ECEN 478: Senior Design

ECEN 478

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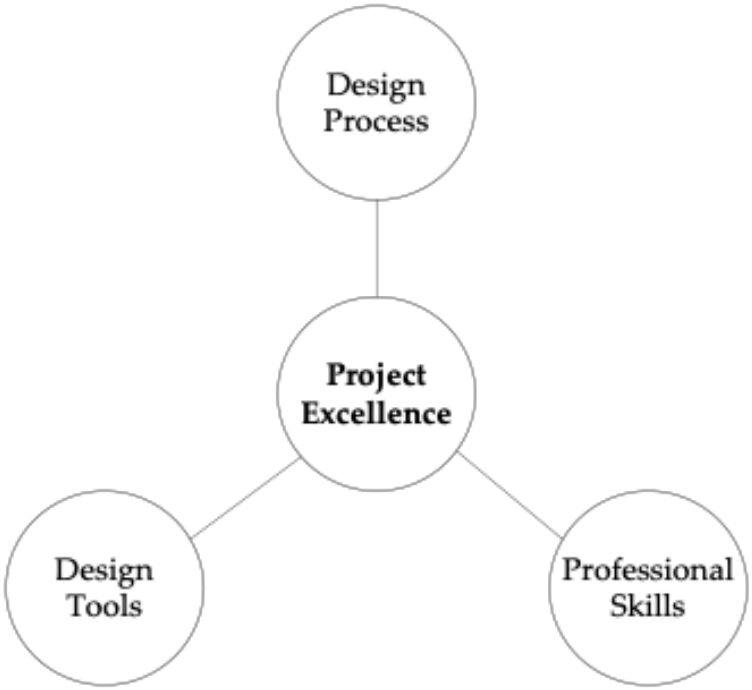
Outline

Motivation

- Engineers are regularly engaged in projects in their careers!
- Middle management continues to shrink
- Industry now organizes more around projects than functions.



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- #1 Area of Continuing Education reported by Penn State Behrend ECE alumni.
- Penn State Behrend School of Engineering Survey 2003 of Fortune 500 companies- #1 required skill for new engineers = PROJECT MANAGEMENT SKILLS

The HOLY GRAIL!

To complete the project

- With available labor
- On-time
- Within budget
- So that it meets the requirements

Learning Outcomes

By the end of this chapter, you should

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- APPLY THIS TO YOUR PROJECT – YOU MUST LEARN BY DOING!

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- Has other task completion responsibilities

Outline

Work Breakdown Structure

Work Breakdown Structure (WBS)

A hirearical breakdown of the activities, tasks, dependencies, costs, and deliverables to be accomplished for the project

Activity

A task or a goup of tasks along with there associated deliverables

Tasks

Actions that accomplish a job

Deliverables

Items that result from the completion of the task, (should progress toward the project goals)

WBS – Other Descripitons

From MIL-HDBK 881

- A product-oriented family tree composed of hardware, software, services, data, and facilities. The family tree results from systems engineering efforts.
- A WBS displays and defines the product, or products, to be developed and/or produced. It relates the elements of work to be accomplished to each other and to the end product.

