Week 1

GSOE9820 Engineering Project Management
Term 3 2022
Dr Imrana I. Kabir

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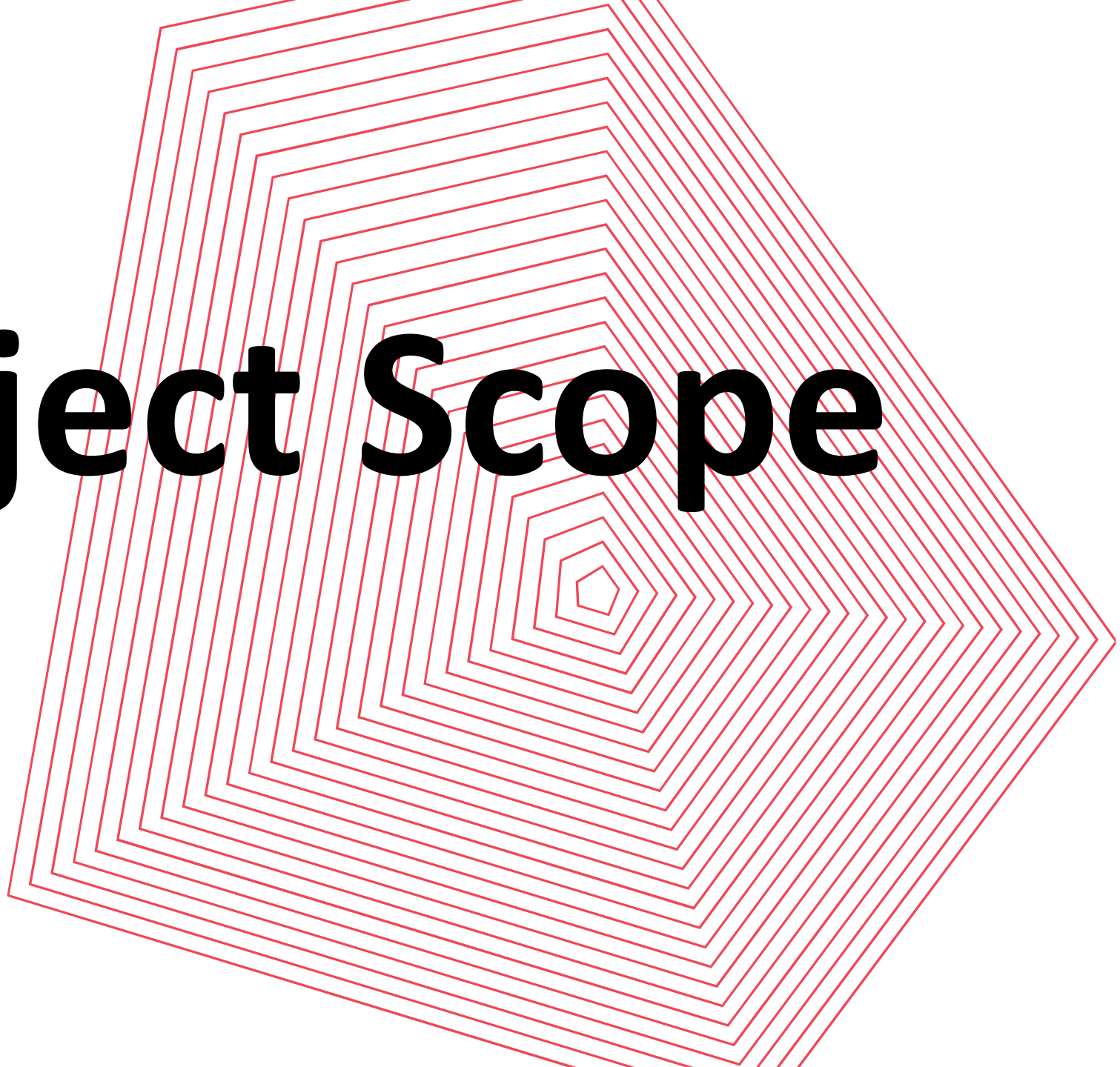
Project Scope



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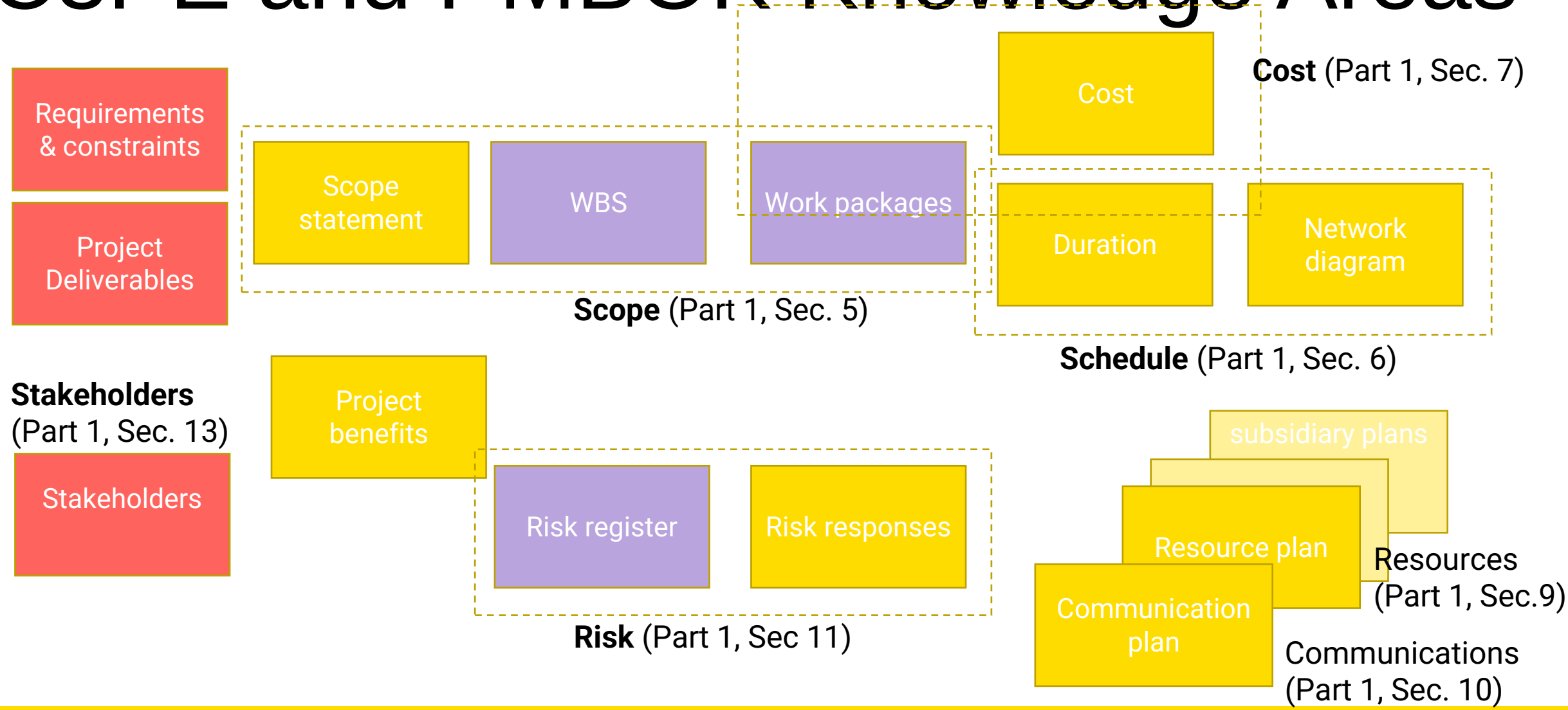
C3PE and PMBOK Knowledge Areas



PMBOK Guide (6th Ed) Part 2, Sec. 1.9 Table 1-1

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Sources:
Smith and Tucker 1984, Gobeli and Larson 1986
http://www.pmi.org/

Why do projects fail?

- The project was not adequately defined at the beginning.
- A lack of clearly defined project goals and objectives.
- Project planning was done with insufficient data.
- Poor work definition.

Black, K. (1996). Causes of project failure: a survey of professional engineers. *PM Network, 10*(11), 21–24.

Collect requirements

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Collecting Requirements (PM Methods)

- Brainstorming
- Interviews
- Focus Groups
- Questionnaires and surveys
- Benchmarking
- Document analysis:
  - Specifications, RFPs
  - Standards
  - Regulations
- Affinity diagramming
- Mind mapping
- Nominal group technique (Delphi methods - wikipedia)
- Observation
- Prototyping/concept designs

Dwivedi, N. “Elicitation Techniques” video in course Software Design: Developing effective requirements, accessed 23/02/2021, LinkedIn Learning accessed through UNSW

PMBOK Guide (6th Ed) Part 1, Sec. 5.2

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Writing requirements

When you are writing a specification:

- Say **“shall”** for mandatory requirements.
- Say **“should”** for optional requirements.
- Be **SMART** (specific, measurable ,attainable, relevant, timely)

How about an agile specification? User stories!

A user story is an informal, general explanation of a feature written from the perspective of the end user.

- “**As…** a student, **I want to…** find out when my lectures are happening, **so that…** I can meet my friends on campus.
- User stories are clever because they connect **stakeholder**, **requirement** and **benefit** together in one trackable item.

