INSE 6411
Product Design Theory and Methodology

Concept selection

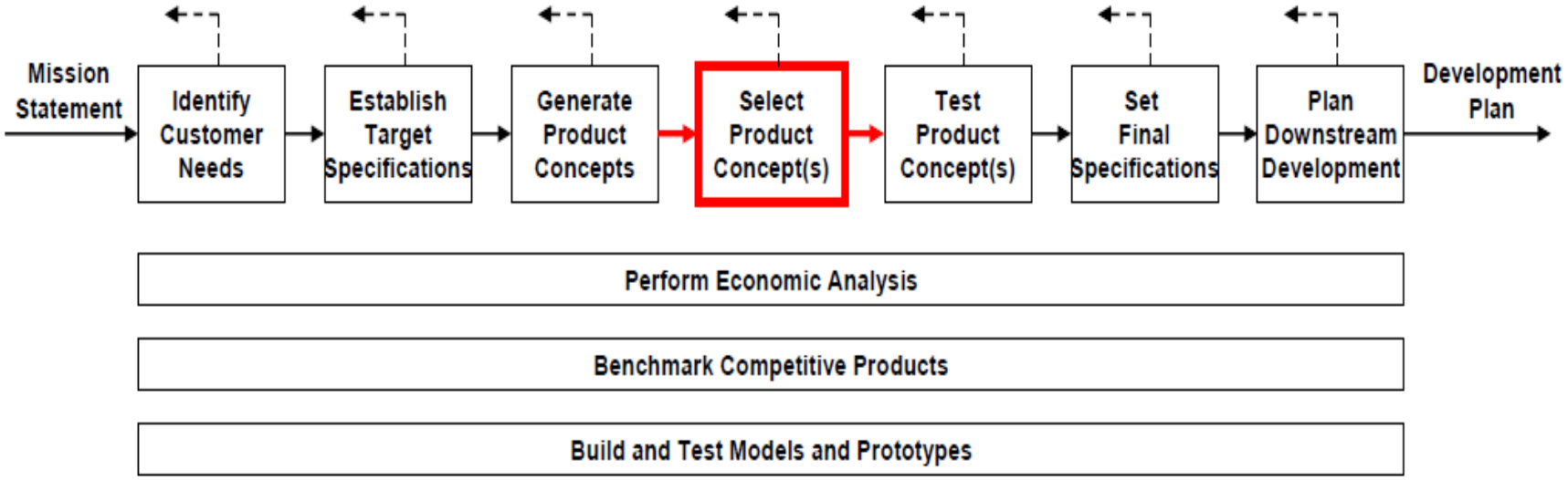
Lecture 9

Andrea Schiffauerova, PhD.

