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EBU5608 Product Development and Management

Topic 8 - Concept Development

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Agenda

- Phase 1 – Concept Development
  - Identify Customer Needs
  - Establishing target specifications
  - Concept generation
  - Concept selection
  - Concept testing
  - Setting final specifications
  - Project planning
  - Economic analysis
  - Benchmarking & modelling

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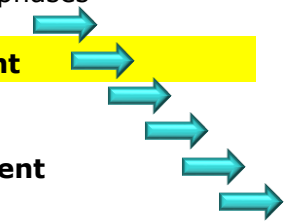
A generic product development process

- Product development **starts** with planning and **concludes** with product launch
- A generic product development process can be used as an example
- The process has six distinct phases
  - 0. **Planning**
  - 1. **Concept development**
  - 2. **System-level design**
  - 3. **Detail design**
  - 4. **Testing and refinement**
  - 5. **Production ramp-up**



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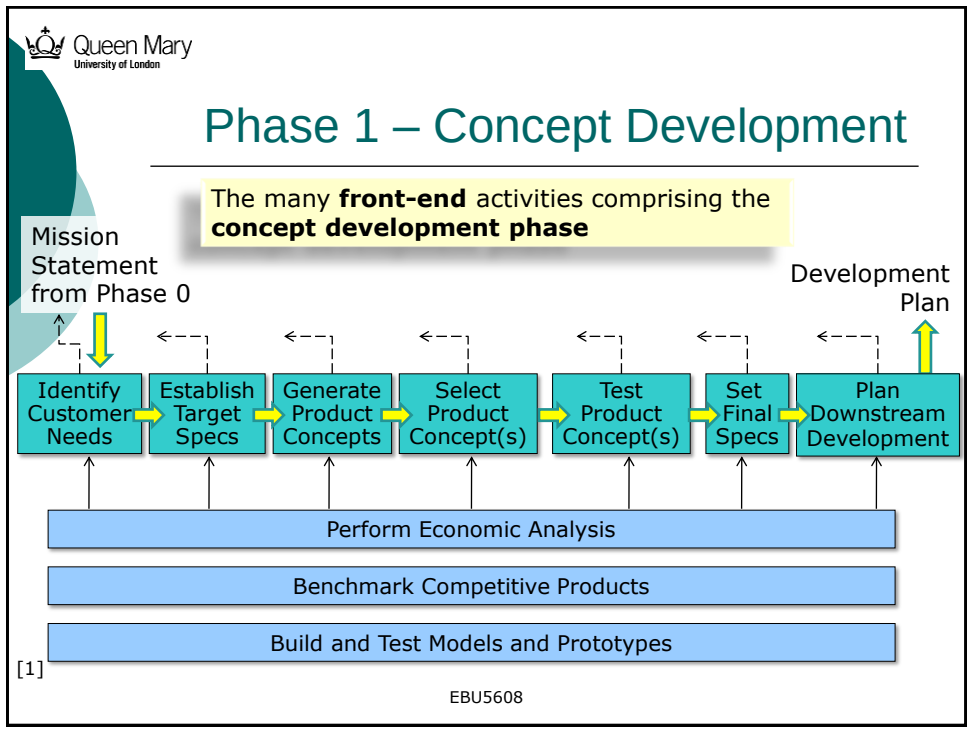
Concept Development

- The **needs** of the target market are identified
- **Alternative** product concepts are generated and evaluated
- One or more concepts are selected for further **development** and **testing**
  - A **concept** is a **description** of the form, function and features of a product
- **Evaluation** and **screening criteria** are used to aid in the **selection**
- Usually accompanied by a set of **specifications**, an **analysis** of competitive products and an economic **justification** for the project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Phase 1 – Concept Development
The many **front-end** activities comprising the **concept development phase**
Mission Statement from Phase 0
Development Plan
Identify Customer Needs
Establish Target Specs
Generate Product Concepts
Select Product Concept(s)
Test Product Concept(s)
Set Final Specs
Plan Downstream Development
Perform Economic Analysis
Benchmark Competitive Products
Build and Test Models and Prototypes
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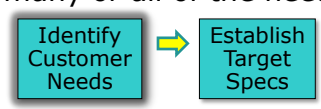
Phase 1 – Concept Development - **Identifying customer needs** [2]