Sydney Harbour foreshore authority

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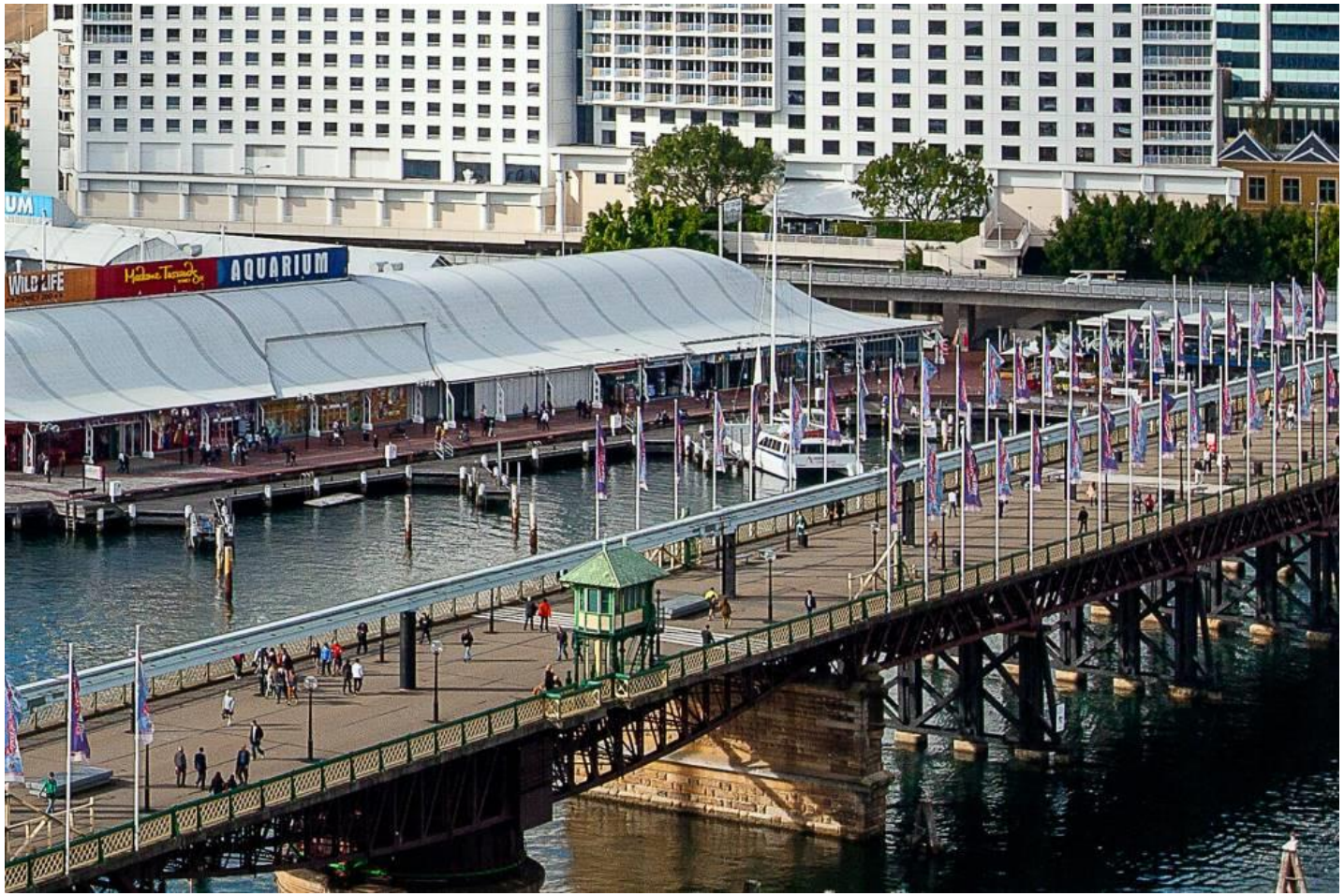
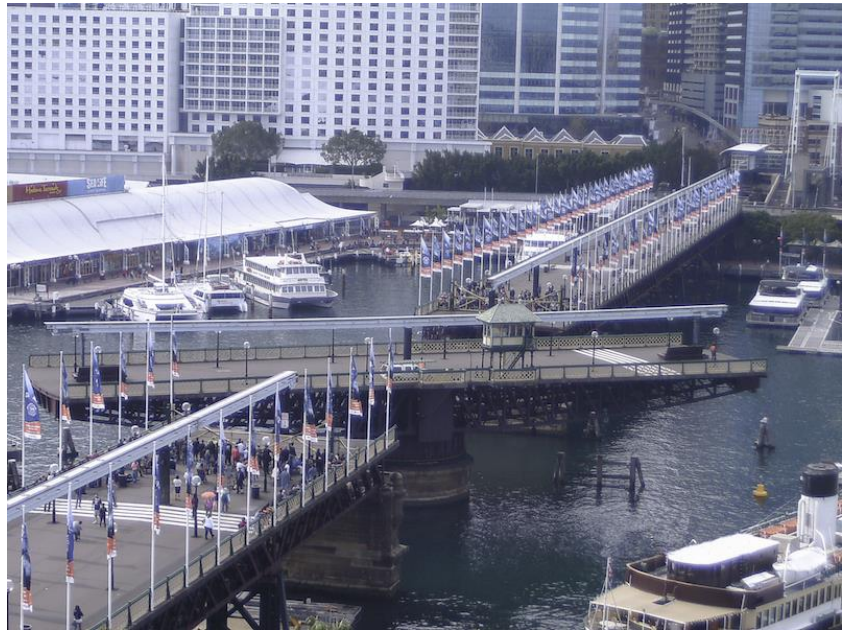
Pyrmont bridge

- Timber bridge
- 14 timber truss spans, each 25m long with a total span of ~ 370m.
- Electric swing span (1st of its kind in the world)
- Central pier to provide access into the harbour for larger boats – the swing path opens





Reference: NSW Government, The Star Group

Pyrmont bridge

Requirements Method: Document analysis Reviewed Roads and Maritime Services (RMS) report on existing conditions (e.g. traffic and transport use)

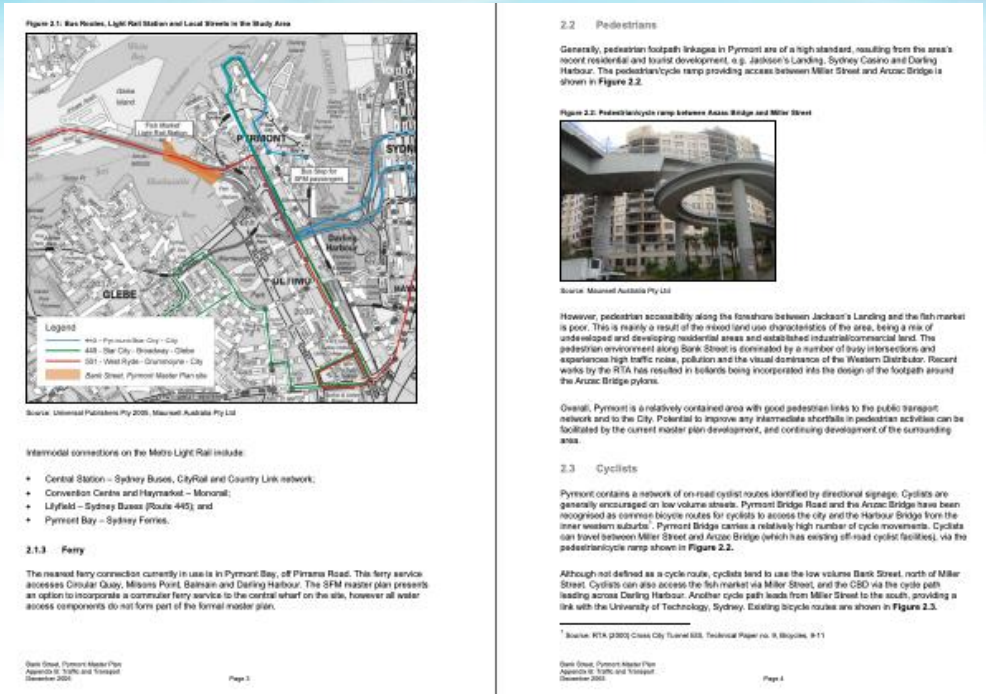


Figure 2.1: Bus Routes, Light Rail Station and Local Streets in the Study Area

PYRMONT

GLEBE

Legend

Source: Universal Publishers Pty 2005, Maunsell Australia Pty Ltd

Intermodal connections on the Metro Light Rail include:

- Central Station – Sydney Buses, CityRail and Country Link network;
- Convention Centre and Haymarket – Monorail;
- Lilyfield – Sydney Buses (Route 445); and
- Pyrmont Bay – Sydney Ferries.

2.1.3 Ferry

The nearest ferry connection currently in use is in Pyrmont Bay, off Pirrama Road. This ferry service accesses Circular Quay, Milsons Point, Balmain and Darling Harbour. The SFM master plan presents an option to incorporate a commuter ferry service to the central wharf on the site, however all water access components do not form part of the formal master plan.

Bank Street, Pyrmont Master Plan
Appendix B: Traffic and Transport
December 2005

Page 3

2.2 Pedestrians

Generally, pedestrian footpath linkages in Pyrmont are of a high standard, resulting from the area's recent residential and tourist development, e.g. Jackson's Landing, Sydney Casino and Darling Harbour. The pedestrian/cycle ramp providing access between Miller Street and Anzac Bridge is shown in Figure 2.2.

Figure 2.2: Pedestrian/cycle ramp between Anzac Bridge and Miller Street

Source: Maunsell Australia Pty Ltd

However, pedestrian accessibility along the foreshore between Jackson's Landing and the fish market is poor. This is mainly a result of the mixed land use characteristics of the area, being a mix of underdeveloped and developing residential areas and established industrial/commercial land. The pedestrian environment along Bank Street is dominated by a number of busy intersections and experiences high traffic noise, pollution and the visual dominance of the Western Distributor. Recent works by the RTA has resulted in bollards being incorporated into the design of the footpath around the Anzac Bridge pylons.

Overall, Pyrmont is a relatively contained area with good pedestrian links to the public transport network and to the City. Potential to improve any intermediate shortfalls in pedestrian activities can be facilitated by the current master plan development, and continuing development of the surrounding area.

2.3 Cyclists

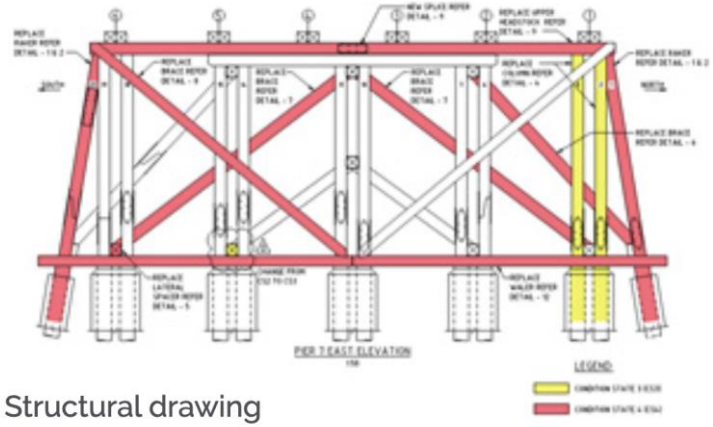
Pyrmont contains a network of on-road cyclist routes identified by directional signage. Cyclists are generally encouraged on low volume streets. Pyrmont Bridge Road and the Anzac Bridge have been recognised as common bicycle routes for cyclists to access the city and the Harbour Bridge from the inner western suburbs[1]. Pyrmont Bridge carries a relatively high number of cycle movements. Cyclists can travel between Miller Street and Anzac Bridge (which has existing off-road cyclist facilities), via the pedestrian/cycle ramp shown in Figure 2.2.

Although not defined as a cycle route, cyclists tend to use the low volume Bank Street, north of Miller Street. Cyclists can also access the fish market via Miller Street, and the CBD via the cycle path leading across Darling Harbour. Another cycle path leads from Miller Street to the south, providing a link with the University of Technology, Sydney. Existing bicycle routes are shown in Figure 2.3.