Concept selection

Textbook - Chapter 8

CONCEPT SELECTION



Concept selection

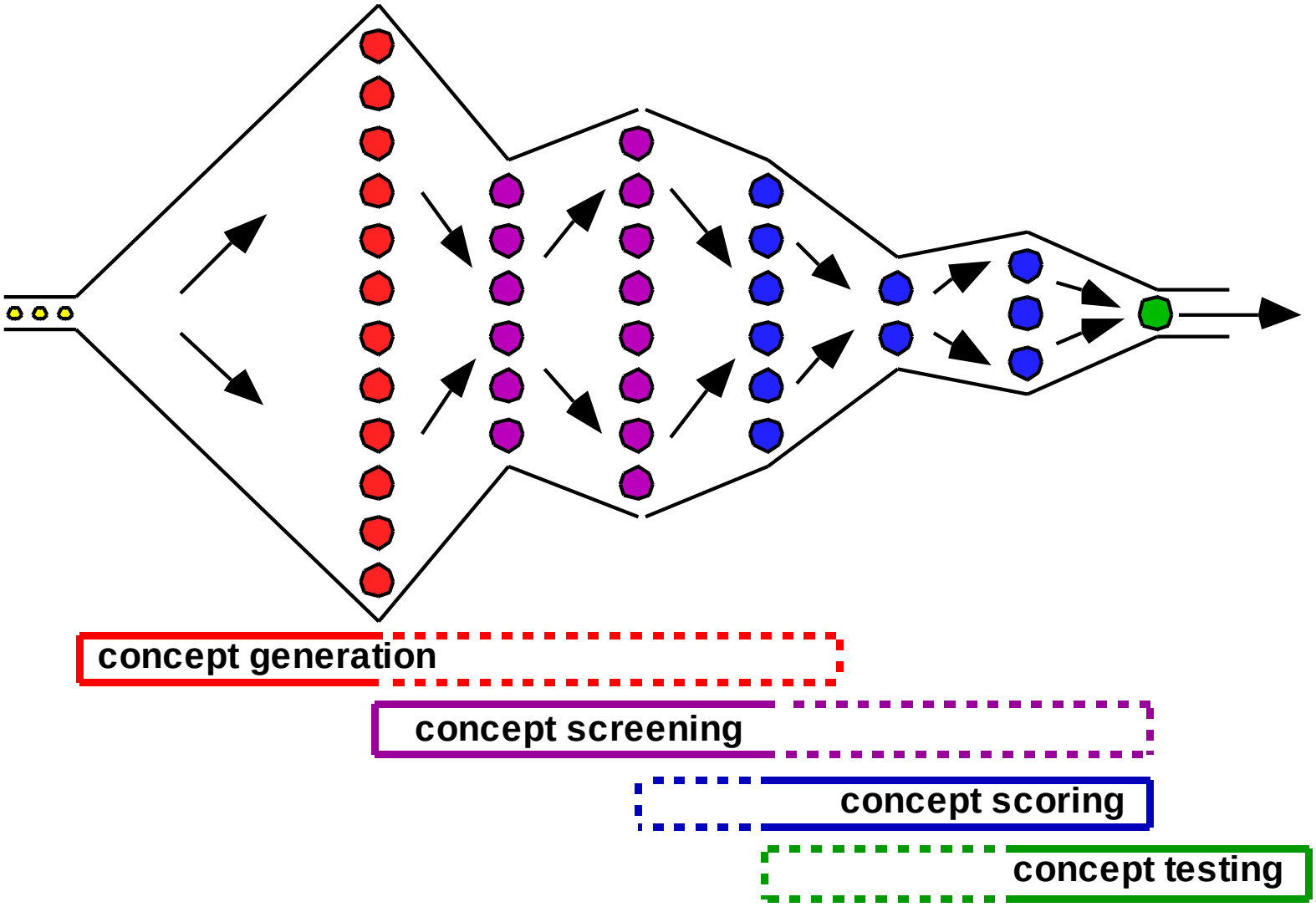
- Concept selection is a process of:
  - ***evaluating*** concepts
  - ***comparing*** the relative strengths and weaknesses of the concepts
  - ***selecting*** one or more concepts for further investigation, testing or development
- All concepts at this phase satisfy the key customer needs, but only one (or more) can be pursued further
- The designs are still abstract, which makes the decision making difficult
- The main objective is not to select a concept, but to develop a concept

