Product Design & Development

Concept Selection
Concept Development Process

- Mission Statement
- Identify Customer Needs
- Establish Target Specifications
- Generate Product Concepts
- Select Product Concept(s)
- Test Product Concept(s)
- Set Final Specifications
- Plan Downstream Development

Tasks:
- Perform Economic Analysis
- Benchmark Competitive Products
- Build and Test Models and Prototypes
Concept Selection Example: Reusable Syringe

- Ease of handling
- Ease of use
- Readibility of dose settings
- Dose metering accuracy
- Durability
- Ease of manufacture
- Portability
Concept selection

• How can the team choose the best concept, given that the designs are still quite abstract?
• How can a decision be made that is embraced by the whole team?
• How can desirable attributes of otherwise weak concepts be identified and used?
• How can the decision-making process be documented?
Choosing a concept

All teams use some method for choosing a concept

• External decisions:
  – Concepts are turned over to the customer, client, or some other external entity for selection.

• Product Champion:
  – An influential member of the product development team chooses a concept based on personal preferences.
Choosing a concept (cont)

• Intuition:
  – The concept is chosen by its ‘feel’. Explicit trade-off criteria are not used. Concept just ‘seems better’.

• Multivoting:
  – Each member of the team votes for several concepts. The concept with the most votes wins.
Choosing a concept (cont)

• Pros and cons:
  – The team lists the strengths and weaknesses of each concept and makes a choice based upon group opinion.

• Prototype and test:
  – The organization builds and tests prototypes of each concept, making a selection based upon test data.
  – The team rates each concept against prespecified selection criteria, which may be weighted.
Choosing a concept (cont)

- Decision matrices:
  - The team rates each concept against prespecified selection criteria, which may be weighted.
Concept selection for the reusable syringe

- There were initially seven distinct concepts for the reusable syringe
- How can we choose the best?
Concept A: Master Cylinder
- Plunger
- Sealed Fluid Pilled Cavity
- Rod
- Pusher
- Dose Setting
- Sleeve

Mode Selector: Note: Slide to set dose, slide to insert.

Note: Cross sectional area of rod 1/11 of cavity → pusher displacement = 1/11 of plunger displacement

Concept B: Rubber Brake
- Plunger
- Flattened Shaft
- Indicator
- Window

Note: Turn plunger 90° to set dose or store plunger.
Concept E: Swash Ring

- Dose set rings
- Stroke is same for all doses
- Plunger
- Shaft support
- Rotatable annulus

Note: Set dose by rotating dose set ring. Pull plunger and push to inject.

Concept F: Lever Set

- Operating lever
- Inject set dose
- Plunger release
- Cam clutch
- Indicator
- Plunger
- Reset release

Note: Set dose by pushing lever forward. Inject by pushing lever back.
Concept G:
Dial Screw

- Dose Set Knob
- Spring
- Gear
- Lead Screw
- Sprag Space
- Note: Set dose by turning set knob. Inject by pressing actuator
- Space for needles and vials
- Vial
- Plunger
- Actuator
Concept selection: Structured method

• A customer-focused product:
  – Because concepts are explicitly evaluated against customer-oriented criteria, the selected concept is likely to be focused on the customer.
Structured method

• A competitive design:
  – By benchmarking concepts with respect to existing designs, designers push the design to match or exceed their competitors' performance along key dimensions.
Structured method

• Better product-process coordination:
  – Explicit product evaluation with respect to manufacturing criteria improves the product’s manufacturability and helps match the product with the process capabilities of the firm.
Structured method

• Reduced time to product introduction:
  – A structured method becomes a common language among design engineers, manufacturing engineers, industrial designers, marketing people and project managers, resulting in decreased ambiguity, faster communication, and fewer false starts.
Structured method

• Effective group decision-making:
  – Within the development team, organizational philosophy and guidelines, willingness of members to participate, and team member’s experience may constrain concept selection.
  – A structured method encourages decision-making based on objective criteria and minimizes the likelihood that arbitrary or personal factors are allowed to influence the product concept.
Structured method

• Documenting the decision-making process:
  – A structured method results in a readily understood archive of the rationale behind concept decisions. This record is useful for assimilating new team members and for quickly assessing the impact of changes in customer needs or in the available alternatives.
Overview of methodology

- The concept selection process is based on two methodologies:
  - Concept Screening
  - Concept Scoring
- Concept screening is just for narrowing the number of concepts
- For a small number of concepts, go directly to concept scoring
Concept Development Funnel

CONCEPT SELECTION PROCESS

- Concept generation
- Concept screening
- Concept scoring
- Concept testing
Concept Screening

• Step 1: Prepare the selection matrix
• Step 2: Rate the concepts
• Step 3: Rank the concepts
• Step 4: Combine and improve the concepts
• Step 5: Select one or more concepts
• Step 6: Reflect on results and process
## Example: Concept Screening

<table>
<thead>
<tr>
<th>SELECTION CRITERIA</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>REF.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of Handling</td>
<td>0</td>
<td>0</td>
<td>–</td>
<td>0</td>
<td>0</td>
<td>–</td>
<td>–</td>
<td>0</td>
</tr>
<tr>
<td>Ease of Use</td>
<td>0</td>
<td>–</td>
<td>–</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number Readability</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Dose Metering</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Load Handling</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Manufacturing Ease</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>0</td>
<td>0</td>
<td>–</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Portability</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>0</td>
<td>–</td>
<td>–</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>PLUSES</th>
<th>SAMES</th>
<th>MINUSES</th>
<th>NET</th>
<th>RANK</th>
<th>CONTINUE?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>4</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**CONCEPT VARIANTS**
Concept Screening

• Prepare the selection matrix
  – Use a reference concept or benchmark
    • Reference is generally either an industry standard or a straight-forward concept with which the team members are very familiar.