[1] Source: RTA (2003) Cross City Tunnel EIS, Technical Paper no. 9, Bicycles, 9-11

Bank Street, Pyrmont Master Plan
Appendix B: Traffic and Transport
December 2005

Page 4



PIER 7 EAST ELEVATION

LEGEND

Structural drawing

Identified:

- timber trusses and piers, required replacement.
- the restoration was determined to be completed in two stages
- *Stage 1* : replacement of the timber pier sets
- *Stage 2*: replacement of the timber trusses
- heritage-listed icon and requires ongoing maintenance (public safety)

Reference: Pyrmont Master Plan, Traffic and Transport, December 2005

Try to write observable requirements that give the client what they actually want and maximum design freedom (and accountability) to your engineers:

An **OK** requirement for bridge design life:

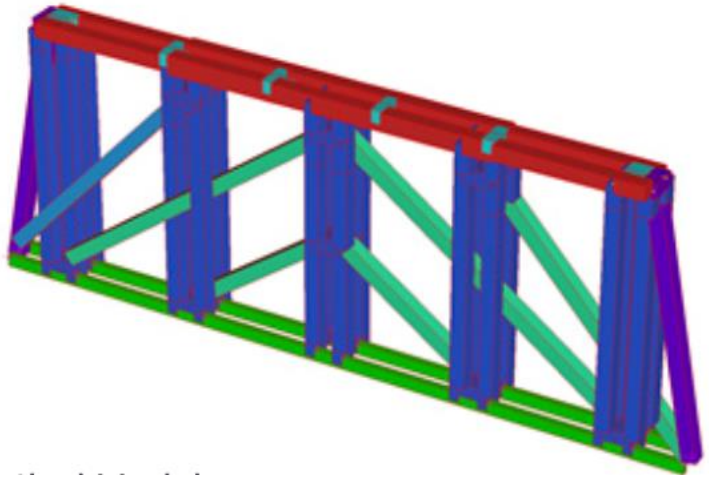
“The bridge shall always be standing.”

A **better** one:

“The bridge shall be fully functional for 95% of the time and traffic performance intended at design.

Writing great requirements simplifies testing and configuration management!

***Functional requirement*:** describes behaviour of the product by actions, processes…
***Non-functional requirement*:** qualities/conditions for product to be effective (PMBOK 5.3.2)



[Inspired by 1.5.1. Department of Transport and Main Roads, Queensland]

Define scope

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Defining Scope

Project Scope

- A definition of the end result or mission of the project. This is often in the form of a product or service for a customer.
- The work that needs to be accomplished to deliver a product, service, or result with the specified features and functions.

Purpose of the Scope Statement

- To clearly define the deliverable(s) for the end user.
- To focus the project on successful completion of its goals.
- To be used by the project owner and participants as a planning tool and for measuring project success.

The challenge in scope definition

Scope definition is the creative center of project management

PMBOK Guide (6th Ed) Part 1, Sec. 3.4.3

What does this mean for me?

The bad ☹

- Scope definition is only deceptively simple.
- You will need your own (or you will need to access) domain-specific knowledge to be effective.
- You can’t assume that scope definition will be procedural or routine or even particularly ‘easy’.
- In planning complex projects, it will involve a high degree of negotiation, compromise and hard work.

What does this mean for me?

The good ☺

- Scope definition and the WBS is not a forgone conclusion.
- As PM, scope definition is where you leave your creative mark on the project.

But, what if you only partly know all the requirements and the scope at the beginning?
(surprisingly, common situation)

Triple constraint

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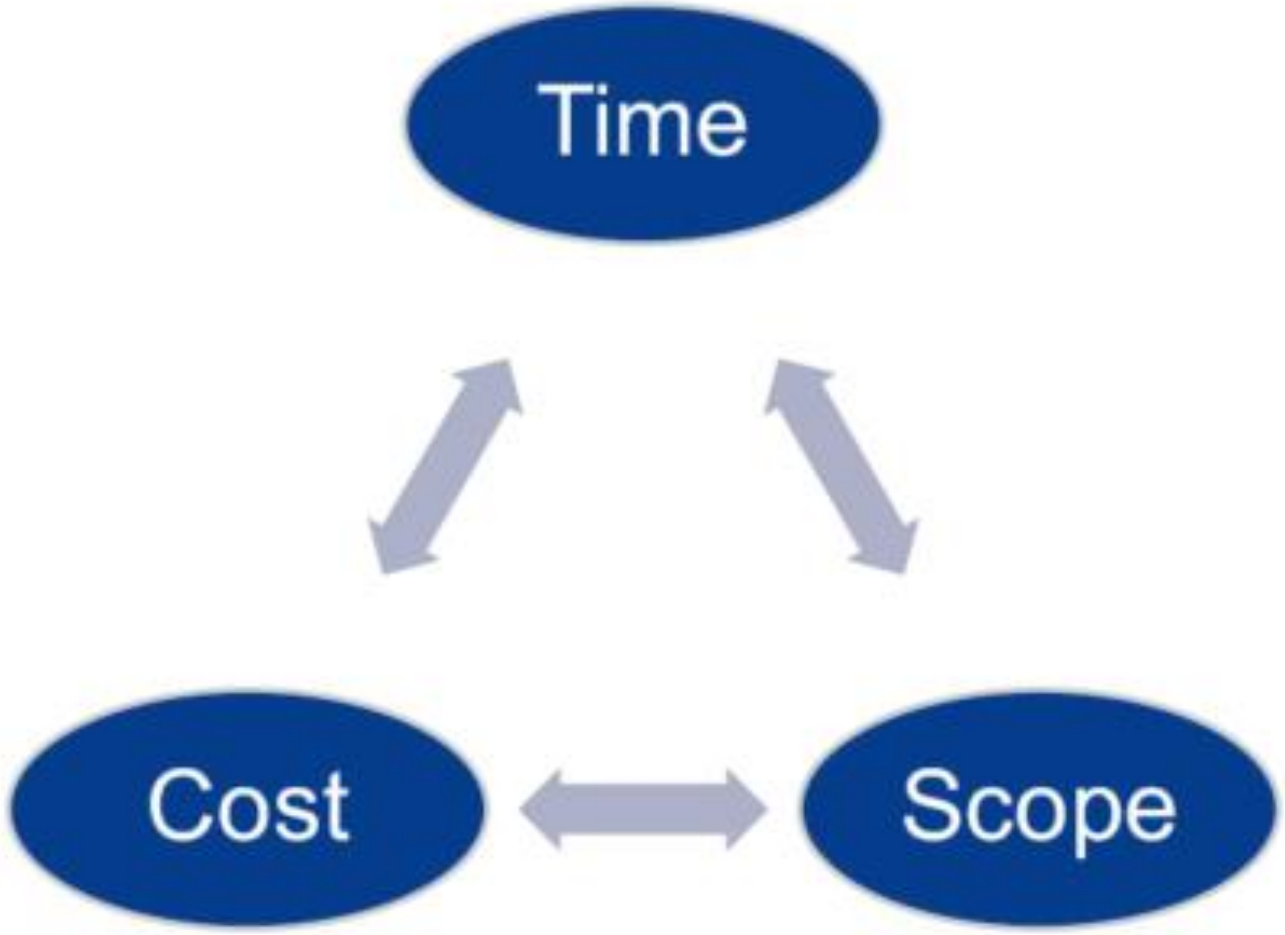
Triple Constraint Model



Establishing Project Priorities

Quality and the ultimate success of a project are traditionally defined as meeting and/or exceeding the expectations of the key stakeholders.

E.g. Customers/Upper management.

It is often measured in terms of

- Cost (budget)
- Time (schedule)
- Scope (performance)

Trade Offs / Compromises

Causes of Project Trade-offs

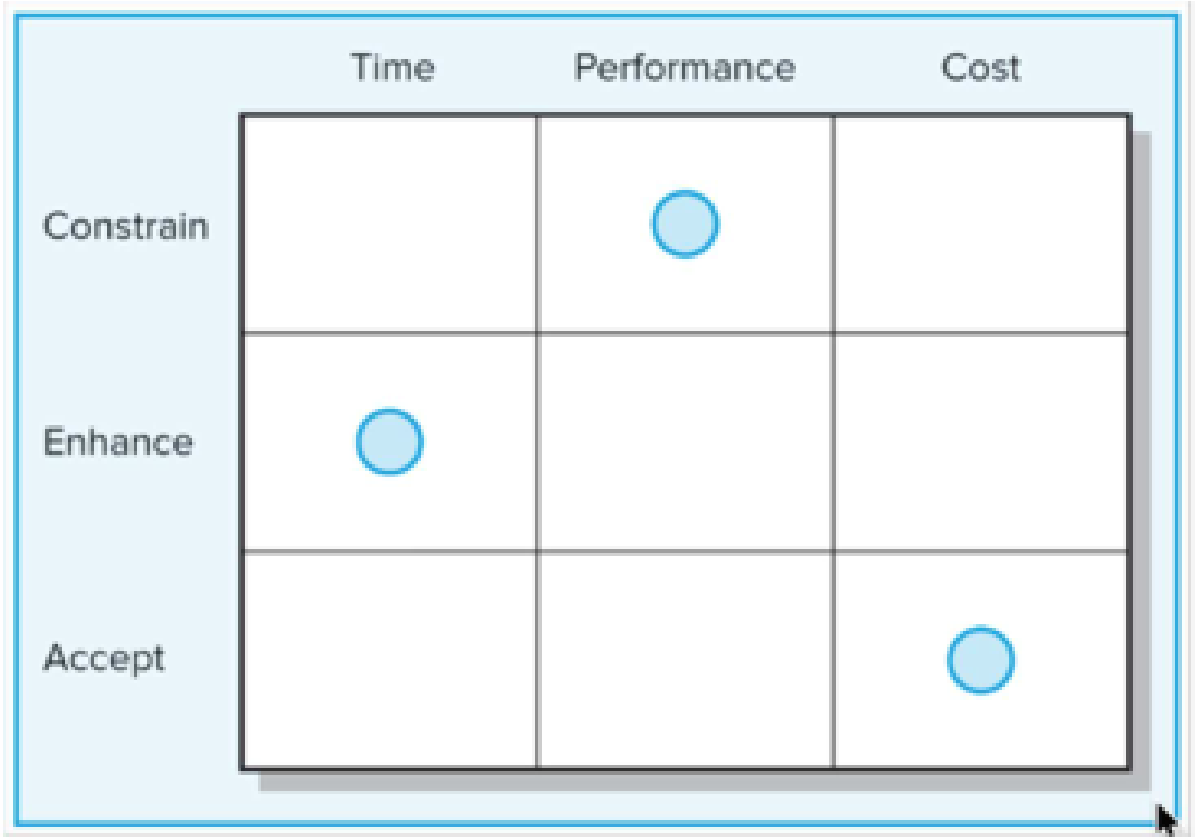
- Shifts in the relative importance of criterions related to cost, time and scope

Managing the Priorities of Project Trade-offs

- Constrain
  - a parameter is a fixed requirement.
- Enhance
  - optimizing a criterion over others.
- Accept
  - reducing (or not meeting) a criterion requirement.

Project Priority Matrix

The purpose is to define and agree on what the priorities and constraints of the project are so that the right decisions can be made at the appropriate time.



The WBS

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WBS summary (definition)

The WBS represents a clear description of the project's deliverables and scope—the "what" of the project. It is *not* a description of a process or schedule that defines how or when the deliverables will be produced, but rather is specifically limited to describing and detailing the project's outcome or scope. As

> "The WBS organizes and defines the total scope of the project. The WBS subdivides the project work into smaller, more manageable pieces of work, with each descending level of the WBS representing an increasingly detailed definition of the project work. The planned work contained in the lowest level WBS components, which are called work packages, can be scheduled, cost estimated, monitored, and controlled."