Concept selection: Overview of methodology

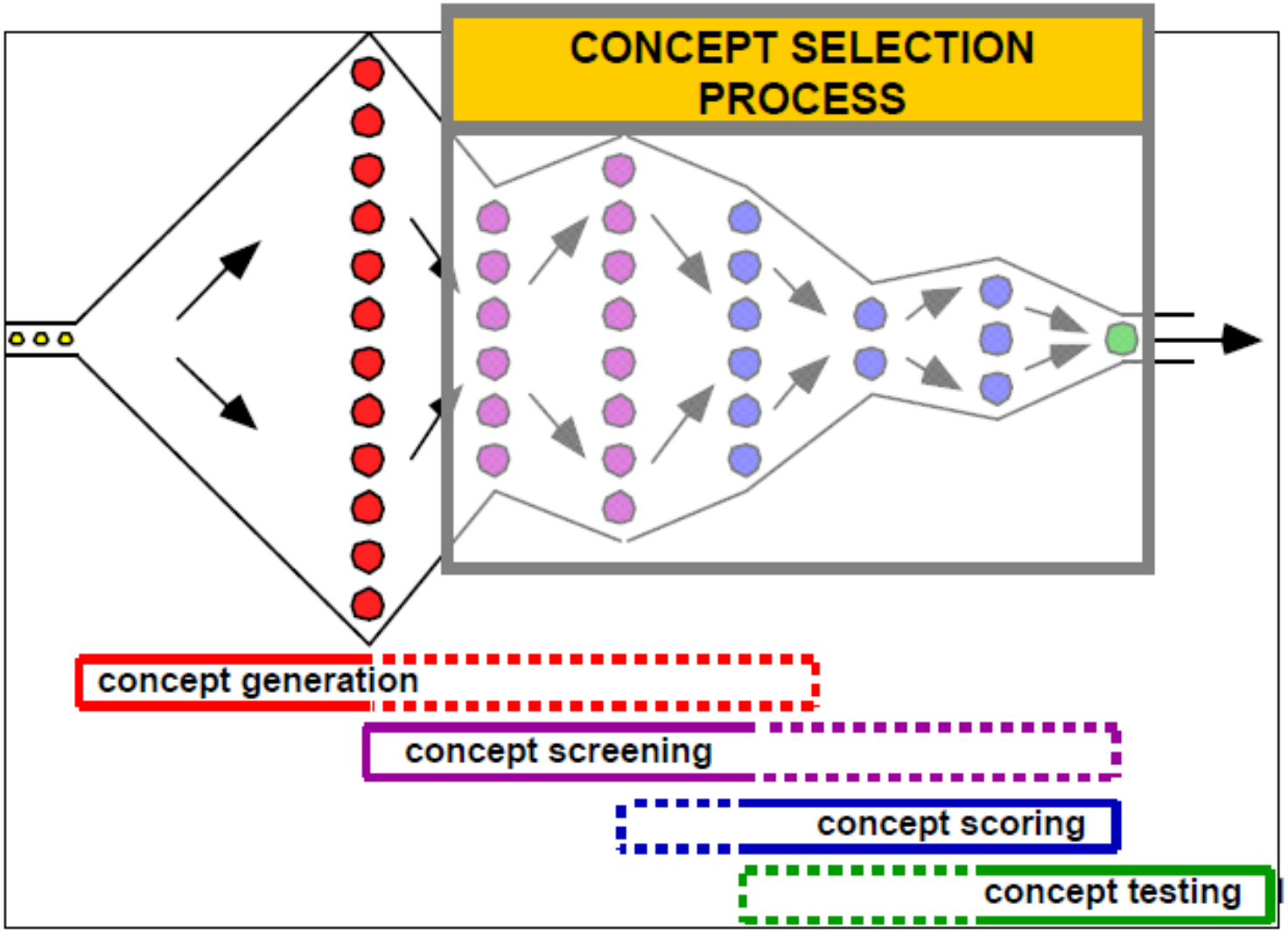
- Two-stage concept selection methodology:
  - **Concept Screening**
    - A quick, approximate evaluation aimed at producing a few viable alternatives
    - For a small number of concepts with simple decision making only concept screening will be sufficient
  - **Concept Scoring**
    - More careful analysis in order to choose the most promising single concept

- Both stages use a selection matrix in order to
  - Rate
  - Rank
  - Combine
  - Select

Concept Development Funnel



Concept Development Funnel



Concept Selection Example: Prefilled Syringe

Concept Screening

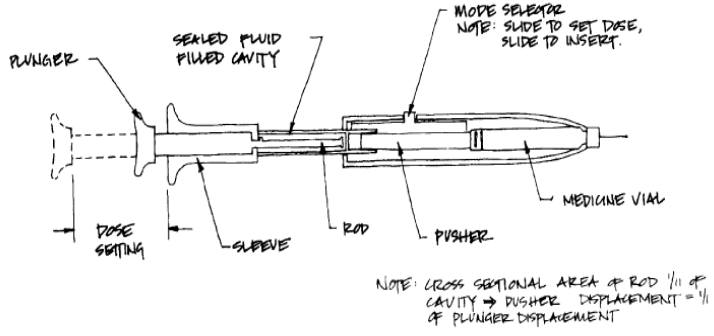
- Often called ***Pugh Concept Selection***
- The purpose:
  - To narrow the number of concepts quickly
  - To improve the concepts
- Five Steps:
  1. Prepare the selection matrix
  2. Rate the concepts
  3. Rank the concepts
  4. Combine and improve the concepts
  5. Select one or more concepts

