

Concept Generation and Selection

EE4900 Senior Design

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September 30, 2008

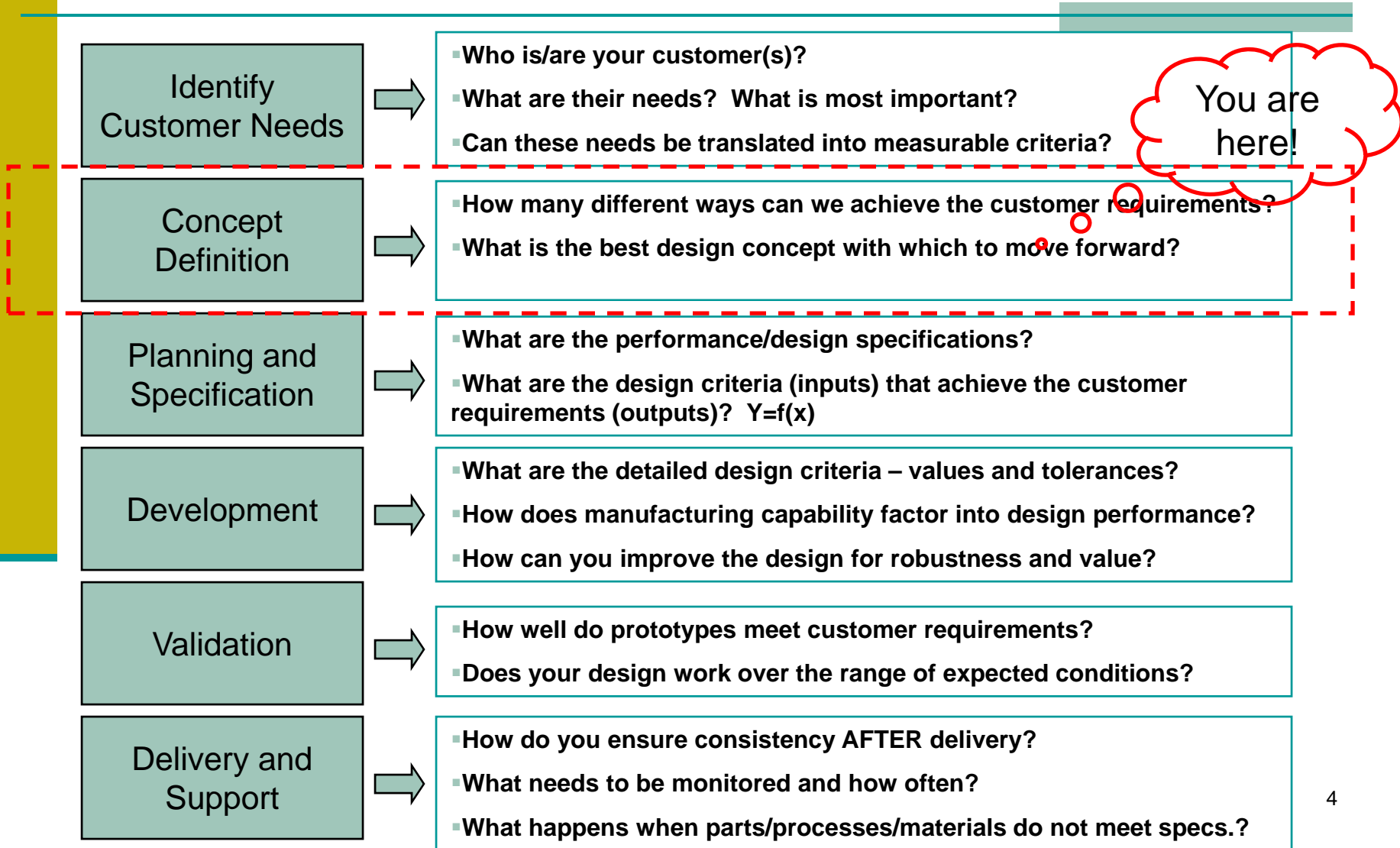
Learning Objectives

- A customer-focused, phased approach to 'doing design'
- The importance of the concept design phase
- A tool to help you be more successful on your projects

