



Air Vehicle Design

AOE 4065 – 4066

III. Project Management Topics

Course Module P1

Basics of Project Management and Project Planning

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Blacksburg, VA**



Overview of AVD Courses

I. Foundational Elements

- F1. Design: *An Engineering Discipline*
- F2. Systems and Systems Thinking
- F3. Basics of Systems Engineering
- F4. Decision Making with Ethics and Integrity

II. Air Vehicle Design Fundamentals

- A1. Purpose & Process
 - Conceptual Design**
- A2. Understand the Problem
- A3. Solve the Problem
- A4. Initial Sizing: *Takeoff Weight Estimation*
- A5. Initial Sizing: *Wing Loading and Thrust Loading Estimation*
- A6. Cost Considerations
- A7. Concept to Configuration: *Key Considerations*
- A7A. Configuration Layout: *Drawings & Loft*

Conceptual & Preliminary Design

- A8. Trade Studies
- A9. Use of Software Tools
- A10. Preliminary Design: *Baseline Design Refinement & Validation*

III. Project Management Topics

- P1. Basics of Project Management and Project Planning**
- P2. Project Organization
- P3. Roles & Responsibilities of Team Members
- P4. Project Execution: *Teamwork for Success*
- P5. Project Risk Management
- P6. Delivering Effective Oral Presentations
- P7. Writing Effective Design Reports

Disclaimer

*Prof. Pradeep Raj, Aerospace and Ocean Engineering, Virginia Tech,
collected and compiled the material contained herein from publicly
available sources solely for educational purposes.*

*Although a good-faith attempt is made to cite all sources of material,
we regret any inadvertent omissions.*

CRUCIALLY IMPORTANT

CMs only introduce key topics and highlight some important concepts and ideas...but without sufficient detail.

We must use lots of Reference Material* to add the necessary details!

(*see Appendix in the Overview CM)

P1. Basics of Project Management and Project Planning

P1.1 What is a Project?

P1.2 What is Project Management?

P1.3 What is Project Planning?

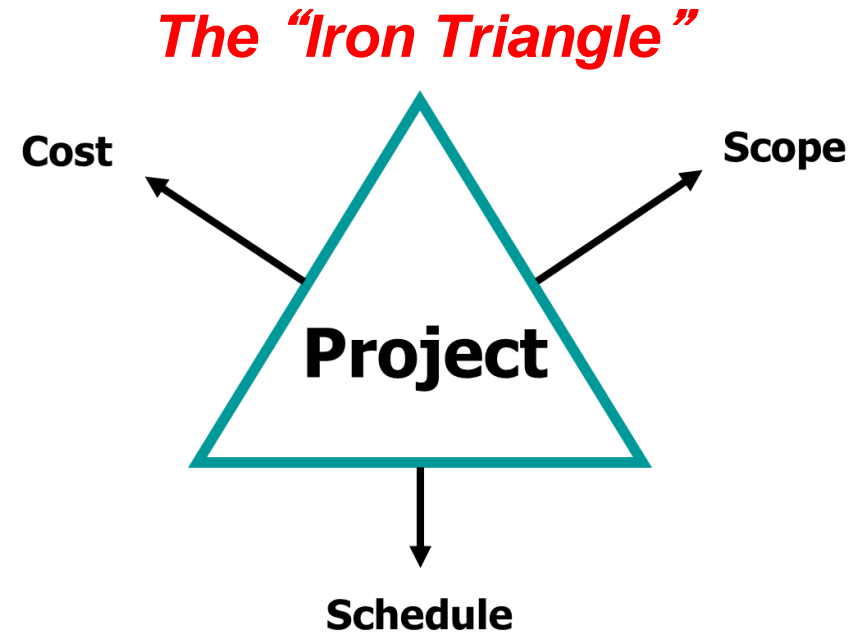
P1.4 What is a Project Plan?

NOTE

A discussion of *what ‘Project’ is* (P1.1) and *what ‘Project Management’ is* (P1.2) provides a suitable context for discussing *‘Project Planning’* (P1.3) and *‘Project Plan’* (P1.4).

What is a Project?

- A project is a *set of tasks* that relate to each other, and together define the Scope of the project.
 - Tasks consume Resources (*Time, Effort, Material*)
 - Each task has a Start and a Finish
- All projects have Cost and Schedule targets
- Purpose of the Project is to (or attempt to) achieve a set of Objectives



All three, i.e., scope, schedule, and cost, cannot be constrained without incurring substantial risk.

Project is an enterprise that must be carefully planned to achieve a particular outcome

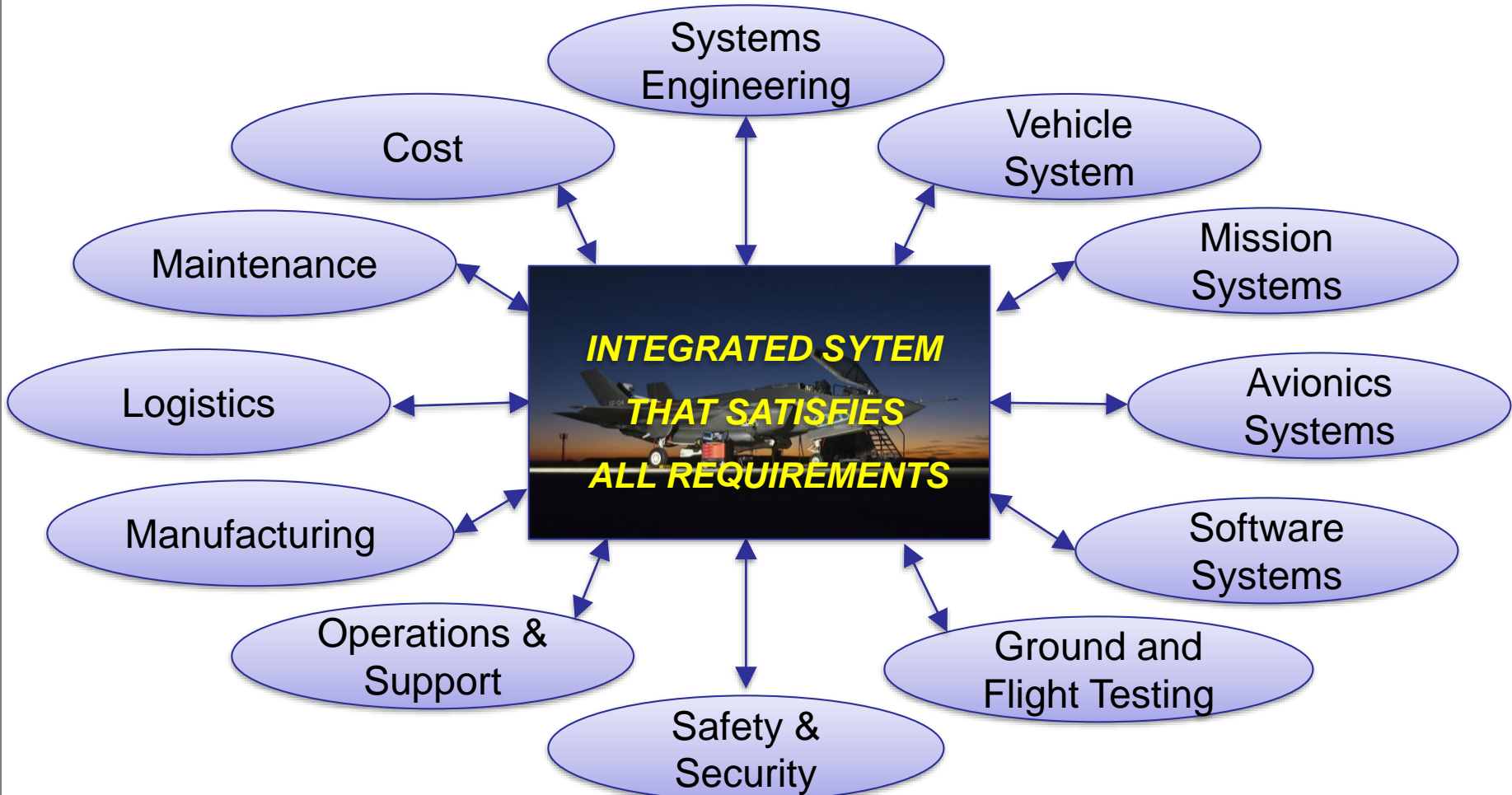
Project in a Nutshell

A Project has

- **Goals** – things you need or want to accomplish—statement of purpose or aim; may be nebulous or less structured
- **Objectives** – steps required to achieve the goal; should be concrete and S.M.A.R.T. (*Specific, Measurable, Attainable, Realistic, Time-bound*)
- **Work (Tasks)** – set of activities you must perform to accomplish the objectives
- **Schedule** – allocated time to finish the work (tasks and activities)
- **Cost** – allocated resources (material, labor, computers, buildings, etc.) to do the work
 - *Is ‘aircraft design’ a project?*
 - *Is ‘oral review’ a project?*
 - *Is ‘final report’ a project?*