Concept Screening

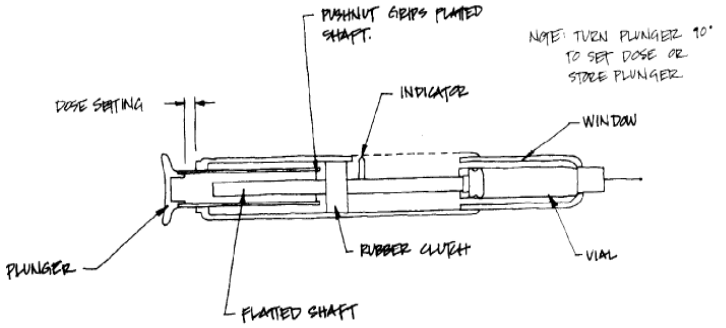
- Step 1: **Prepare the selection matrix**
  - *Enter **concept variants***
    - The same level of detail
    - Graphical and/or textual representation

SELECTION CRITERIA	CONCEPT VARIANTS							
	A	B	C	D	E	F	G	REF.
Ease of Handling								
Ease of Use								
Number Readability								
Dose Metering								
Load Handling								
Manufacturing Ease								
Portability								

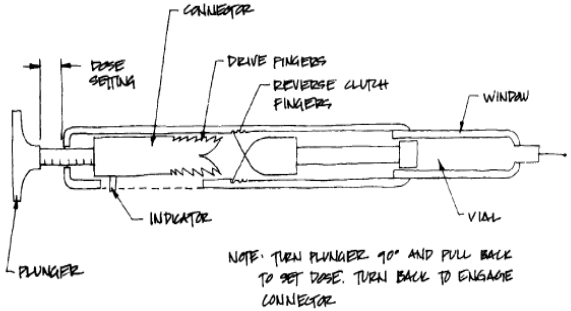
Concept A:
Master Cylinder



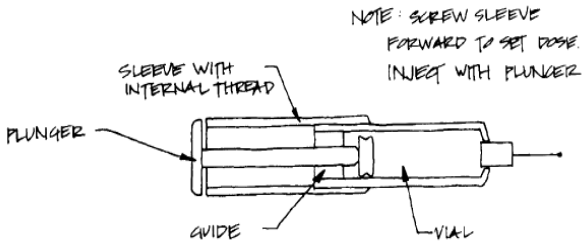
Concept B:
Rubber Brake



Concept C:
Ratchet

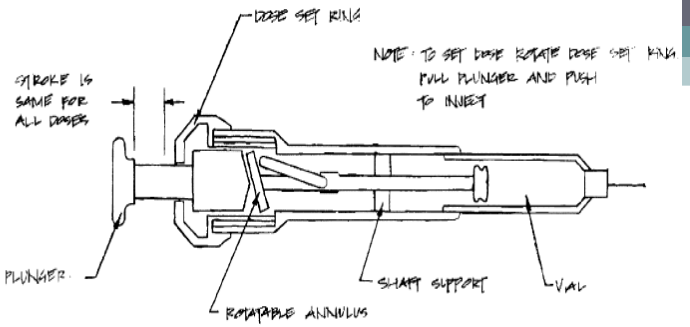


Concept D:
Plunge Stop

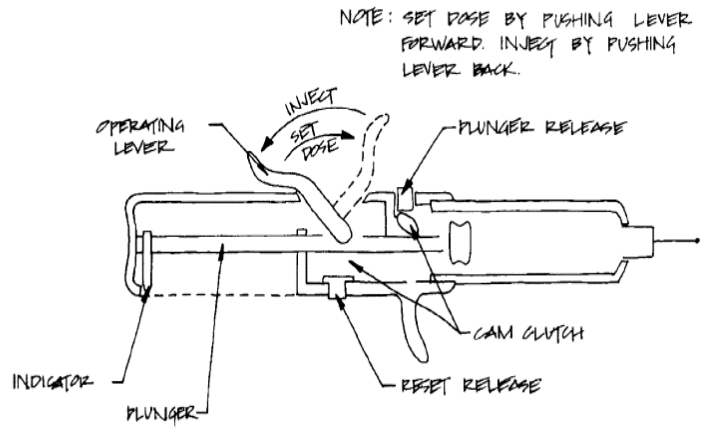


From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

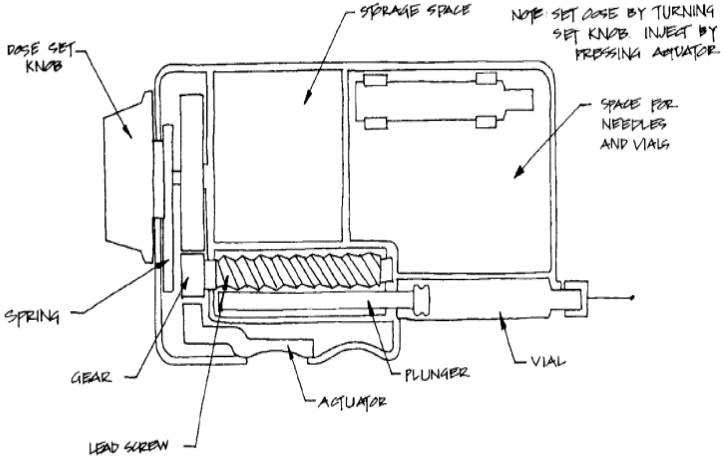
Concept E:
Swash Ring



Concept F:
Lever Set



Concept G:
Dial Screw



From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Concept Screening

- Step 1: **Prepare the selection matrix**
  - *Choose **selection criteria***
    - Consider use of primary customer needs
    - Consider use of enterprise needs (price, manufacturability, etc.)
    - Choose criteria that differentiate your concepts
    - List criteria of similar importance
    - Do not list unimportant criteria

SELECTION CRITERIA	CONCEPT VARIANTS							
	A	B	C	D	E	F	G	REF.
Ease of Handling								
Ease of Use								
Number Readability								
Dose Metering								
Load Handling								
Manufacturing Ease								
Portability								

Concept Screening

- Step 1: **Prepare the selection matrix**
  - *Choose **reference concept***
