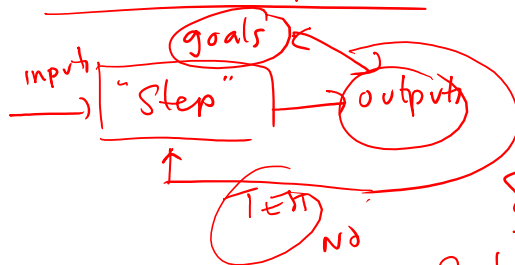# ECSE-211
Design Principles and Methods

Lecture: Design 3

25 January 2019

The Engineering Design Process

A control process   — management

goals

input "Step" → output

TEST NO

STEP 1

Problem — Requirements

? "analyse" question.

Two Major Issues in Design

- 1. Solving the Problem and achieving a solution
  - Subject to:
    - What can be done physically
    - What exists to solve the problem
    - How much time is allowed
    - What skill level the design team has
    - What the budget is
    - …

Two Major Issues in Design

- 2. Controlling the Process
  - Identifying the phases to achieve a design
  - Estimating the time and cost of each phase
  - Allocating resources to each phase
  - Tracking the process
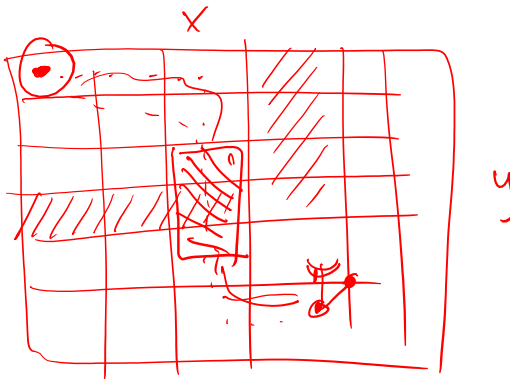 - Adjusting the process to achieve the targets
  - …

in budget ?
on time ?

The Engineering Design Process

The Design Problem

"Design an autonomous robot capable of collecting a ring from a tree and crossing a river to do it...."
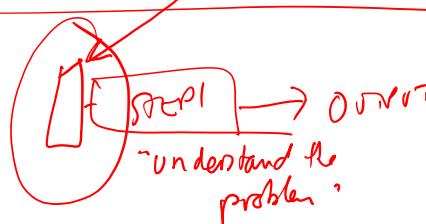
localize
navigate
identify tree

The Starting Point

- Categorize what you have to perform the solution
- Make lists
- Generic information
- Start with the problem
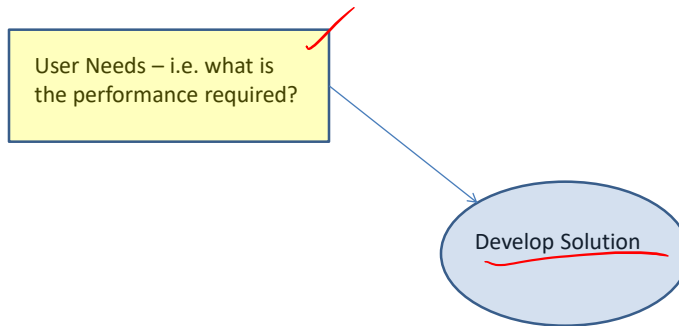 - What is it?
  - Any obvious sub-problems?

The Starting Point

- Back to the beginning…
- What do we have at the start point?
  - What are the inputs to the system (process)?

Design – Needs and Givens

- To solve a design problem, we have three (maybe more) major pieces of input:

User Needs – i.e. what is the performance required?

Develop Solution

Design – Needs and Givens

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The available tools and components

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- To solve a design problem, we have three (maybe more) major pieces of input:

User Needs – i.e. what is the performance required?	Team Knowledge
The available tools and components	Develop Solution

Design – Needs and Givens

- But… there is a fourth box…

User Needs – i.e. what is the performance required?	Team Knowledge
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BUDGET