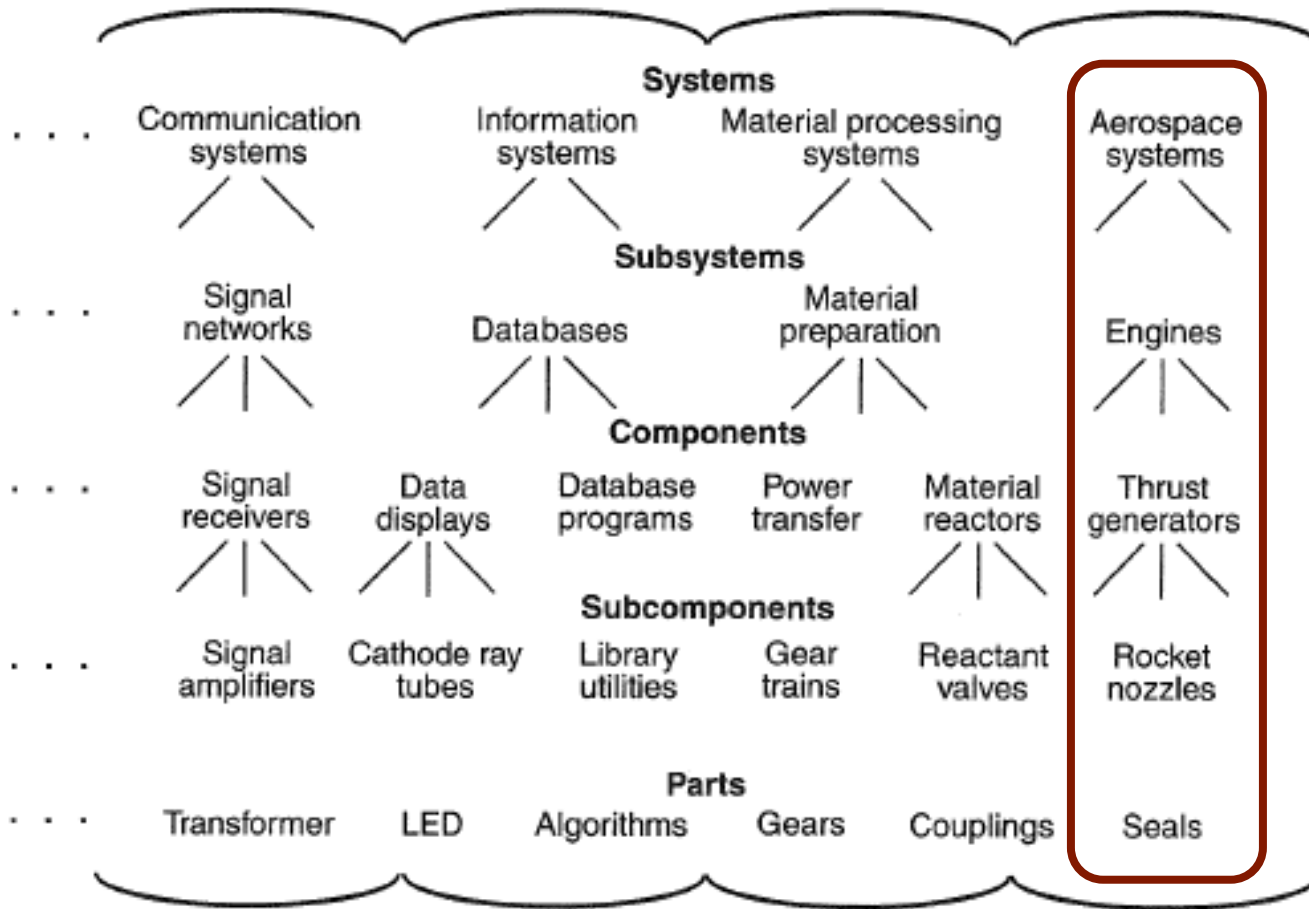
Typical Air Vehicle System Design

A Truly Multidisciplinary Project



People in various disciplines provide “expert advice” and quality *data*—*on time and on budget*—to system integration team for integration into an air vehicle system that meets all **DESIRED REQUIREMENTS** and MoMs

Teams Perform Tasks to Design a System that Best Meets the Project Requirements



Traceable and Testable Requirements Must Flow Down from the Top Level to the Lowest Level

“Requirements Drive Design!”

Success of a design project demands that tasks be performed—Expertly, Efficiently, Effectively—to achieve the design objectives within cost and schedule targets.

The Question is How?

- ***How to leverage **expertise**?***
- ***How to increase **efficiency**?***
- ***How to improve **effectiveness**?***

The Answer is:

Through Good Project Management (PM)!

P1. Basics of Project Management and Project Planning

P1.1 What is a Project?

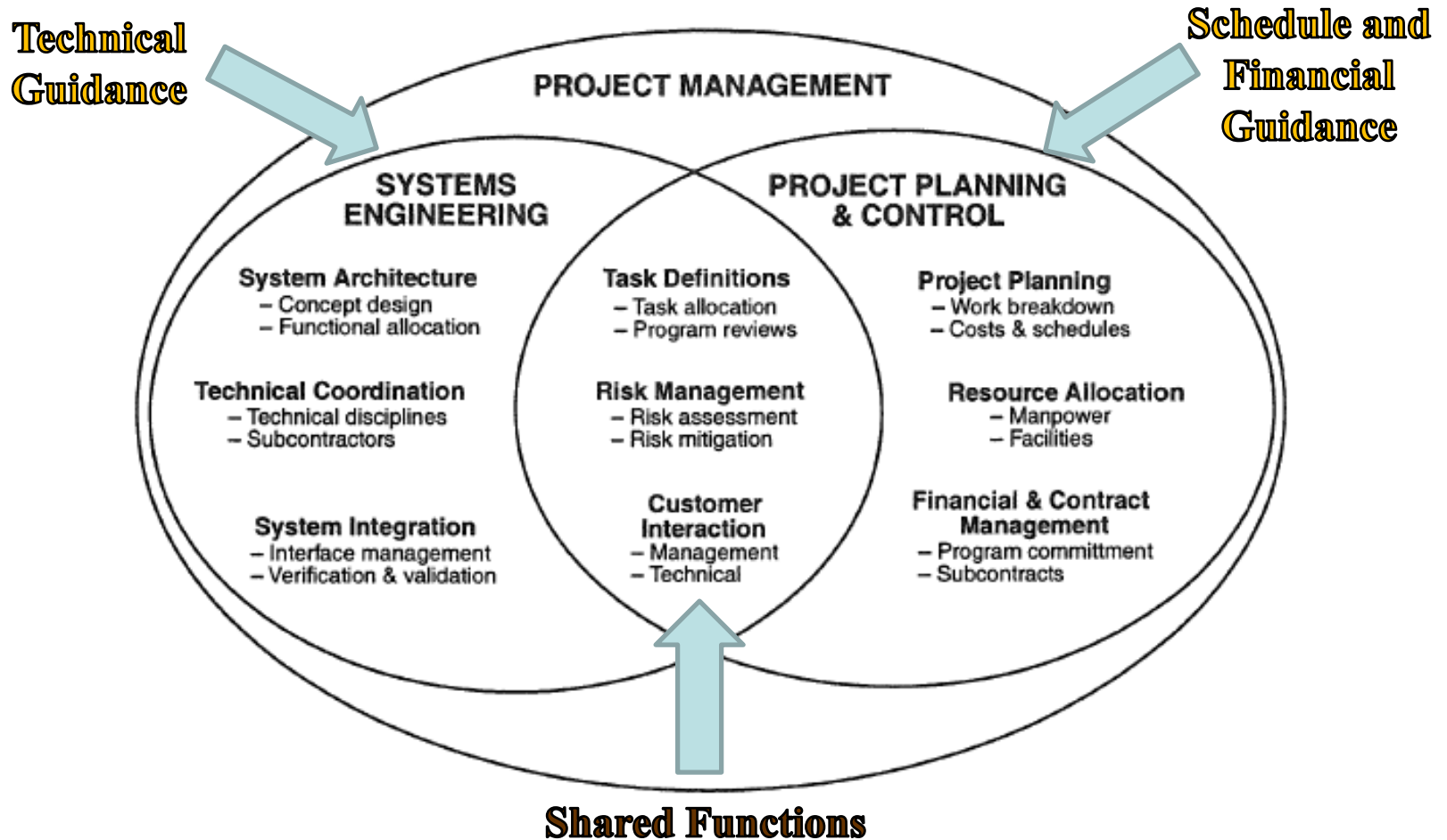
P1.2 What is Project Management?

P1.3 What is Project Planning?

P1.4 What is a Project Plan?

What is Project Management (PM)?

Project Management is a body of practices, methods, and tools for completing a project within **time, cost and scope at the desired performance/ specification level while effectively and efficiently **utilizing resources** and carefully **managing risks** and opportunities**



Source: Fig. 4-1, Ref. SE 2 (Kossiakoff and Sweet); and AOE-3564 Lectures by Bryan Moser (MIT)

An in-depth discussion of all aspects of Project Management depicted in the previous slide is beyond the scope of the Air Vehicle Design courses.

