ECSE-211
Design Principles and Methods

Lecture 8: The Design Team and Project Management

Date: 6 February 2023

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Last Lecture

- Importance of Validation – implemented through testing
- Tests and parameter spaces
- What makes a good test?
- The concept of a Test Plan

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But First…

- The end of the last lecture
- The Test Document

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A Test Document

- *Date:* 11 February 2015
- *Tester:* John Smith
- *Author:* John Smith
- *Hardware version*: robot version 2.1
- *Software version:* 3.2
- *Goal:* Determine if the robot can avoid obstacles

Current v5.6

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A Test Document

(0,0)

- *Procedure:* The robot should be placed at the origin of the grid facing North. Obstacles will be placed at grid locations (0,1), (1,0), (2,2). The robot will be instructed to travel to location (4,4). The test should be performed at least 10 times.
- *Expected Result:* The robot should identify any obstacles in its path and avoid them by at least 5cm. The robot LCD display should indicate that it has seen an obstacle. It should arrive at the destination with an accuracy of better than 5 cm.

± 5cm

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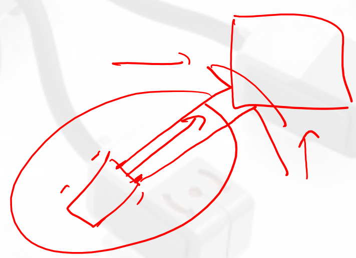
Test Document

- *Test Report:* The test was performed 12 times following the protocol described above. The complete results can be seen in the spreadsheet (Obstacle_Avoid_Test_11Feb.xls). In summary, the robot hit an obstacle on 5 of the 12 runs. In each case, the robot approached the obstacle on a diagonal and hit a corner.



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Test Document

- *Conclusion:* The robot performance did not meet the specified outcomes. The obstacle avoidance is unreliable.
- *Action:* This test report should be sent to the software team to review the obstacle avoidance process. The Gantt chart should be updated to show the revised tasks
- *Distribution:* Software development, project management

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Testing

- Each subsystem, or component, has a design specification
- Each subsystem has requirements documents
- Each subsystem has a design
- Each subsystem has a test set associated with it..
  - Each test has a document associated with it including the rationale for the test, the test protocol and the results

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The Test Plan

- Just as with the design timeline, there should be a test timeline
- This should be integrated with the main design timeline
- Some of the design phases might be dependent on the successful completion of certain tests.
- *Develop a test plan!*
- Does this involve full regression testing?

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Testing

- Note – *Tests can consume an inordinate amount of time..*
- Incomplete testing can result in potential failure points not being identified.
- Badly designed tests achieve nothing and may result in failures further downstream in the process.

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What is a Failure?

- How do you define a test failure?
  - Is there an error bound on the compliance with the specifications?
  - What is it?
  - Is a failure a terminal event or can the system "soft fail", i.e. gradually degrade in performance?..
- How will your process respond to a failure?
  - Have you built this into the budget and into the timeline?

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Testing

- This is as important as the design process
- It provides the information for controlling the design process
- Well designed test sets can catch problems early and reduce the costs.
- Testing gets more expensive as you move further into the design process
- ALLOW 2 WEEKS FOR THE FINAL INTEGRATION TESTS OF THE SYSTEM

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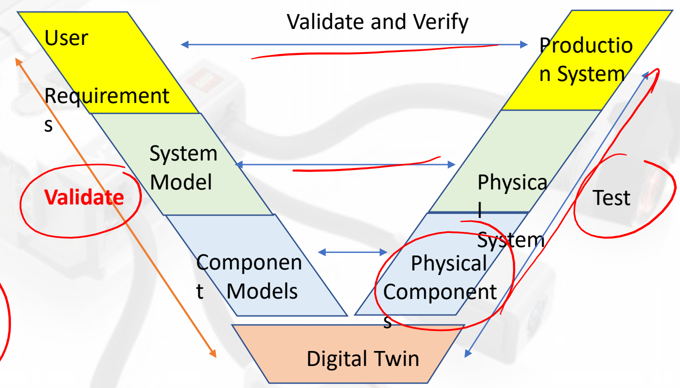
Next – Process Management