Design – Needs and Givens

- But… there is a fourth box…

REQUIREMENTS

User Needs – i.e. what is the performance required?	Team Knowledge
The available tools and components	Develop Solution
	BUDGET!
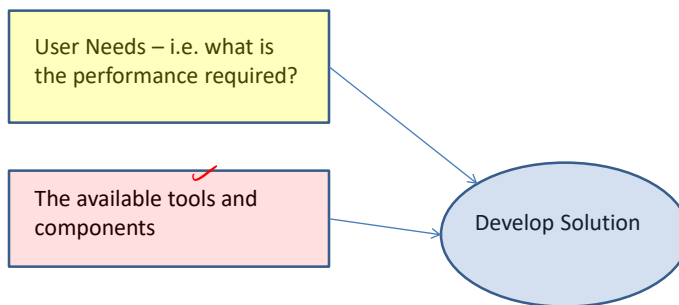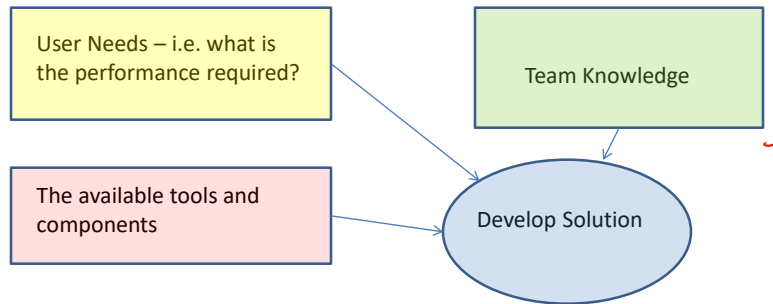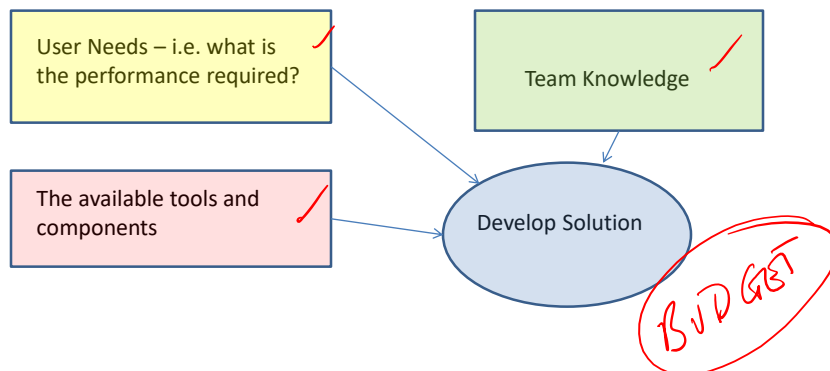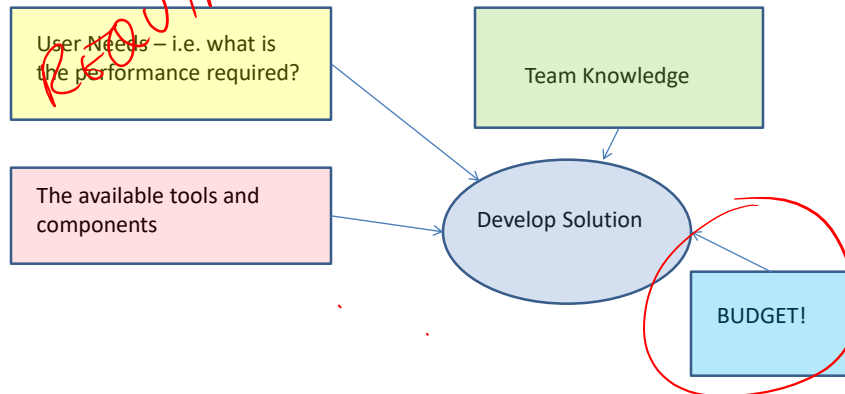
The Requirements Document

- The first piece of documentation in the system
- *Defines the first box*
- When completed, this should give a complete description of the needs of the client..
  - All questions should be answered before the real design can start..
  - It also provides a list of the unknowns… (real important!)

The Requirements Document

- This is a formal document and must have a structure…
- All Documents in the process must have:
  - A title ✓
  - The author name ✓ ← person responsible
  - Date ←
  - Version number ←
  - Edit history ←

The Requirements Document

- The goal is to understand what the user wants
  - What is the system meant to do?
    - List any performance data you have
  - What can you use to solve the design problem?
    - List any items that are explicitly specified
  - Are there tolerances on performance?
    - List them
  - Is there a deadline?
    - List it
  - …
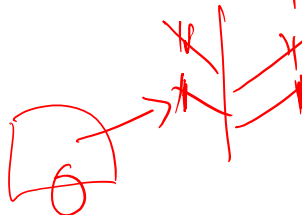
1/31/2019

The Second Piece of Input

- Maybe the questions are based on the capabilities/resources you have…

The Second Piece of Input

- Maybe the questions are based on the capabilities/resources you have…
- What tools/components do you have access to for solving the problem?
  - Identify the solution environment…
  - Note – this is not the environment the final device will operate in (that is given in the requirements)

9

The Solution Environment

- This is Box 2
- Determine what tools you have
  - Software?
  - Hardware?
- What building blocks/components you have
  - Capabilities of parts..
  - Software?
  - Hardware?

The Solution Environment

- Develop a set of questions
- Develop a set of answers
- Complete a document

The System Document

- The second piece of documentation
- *Fills in the second box*
- When complete, everything about the system available for implementing the solution should be known.
- In trying to complete this document initially, there will be unknowns…
  - How do you resolve these? ← *research*
    → *Labs*

The System Document

- Completing the system document may identify issues with the requirements…
- This is an iterative process…
  - Ask more questions
  - Return to the Requirements Document and revise it – in consultation with the user.

The Third Input

- Maybe the questions are based on the human capabilities/resources you have…

The Third Input

- Maybe the questions are based on the capabilities/resources you have…
- What is the team capable of? What is your knowledge/capability base?
  - Create an inventory of capabilities – these may constrain your solution..
  - Document what you can do:
    - E.g. John has worked with Mindstorms before – he knows how to program it
    - E.g. Mary has been involved in a robotics project before McGill

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Create a document – Write it down – who has expertise in what?

Capabilities Document

- This is the third document
- *Fills in the third box*
- This is the knowledge/skill base of the team
  - Who can program?
  - Who understands mechanics?
  - Who understands systems?
  - Who can manage?
  - …..

The Fourth (last and most important!) Input

- Maybe the questions are based on the budget you have…
  - The budget involves time
  - The budget involves available systems
  - *The budget involves money!*

The Constraints Document

- This is the fourth document
- *It fills in box four*
- Defines the constraints imposed by budget
  - Time available – i.e. people times hours times salary
  - Systems available – i.e. component provided, components which might be acquired
- This document may also affect the requirements document – it may need revising.