From: Project Management Institute, Practice Standard for Work Breakdown Structures (Project Management Institute, 2nd ed., 2006)

PMBOK Guide (6th Ed) Part 1, Sec. 5.4.1

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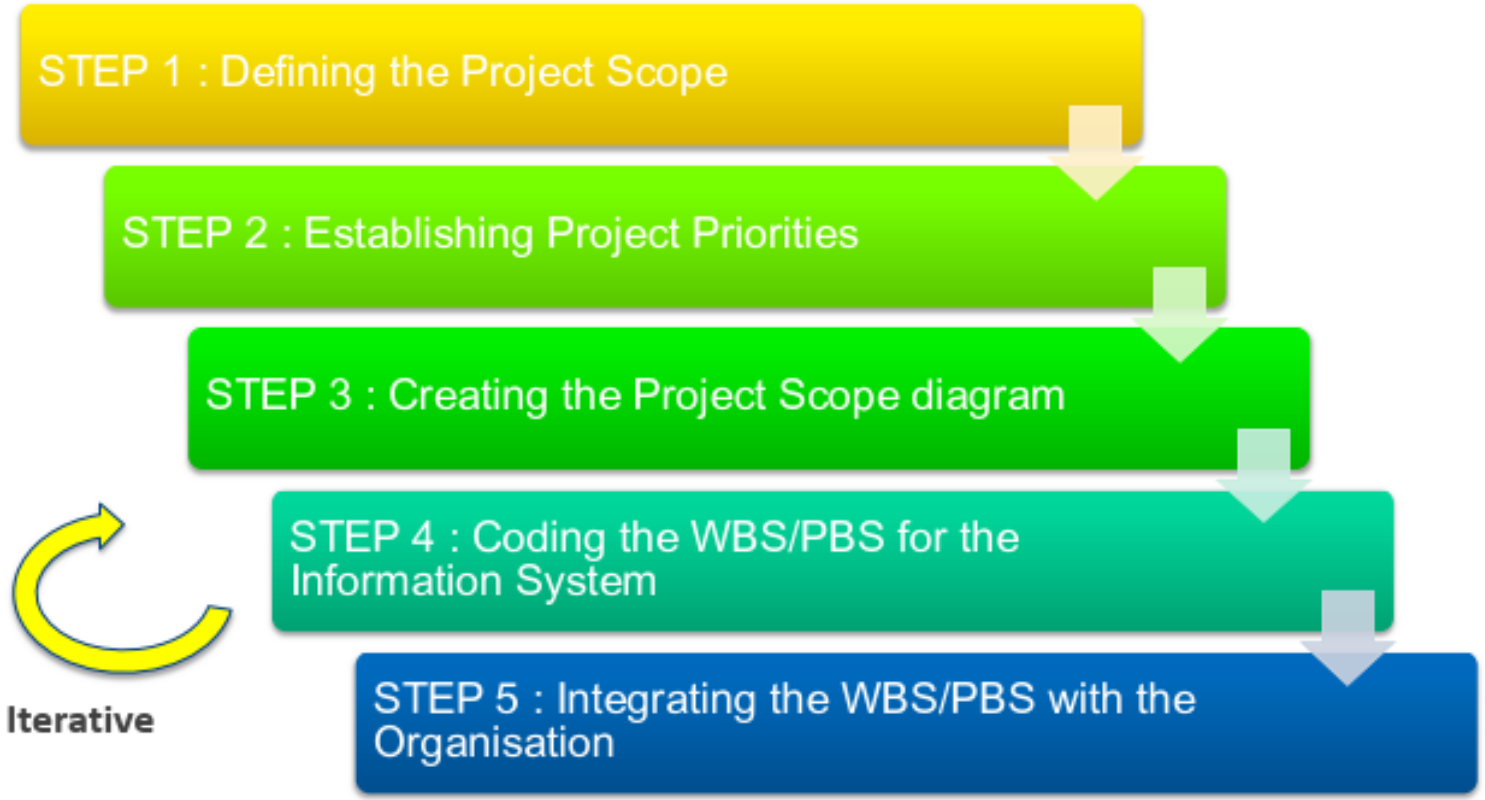
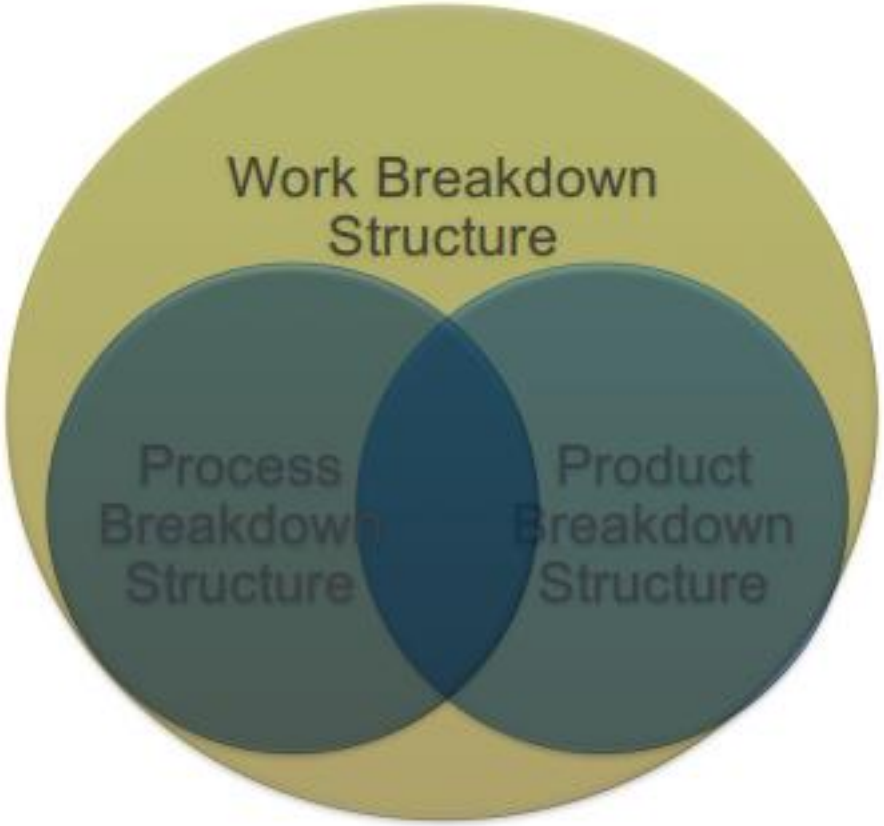
Generating the WBS



The Project Scope Diagram



This video gives a nice explanation of how the WBS includes more than just the PBS, and how it is not about scheduling, and the presenter defines the work packages correctly.

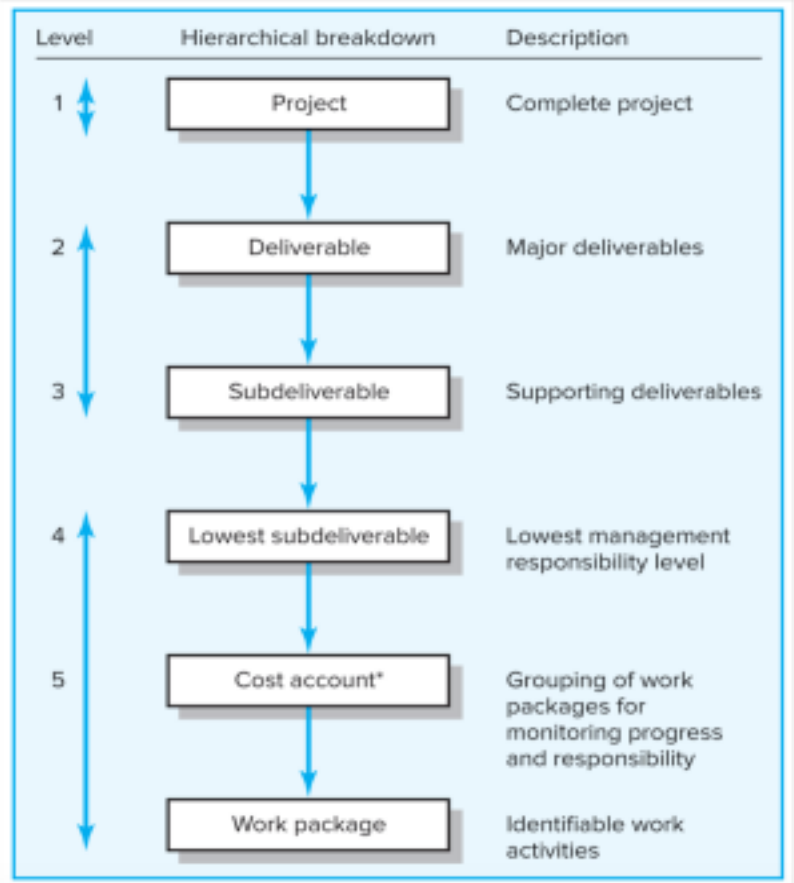
Rogers, J. “Work breakdown structure” video in course Construction Management, Planning and Scheduling, accessed 23/02/2021, LinkedIn Learning accessed through UNSW

The Work Breakdown Structure

- The WBS is a hierarchical outline (map/diagram) that identifies the **total scope of work** to be carried out by the project team to accomplish the project objectives and create the required deliverables.

- Defines the relationship of the final deliverable (the project) to its sub-deliverables, and in turn, their relationships to **work packages**.