- So – we have looked at the steps and outcomes in the V-Cycle
- We have discussed the implementation of the processes to move from state to state
- Now the process needs controlling – the next lecture will look at the team structures, the management system and the tools to enable management



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Questions – Requirements versus Constraints

- Follow up to some questions received…
- What is the difference? –
  - In the impact on the design process, for DPM, there is really not much difference
  - In general, requirements are developed from the client “needs” document or specifications for the “product”
    - They define the Design Space
  - However, a client will not see all the issues that control the design space
    - The engineering team may see issues or constraints which will impact the solution
    - These can be considered “constraints” as opposed to “requirements”

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Requirements versus Constraints

- An example –
  - In an autonomous electric vehicle, the client has determined that the electric motor should generate 400 Nm of torque and it must fit in a space of 0.3m by 0.3 m by 0.2m
    - These are requirements and certainly restrict the design space
  - The engineering team are experienced in motor design and know that you cannot have a current density in the motor of more then 5A/mm2 without also having to introduce a cooling system
    - This constrains the design space over and above the requirement

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Questions

- Question 1
- Why is validation/verification important?

allows us to check that ideas will meet requirements

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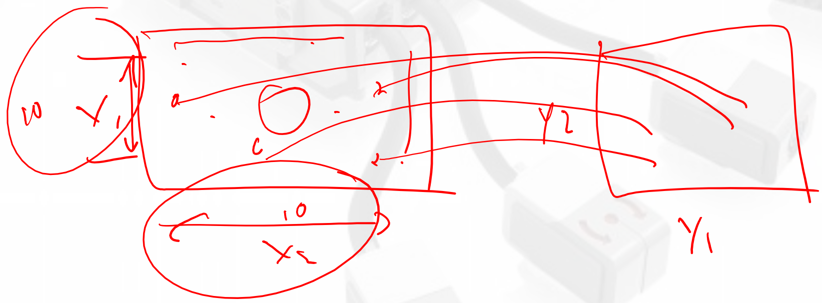
Question 2

- What makes a good test?

test all possible situation



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Contents

- Controlling the Process - management
- The concept of a Gantt Chart
- The PERT Chart and the Critical Path
- Planning – estimating task times
- Resources – the Design Team
- Jobs and Responsibilities

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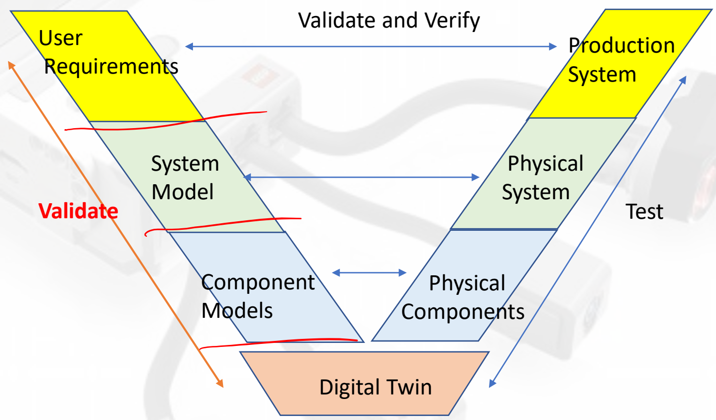
The Engineering Design Process

- We have:
  - Considered the outputs at each stage of the process
  - Described the processes relating the inputs to the outputs
  - Looked at the validation exercises which enable the move to the next stage
- But
  - How is it actually controlled?
  - How is a process implemented?



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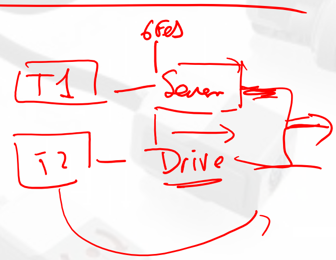
Project Management

- We have a design process but to implement it needs management
- How do we control the process?
- There are several steps – points at which the results can be checked
  - Each check point is a go/no go decision
  - Some components can execute in parallel
  - The process must complete at a specific time



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Project Management

- In the engineering design process, we need to have predictability.
- Why?
  - We need to be able to estimate times to completion and costs…
- So – this needs Planning – *the first step of the process*

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Project Management

- This is an issue which is fundamental to Engineering projects
- It is necessary to understand what has to be done to achieve the goals
- The V-Cycle can be developed as a set of stages
- Each one is a "Milestone"
- But – what is a Milestone?