• Rate the concepts
  – Assign relative scores
    • “better than” (+)
    • “same as” (0)
    • “worse than” (-)
Concept Screening

• Rank the concepts
  – The sum of all the “better than” “same as” and “worse than”

• Combine and improve the concepts
  – Is there a concept that is generally good but degraded by one bad feature?
    Can a minor modification improve the overall concept while remaining distinct from the other concepts?
Concept Screening

• Are there two concepts which can be combined to preserve the “better than” qualities while annulling the “worse than” qualities?
Concept Screening

• Select one or more concepts
  – The number of concepts selected for further review will be limited by team resources (personel, money, and time)
  – The team must clarify which issues need to be investigated further before a final selection can be made.
Concept Screening

• Reflect on the results and the process
  – All of the team members should be comfortable with the outcome
Remember…

The goal of concept selection is not to
• Select the best concept.
The goal of concept selection is to
• Develop the best concept.
So remember to combine and refine the concepts to develop better ones.
Concept Scoring

- Step 1: Prepare the selection matrix
- Step 2: Rate concepts
- Step 3: Rank concepts
- Step 4: Combine and improve concepts
- Step 5: Select one or more concepts
- Step 6: Reflect on results and process
### Relative Performance

<table>
<thead>
<tr>
<th>Relative Performance</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much worse than reference</td>
<td>1</td>
</tr>
<tr>
<td>Worse than reference</td>
<td>2</td>
</tr>
<tr>
<td>Same as reference</td>
<td>3</td>
</tr>
<tr>
<td>Better than reference</td>
<td>4</td>
</tr>
<tr>
<td>Much better than reference</td>
<td>5</td>
</tr>
</tbody>
</table>

**Exhibit 7-8**

Hierarchical decomposition of selection criteria. In conjunction with more detailed concepts, the team may need to break down criteria to the level of detail necessary for meaningful comparison.
## Example: Concept Scoring

<table>
<thead>
<tr>
<th>Selection Criteria</th>
<th>Weight</th>
<th>Rating</th>
<th>Weighted Score</th>
<th>Rating</th>
<th>Weighted Score</th>
<th>Rating</th>
<th>Weighted Score</th>
<th>Rating</th>
<th>Weighted Score</th>
<th>Rating</th>
<th>Weighted Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of Handling</td>
<td>5%</td>
<td>3</td>
<td>0.15</td>
<td>3</td>
<td>0.15</td>
<td>4</td>
<td>0.2</td>
<td>4</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of Use</td>
<td>15%</td>
<td>3</td>
<td>0.45</td>
<td>4</td>
<td>0.6</td>
<td>4</td>
<td>0.6</td>
<td>3</td>
<td>0.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Readability of Settings</td>
<td>10%</td>
<td>2</td>
<td>0.2</td>
<td>3</td>
<td>0.3</td>
<td>5</td>
<td>0.5</td>
<td>5</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dose Metering Accuracy</td>
<td>25%</td>
<td>3</td>
<td>0.75</td>
<td>3</td>
<td>0.75</td>
<td>2</td>
<td>0.5</td>
<td>3</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Durability</td>
<td>15%</td>
<td>2</td>
<td>0.3</td>
<td>5</td>
<td>0.75</td>
<td>4</td>
<td>0.6</td>
<td>3</td>
<td>0.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of Manufacture</td>
<td>20%</td>
<td>3</td>
<td>0.6</td>
<td>3</td>
<td>0.6</td>
<td>2</td>
<td>0.4</td>
<td>2</td>
<td>0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portability</td>
<td>10%</td>
<td>3</td>
<td>0.3</td>
<td>3</td>
<td>0.3</td>
<td>3</td>
<td>0.3</td>
<td>3</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Score</strong></td>
<td></td>
<td></td>
<td><strong>2.75</strong></td>
<td></td>
<td><strong>3.45</strong></td>
<td></td>
<td><strong>3.10</strong></td>
<td></td>
<td><strong>3.05</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rank</strong></td>
<td></td>
<td></td>
<td><strong>4</strong></td>
<td></td>
<td><strong>1</strong></td>
<td></td>
<td><strong>2</strong></td>
<td></td>
<td><strong>3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Continue?</strong></td>
<td>No</td>
<td>Develop</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ETM 551 Concept Selection 33
... but remember

- Subjective criteria may be important
- Keep an open mind on improvements
- Decide where to include costing
- Select elements of aggregate concepts
- Apply concept selection throughout the process
Retail Prices of the Pencils

- Twist-Erase Pentel 7.60 YTL
- Rotring Tikky II 6.30
- Bic Disney Coloured 4.00
- Techniclick G Pentel 3.80
- Bic Matic Crayon Pencil 1.90
- Script Line Colegial 0.50
Selection Example

- Twist-Erase Pentel
- Rotring Tikky II
- Bic Disney Coloured
- Techniclick G Pentel
- Bic Matic Crayon Pencil
- Script Line Colegial
Caveats

• Beware of the best "average" product.
• Perform concept selection for each different customer group and compare results.
• Check sensitivity of selection to the importance weightings and ratings.
• May want to use all of detailed requirements in final stages of selection.
• Note features which can be applied to other concepts.
Summary

- All teams use the same method for selecting concepts.
- Successful design is facilitated by structured concept selection.
- Concept screening uses a reference concept to evaluate concept variants against selection criteria.
- Concept screening uses a coarse comparison system to narrow the range of concepts under consideration.
Summary

- Concept scoring uses weighted selection criteria and a finer rating scale.
- Both screening and scoring use a matrix as the basis of a six-step process
  - Prepare the selection matrix
  - Rate the concepts
  - Rank the concepts
  - Combine and improve the concepts
  - Select one or more concepts
  - Reflect on the results and the process