We instead highlight a few relevant and essential topics:

- **Systems Engineering (CM F3)**
- **Project Planning (CM P1)**
- **Project Organization (CM P2)**
- **Project Execution (CM P4)**
- **Project Risks (CM P5)**

How Does PM Fare Today?

- **“At the last company-wide review, we were late on 50 key project milestones, representing an overrun of \$1.2 billion.”**
- **“We spend more on research, development and engineering than our competitors, yet our products are no better than theirs, and sometimes worse.”**
- **In the last eight years, the schedule slippages and costs of major DoD weapons systems acquisition programs are growing and performance to requirements is deteriorating to the point that some systems will not meet the needs of the warfighters. (Paraphrase of GAO report.)**
- **On average, across more than 200 companies, only 70% of initial program commitments are delivered when the program enters service.** *(PRTM Performance Management Group survey, private communication)*

“Model-Based Project Design” Approach Holds the Key to Effective PM—An Entirely New Approach (AOE-3564 course)!

P1. Basics of Project Management and Project Planning

P1.1 What is a Project?

P1.2 What is Project Management?

P1.3 What is Project Planning?

P1.4 What is a Project Plan?

What is Project Planning?

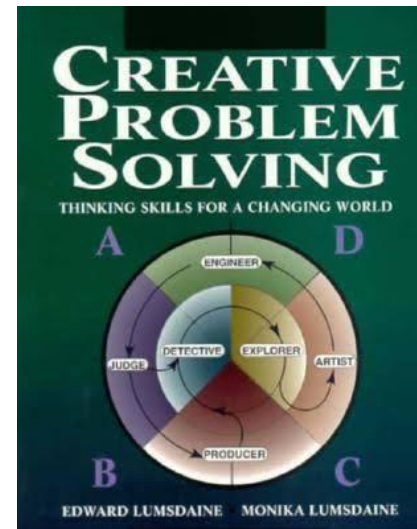
“Project Planning is a social process through which activities, roles, and dependencies are discovered, awareness aligned, systemic outcomes anticipated, and commitments made to achieve targets.”*

- Planning offers a means of communicating with all stakeholders *where* we are going and *how* we are going to get there
- Planning creates a ‘Project Plan’ that helps to manage time, cost, quality, risk, people, suppliers, etc., with the aim of delivering the project on time, on budget

“If you don’t take time to plan, you are planning to waste time.”

Creative Problem Solving

Edward and Monika Lumsdaine
Michigan Tech



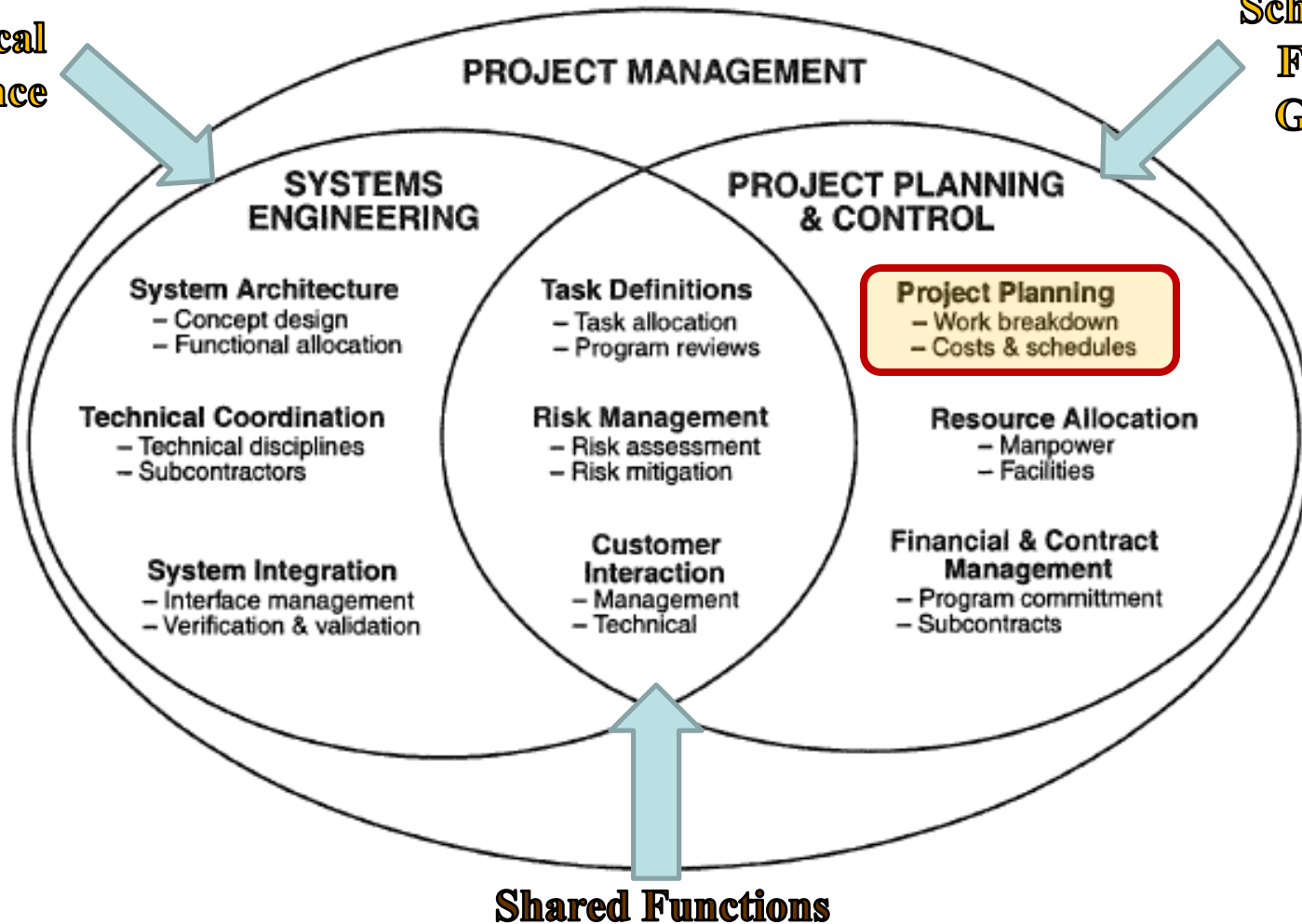
We Next Discuss Widely-practiced Traditional Approaches for Project Planning

Project Planning

An Essential Element of PM

**Technical
Guidance**

**Schedule and
Financial
Guidance**



In Project Planning, tasks and deliverables are defined, and schedule is created.

Project Planning: WBS

Work Breakdown Structure (WBS) for structuring work

WBS is a means of structuring system development work (activities or tasks) based on system decomposition.

Basic purposes of WBS:

- (a) **Technical**—establishes a structure for
 - identifying products, processes, and data;
 - managing risk;
 - enabling configuration and data management and control;
 - organizing technical reviews.
- (b) **Organizational**—key contributor to a coordinated, complete and comprehensive view of the project.
- (c) **Business**—provides a structure for budgets and cost estimates.



The *first* three (3) levels of WBS of a system design effort are:

Level 1. Overall System

Level 2. Major Elements

Level 3. Subsystems & Components

Levels below the first three represent decomposition to subcomponents, parts, or items

WBS (Work Breakdown Structure)

WBS is a hierarchical structure of all of the tasks to be accomplished (*what* must be done) during a project.