    - Could be industry standard, best-in-class benchmark, top seller, an early concept, a new concept or one of the considered concepts
    - Pick a reference that will allow you to <u>differentiate</u> your concepts

SELECTION CRITERIA	CONCEPT VARIANTS							
	A	B	C	D	E	F	G	REF.
Ease of Handling								
Ease of Use								
Number Readability								
Dose Metering								
Load Handling								
Manufacturing Ease								
Portability								

Concept Screening

- Step 2: **Rate the concepts**
  - Rate the concepts - assign relative scores
    - "better than" (+)
    - "same as" (0)
    - "worse than" (-)
  - Use objective metrics if possible

SELECTION CRITERIA	CONCEPT VARIANTS							
	A	B	C	D	E	F	G	REF.
Ease of Handling	0	0	–	0	0	–	–	0
Ease of Use	0	–	–	0	0	+	0	0
Number Readability	0	0	+	0	+	0	+	0
Dose Metering	+	+	+	+	+	0	+	0
Load Handling	0	0	0	0	0	+	0	0
Manufacturing Ease	+	–	–	0	0	–	0	0
Portability	+	+	–	–	0	–	–	0

Concept Screening

- Step 3: **Rank the concepts**
  - The sum of all the “better than” “same as” and “worse than”

	CONCEPT VARIANTS							
SELECTION CRITERIA	A	B	C	D	E	F	G	REF.
Ease of Handling	0	0	–	0	0	–	–	0
Ease of Use	0	–	–	0	0	+	0	0
Number Readability	0	0	+	0	+	0	+	0
Dose Metering	+	+	+	+	+	0	+	0
Load Handling	0	0	0	0	0	+	0	0
Manufacturing Ease	+	–	–	0	0	–	0	0
Portability	+	+	–	–	0	–	–	0
PLUSES	3	2	2	1	2	2	2	
SAMES	4	3	1	5	5	2	3	
MINUSES	0	2	4	1	0	3	2	
NET	3	0	–2	0	2	–1	0	
RANK	1	3	7	5	2	6	4	
CONTINUE?	Yes	Yes	No	No	Yes	No	Yes	

Concept Screening

- Step 4: **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?
  - Are there two concepts which can be combined to preserve the “better than” qualities while eliminating the “worse than” qualities?