Outline

- Overview of Development Process
- Concept designs
- Concepts, brainstorming, and teaming
- The 10-step method
- Application on your projects
- Questions
- Additional references

Phases of a Development Process



Concept Designs

- **What?** A concept design is simply a 'big-picture' solution to your customer requirements
- **When?** Explore concepts **BEFORE** locking in on a detailed design, but only **AFTER** you have determined your customer needs
- **The goal?** A robust concept...more on this later



Concept car designs:

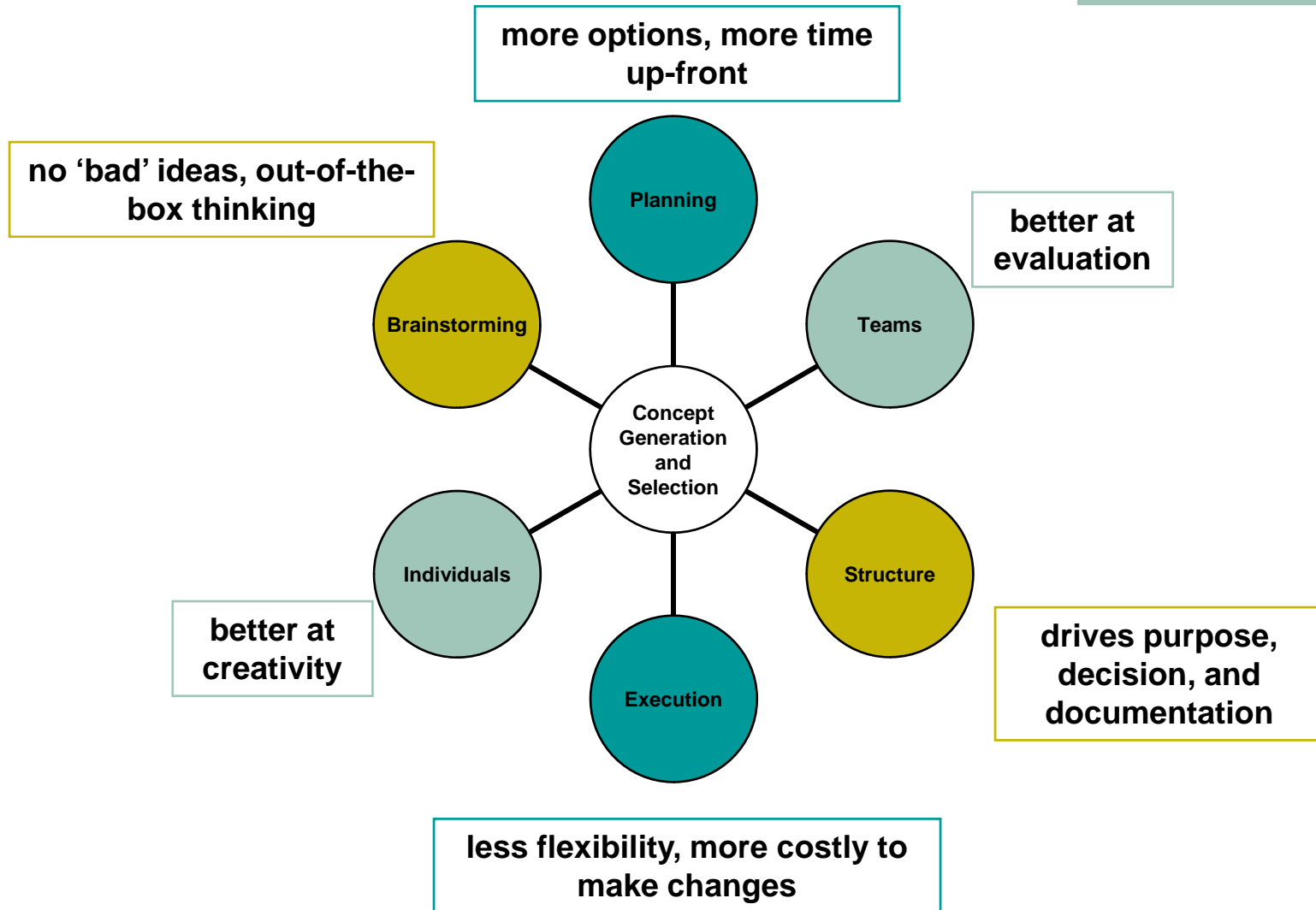


Detailed design:

[features.pdf](#)

Design problems always have more than one solution

Concepts, Brainstorming, and Teaming – A ‘Balanced Approach’



Concept Generation and Selection in 10-steps

1. Determine customer requirements for your design
2. Define importance / weighting factors for these requirements
3. Decide how the team will convey concepts
4. Establish a strong base-case concept
5. Generate MANY concepts
6. Evaluate concepts using a Pugh matrix
7. Identify the best 2-3 new concepts
8. Look for hybrid solutions and identify a new base-case
9. Do a reality check - start over if needed
10. Select a robust concept and move forward

1. Determine customer requirements

- The most important step in the design process!
- Requirements are functional product or service measures that directly relate to the customer's true needs
- Customers define the 'what's' and the engineering team develops the 'how's'
- Ask the customer - communication with your sponsor, input from their customers, surveys, etc.

Example: Design a transportation system to get to class

4. Customer Requirements

low cost
reliable, year-round
flexible to class schedule
short commute time
comfortable
safe
marketing - fashionable, status symbol
can socialize on the way
environmentally friendly

2. Define importance/weighting factors for the requirements

- Not everything is equally important!
- Looking at the needs in total, reducing risk of over/under designing
- Suggest a 1-3-5 scale for low-medium-high importance, respectively

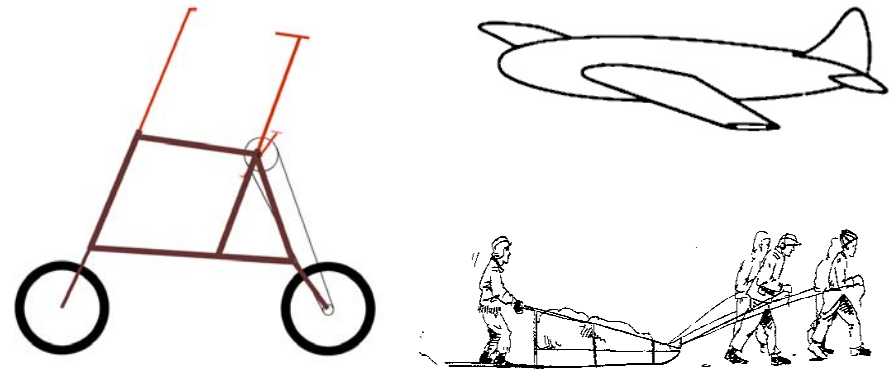
Example: Design a transportation system to get to class

4. Customer Requirements	5. Importance Weighting Factor (1-3-5 scale)
low cost	5
reliable, year-round	5
flexible to class schedule	3
short commute time	1
comfortable	3
safe	5
marketing - fashionable, status symbol	1
can socialize on the way	3
environmentally friendly	5

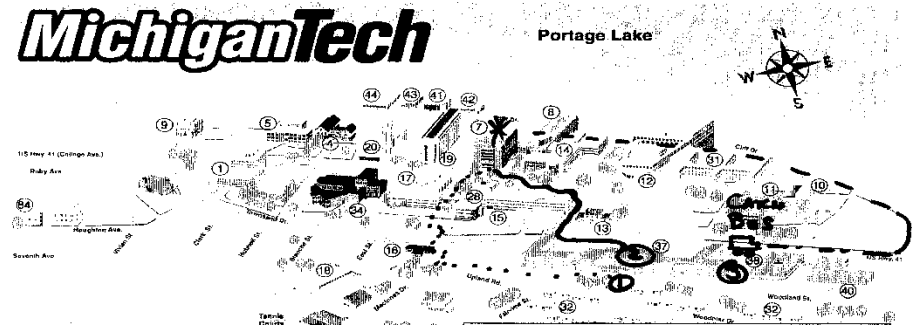
3. Decide how to convey concepts

- A standard way will drive an objective means of evaluation
- The nature of the design task will help determine a natural way to display
- Examples: Sketches, schematics, process flow maps, storyboards, Gantt charts