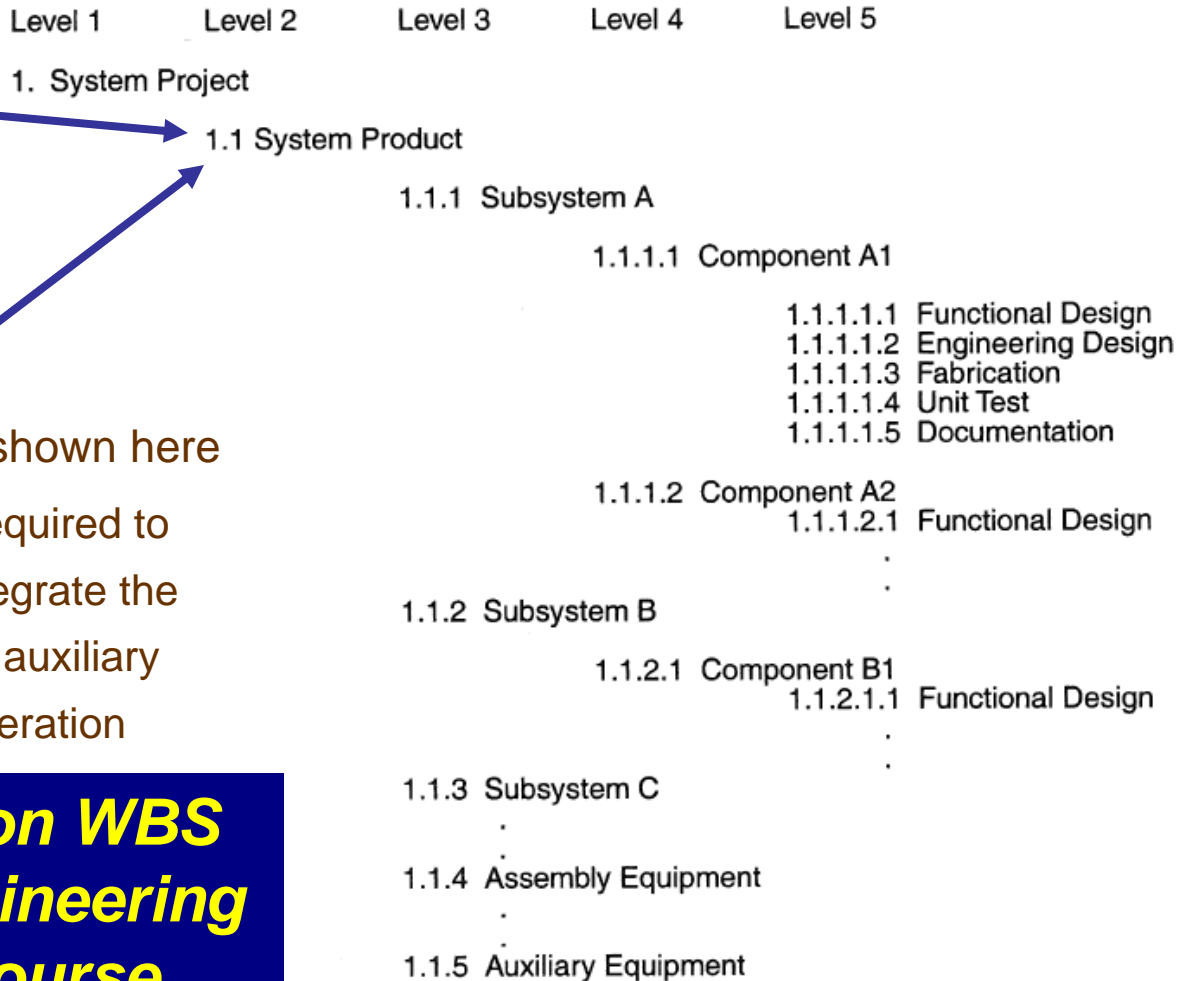
- WBS is specifically tailored to each project

- Typical Level 2 Categories

- *System Product*
- *System Support*
- *System Testing*
- *Project Management*
- *Systems Engineering*

- *System Product* example is shown here

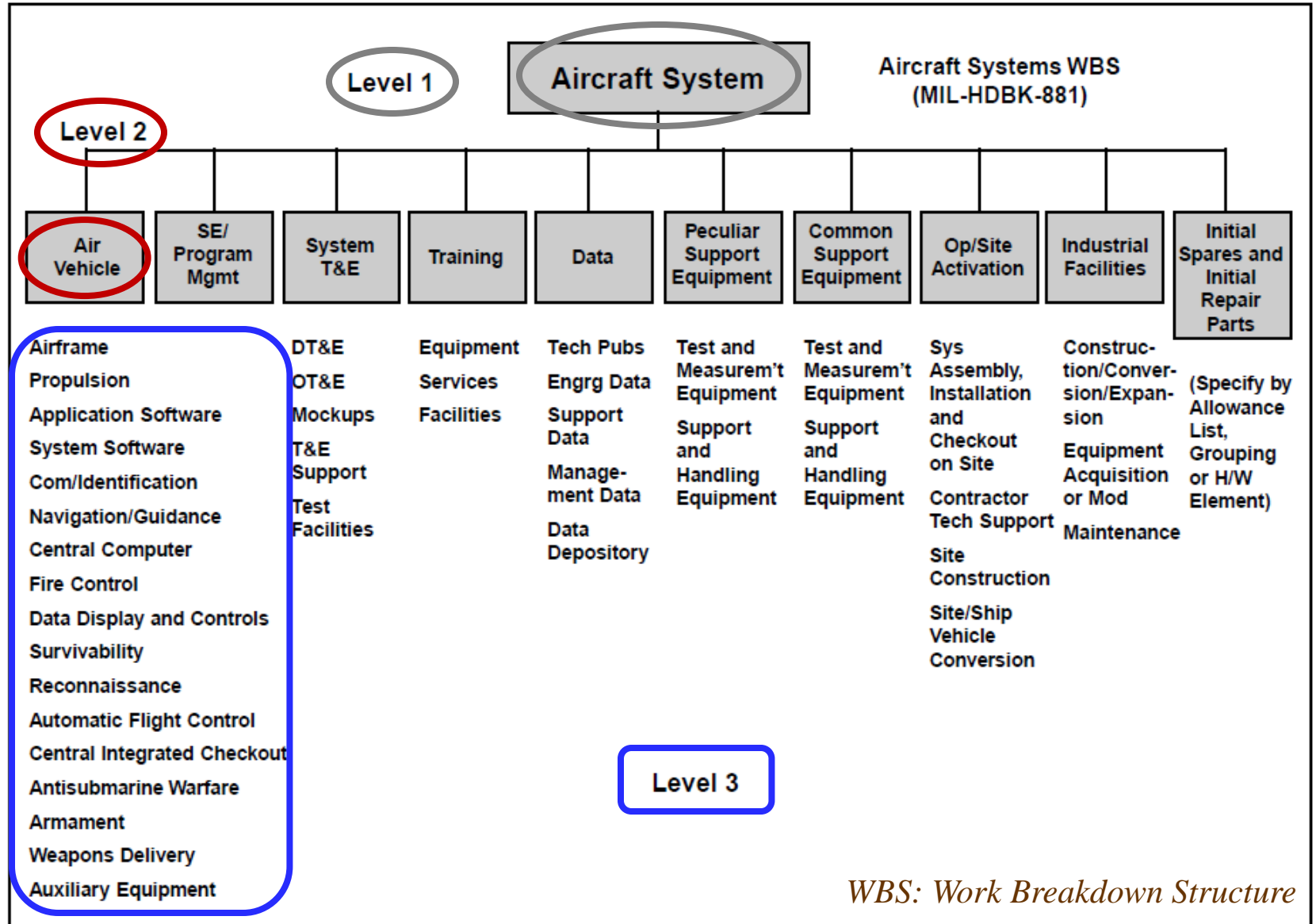
- WBS depicts total effort required to develop, produce, and integrate the system, together with any auxiliary equipment required for operation



We mainly focus on WBS for Air Vehicle Engineering Design in this course

A Complete Three-level WBS Example

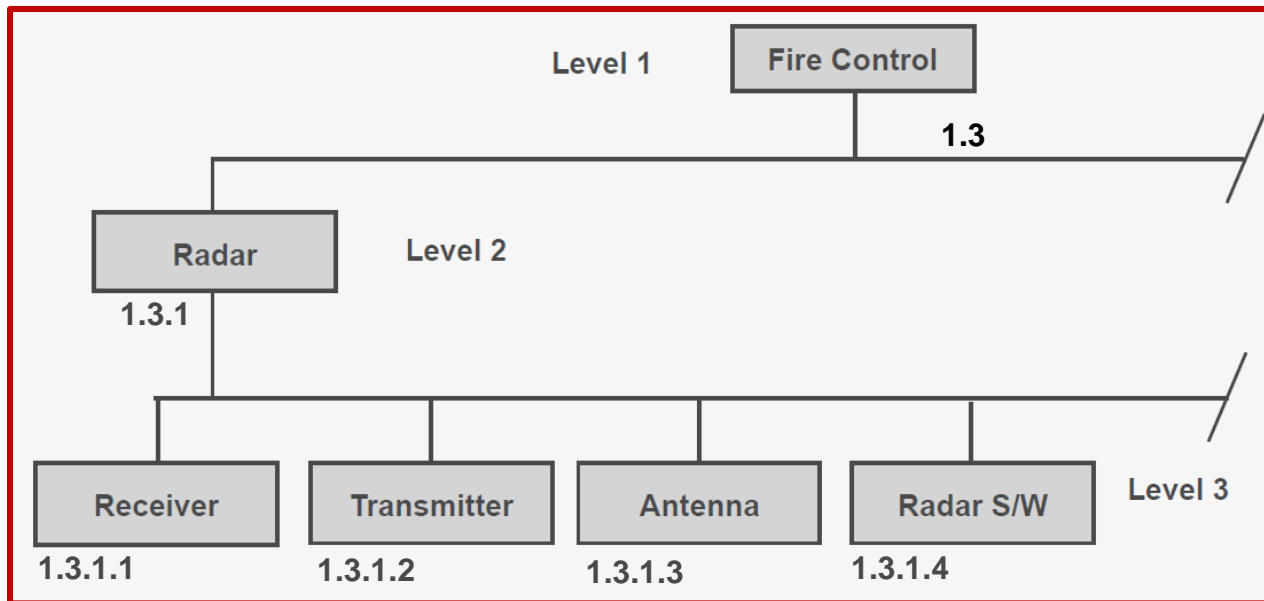
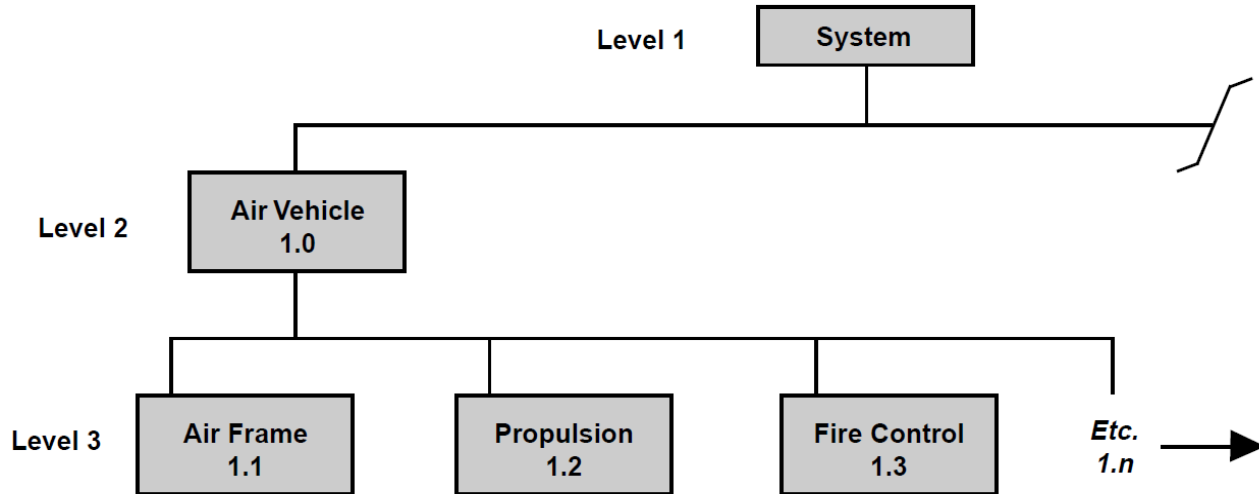
An Aircraft System