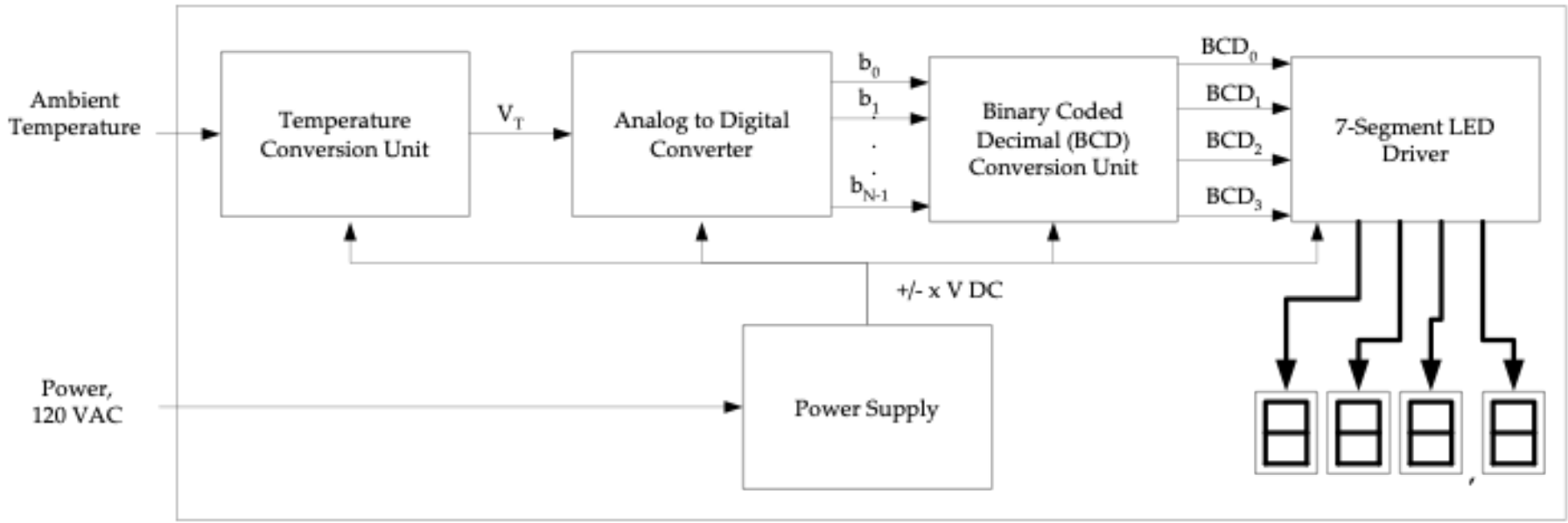
Elements in WBS

- Activities
- Responsibilities
- Timeline
- Dependencies
- Costs

HINT: THESE THINGS OUGHT TO BE IN YOUR PLAN!

Example – Thermometer Design

Problem: Create the WBS for a temperature monitoring system design



Example - Thermometer, cont'd

There are three main tasks

1. The analog interface circuitry.
2. The LED & digital circuitry.
3. Integrate & Test.

Example – Thermometer, cont'd

- **Activity:** Design Circuitry
- **Description:** Complete the detailed design and verify it.
- **Deliverables/Checkpoints:** 1) Circuit schematic, and 2) Verify in simulation.
- **Duration:** 14 days.
- **People:** Jana (1), Rob (1)
- **Resources:** PC, SPICE Simulator
- **Predecessors:** none

Example – Thermometer Design

ID	Activity	Description	Deliverables / Checkpoints	Duration (days)	People	Resources	Predecessors
1	**Interface Circuitry**						
1.1	Design Circuitry	Complete the detailed design and verify it in simulation.	• Circuit schematic • Simulation verification	14	Rob (1) Jana (1)	• PC • SPICE simulator	
1.2	Purchase Components		• Identify parts • Place order • Receive parts	10	Rob		1.1
1.3	**Construct & Test Circuits**	Build and test.					
1.3.1	Current Driver Circuitry	Test of circuit with sensing device.	• Test data • Measurement of linearity	2	Jana (1) Rob (2)	• Test bench • Thermo-meter	1.2
1.3.2	Level Offset & Gain Circuitry	Test of circuit with voltage inputs.	• Test data • Measurement of linearity	3	Rob (1) Jana (2)	• Test bench	1.2
1.3.3	**Integrate Components**	**Integrate the current driver and offset circuits.**	**• Test data verifying functionality and linearity requirement**	**5**	**Rob (1) Jana (1)**	**• Test bench • Thermo-meter**	1.3.1 1.3.2

Activity Duration Estimates

PERT: Project Evaluation and Review Technique

- Statistical methods to estimate project completion time.
- Based on earlier studies that show that project task completion follows a Beta probability distribution

