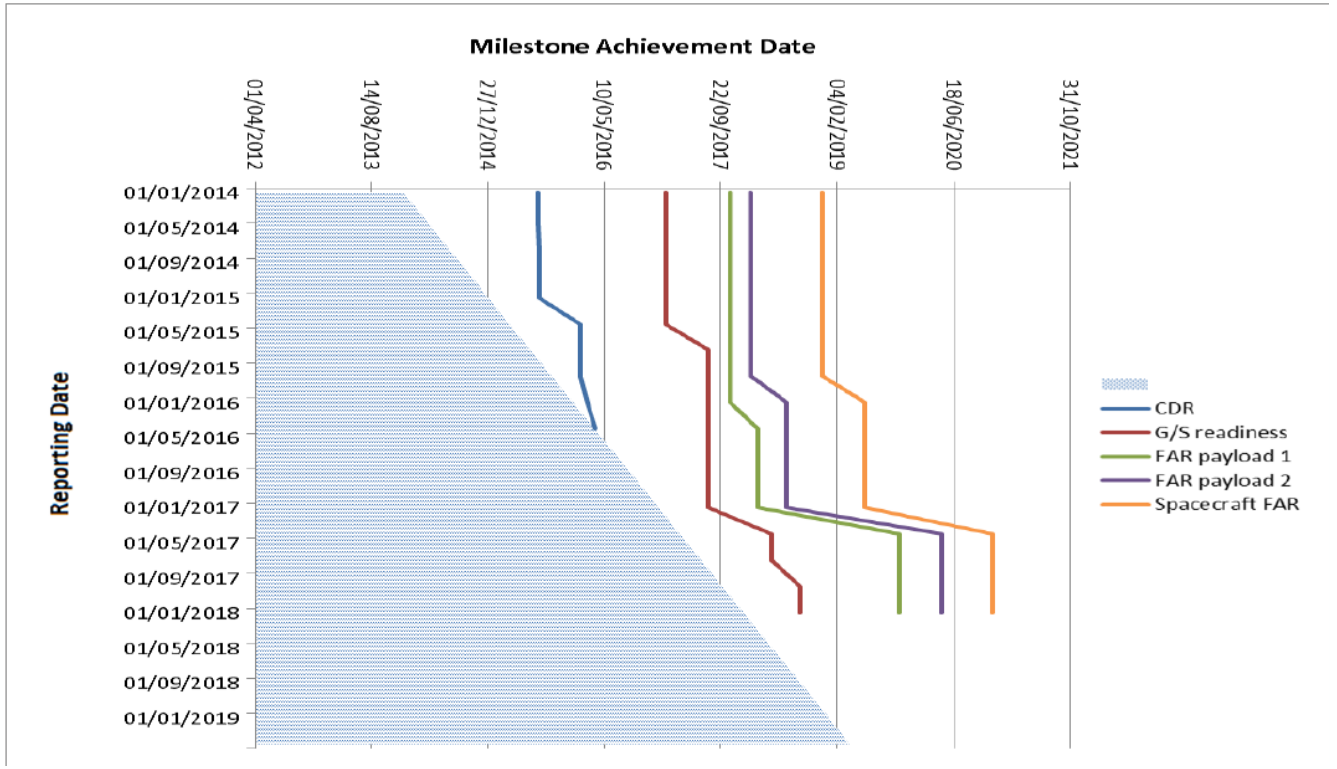
Exercise 9: Final exercise – everything into practice

Put the plan into action…

- Appoint a PM
- Appoint 2 PCs
- Appoint a worker
- Appoint some guests
- Execute, monitor and assess your planned project