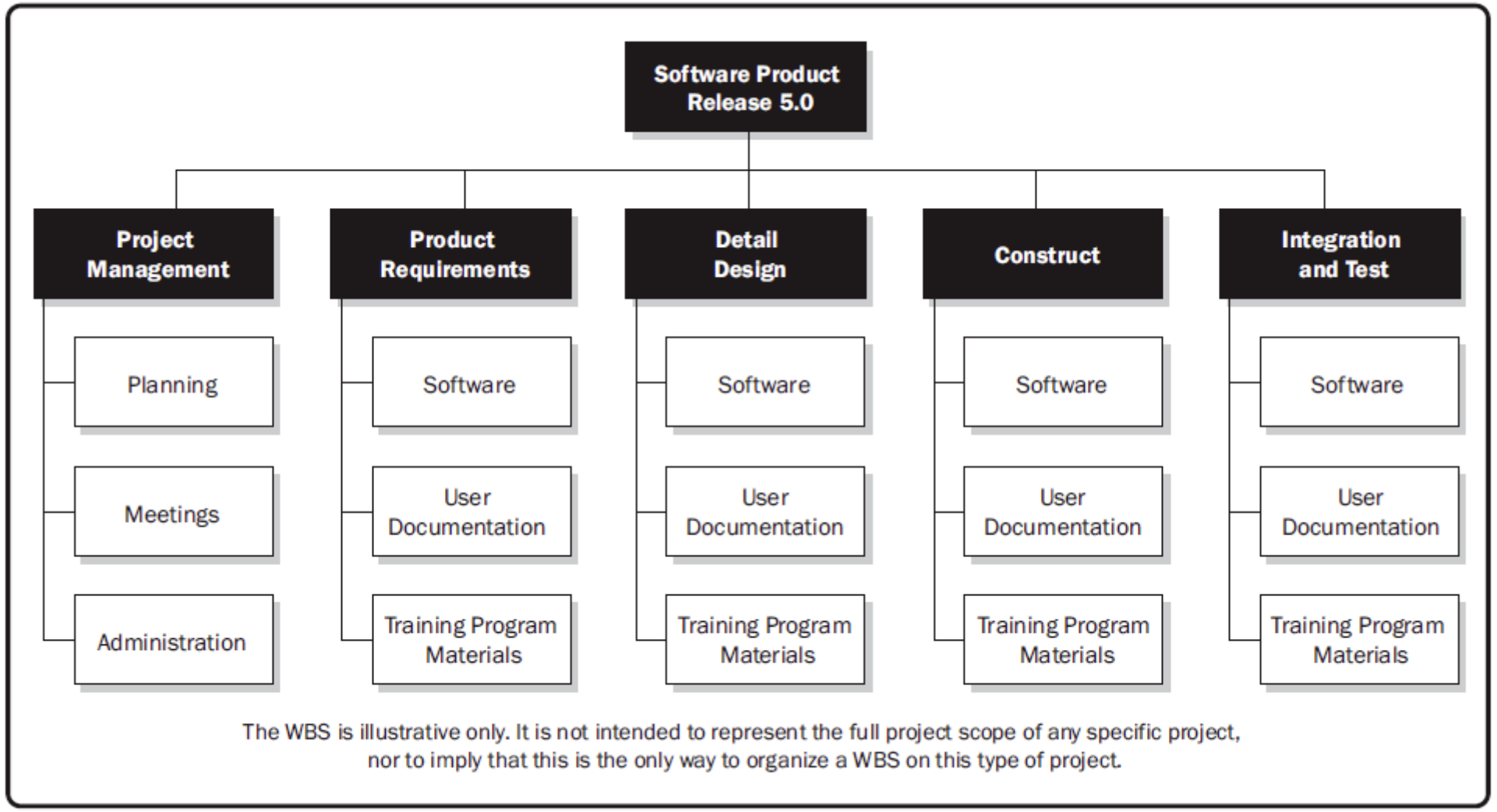
Building a WBS hierarchy



Advantages of using a WBS

- To improve estimating
- To better control the project execution
- To more accurately verify project completion
- To improve the opportunity for use of historical information, which, can aid in both speed and accuracy of future projects.
- Is a repeatable process that can be used as a template for future similar projects.

Example WBS for a software project



PMBOK Guide (6th Ed) Part 1, Sec. 5.4.2

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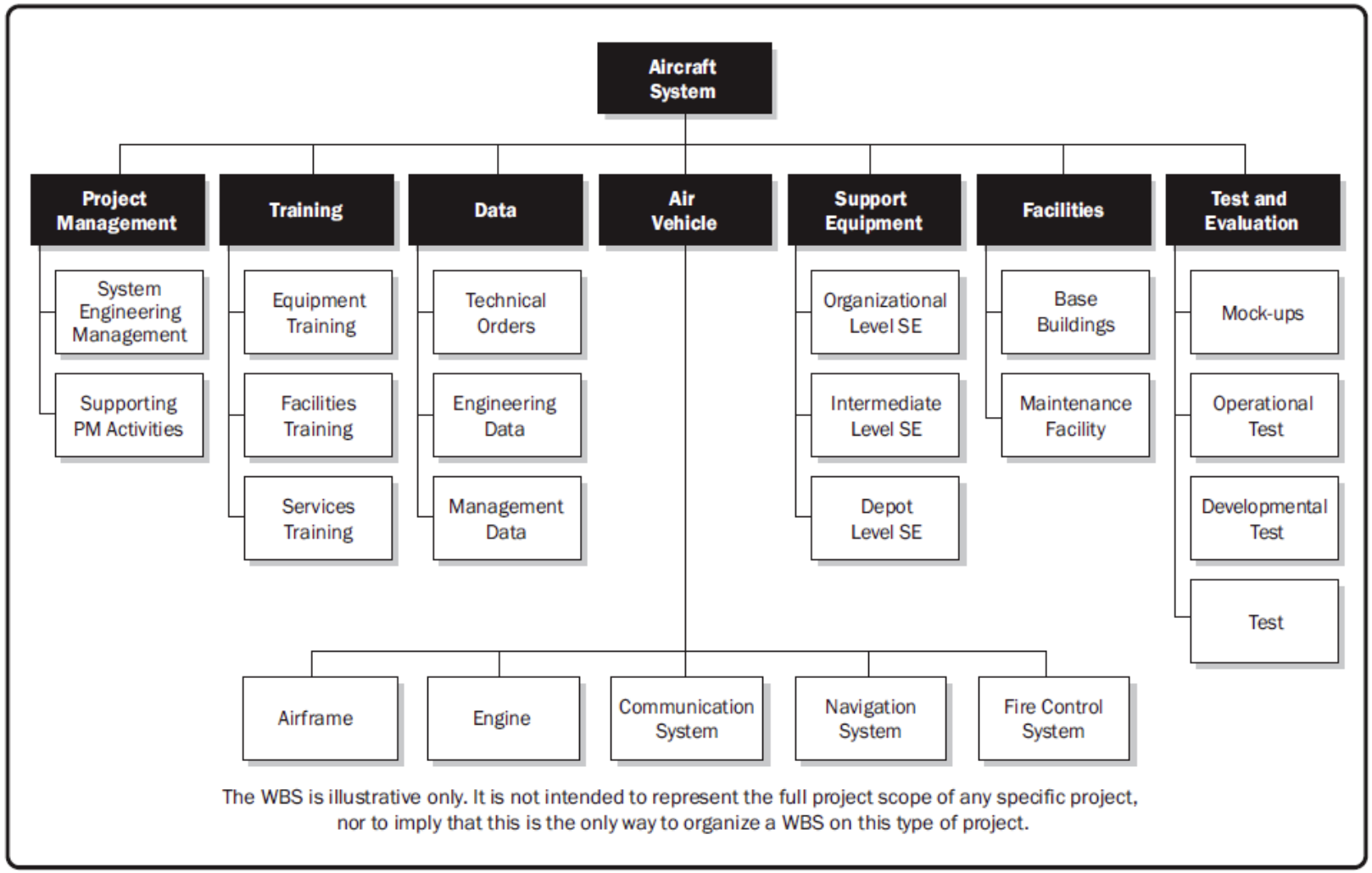
Example WBS for an engineering project



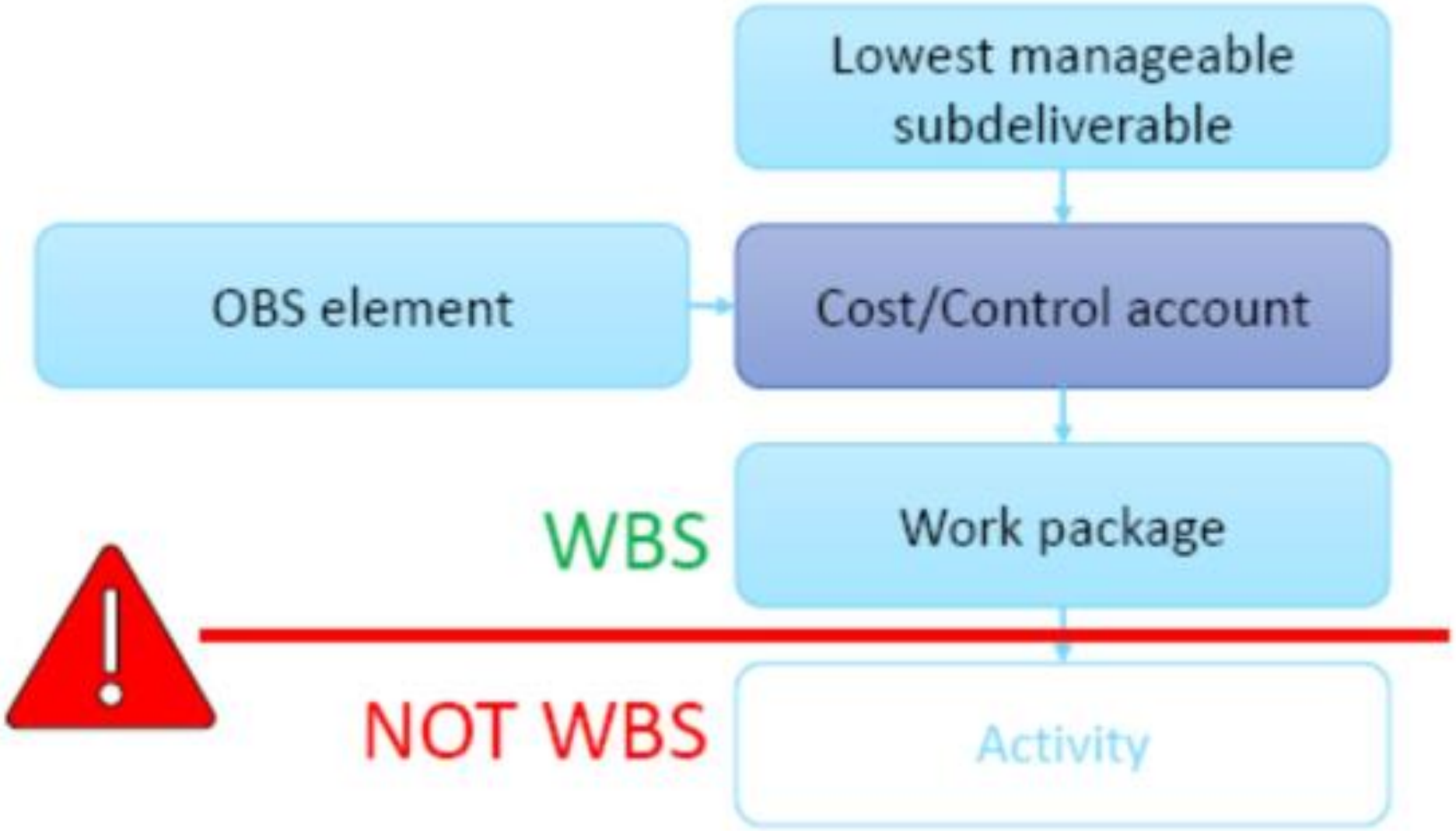
PMBOK Guide (6th Ed) Part 1, Sec. 5.4.2

Work Packages

A work package is the lowest level of the WBS.

It is **output-oriented** and contains the project details:

1. Defines work (what)
2. Identifies time to complete a work package (how long)
3. Identifies a time-phased budget to complete a work package (cost)
4. Identifies resources needed to complete a work package (how much)
5. Identifies a person responsible for units of work (who)
6. Identifies monitoring points (milestones) for measuring success.