The **first activity** involved in the concept development process is **identifying customer needs**

- Goal is to **understand** customers' **needs**
- Then to effectively **communicate** them to the development team
- The **output** of this step is:
  - Customer need **statements** organised in a hierarchical list, with **importance** weightings for many or all of the needs

See in Topic 7 for more details



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Phase 1 – Concept Development - **Establishing target specifications**

- **Specifications** provide a precise **description** of what a product has to do
- Are a **translation** of the customer needs into **technical** terms
- The **output** of this stage is:
  - A list of target **specifications**
  - Each specification consists of a **metric**, and marginal and ideal **values** for that metric

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Phase 1 – Concept Development - **Establishing target specifications**

There are 4 steps to this process:

1. Prepare the list of **metrics**, i.e. the **technical** or **manufacturing** features of the product based on the customer needs
2. Collect competitive benchmarking information
3. Set ideal and marginally acceptable target values
4. Reflect on the results and the process

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Product Specifications Example: Mountain Bike Suspension Fork

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

[2]

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Product Specifications Example: Mountain Bike Suspension Fork

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Product Specifications Example: Mountain Bike Suspension Fork

Useful metrics reflect as directly as possible the degree to which the product satisfies the customer needs.

customer need: *"the suspension is easy to install"*

corresponding ***specification*** *:*
" the average time to assemble the fork to the frame is less than 75 seconds."

metric: *"average time to assemble"*

value of this metric: *"less than 75 seconds"*

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Link Metrics to Needs

	Need	1 Attenuation from dropout to handlebar at 10hz	2 Spring pre-load	3 Maximum value from the Monster	4 Minimum descent time on test track	5 Damping coefficient adjustment range	6 Maximum travel (26in wheel)	7 Rake offset	8 Lateral stiffness at the tip	9 Total mass	10 Lateral stiffness at brake pivots	11 Headset sizes	12 Steertube length	13 Wheel sizes	14 Maximum tire width	15 Time to assemble to frame	16 Fender compatibility	17 Instills pride	18 Unit manufacturing cost	19 Time in spray chamber w/o water entry	20 Cycles in mud chamber w/o contamination	21 Time to disassemble/assemble for maintenance	22 Special tools required for maintenance	23 UV test duration to degrade rubber parts	24 Monster cycles to failure	25 Japan Industrial Standards test	26 Bending strength (frontal loading)
1	reduces vibration to the hands.	•		•	•																						
2	allows easy traversal of slow, difficult terrain.		•																								
3	enables high speed descents on bumpy trails.	•		•	•																						
4	allows sensitivity adjustment.					•																					
5	preserves the steering characteristics of the bike.						•	•																			
6	remains rigid during hard cornering.		•						•																		
7	is lightweight.									•																	
8	provides stiff mounting points for the brakes.										•																
9	fits a wide variety of bikes, wheels, and tires.											•	•	•	•												
10	is easy to install.															•											
11	works with fenders.																•										
12	instills pride.																	•									
13	is affordable for an amateur enthusiast.																		•								
14	is not contaminated by water.																			•							
15	is not contaminated by grunge.																				•						
16	can be easily accessed for maintenance.																					•					
17	allows easy replacement of worn parts.																					•	•				
18	can be maintained with readily available tools.																						•				
19	lasts a long time.																							•	•		
20	is safe in a crash.																									•	•

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List of Metrics and Units for the suspension

