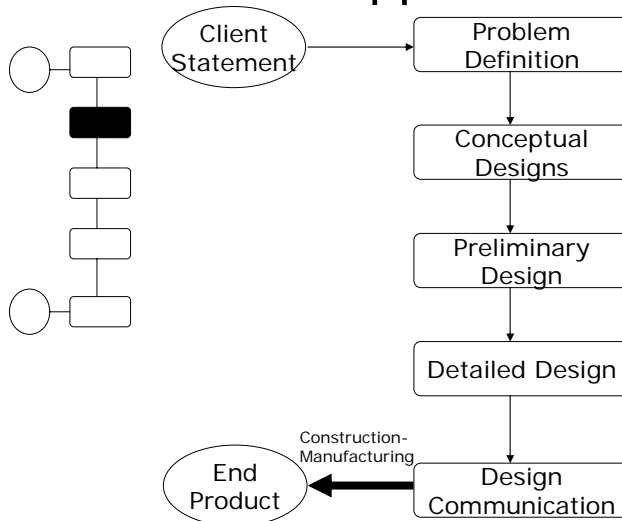


Conceptual Design

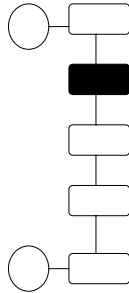
1

Product/Project Development Approach



2

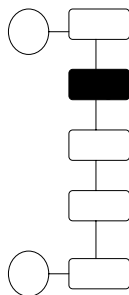
Conceptual Design



- Input:
 1. Revised problem statement
 2. Requirements (ranked)
 3. Statement of Deliverables
- Tasks:
 1. Establish desired design functions
 2. Generate conceptual design alternatives
 3. Compare conceptual design alternatives
- Output:
 1. Most promising conceptual design(s)

3

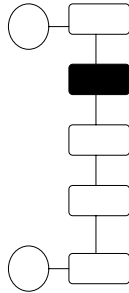
Conceptual Design



- Functions: What a design must do to realize the stated requirements
- Hints:
 1. Typically defined by action verbs
 2. Break down requirements into as many single action statements as possible
 3. Imagine that a product/object already exists and ask what would happen if it all of a sudden vanished
 4. Consider how the product might be used and maintained over its lifetime
 5. Reverse engineering: using a similar product, establish what it does, how does it do that or why would you want it to do that (care must be taken to keep goals of current client in mind).
 - It is easy to get sidetracked at this stage. KEEP FOCUSED

4

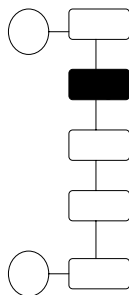
Conceptual Design



- Keep in mind that requirements and functions are two different things
 - Requirements describe what the final object will be and what qualities it will have.
 - Defined by terms such as “are” and “be”
 - Functions describe what the object will do with particular focus on the input-output transformations that the object will accomplish.
 - Defined by ‘action verbs’

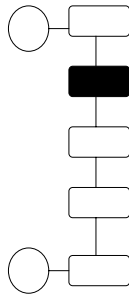
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Conceptual Design



- E.g. Skytrain
 - the overall requirement is to transport large number of passengers across the GVRD
 - Some functions would be:
 - Get people to train
 - Get people in and out rapidly
 - Transport people in a comfortably and safely
 - Transport large number of people
 - Collect fees
 - What about exterior items
 - Minimize impact of train on existing road traffic?
 - Minimize impact during construction?

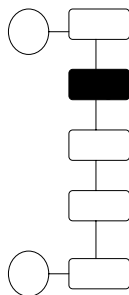
6



- Now that you know what the system must do, come up with ideas of how this can be done
- Consider alternative designs for each function (or group of functions)

7

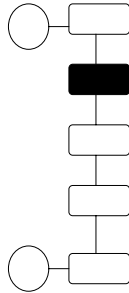
Conceptual Design



- Generate Design Alternatives
 - Principle of least commitment: Avoid committing to a design until forced to by the exhaustion of additional information or alternative choices.
 - Acquiring the information needed to achieve functions
 - Literature review (journals, handbooks, codes)
 - Surveys and questionnaires
 - Focus groups
 - Brainstorming
 - Benchmarking (competitive products)
 - Think outside the box
- At this point, there is no need to evaluate the appropriateness of an alternative!
 - A “crazy” alternative now may morph into a great design

8

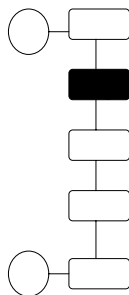
Conceptual Design



- E.g. How are you going to achieve the function of transporting people safely and comfortably?
 - Seats? Standing? View?
 - Acceleration/deceleration? Emergency shutoffs? Ventilation? Air conditioning? Capacity?
- E.g. How are you going to achieve the function of getting people out?
 - Door design? Door automation? Door Size? Connection between outside (i.e. platform) and train door?

9

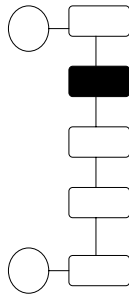
Conceptual Design



- Generate a bunch of designs
 - Brainstorm
 - Group process
 - No ideas are bad
 - Well initially anyway!