WBS: Work Breakdown Structure

A Typical Air Vehicle System

Work Breakdown Structure (WBS) Example Down to *Subsystem* Level



Subsystem
Fire Control
1.3

Note:
‘Fire Control’ refers to
control of
‘weapons fire’

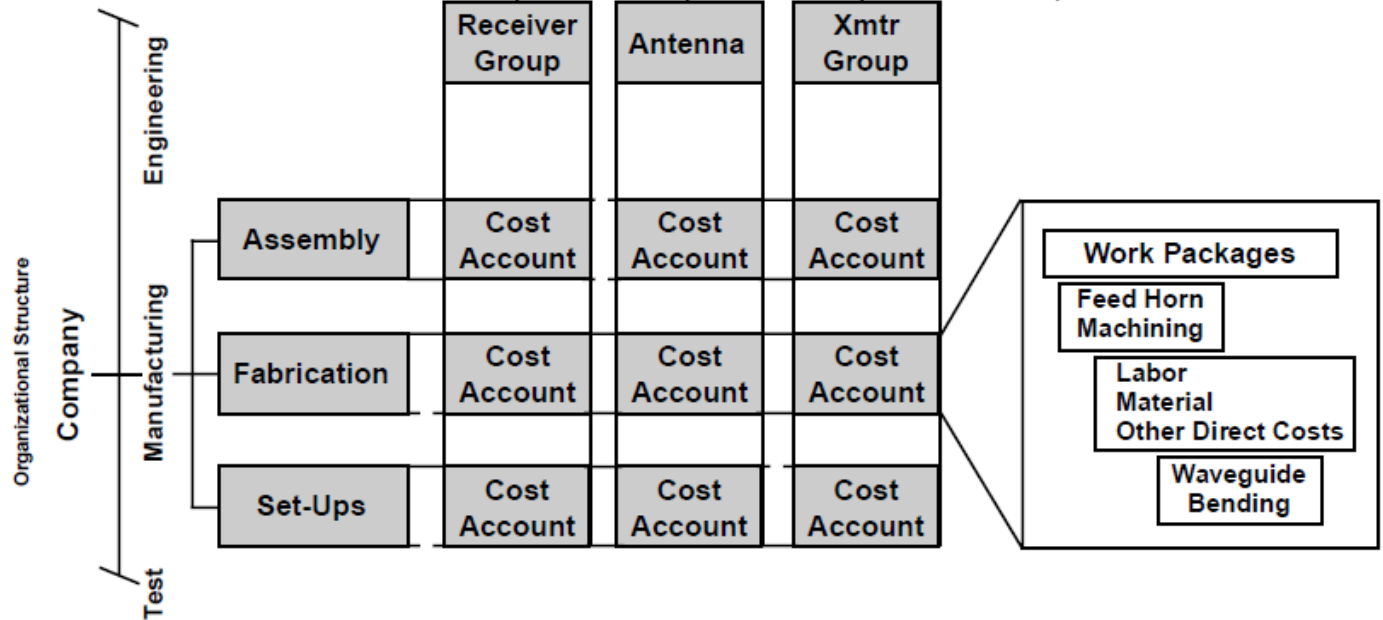
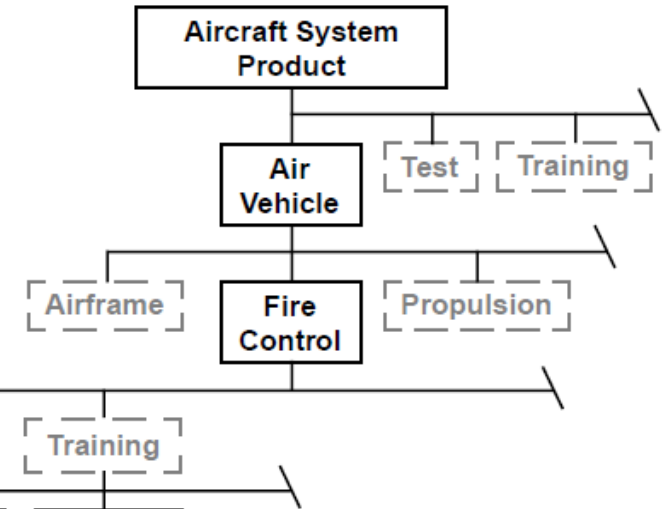
Project Planning: WBS

Crucial Role of Work Breakdown Structure (WBS)

WBS is used to

- a) logically decompose the work down to work packages; *requirements must flow down as well!*
- b) matrix work against teams responsible for the tasks
- c) create cost accounts and task definition at a detailed level
- d) track technical and other progress

Work Breakdown Structure



10 Steps of Project Planning



Source: <https://www.techtarget.com/searchcio/definition/project-planning>

Project Planning: 10 Steps

- 1. Define stakeholders.** Stakeholders include anyone with an interest in the project. They can include the **customer** or **end user**, members of the **project team**, other people in the organization the project will affect and outside organizations or individuals with an interest.
- 2. Define roles.** Each stakeholder's role should be clearly defined. Some people will fill multiple roles, however.
- 3. Introduce stakeholders.** Hold a meeting to bring stakeholders together and unify the **vision** behind the project. The topics covered should include **scope, goals, budget, schedule** and roles.
- 4. Set goals.** Take what is gleaned from the meeting and refine it into a project plan. It should include goals and **deliverables** that define what the product or service will result in.
- 5. Prioritize tasks.** List **tasks** necessary to meet goals and prioritize them based on importance and interdependencies. A **Gantt chart** can be helpful for mapping project dependencies.
- 6. Create a schedule.** Establish a **timeline** that considers the **resources** needed for all the tasks.
- 7. Assess risks.** Identify **project risks** and develop strategies for mitigating them.
- 8. Communicate.** Share the plan with all stakeholders and provide **communications** updates in the format and frequency stakeholders expect.
- 9. Reassess.** As **milestones** are met, revisit the project plan and revise any areas that are not meeting expectations.
- 10. Final evaluation.** Once the project is completed, performance should be evaluated to learn from the experience and identify areas to improve.

P1. Basics of Project Management and Project Planning

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P1.2 What is Project Management?