$$t_e = \frac{t_a + 4t_m + t_b}{5}$$

Outline

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Network Diagrams

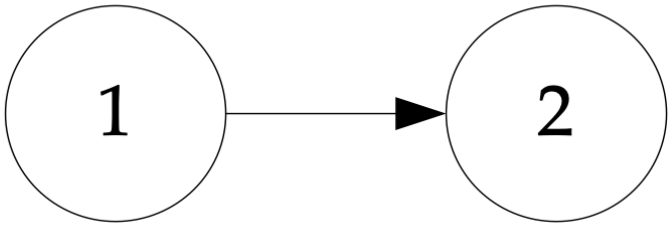
Network Diagram

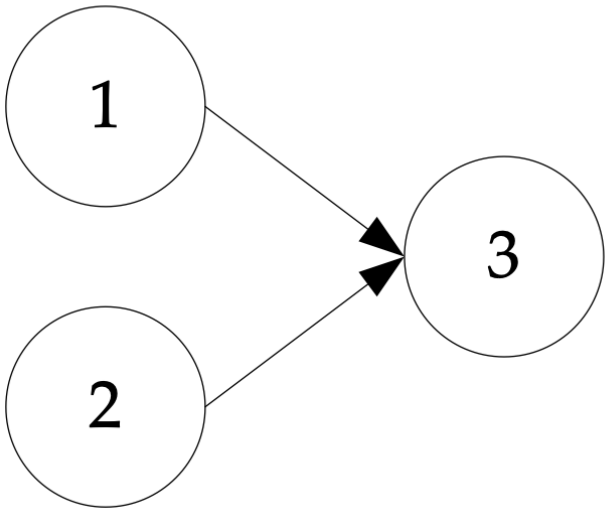
A directed graph for the project that shows all the activities/tasks as (vertices) and the dependencies as (directed edges).

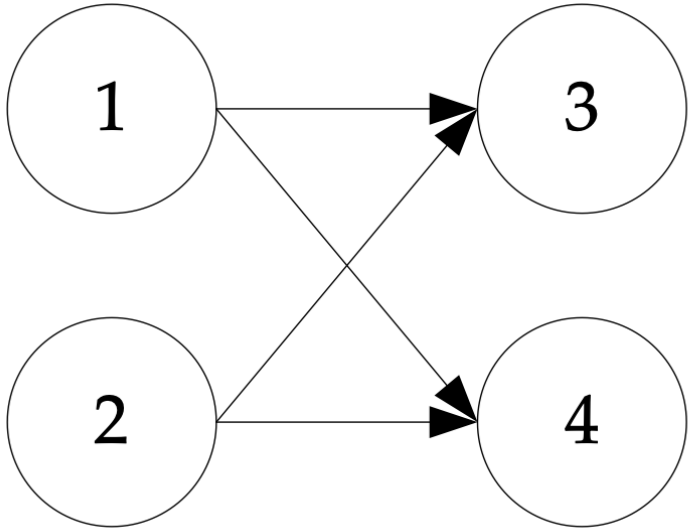
It is also known as AON (Activity on Node)