Metric #	Need #s	Metric	Imp	Units
1	1,3	Attenuation from dropout to handlebar at 10hz	3	dB
2	2,6	Spring pre-load	3	N
3	1,3	Maximum value from the Monster	5	g
4	1,3	Minimum descent time on test track	5	s
5	4	Damping coefficient adjustment range	3	N-s/m
6	5	Maximum travel (26in wheel)	3	mm
7	5	Rake offset	3	mm
8	6	Lateral stiffness at the tip	3	kN/m
9	7	Total mass	4	kg
10	8	Lateral stiffness at brake pivots	2	kN/m
11	9	Headset sizes	5	in
12	9	Steertube length	5	mm
13	9	Wheel sizes	5	list
14	9	Maximum tire width	5	in
15	10	Time to assemble to frame	1	s
16	11	Fender compatibility	1	list
17	12	Instills pride	5	subj
18	13	Unit manufacturing cost	5	US$
19	14	Time in spray chamber w/o water entry	5	s
20	15	Cycles in mud chamber w/o contamination	5	k-cycles
21	16,17	Time to disassemble/assemble for maintenance	3	s
22	17,18	Special tools required for maintenance	3	list
23	19	UV test duration to degrade rubber parts	5	hours
24	19	Monster cycles to failure	5	cycles
25	20	Japan Industrial Standards test	5	binary
26	20	Bending strength (frontal loading)	5	MN

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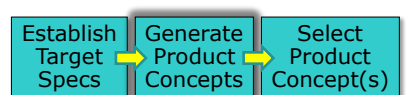
Phase 1 – Concept Development - **Concept generation**

- The goal of **concept generation** is to thoroughly **explore** the space of product concepts that may address the customer needs
- Concept generation includes a **mix** of
  - external **search**
  - creative **problem solving** within the team, and
  - systematic exploration of the various **solution fragments** the team generates
- The **result** of this activity is usually a **set** of 10-20 concepts – each is typically represented by a sketch and a brief descriptive text



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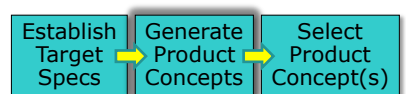
Phase 1 – Concept Development - **Concept generation**

- Concept generation can be a **complex** problem
- One approach is to break the problem into **simpler sub-problems** and then to look for solutions to these sub-problems
- The sub-problem solutions are then **integrated** into a total solution
- Because there will rarely be a **single** overall solution, this allows a **number** of possible concepts to be generated
- The next slide shows this process



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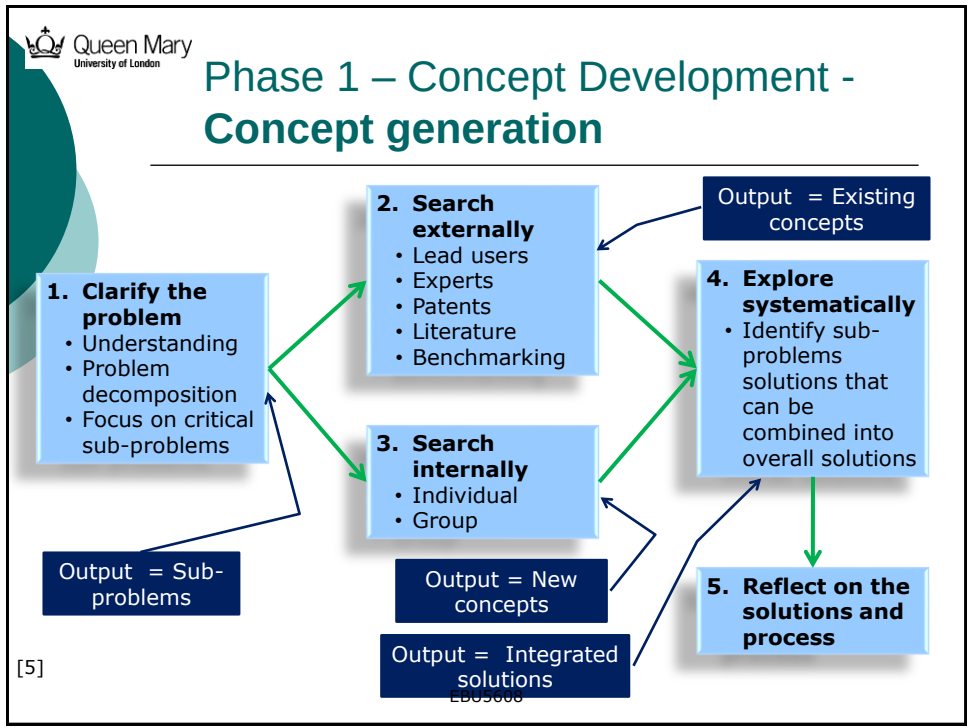
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Phase 1 – Concept Development -
Concept generation
1. Clarify the problem
• Understanding
• Problem decomposition
• Focus on critical sub-problems
2. Search externally
• Lead users
• Experts
• Patents
• Literature
• Benchmarking
3. Search internally
• Individual
• Group
4. Explore systematically
• Identify sub-problems solutions that can be combined into overall solutions
5. Reflect on the solutions and process
Output = Existing concepts
Output = Sub-problems
Output = New concepts
Output = Integrated solutions
[5]