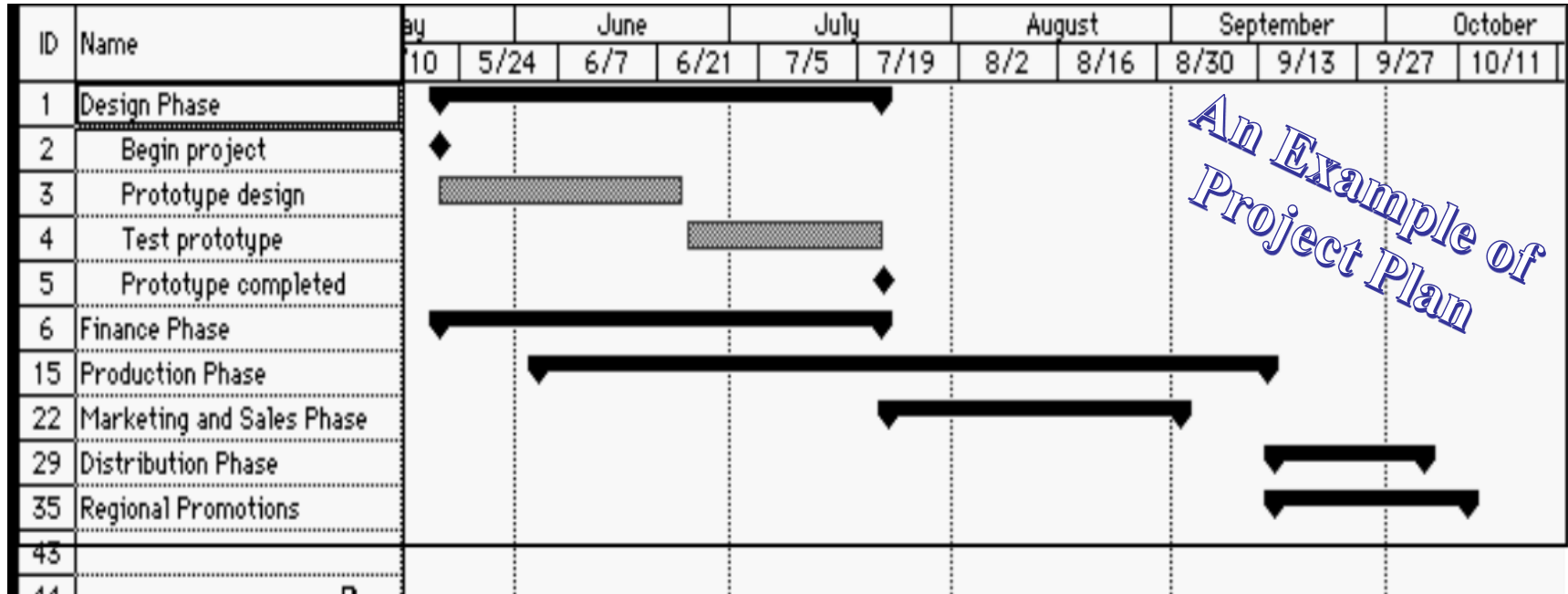
P1.3 What is Project Planning?

P1.4 What is a Project Plan?

Project Plan:

An Outcome of Project Planning

Gantt Chart is widely used to graphically depict project plan
A basic Gantt chart shows a sequence of WBS tasks in the order they need to be performed over specified time to complete the project

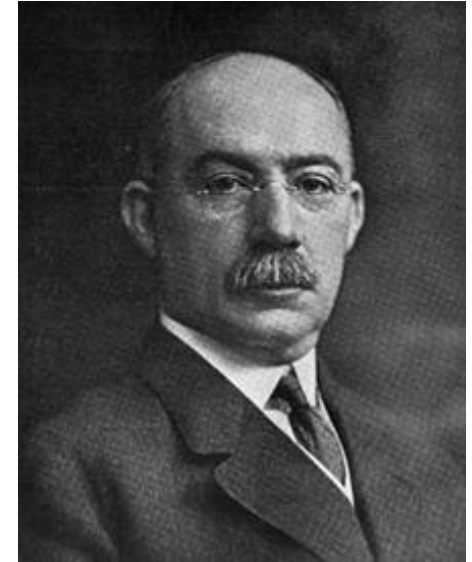


- Provides common overview of project plan to ALL stakeholders
- Useful for monitoring Progress

Gantt Chart depicts an integrated set of interdependent tasks that represent the complete project

History of Gantt Chart

- **Henry Gantt:** *Gantt Chart* (1903 paper, 1920 book) and *Organizing for Work* (1919)
- **First Claim:** “... if the facts about a business can be represented in a compact and comprehensive manner, then it will be found possible to run any business more efficiently than has been the custom in the past.”
- **Gantt’s principles for his chart (circa 1912)**
 - “*All activities can be measured by the amount of time needed to perform them*”
 - “*The space representing the time unit on the chart can be made to represent the amount of activity which should have taken place in that time*”
- **Second Claim:** “Bearing in mind these two principles, the whole system is readily intelligible and affords a means of charting all kinds of activities, the common measure being time.”



Henry Laurence Gantt
1861-1919

The Gantt Chart—a 1903 Technology—Still Widely Used!

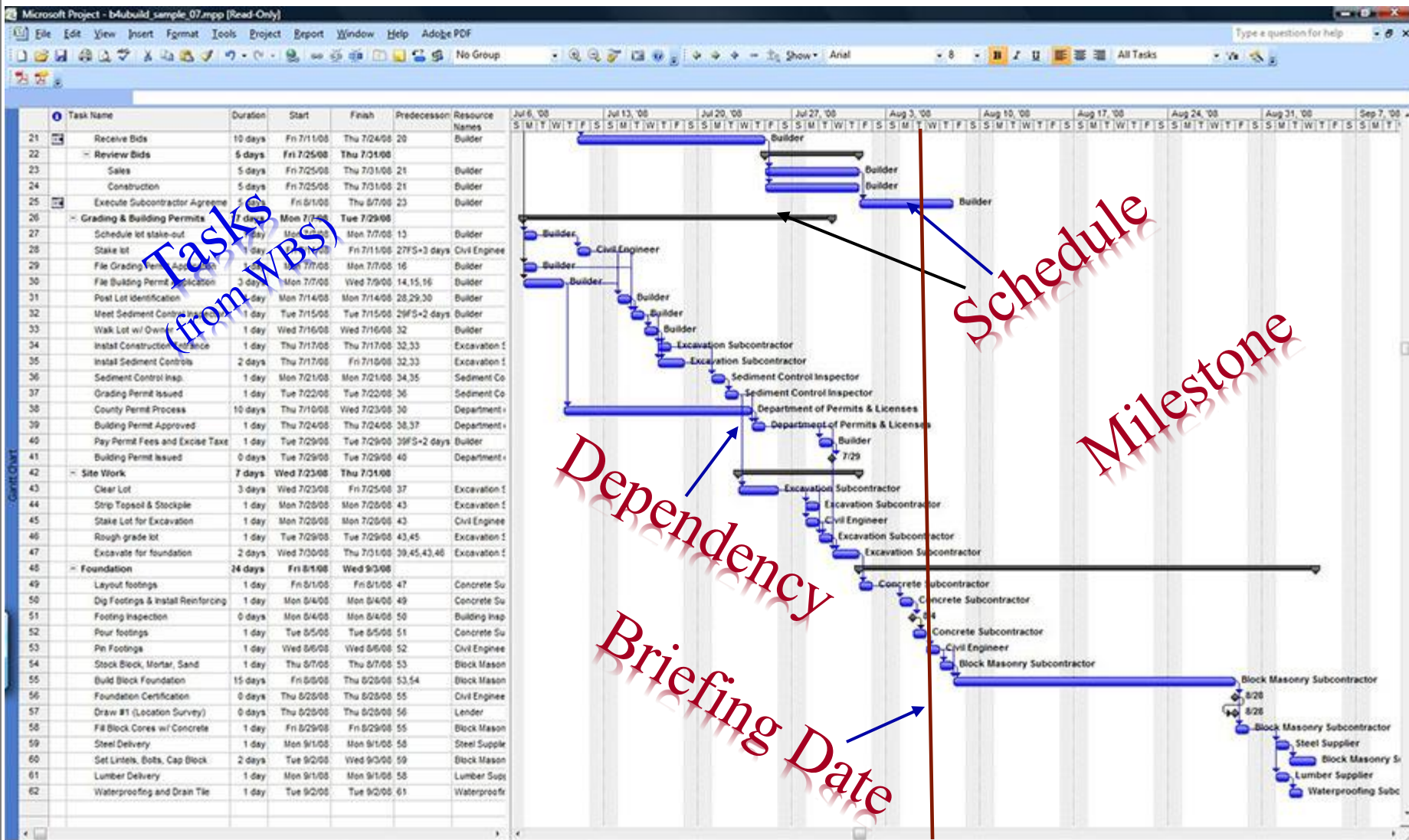
Making a Gantt Chart

- **Identify/Define and Select Content**
 - **Tasks to accomplish objectives:** *Define using Work Breakdown Structure (WBS) construct*
 - **Schedule of each task:** *must have well defined beginning (start date), end (finish date), duration (days), level of effort (labor hrs.)*
 - **Milestones:** *Represent major events, deliverables, task completions, etc.*
 - “90% task complete” is **not** a milestone, it is progress
 - **Deliverables:** *Clearly identified product (what) to be delivered and delivery date (when)—they are the reasons for doing the tasks in the first place!*
- **Use available Software—don’t waste time to write your own!**
 - Microsoft Project: a good starting point
- **See references PM 1 and PM 2 for ways of estimating schedule of tasks**

- *The ubiquitous Gantt chart is the first exposure of many people to Project Planning and Management.*
- *The chart—a 1903 technology—is still in use today for planning, scheduling and monitoring projects.*
- *Modern Gantt charts also show dependencies between activities.*

It's NOT Rocket Science!