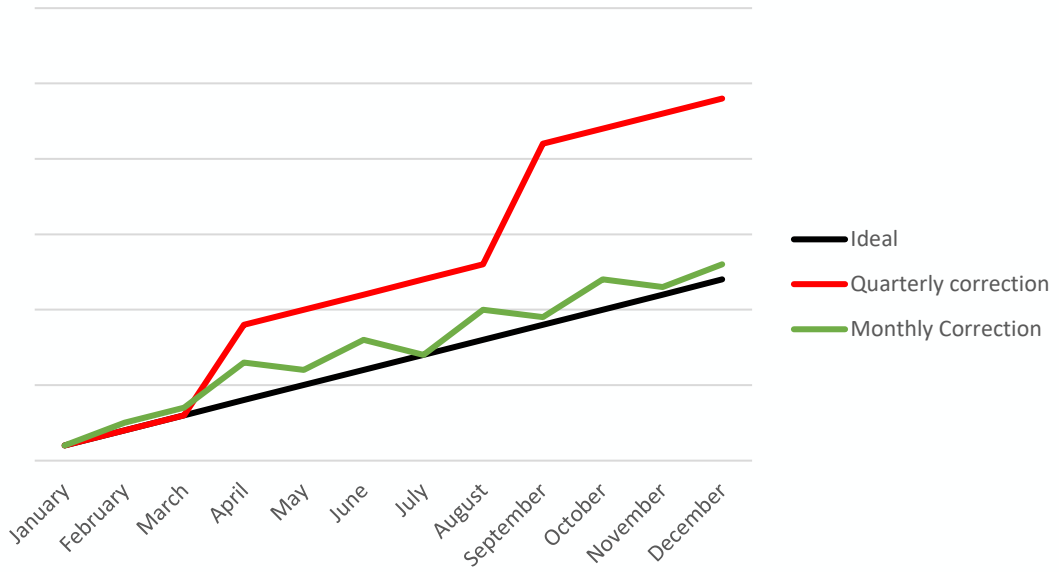
Monitoring - Trend Chart: Milestones planned vs actual date

- Trend charts help to identify systematic errors and issues that need to be addressed.
  - Project milestones are marked horizontally across the top of the chart on a time axis
  - The vertical axis shows when the actual milestone achievement times are/were expected
- A project which runs perfectly to plan will show a vertical set of lines
- Slipping projects will be slanting towards the right
- Improvements will be slants to the left
- The degree of slant will indicate trends



Right slanting lines need action: The earlier the action, the less the cost and disruption

Monitoring - The importance of frequent monitoring



Frequent monitoring cuts COSTS and reduces CORRECTIONS

A frequent monitoring (reporting and updating) reduces the time that
Deviations can accumulate making corrections smaller and easier which reduces costs.
A balance needs to be found between the effort involved in monitoring versus savings in schedule and costs
Typically ESA requests quarterly or monthly reporting. This is not sufficiently frequent internally. Weekly is recommended depending on the project.

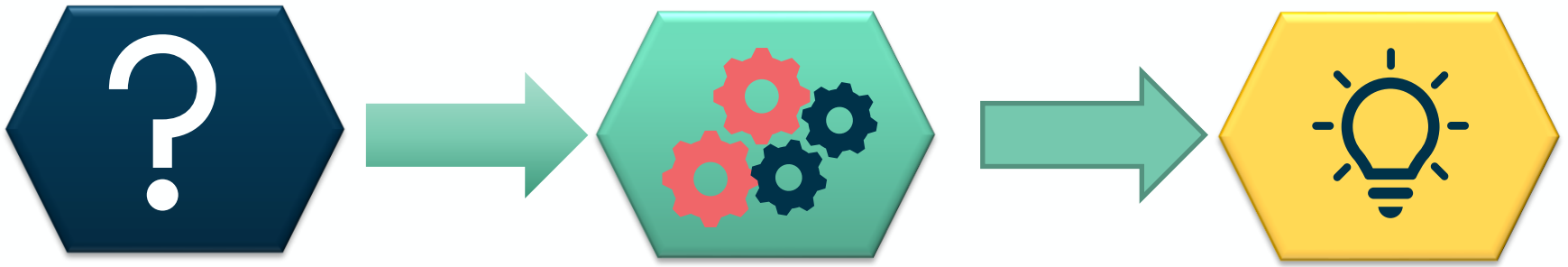
A Problem!

If costs are overrunning:

- is it because progress has been swift, causing faster expenditure?
- or, is it because significant problems have resulted in greater expenditure than was planned?
- We need to carefully monitor work in progress and the financial value this has created!

Problem Solving

- First be sure to define the problem!
- Do not rush into action
- Ensure that you treat the cause not the effects
- List potential solutions - be creative in these
- Determine decision criteria
- Go for least cost / greatest benefit
- Make sure the problem does not recur



Managing Changes - Internal

- Poor change management is a major cause of project failure !
- You SHOULD be changing your plans – based on the monitoring; change is normal and can be used as an opportunity. Always be willing to make changes that adapt to changing circumstances and help achieve the objective and maximise efficiency.
- Make adequate allowances in your planning:
  - Plan the monitoring points and Reviews
  - Have options in project plans where there are high risks (link to your risk management)

The Snowball Effect – Part 1

- What appear to be minor changes at the time can rapidly accumulate to have a major effect on the project finish date, or on the project costs.