- Nodes = Activities
- Edges = dependencies

AON Basics

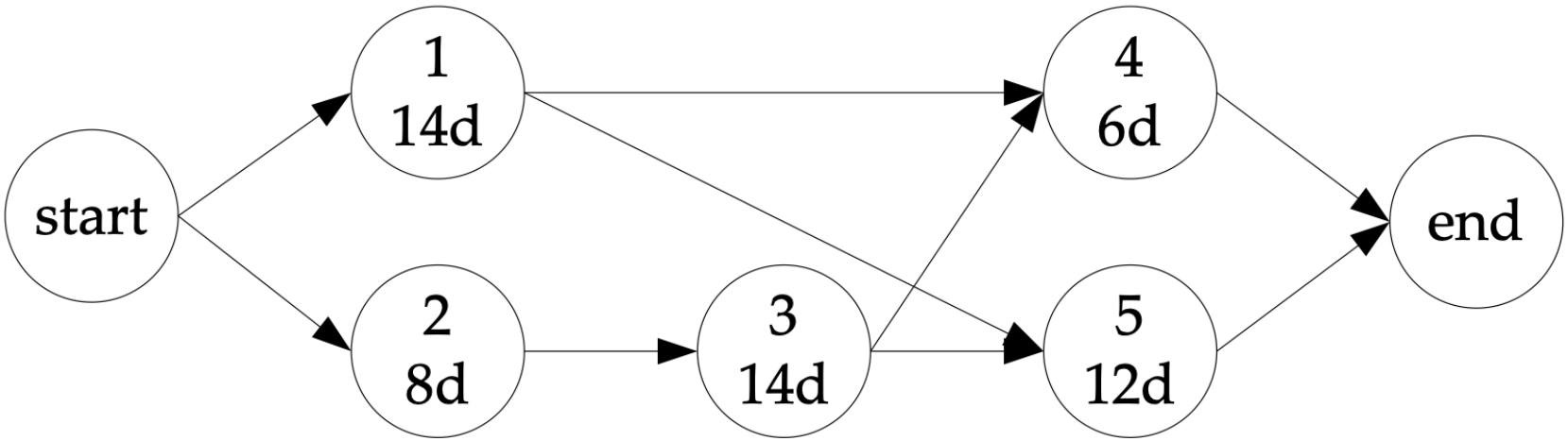






Example: Network Diagram

Problem: identify the paths to completion.



Network Diagram Definitions

Critical Path

The longest duration path in the network diagram.

Slippage (for an activity)

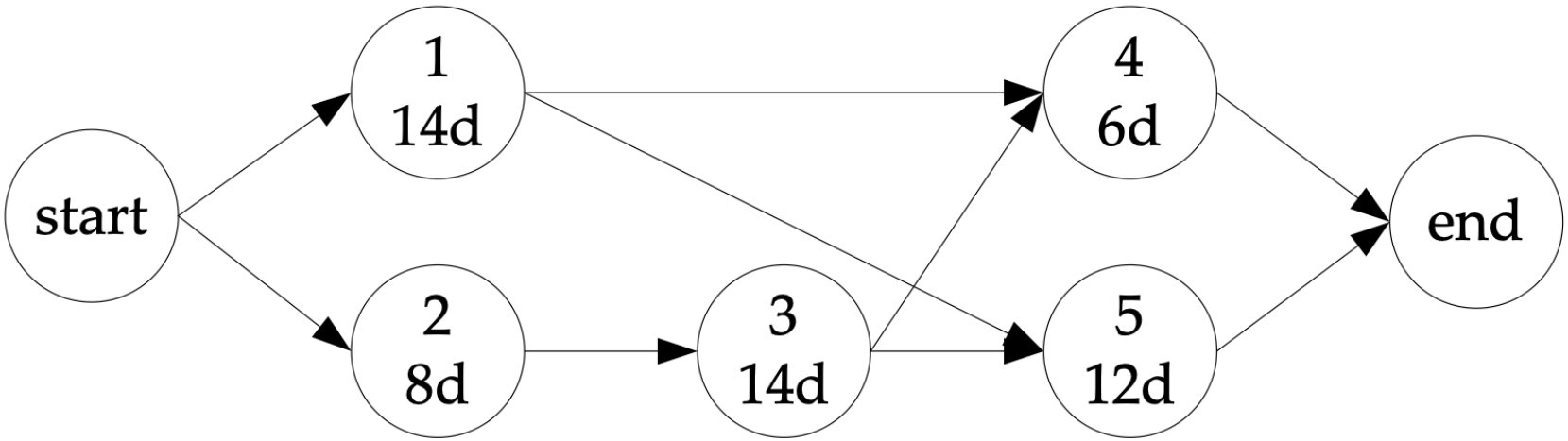
An activity that falls behind the schedule

Float (for an qctivity)

The amount of time that an activity can slip without extending the overall project completion time.

Excercise

Problem: Calculate the float for all activities in network.