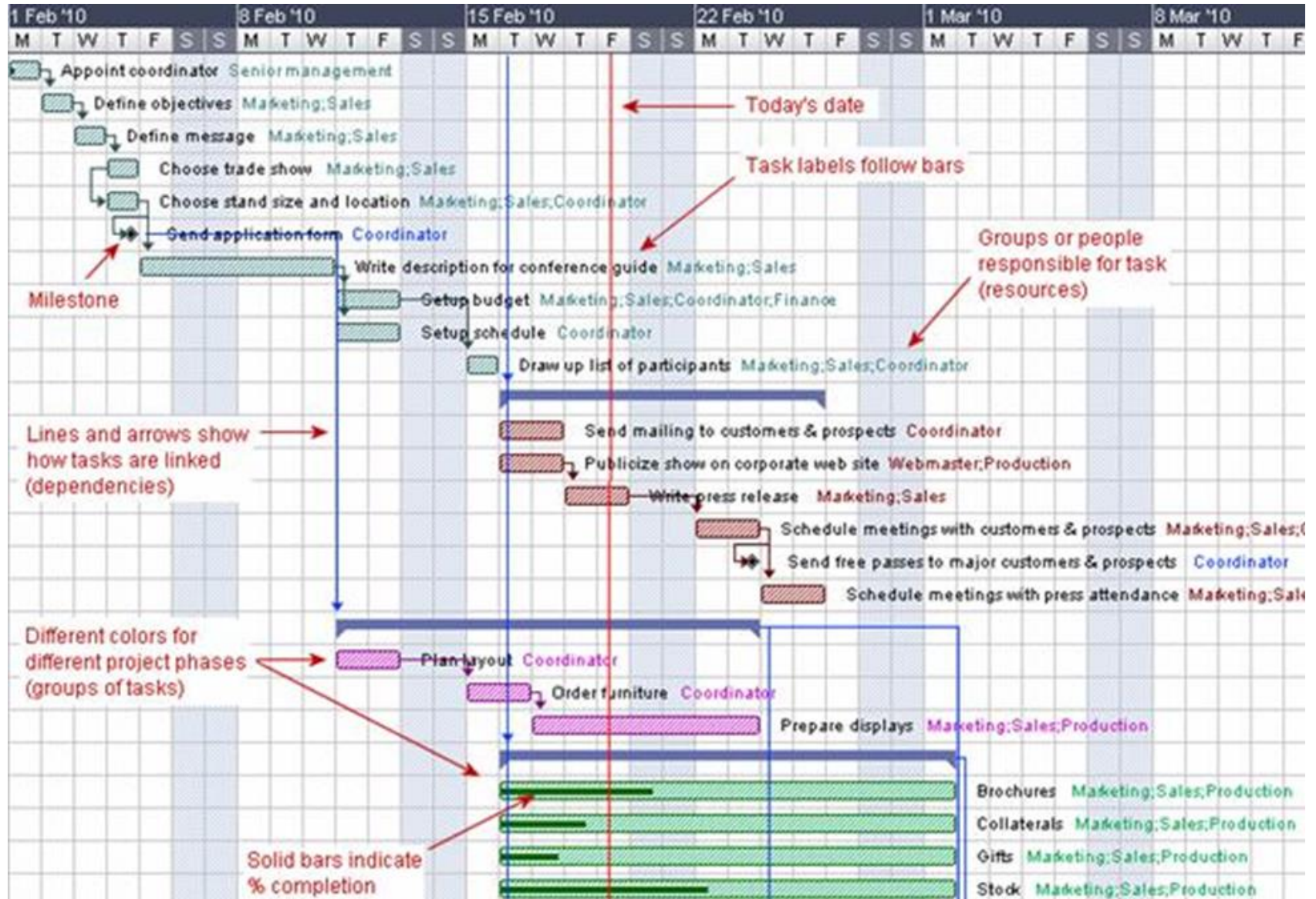
Key Elements of a Gantt Chart



Source: http://www.b4ubuild.com/resources/schedule/gant_chart_02b.jpg

Built Using MS Project

Example of A Detailed Modern Gantt Chart Illustrating Key Features





Example of a Gantt Chart: VT Senior Design Team

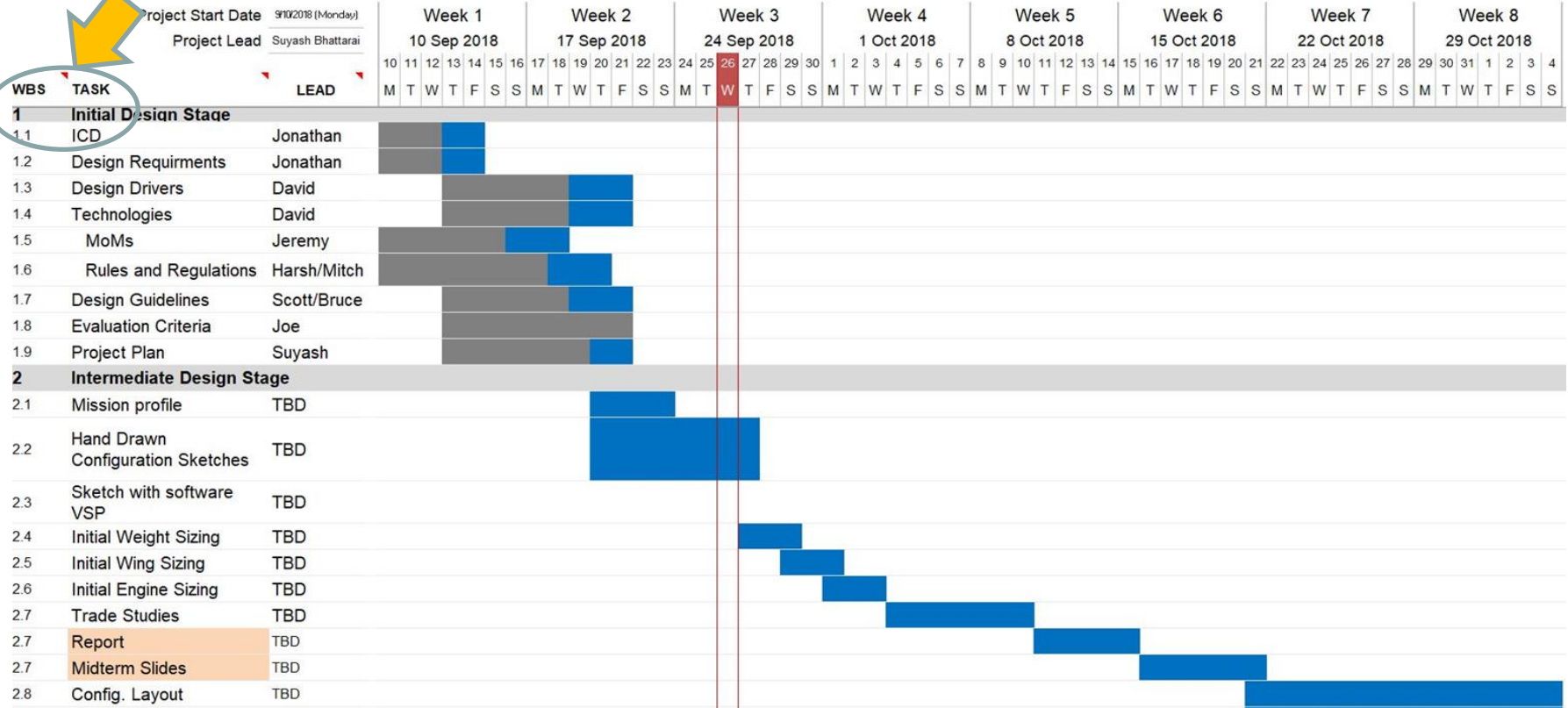
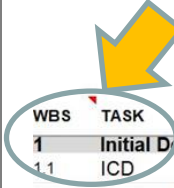
AfricAir

Senior Design Team

Gantt Chart Template © 2006-2018 by Vertex42.com.