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Milestones

- What is a milestone?
  - A defining point in the process – a reference point a "known" distance into a project
  - An event that receives special attention – usually put at the end of a stage to mark the completion of a work package or phase (Wikipedia)
  - It is a decision point in the process and can affect the future of a project
- So – an example:
  - Completing the Requirements Document – could be the first Milestone
    - A point where the document has been validated and the process can move on
  - The next might be the design of the System Model
  - …

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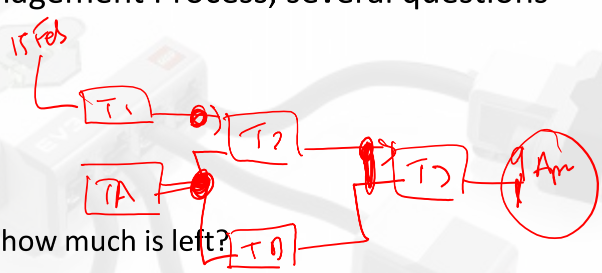
Project Planning

- As a part of the Planning and Management Process, several questions need to be answered:
  - What tasks need doing?
  - What are the dependencies?
  - Where are the milestones?
  - When are the deliverables due?
  - How much budget has been spent, how much is left?



- To enable this and provide a visual "picture" of the progress of the process, tools exist
- A primary tool is the "Gantt Chart"

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GANTT Chart

- Chart to illustrate a project schedule
- Work breakdown of project in terms of
  - terminal elements – milestones
  - summary elements – tasks on the route to milestones
- Can show current schedule status

- Dates back to around 1910
- Now implemented on personal computers and is common in collaborative projects..

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GANTT Chart

- Common technique for representing the phases and activities of a project
- A Gantt chart only shows the schedule.
  - The tasks and project breakdown should be done first
  - Tasks also need resources – the Gantt chart does not do this
- A Gantt chart focuses on schedule management *NOT on the size of a project or the relative sizes of work elements*
  - It can indicate if a project is on time or not
  - But - the magnitude of a "behind-schedule condition" may not be correctly indicated.

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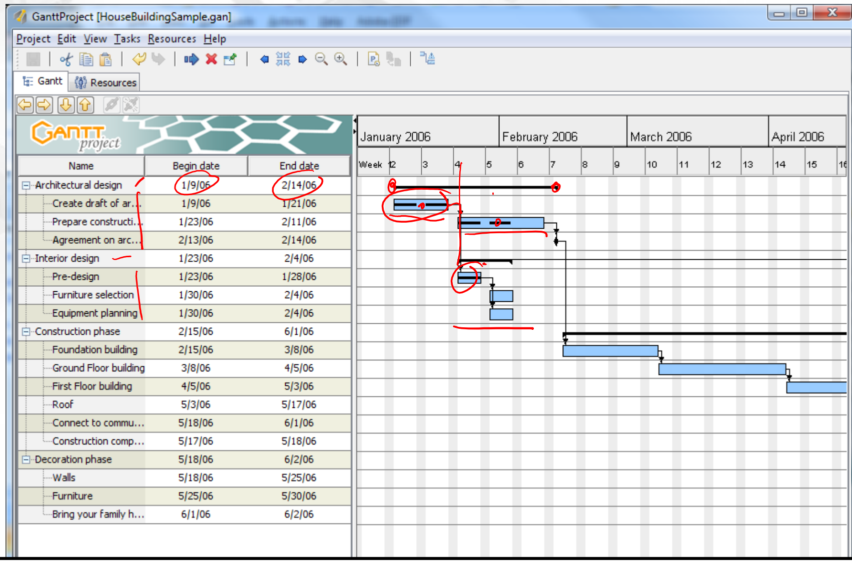
The GANTT Chart



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Resource Allocation

- What is a Resource?
  - It could be access to a computer system to model part of the design
  - It could be access to a lab to test a design
  - *It is definitely the people in the Design Team who implement the process…*
- A task can only be performed (executed) by using a resource
- Each task in the plan MUST have a resource allocated to it if it is to be implemented
- *A resource plan usually accompanies the design of the Gantt Chart*