10

Comparison of Conceptual design



- Does not need to be comprehensive
- Evaluate concepts in terms of what the functions are trying to achieve
 - E.g. transporting people safely and comfortably
 - How are different seating/standing alternatives going to meet this function?
 - How is this going to affect other functions?
 - What about the impact on the requirements and constraints?

11

Qualitative comparison

Comparison of Different types of seating/standing arrangements

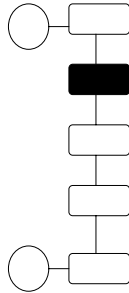
	Seating only	Standing only	Half seating half standing
Safety	Excellent	Poorest	Medium
Capacity	Poorest	Highest	Medium
Cost	Highest	Lowest	Medium
Maintenance	Highest	Lowest	Medium
Speed at which can get people in and out	Slow	Fast	Medium

Note: Not a comprehensive list!!! Just for illustrative purposes!

12

Weighted/scored comparison

Comparison of Different types of seating/standing arrangements



	Weight	Seated	Standing	Half-half
Safety¹	0.3	0.9 (0.27)	0.0 (0.0)	0.45 (0.135)
Capacity²	0.3	0.25 (0.075)	1.0 (0.3)	0.35 (0.105)
Cost³	0.2	0.0 (0.0)	0.35 (0.07)	0.25 (0.05)
Maintenance⁴	0.2	0.0 (0.0)	0.85 (0.17)	0.35 (0.07)
Total	1.00	0.35	0.54	0.36

1- 1 - ratio of likelihood of alternative to likelihood of injury while standing (based on historical information)

2- Ratio of capacity compared to capacity while standing

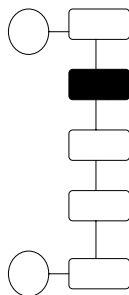
3- 1 - ratio of cost of alternative to cost of seats only

4- 1 - ratio of maintenance cost to maintenance cost for seats

Don't get fooled by number!!!
Still highly biased!!!!

13

Iterative process



- There is no need to feel compelled to remain constrained within the confines of the set of initial conceptual designs that were initially considered
- The development of conceptual designs, their general evaluation, the selection of conceptual designs for further consideration, the subsequent preliminary designs, the evaluation of preliminary designs, the selection of a preliminary design for further consideration, and the ability of the preliminary to meet the design requirements is an iterative process

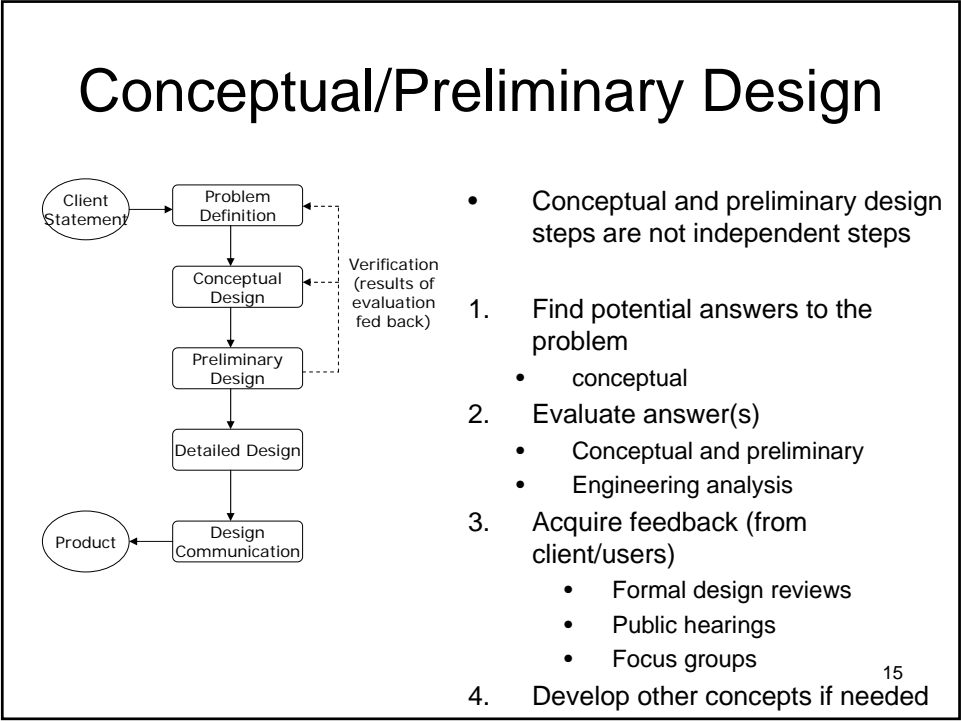
14

Conceptual/Preliminary Design

```
graph TD; CS([Client Statement]) --> PD[Problem Definition]; PD --> CD[Conceptual Design]; CD --> PD; CD --> Prelim[Preliminary Design]; Prelim --> DD[Detailed Design]; DD --> DC[Design Communication]; DC --> Product([Product]); DC -.-> CD; DC -.-> Prelim; DC -.-> PD;
```

- Conceptual and preliminary design steps are not independent steps

- Find potential answers to the problem
 - conceptual
- Evaluate answer(s)
 - Conceptual and preliminary
 - Engineering analysis
- Acquire feedback (from client/users)
 - Formal design reviews
 - Public hearings
 - Focus groups
- Develop other concepts if needed



- # Conceptual/Preliminary Design
-
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