Project Start Date 9/10/2018 (Monday)

Project Lead Suyash Bhattarai



Only Partial Project Plan Shown



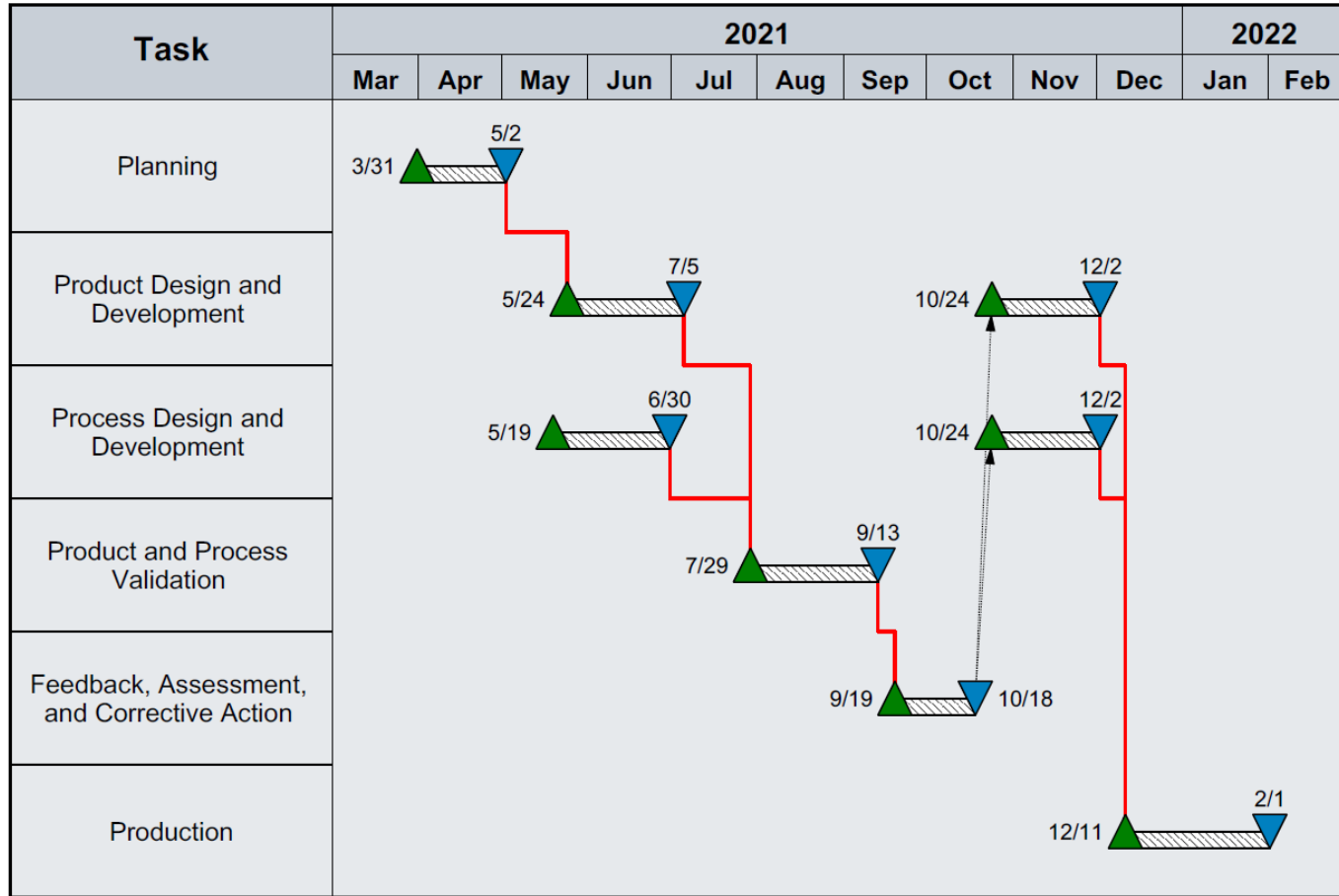
Only a snippet.

High-level Gantt Chart Example

Good for Oral Presentations

Product Development Schedule Phase One

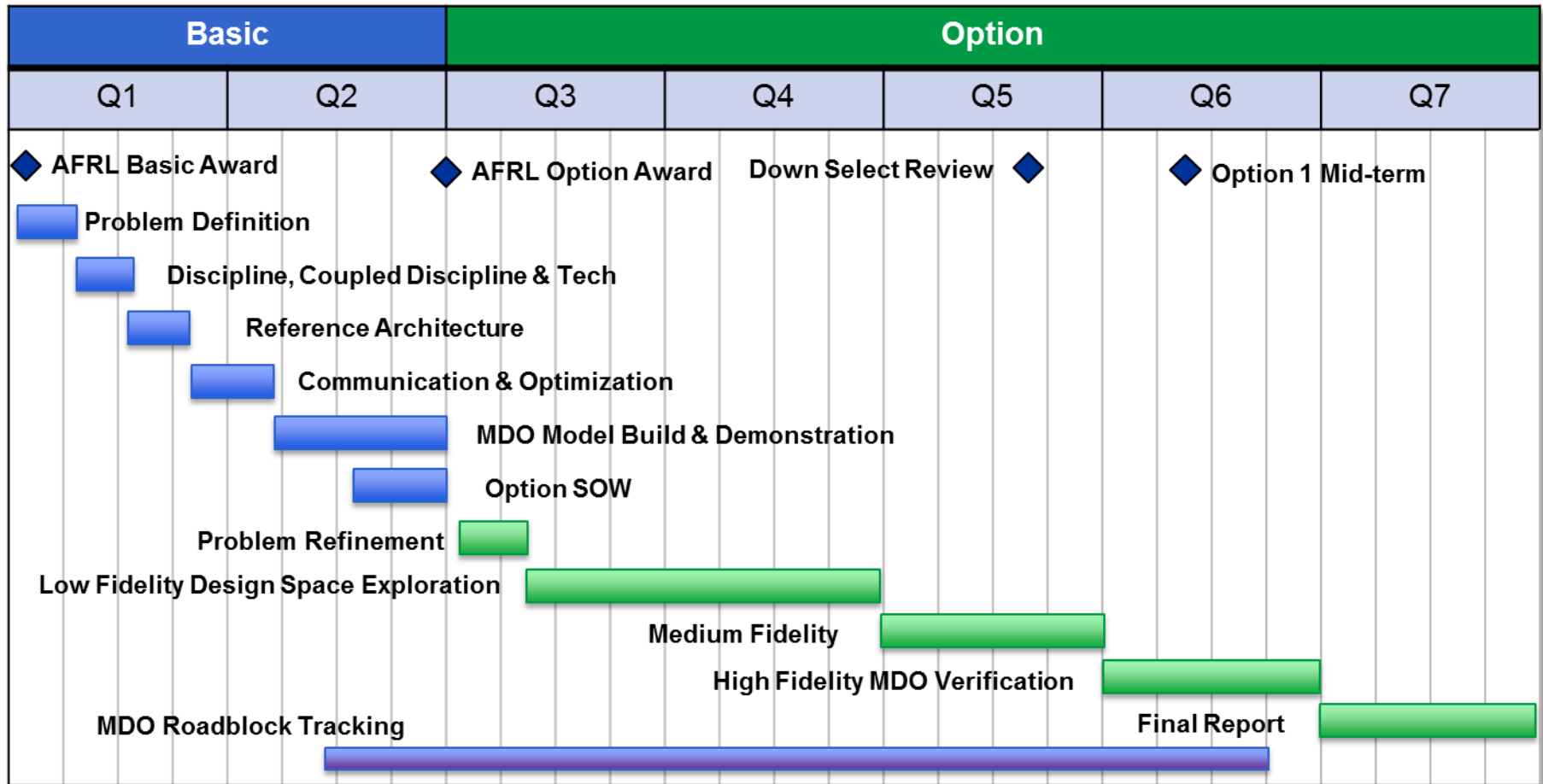
Created Using Milestones Software
www.kidasa.com



Source: <http://www.ganttchart.com/Chart/Ganttwithdependencies.pdf>

High-level Gantt Chart Example

Good for Oral Presentations



Note: Level of Effort (task-by-task labor hours allocation)

- May be added to the chart, or
- Be kept on separate chart if more convenient.

Tips for Project Planning

- **Start from the End (*Go from Right to Left*)**
 - The project is highly successful if completed on time and on budget.
 - Use project completion date and milestones deadlines as constraints for allocating time and resources to all tasks.
 - *Estimate task duration based on historical data*--if similar tasks had been done before. Use the available record of resources (time and effort) from past projects. May need to adjust duration to meet current project deadlines.
 - Without any past data, apply other techniques (see References PM 1 and PM 2) to estimate task duration including inputs from experienced experts.
 - *Make sure all tasks are scheduled (including interdependencies and overlaps) in a manner that ensures their timely completion.*
- **Allocate resources subject to budget constraints**
 - Resolve mismatch between initial estimate of resources and allocation through innovative approaches to perform the task or scope change in consultation with the customer.

Project Planning is a Dynamic Activity—Ends when the Project Ends!



Epilogue

Plan and Planning: Not the Same

“No plan of operations extends with any certainty beyond the first encounter with the main enemy forces.”

-- Helmuth von Moltke

German Military Strategist

A Corollary:

“No Plan Survives Contact With Reality.”



Dwight David “Ike” Eisenhower
14 Oct 1890 – 28 Mar 1969

**“Plans are worthless;
planning is everything.”**

Gen. Eisenhower

World War II: Supreme Commander of
the Allied Expeditionary Force in Europe
34th U.S. President (1953-1961)

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