Example: Design a **transportation system** to get to class



Example: Design the **best route** to class



4. Establish a strong base-case concept

- The best initial design the team and/or sponsor have thought of
- The leading competitor's approach
- The current design (if redesigning)
- A strong baseline 'raises the bar' for your brainstorming efforts

Example: Design a transportation system to get to class

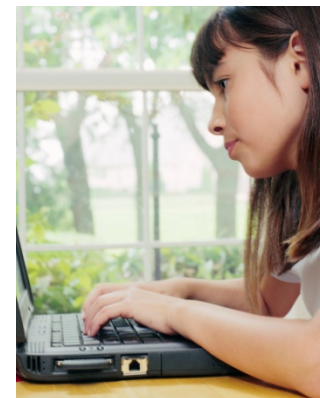
Base-case = walking



5. Generate MANY concepts

- You know your customer requirements, how to display your concepts, and the target to beat so...
- Get creative – allow time and place for individual creativity
- Brainstorm vs. Braindrizzle – quantity is your focus...no bad ideas initially

Example: Design a transportation system to get to class



6. Evaluate your concepts using a Pugh matrix

- **Pugh matrix** – a tool to facilitate the concept evaluation and selection process
- The base-case gets a score of '5' for each of the customer requirements
- New concepts are scored relative to the base-case with a 1-5-9 approach:
 - Much worse than the base-case, score a '1'
 - Roughly equal to the base-case, score a '5'
 - Much better than the base-case, score a '9'
- Work across the matrix for each customer requirement

Important for **teams**:

- ❖ **Dialog, listening, communication**
- understand team differences
- ❖ **Consensus** - do not 'average'
individual scores or matrix will fail to yield useful info.
- ❖ **Directional tool** -only much better or worse matters

The completed Pugh matrix for our transportation system example

Concept Selection Matrix											
1. Date: 10/10/06											
2. Objective: Design a transportation system to get to class											
3. Target Customer: Average MTU student											
4. Customer Requirements	5. Importance Weighting Factor (1-3.5 scale)	Walk	Drive	Bike	Snowmobile	Take the bus	Telecommute	Fly out of CMX	Segway Transporter		
low cost	5	5	1	5	1	5	5	1	1		
reliable, year-round	5	5	5	1	1	5	9	1	5		
flexible to class schedule	3	5	5	5	5	1	9	1	5		
short commute time	1	5	9	9	5	5	9	9	9		
comfortable	3	5	9	5	5	9	9	5	5		
safe	5	5	9	5	5	9	9	9	5		
marketing - fashionable, status symbol	1	5	9	9	9	1	1	9	9		
can socialize on the way	3	5	5	1	1	5	1	5	1		
environmentally friendly	5	5	1	5	1	1	5	1	5		
Totals		45	53	45	33	41	57	41	45	0	0
9. Weighted Totals		155	155	131	87	151	207	111	131	0	0

7. Identify the best 2-3 concepts

4. Customer Requirements	5. Importance Weighting Factor (1-3.5 scale)	5. Importance Weighting Factor (1-3.5 scale)									
		Walk	Drive	Bike	Snowmobile	Take the bus	Telecommute	Fly out of CMX	Segway Transporter		
low cost	5	5	1	5	1	5	5	1	1		
reliable, year-round	5	5	5	1	1	5	9	1	5		
flexible to class schedule	3	5	5	5	5	1	9	1	5		
short commute time	1	5	9	9	5	5	9	9	9		
comfortable	3	5	9	5	5	9	9	5	5		
safe	5	5	9	5	5	9	9	9	5		
marketing - fashionable, status symbol	1	5	9	9	9	1	1	9	9		
can socialize on the way	3	5	5	1	1	5	1	5	1		
environmentally friendly	5	5	1	5	1	1	5	1	5		
Totals		45	53	45	33	41	57	41	45	0	0
9. Weighted Totals		155	155	131	87	151	207	111	131	0	0

- Excluding the base-case, look at the highest weighted totals
- Proceed to step 8.