Lowest manageable subdeliverable
OBS element
Cost/Control account
WBS
Work package
NOT WBS
Activity

Coding the Work Package

The WBS Coding System defines:

- Levels and elements of the WBS
- Organization elements
- Work packages
- Budget and cost information

The most commonly used scheme is numeric indention

Allows reports to be consolidated at any level in the organization structure

On larger projects the WBS is often further supported with a WBS dictionary

An Activity

Activity

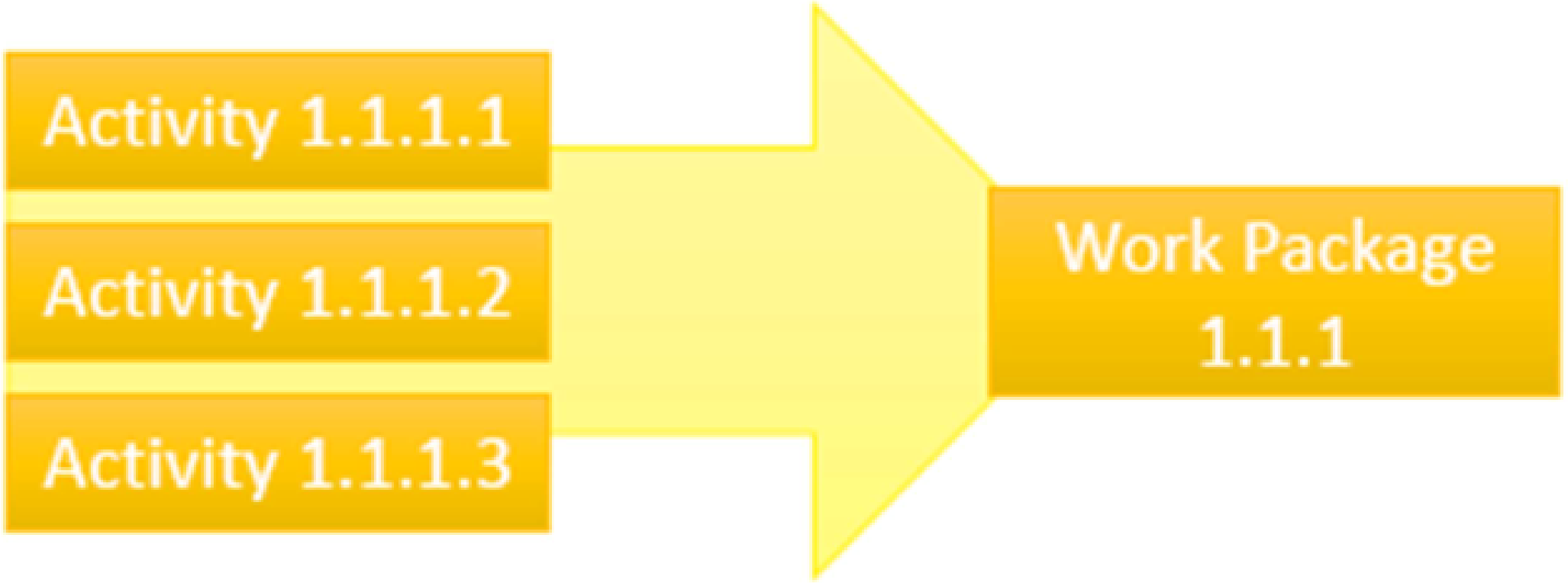
- A distinct, scheduled **portion of work** performed during the course of a project
- A series of actions results in a work package
- It cannot be handed over to the project stakeholders
- It is generally defined using a **verb** (polishing, testing)

Sample WBS Coding

Numbering element	Description	Level
1.0	Project/Contract name	1
1.1	Major project Subsystem	2
1.1.1	Task	3
1.1.1.1	Subtask	4
1.1.1.1.1	Work Package	5
1.1.1.1.1.1	Components	6

Example of alternative coding scheme : **3R-237A-P2-33.6**

Activities combine to form part of a Work Package



Common WBS Misconceptions

A WBS is not an exhaustive list of work. It is instead a comprehensive classification of project scope.

A WBS is neither a project plan, a schedule, nor a chronological listing. It specifies **what** will be done, not how or when.

A WBS is not an organizational hierarchy, although it may be used when assigning responsibilities.

WBS Tips

Plan outcomes, not just actions

100% Rule

- The WBS must capture all deliverables of the project

Have mutually exclusive work packages

- No work package should be described in more than one sub-deliverable

Level of Detail

- Sub-deliverables should be small enough for 1 person to be responsible
- No activity should be longer than 10 days or a single reporting period

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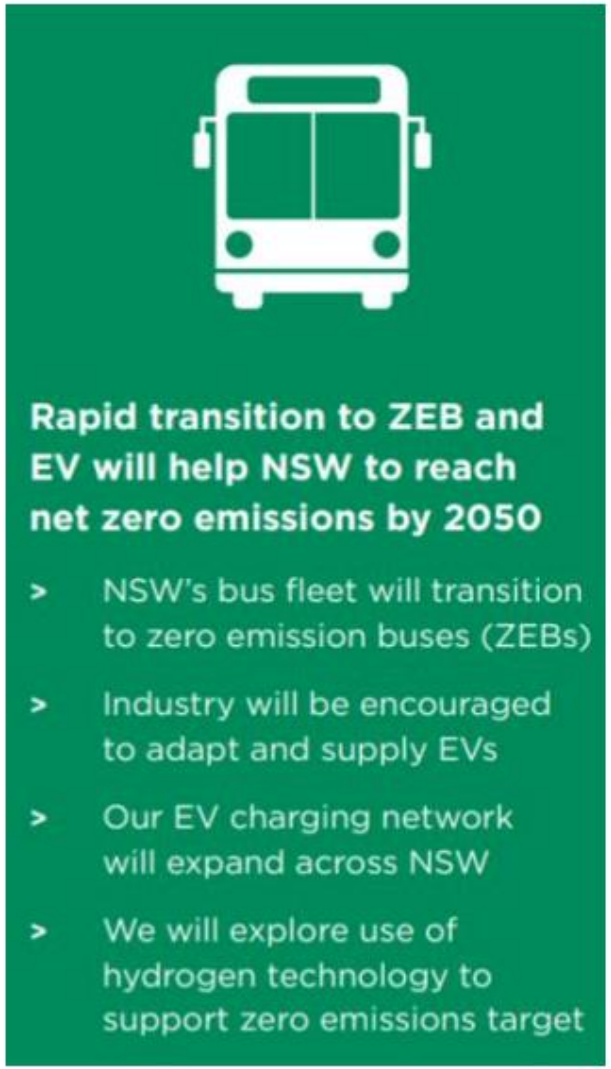
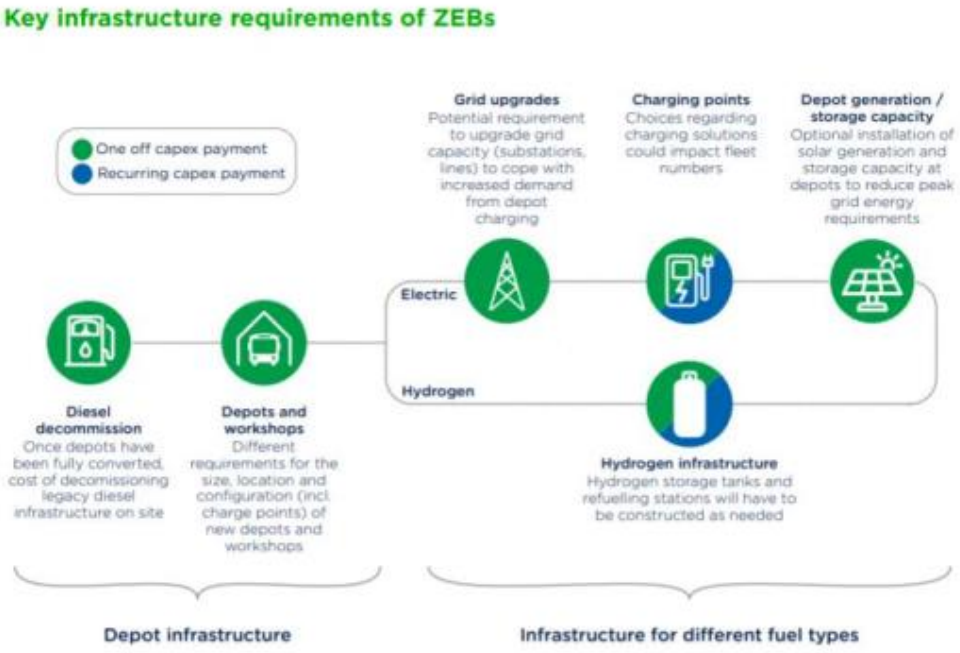
Example Project – Zero Emission Buses

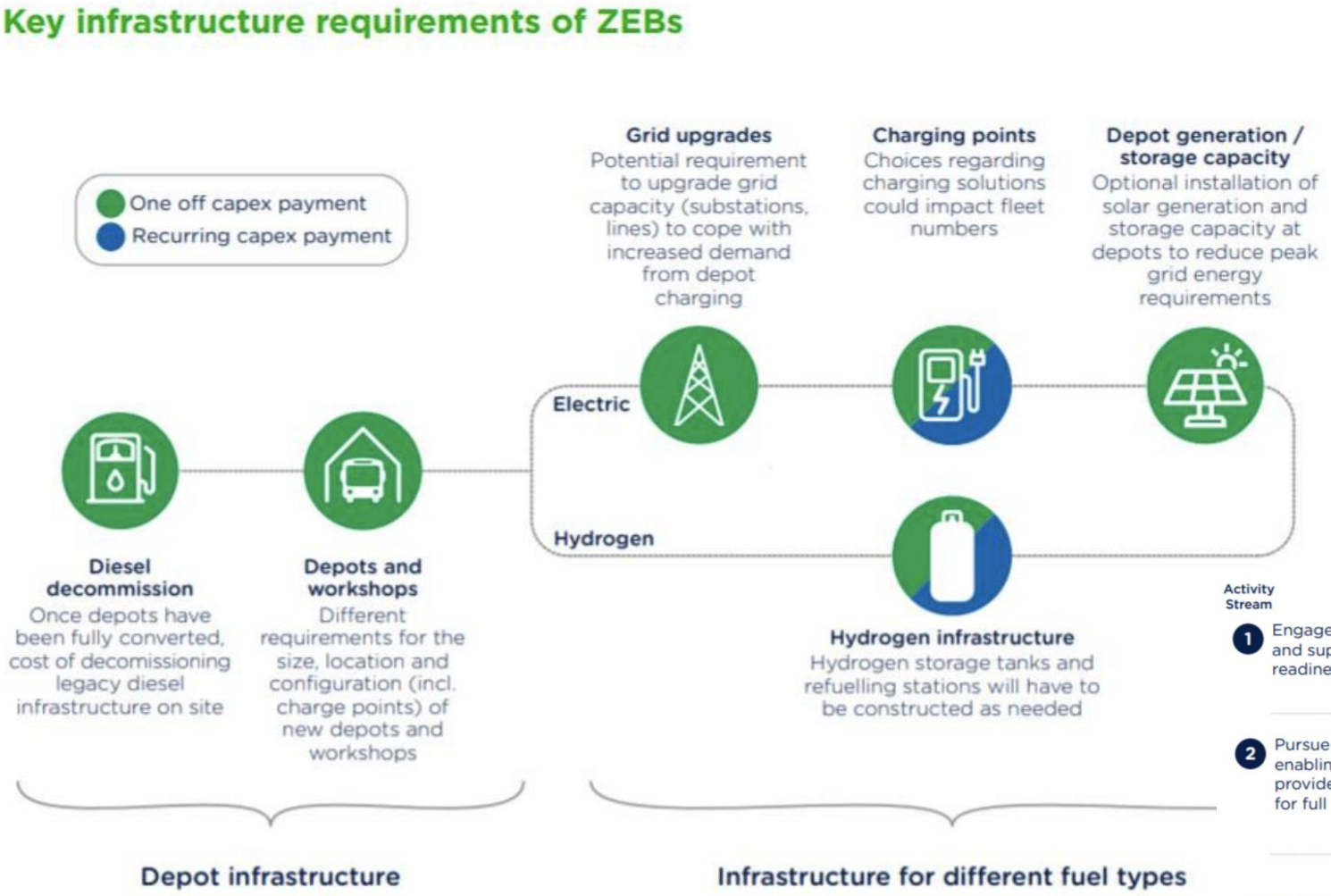
Plan a project for Transport for NSW (TfNSW) to shift towards net zero emissions with the goal to **transition all 8000 buses** in NSW to a zero-emissions fleet.