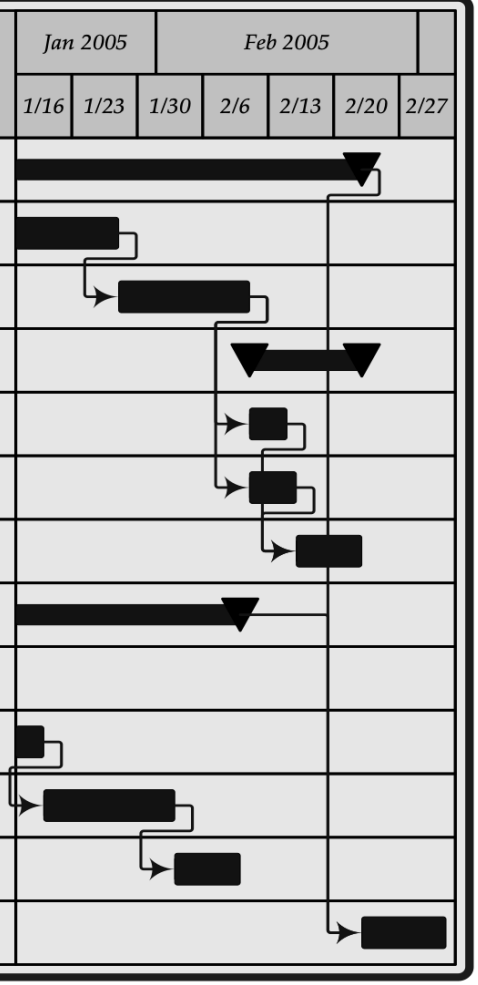


Outline

Gantt Chart

It is a graphical representation for the WBS emphasizing the schedule

Task Name	Start	Finish	Duration
1: Interface Circuitry	**1/10/2005**	**2/22/2005**	**32d**
1.1: Design Circuitry	1/10/2005	1/27/2005	14d
1.2: Purchase Components	1/28/2005	2/10/2005	10d
1.3: Construct & Test Circuits	**2/11/2005**	**2/22/2005**	**8d**
1.3.1: Current Driver Circuitry	2/11/2005	2/14/2005	2d
1.3.2: Level Offset & Gain Circuitry	2/11/2005	2/15/2005	3d
1.3.3: Integrate Components	2/16/2005	2/22/2005	5d
2: LED & Driver Circuitry	**1/10/2005**	**2/9/2005**	**23d**
2.1 Research A/D Converters	1/10/2005	1/10/2005	1d
2.2 Complete Hardware Design	1/11/2005	1/19/2005	7d
2.3 Purchase LED & Driver Components	1/20/2005	2/2/2005	10d
2.4: Construct & Test	2/3/2005	2/9/2005	5d
3: System Integration & Test	2/23/2005	3/3/2005	7d



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Cost Estimation

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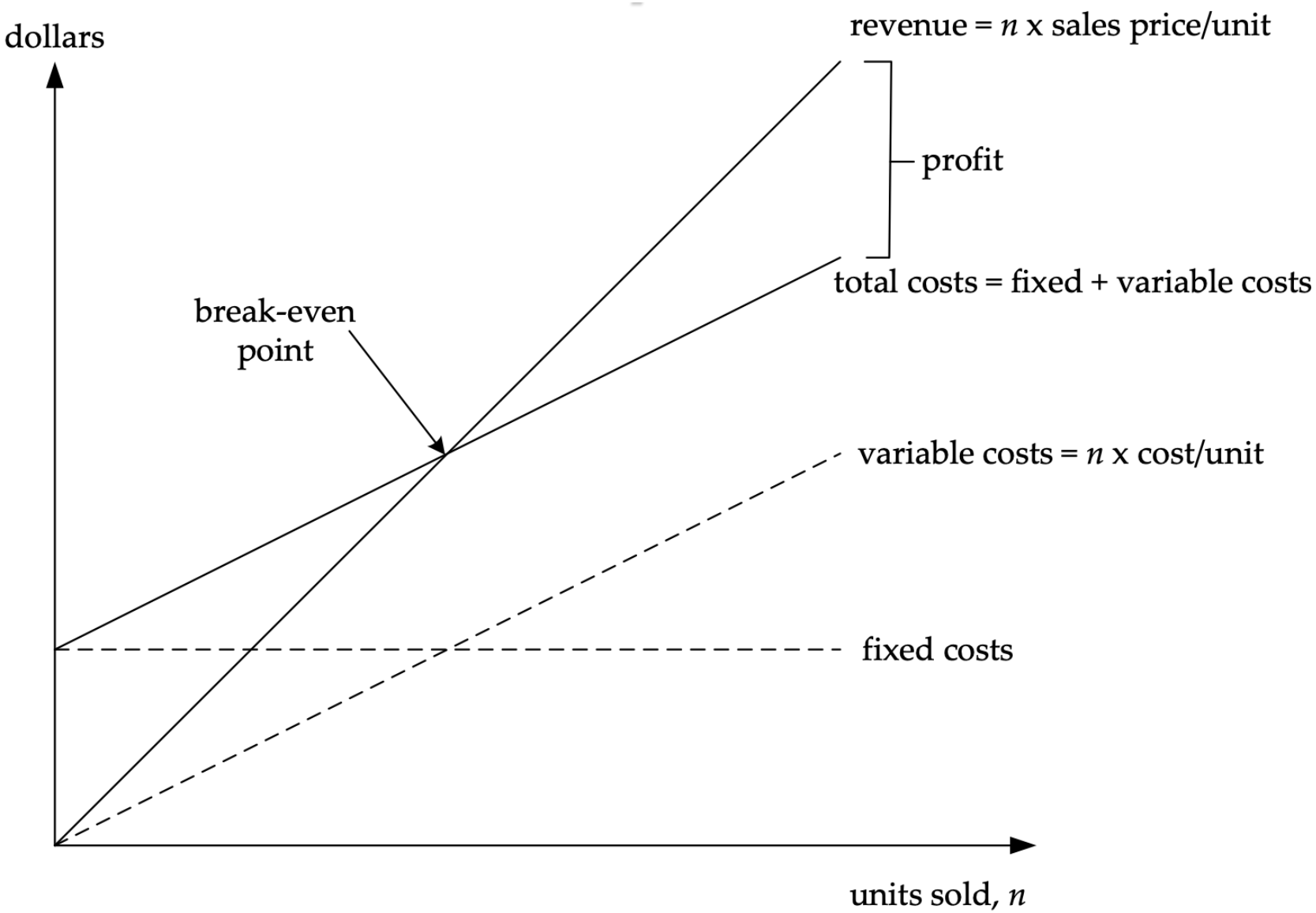
- Basics presented here – complex problem that requires experience.