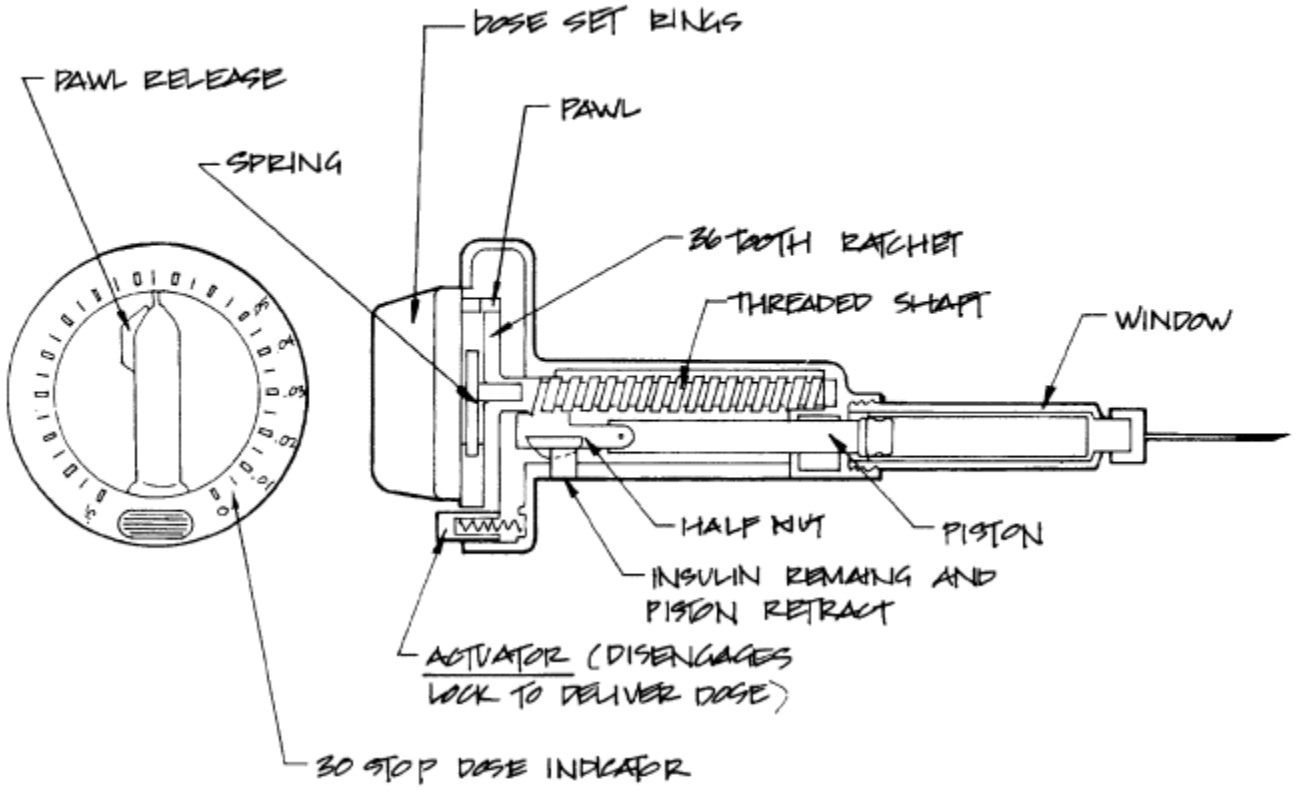
Concept Screening

- Step 4: Combine and improve the concepts

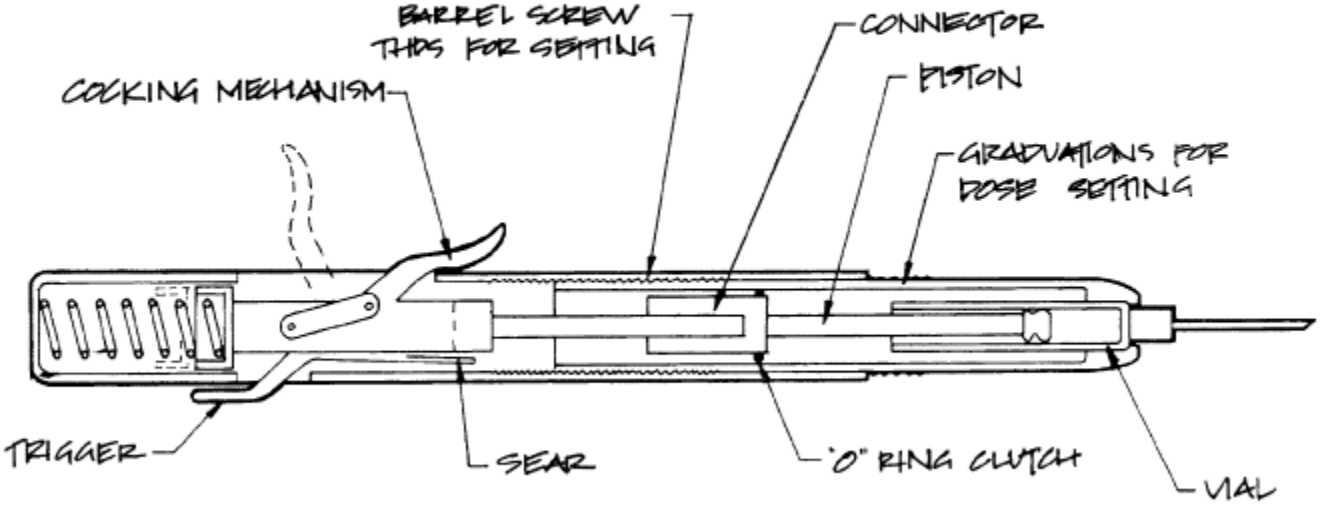
SELECTION CRITERIA	CONCEPT VARIANTS							
	A	B	C	D	E	F	G	REF.
Ease of Handling	0	0	–	0	0	–	–	0
Ease of Use	0	–	–	0	0	+	0	0
Number Readability	0	0	+	0	+	0	+	0
Dose Metering	+	+	+	+	+	0	+	0
Load Handling	0	0	0	0	0	+	0	0
Manufacturing Ease	+	–	–	0	0	–	0	0
Portability	+	+	–	–	0	–	–	0
PLUSES	3	2	2	1	2	2	2	
SAMES	4	3	1	5	5	2	3	
MINUSES	0	2	4	1	0	3	2	
NET	3	0	–2	0	2	–1	0	
RANK	1	3	7	5	2	6	4	
CONTINUE?	Yes	Yes	No	No	Yes	No	Yes	

- Combine D + F = **DF**
- Improve G = **G+**

Concept G+:
Dial Screw+



Concept DF:
Lever Stop



From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Concept Screening

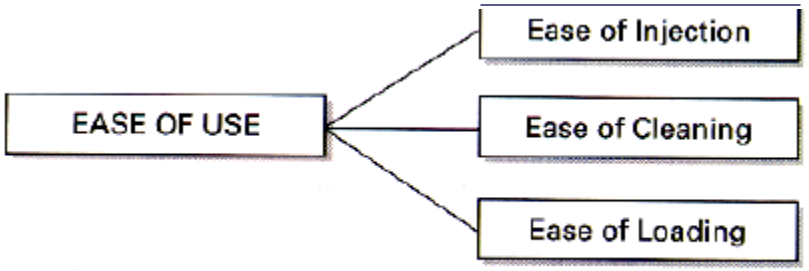
- Step 5: **Select one or more concepts**
  - The number of concepts selected for further review will be limited by team resources (personnel, money, and time)
  - The team must clarify which issues need to be investigated further before a final selection can be made.
    - Another round of concept screening?
    - Will concept scoring be applied next?

Concept Scoring

- Used when increased resolution (detail) will better differentiate among competing concepts
- A more quantitative version of concept screening
- Five steps:
  1. Prepare the selection matrix
  2. Rate the concepts
  3. Rank the concepts
  4. Combine and improve the concepts
  5. Select one or more concepts

Concept Scoring

- Step 1: **Prepare the selection matrix**
  - *Choose **selection criteria***
    - Consider more detailed selection criteria



  - *Include **importance weights** for the criteria*
    - 1 to 5
    - allocating 100% among all

Concept Scoring

- Step 1: **Prepare the selection matrix**
  - *Enter **concepts***

Concepts			
A (reference) Master Cylinder	DF Lever Stop	E Swash Ring	G+ Dial Screw+

  - *Choose **reference concept***
    - Different reference concepts may be used for each criterion to avoid scale compression
    - Average performance concept, benchmarked concept, target values for product specifications