Duration: 3 year
Budget: $6,000,000
Scope: optimize



Analyse project information from TfNSW (Project Sponsor)



"The NSW Government is working towards achieving a target of net-zero emissions by 2050. Transport for NSW has responded accordingly and will attempt to transition the NSW bus fleet to net zero by 2030."

Example - Purpose Statement

The main purpose of this project is to **help the NSW Government achieve its 2050 net zero-emission target**, by reducing emissions from the NSW bus fleet and associated infrastructure to support zero-emission buses (ZEBs). This will **enhance economical activity** for the energy/transport sector and environmental **benefits for the NSW general public**.

Why is the project being done? ✔
What broader organizational strategy does this target? For whom? ✔

Disclaimer: these statements are not perfect and are not guaranteed 100%!

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Example - Scope Statement

This three-year project **involves** **renovating** the existing NSW bus diesel depots and **constructing** new depots for zero-emission operation. This needs to be achieved under AUD **$2,000,000** per calendar year starting **January 1st 2021 – December 31st 2023.**

This project will incorporate appropriate data **analysis** to consider the most appropriate power method such as **hydrogen and electric infrastructure.** Guided **evaluations** will be performed to consider charging techniques and technologies, depot **specifications**/equipment/facilities, digital **uplifts** and smart sensors, system safety/verification/performance testing, and training/transition workshops to smooth the transition for 8000 future ZEBs.

What is being delivered (in a reasonable amount of detail)? ✔
What are the constraints of the project? ✔
Does this represent 100% of the work to indicate project completion? ✔

Disclaimer: these statements are not perfect and are not guaranteed 100%!

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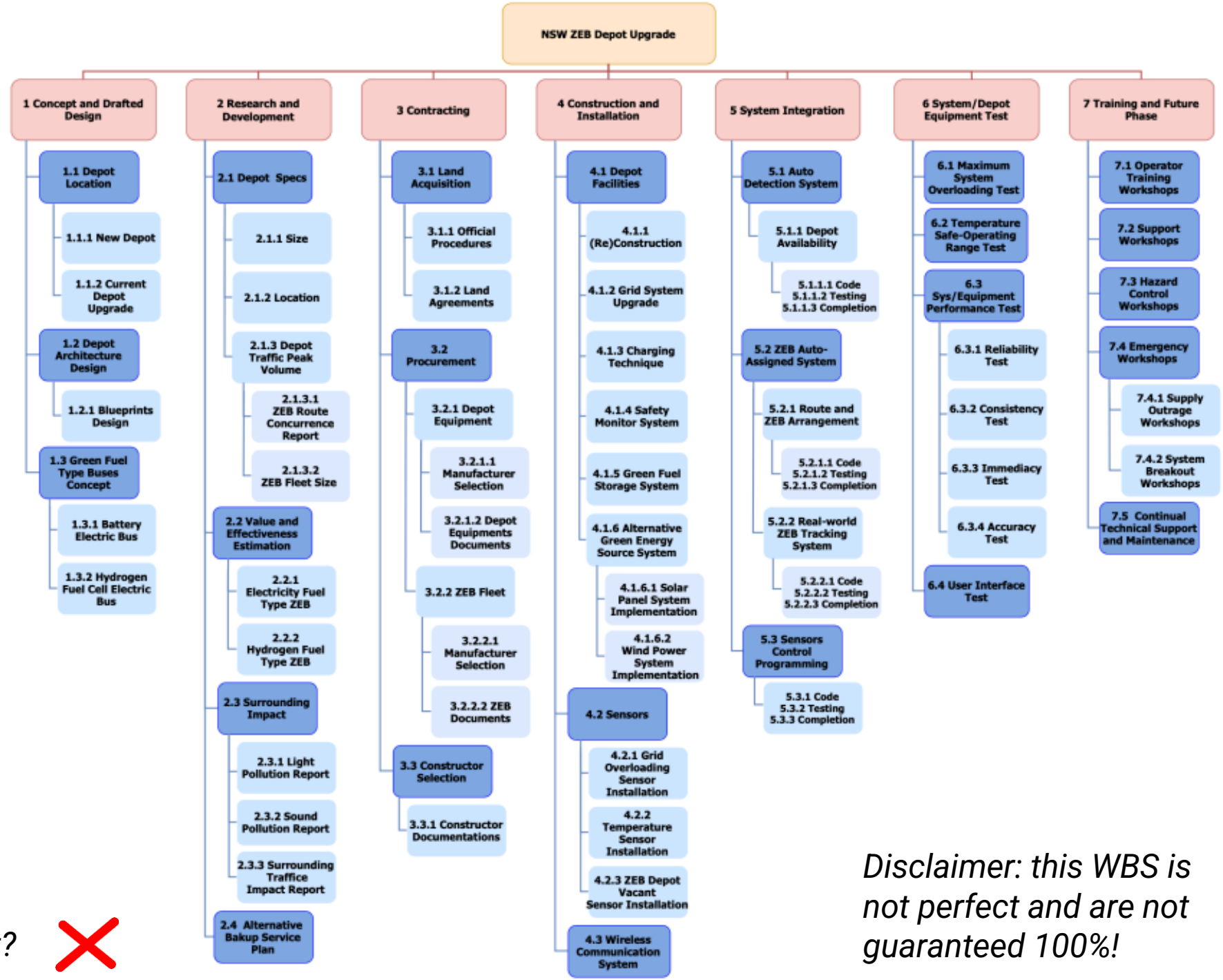
Example - WBS

Is each sub-deliverable small enough for 1 person to be responsible? ⚠

Is each work package indicative of a noun, and NOT an activity/verb? Does it focus on objectives and deliverables, rather than actions? ⚠

Does this represent 100% of the scope to indicate project completion? ⚠

Is the WBS Coding correct? ✗



Disclaimer: this WBS is not perfect and are not guaranteed 100%!

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Formulating WBS in different PM lifecycles

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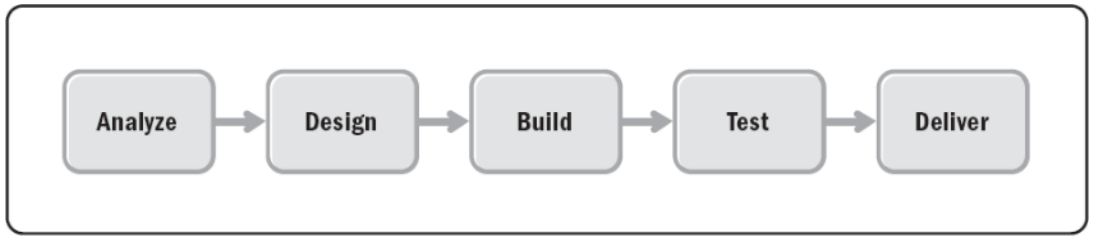
Predictive lifecycle

Concept



Characteristics

- Take advantage of **prior knowledge** and **experience**
- Useful for project with **extensive design**, e.g. safety requirements, regulatory constraints
- **Reduced uncertainty** in deliverables
- Should **reduce complexity** in projects and **minimise cost** (but change needs to be carefully controlled, if not can become overwhelming)

Agile Practice Guide (2017) Sec. 3.1.1

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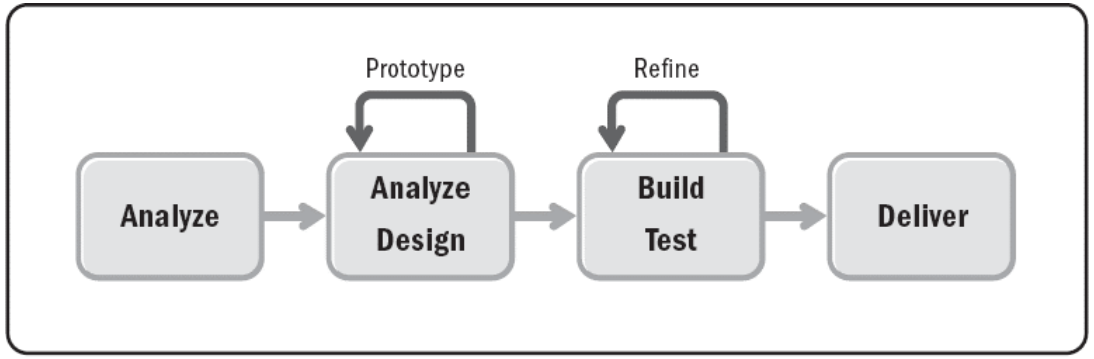
Iterative lifecycle

Concept



Characteristics

- Implicit in **prototyping**: improve the product or result through successive prototypes or proofs of concept.
- Useful for **high complexity**, **frequent changes**
- Sometimes prototypes are the only way to obtain comprehensive requirements
- Projects **take longer** because they prioritise learning rather than speed of delivery

Agile Practice Guide (2017) Sec. 3.1.2

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Incremental lifecycle

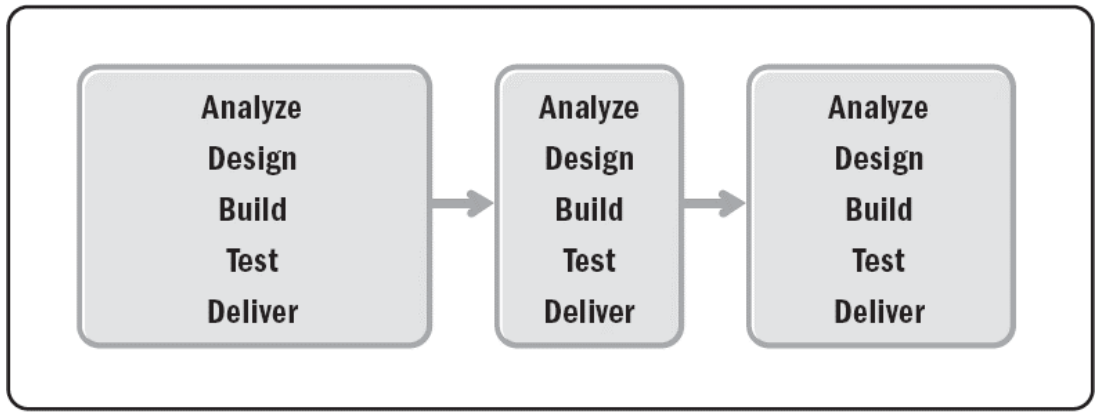
Characteristics

- Delivering value to sponsors or customers **more often than a single, final product.**
- The delivery team may deviate from the original plan, but can manage this change because they keep on delivering value to customer **very soon after**