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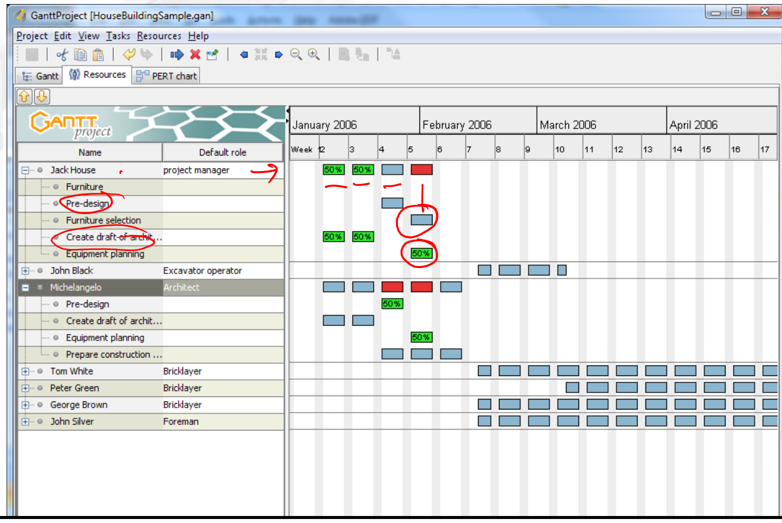
Resource Usage



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Alternate Methods of Displaying a Project

- The Gantt chart provides a flow of work – a timeline
- It illustrates dependencies
- The information can be displayed in alternate formats to make some issues clearer
  - E.g. the PERT Chart

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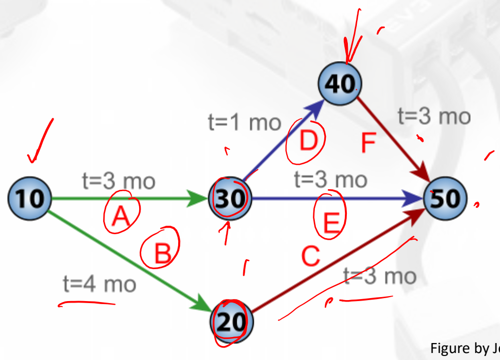
The PERT Chart

- Project Evaluation and Review Technique
  - Used to analyze and represent the tasks in completing a given project
  - Developed by the U.S. Navy in the 1950's



A PERT network chart for a 7 month project with 5 milestones (10 through 50) and 6 activities (A through F)

Figure by Jeremy Kemp, ref. Wikipedia

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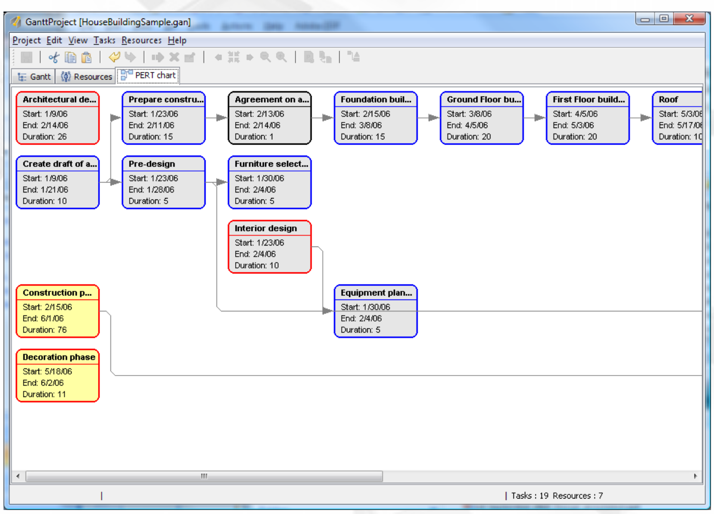
The PERT Chart



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The Critical Path

- The longest string of dependent tasks in the system..
  - For example:
    - In completing a degree in Engineering, several courses are pre-requisite to others. E.g. DPM requires Introduction to Computing, Introduction to electronics requires Circuits 2 which also requires Circuits 1… so a 3 semester dependency…
    - To estimate when you will graduate, you need to draw out the dependency chains and identify the longest chain – this is the critical path.
- The Critical Path needs to be identified
  - this is where, if a task does not complete or completes late, the final deadline could be moved
- The Critical Path can change dynamically

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