Concept Scoring

- Step 2: **Rate the concepts**
  - *Choose **scale*** (1 to 5, or 1 to 9)
    - Reference point is in the middle

Relative Performance	*Rating*
Much worse than reference	1
Worse than reference	2
Same as reference	3
Better than reference	4
Much better than reference	5

  - Assign relative scores to the concepts
    - For each criterion consider the performance of each concept relative to the reference point

Concept Scoring

(3) Reference concept

		Concepts							
		A Master Cylinder		DF Lever Stop		E Swash Ring		G+ Dial Screw+	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Ease of Handling	5%	(3)		3		4		4	
Ease of Use	15%	(3)		4		4		3	
Readability of Settings	10%	2		(3)		5		5	
Dose Metering Accuracy	25%	(3)		3		2		3	
Durability	15%	2		5		4		(3)	
Ease of Manufacture	20%	(3)		3		2		2	
Portability	10%	(3)		3		3		3	

Concept Scoring

- Step 3: **Rank the concepts**
  - Calculate weighted scores by multiplying the raw scores by the criteria weights

$$S_j = \sum_{i=1}^{n} r_{ij} w_i$$

where

r_{ij} = raw rating of concept j for the ith criterion
w_i = weighting for ith criterion
n = number of criteria
S_j = total score for concept j

Concept Scoring

③ Reference concept

		Concepts							
		A Master Cylinder		DF Lever Stop		E Swash Ring		G+ Dial Screw+	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Ease of Handling	5%	**3**	0.15	3	0.15	4	0.2	4	0.2
Ease of Use	15%	**3**	0.45	4	0.6	4	0.6	3	0.45
Readability of Settings	10%	2	0.2	**3**	0.3	5	0.5	5	0.5
Dose Metering Accuracy	25%	**3**	0.75	3	0.75	2	0.5	3	0.75
Durability	15%	2	0.3	5	0.75	4	0.6	**3**	0.45
Ease of Manufacture	20%	**3**	0.6	3	0.6	2	0.4	2	0.4
Portability	10%	**3**	0.3	3	0.3	3	0.3	3	0.3

Concept Scoring

③ Reference concept

		Concepts							
		A Master Cylinder		DF Lever Stop		E Swash Ring		G+ Dial Screw+	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Ease of Handling	5%	**3**	0.15	3	0.15	4	0.2	4	0.2
Ease of Use	15%	**3**	0.45	4	0.6	4	0.6	3	0.45
Readability of Settings	10%	2	0.2	**3**	0.3	5	0.5	5	0.5
Dose Metering Accuracy	25%	**3**	0.75	3	0.75	2	0.5	3	0.75
Durability	15%	2	0.3	5	0.75	4	0.6	**3**	0.45
Ease of Manufacture	20%	**3**	0.6	3	0.6	2	0.4	2	0.4
Portability	10%	**3**	0.3	3	0.3	3	0.3	3	0.3
Total Score		2.75		3.45		3.10		3.05	
Rank		4		1		2		3	
Continue?		No		Develop		No		No	

Concept Scoring

③ Reference concept

		Concepts							
		A Master Cylinder		DF Lever Stop		E Swash Ring		G+ Dial Screw+	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Ease of Handling	5%	**3**	0.15	3	0.15	4	0.2	4	0.2
Ease of Use	15%	**3**	0.45	4	0.6	4	0.6	3	0.45
Readability of Settings	10%	2	0.2	**3**	0.3	5	0.5	5	0.5
Dose Metering Accuracy	25%	**3**	0.75	3	0.75	2	0.5	3	0.75
Durability	15%	2	0.3	5	0.75	4	0.6	**3**	0.45
Ease of Manufacture	20%	**3**	0.6	3	0.6	2	0.4	2	0.4
Portability	10%	**3**	0.3	3	0.3	3	0.3	3	0.3
Total Score		2.75		3.45		3.10		3.05	
Rank		4		1		2		3	
Continue?		No		Develop		No		No	

Concept Scoring

- Step 4: **Combine and improve the concepts**
  - Look for changes and combinations that improve the concept

- Step 5: **Select one or more concepts**
  - Check sensitivity of selection to the importance weightings and ratings.
  - Consider uncertainty about ratings

Concept Selection – a final remark

- 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.

Next lecture

- March 19
  - Concept Testing
  - Product Generation