Example:

- Software - provide a customer with a single, fully working function in a new software design;
- Builder: build and completely decorate a single room in a new house and show it to the customer

Concept



Agile Practice Guide (2017) Sec. 3.1.3

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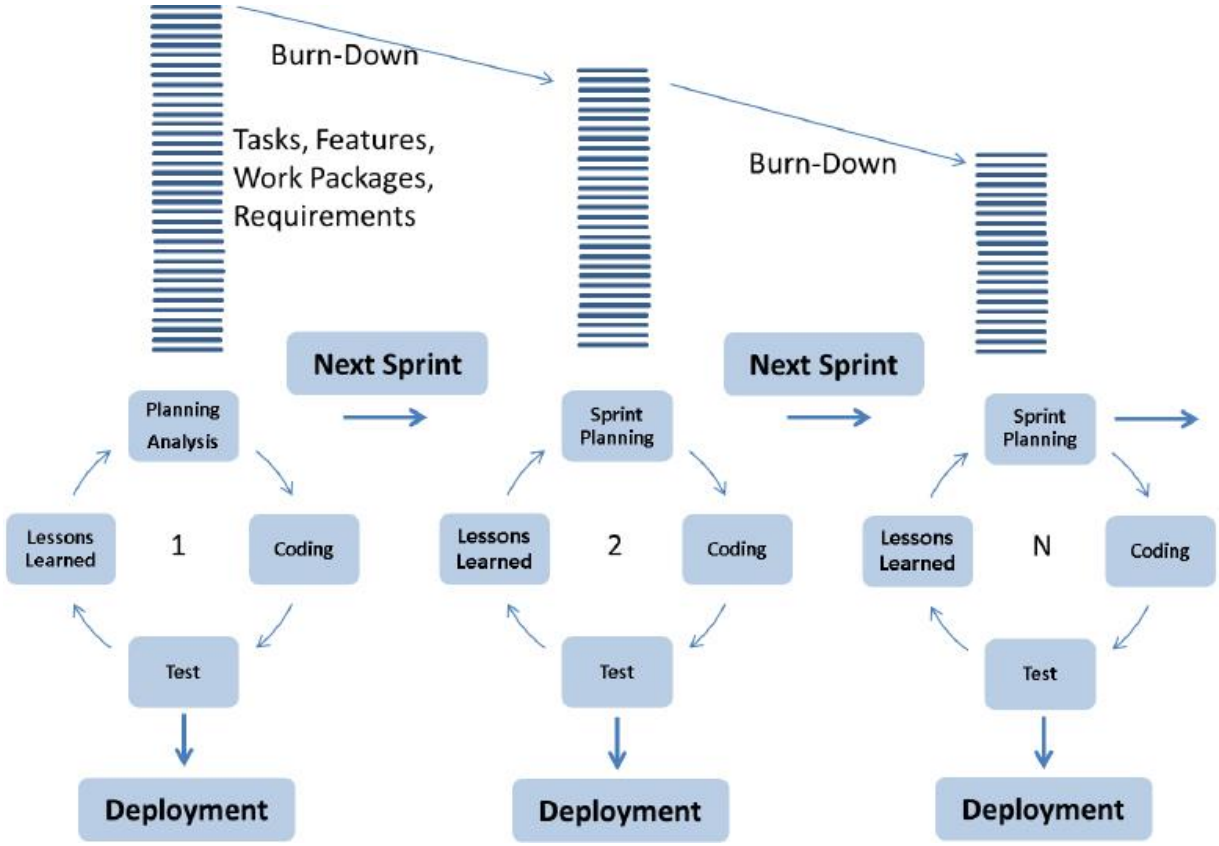
Agile lifecycle



The 100% ‘Agile’ PM model works best with few interdependencies between most of the work packages

Focused on continuous releases that incorporate customer feedback, which can be more suitable for modern businesses with rapid responses/change

Straçusser, G. (2015). Agile project management concepts applied to construction and other non-IT fields. Paper presented at PMI® Global Congress 2015—North America, Orlando, FL. Newtown Square, PA: Project Management Institute.

Lifecycle summary

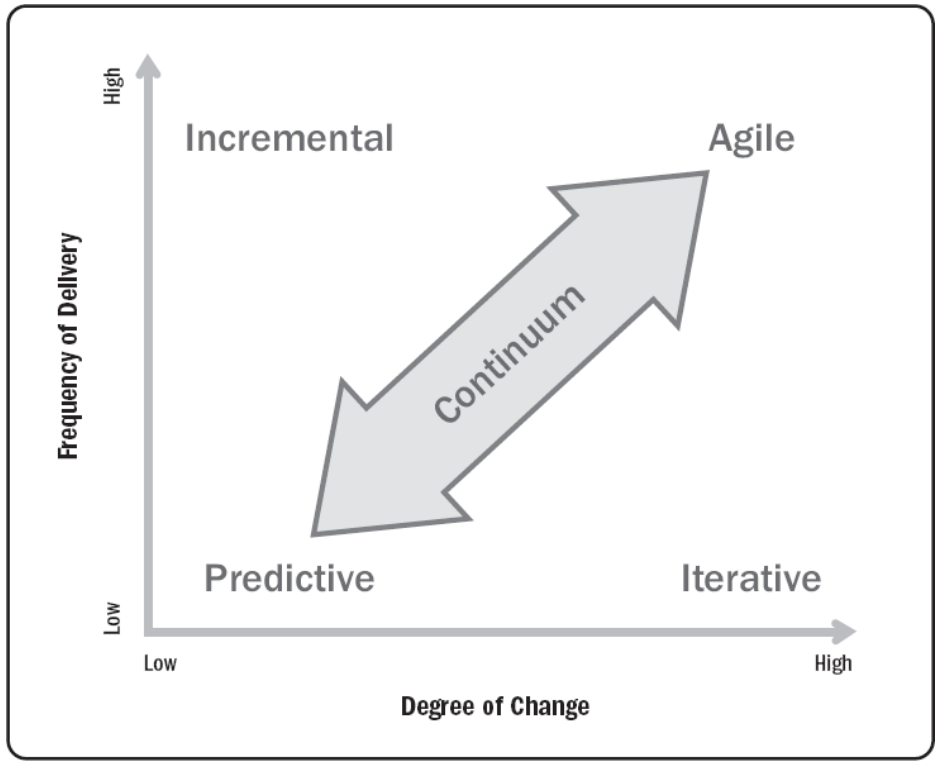


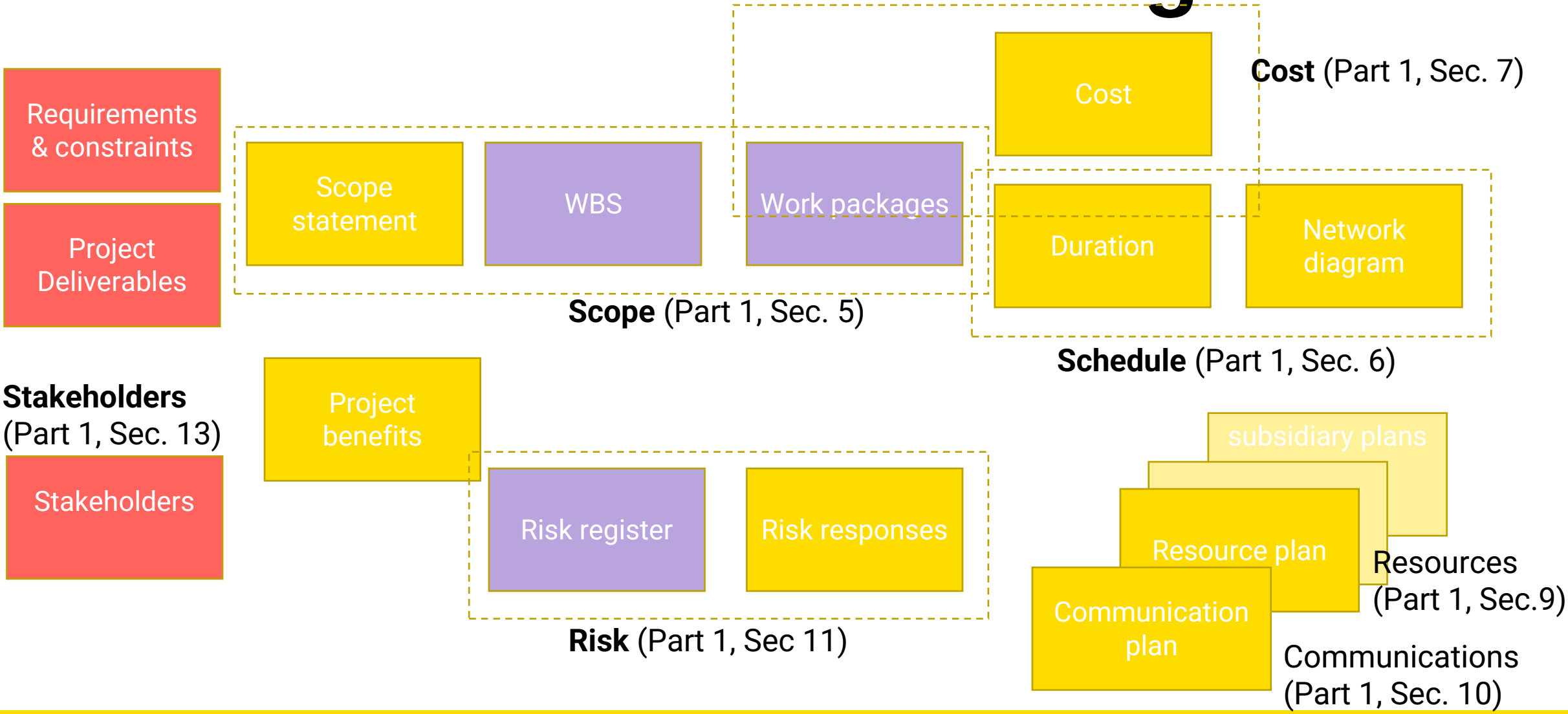
Figure 3-1. The Continuum of Life Cycles

Table 3-1. Characteristics of Four Categories of Life Cycles

Characteristics				
Approach	**Requirements**	**Activities**	**Delivery**	**Goal**
Predictive	Fixed	Performed once for the entire project	Single delivery	Manage cost
Iterative	Dynamic	Repeated until correct	Single delivery	Correctness of solution
Incremental	Dynamic	Performed once for a given increment	Frequent smaller deliveries	Speed
Agile	Dynamic	Repeated until correct	Frequent small deliveries	Customer value via frequent deliveries and feedback

Agile Practice Guide (2017) Sec. 3.1.

C3PA and PMBOK Knowledge Areas



PMBOK Guide (6th Ed) Part 2, Sec. 1.9 Table 1-1

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