Managing Changes - External

- Especially during reviews, your customer can/will request changes
- When discussing changes, look at and agree what is technically best to achieve the objective first and ignore the other issues.
- Once the best technical approach is agreed discuss again. Does this have a cost and/or schedule impact? Is this new work or within the scope of the contract?
- If it is new and additional work then only agree to do the work if it is paid for in some way (either extra money or descoping something else). Trigger a CCN to your contract to cover this (or decide on company investment).
- If it is within the scope of the contract but affects schedule – make sure this is clearly communicated in a written manner.

The Snowball Effect – Part 2

- Customers will tend to forget all the minor changes and delays! Make sure you **document them** and point out the consequences of these regular minor items.
- The sum of many minor changes can add up to a major change that needs a CCN.

Managing changes – What is a CCN for ESA

A CCN is a contract change notice. It is an amendment to your original contract, that might add or replace entire parts of it.

If a change is out of scope of the contract it may be documented in a CCN which can cover

- Description of the agreed additional work
- Changes in schedule
- Additional deliverables
- Change in cost

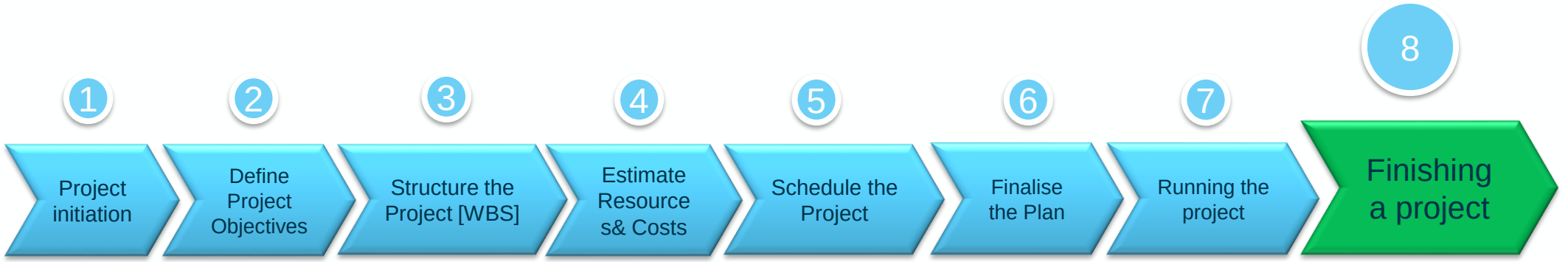
A CCN needs to be agreed and signed by both parties until it is signed by both parties you have no contractual cover or obligation for any additional work.

CCNs cannot be retrospective, they need to be agreed before the work is done.

There is a CCN template in the ESA contract .

> Finishing a Project Successfully

> Finishing a Project Successfully



Project Closure

The last things to do in an ESA development project:

- Final deliveries (H/W and Final Report)
- Travel to ESTEC – Final presentation
- Complete the Contract Closure Document (CCD)
- Invoice and Get paid <- This is NOT the end for you!
- Formally close down your project internally:
  - File/Archive all documentation
  - Hold an internal **lessons learnt** meeting (what went well, what went wrong,)
  - **Update estimation databases and models**
  - Dismantle/ dispose of no-longer required items

DON'T FORGET A TEAM CELEBRATION !!!

Project Completion Document

Project Name/Number:

Author:

Date:

Issue: Revision:

1. Achievement of Objectives

2. Project Handover

3. Performance against Plans

4. Impact of Changes

5. Lessons Learnt

ESA CCD
(Annex to the Contracts)

> Backup slides

Easiest organisation of RIDS

RID #	Document	Page	Comment	Suggested actions	Reply	Open/Closed	Agreed Action	Closure Date
SPA01	Design Document	3	********	Update document	Agreed	Closed		
SPA02	Design Document	10	******	Perform Analysis	Not needed ****	Open		
SPA03	Design Document	12	***	Justify	******	Closed		
SPA04	Test Plan	6	******	Add test	Test can be added under CCN	Open		
SPA05	Test Plan	7	***	Update document	Agreed	Closed		
PS01								
PS02								
PS03								

Example of a suggest efficient manner to collect, respond to and record RIDs and actions for a technology development contract review. This can be attached to the MOM reducing work.