8. Look for hybrid concepts

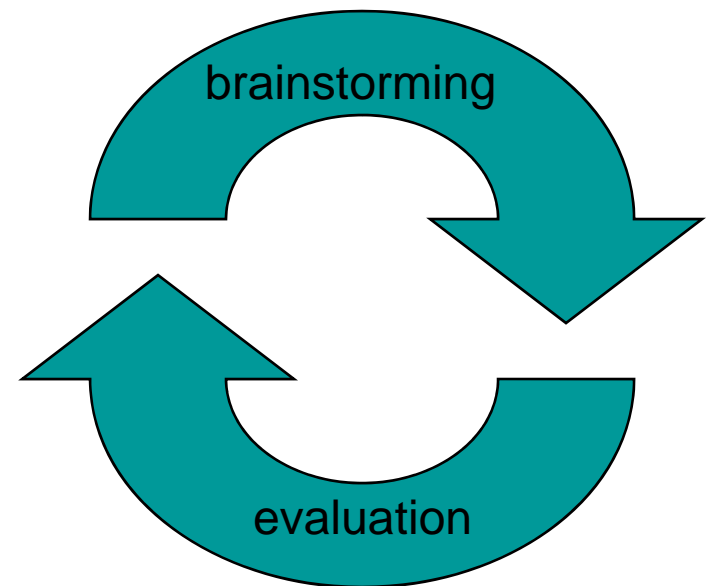
4. Customer Requirements	5. Importance Weighting Factor (1-3-5 scale)	Walk	Drive	Bike	Snowmobile	Take the bus	Telecommute	Fly out of CMX	Segway Transporter		
		low cost	5	5	1	5	1	5	5	1	1
reliable, year-round	5	5	5	1	1	5	9	1	5		
flexible to class schedule	3	5	5	5	5	1	9	1	5		
short commute time	1	5	9	9	5	5	9	9	9		
comfortable	3	5	9	5	5	9	9	5	5		
safe	5	5	9	5	5	9	5	9	5		
marketing - fashionable, status symbol	1	5	9	9	9	1	1	9	9		
can socialize on the way	3	5	5	1	1	5	1	5	1		
environmentally friendly	5	5	1	5	1	1	5	1	5		
Totals		45	53	45	33	41	57	41	45	0	0
9. Weighted Totals		155	155	131	87	151	207	111	131	0	0

- Mix / match the best parts of the strongest concepts
- Encourages further idea generation – ‘what if we...’

9. Do a reality check

- Is your new base case realistic?
- Are you missing customer requirements?
- Do you have unnecessary requirements?
- Is the base case weak?
- Team dynamics, effort?

Is telecommuting really a viable solution for you to get to class?



The value of any tool lies in knowing when & how to use it

10. Select a robust concept and move ahead

- Has potential to *delight* the customer (not just satisfy)
- Employs a *systems* approach
- Not easily copied by *competitors*
- Review with your *customer* – get their feedback

At this stage your team is now migrating from creativity & brainstorming towards action & decision

Application on your projects

Use this process to develop concept designs for your projects. Teams should brainstorm many concepts (5, 10, 20, perhaps more). Use results to justify your concept design to your sponsor and advisors. Include the matrix and associated discussion/critique in your PDR and final report documentation. Some considerations:

- What is the nature of the design task for your project? System level design? Component design? Process design? Application design?
- Are your customer needs translated into measurable criteria?
- How do you plan to get the importance weightings?
- Deciding on the base-case?
- How will you encourage and maximize individual creativity in your teams?
- Required materials/logistics for brainstorming – team space, Post-It® notes, whiteboards, flip charts, laptop, etc.
- When do you need to present a proposed design concept to your sponsor?

Questions?



Additional references

TRIZ (pronounced 'Trees'): Russian for Theory of Inventive Problem Solving

<http://www.triz-journal.com/>

Six Sigma Methodologies: can search here for tips on brainstorming, applications of Pugh matrix, etc.

<http://www.isixsigma.com/>