Break-Even Analysis-Definations

- **Fixed costs** Constants costs despite the number of units produced (rent, design, research, facilities,..)
- **Variable Costs** Costs that varies with the number of units produced (# of labor, materials, power)
- **Break-Even Point** It is the point at which the revenue is equal to the total cost

Break-Even Analysis



Cost Models

Using the PERT model

$$Cost_e = \frac{Cost_a + 4Cost_m + Cost_b}{5}$$

IBM Model for software development man hours cost

$$effort_{worker\_months} = a(KLOC)^b$$

- a = 5.2
- b = 0.91

Example

Consider a software development project that has a team of 10 software development engineers. The team has proposed a design and estimates that it will require 50,000 lines of code to complete the project. The average cost to the Company for an engineer is $100,000 per year, including salary, benefits, and overhead. Estimate (a) the time required to the complete the project and (b) the labor costs.

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Ans

- $effort_{worker\_months} = a(KLOC)^b = 5.2(50)^{0.91} = 183$

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Ans

- $effort_{worker\_months} = a(KLOC)^b = 5.2(50)^{0.91} = 183$
- Since we have 10 developers, each developer needs 18.3 month to complete his work. Thus, labor costs = 18.3/12 * \$100,000 * 10 = 1.53 million

Bill of Materials (BOM)

- An all-inclusive list of items and material required to create a product (or prototype)
- Both a "shopping list" and a "recipe" for the product
- Answers the following questions
  - What to buy?
  - Where to buy?
  - How to assemble?

See examples at link given for related quiz preparation assignment

Guidance

- Take the initial time estimates for activities and double them!
- Assign a lot of time for testing and integration.
- Factor in lead times for part ordering.
- Assign a project manager(s).
- Do not assign all team members to all tasks.
- Track the progress versus the plan.
- Don't become a slave to the plan.
- Experience counts

Project Application

A Project Plan should contain

- Work Breakdown Structure. Identify the activities, deliverables, responsibilities, duration, resources, and dependencies.
- Gantt Chart and/or Network Diagram. Provide a graphical representation of the project plan.
- Costs. Develop a tabulated list of costs and for the equipment, materials, and labor necessary to carry out the project.

Summary

- important objectives of project management are to complete the project
  - Labor
  - On-time
  - Within budget
  - To meet the needs of the user.
- WBS – hierarchical breakdown of activities needed to complete a project.
- Network diagram – graphical representation of activities for project – can use for quantitative analysis of project.
- Cost estimates
  - Break-even analysis
  - Cost estimation models
  - BOM

Questions