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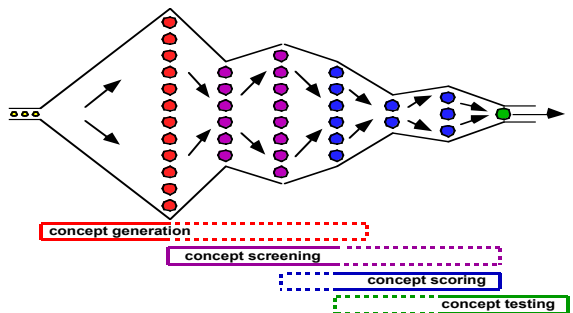
Concept development funnel



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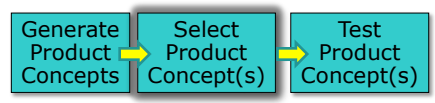
Phase 1 – Concept Development - **Concept selection**

- Concept selection is the activity in which various product concepts are **analysed** and sequentially **eliminated** to identify the most **promising** concept(s)
- Usually requires several **iterations** of the screening process shown on the next slides



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Screening and evaluation of business opportunities

- There are **5 stages** to the screening and evaluation process:
  1. **Initial screen** - entry screen or preliminary screen
  2. **Customer** screen
  3. **Technical** screen
  4. **Final** screen
  5. **Business** analysis

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Screening and evaluation - 1. Initial screen

1. **Initial screen**, entry screen or preliminary screen
   - First **formal evaluation** of the idea
   - **Ideas** come from a pool of concepts – possibly multiple development teams
   - **Screening** will include
     - **Technical feasibility** check – liaise with R&D, possible initial prototype created
     - **Marketing feasibility** test – short market research project undertaken
     - Evaluation of the **strategic opportunity** – is it in line with corporate and product strategies?

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Screening and evaluation - 1. Initial screen (contd.)

- Evaluation **criteria** are used to make the decisions regarding the future of the projects
- This is a **quick step** – inappropriate projects can be removed with minimal expenditure
- This is important at this stage as the further into development you get, investment and thus potential loss increases

Screening and evaluation - Initial screen criteria

- Evaluation criteria can be used to **formalise** the decision-making process regarding project funding
- The following slides provide a list of the **Key Evaluation Criteria** that are often used by managers having to make this type of decision

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Screening and evaluation - Initial screen criteria

Key Evaluation Criteria	
Technical	"Do we have experience of the technology?" "Do we have the skills and facilities?" "What is the probability of technical success?"

Screening and evaluation - Initial screen criteria

Key Evaluation Criteria	
Research direction and balance	"Is it compatible with research goals?" "Balance of risk in the project portfolio?"

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Screening and evaluation - Initial screen criteria

Key Evaluation Criteria	
Competitive rationale	"How does this project compare relative to the competition?" "Is it necessary to defend an existing business?" "Is the product likely to be superior to existing products?"

Screening and evaluation - Initial screen criteria

Key Evaluation Criteria	
Patentability	"Can we get patent protection?" "What will be the implications for defensive research?"

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Screening and evaluation - Initial screen criteria

Key Evaluation Criteria	
Stability of the market	"How stable is the technology?" "Is the market developed?" "Is there an industry standard?"

Screening and evaluation - Initial screen criteria

Key Evaluation Criteria	
Integration and synergy	"What is the level of integration of this project with other products and raw materials?" "Will it stand alone?"

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Screening and evaluation - Initial screen criteria

Key Evaluation Criteria	
Market	"What is the size of the market?" "Is it a growing market?" "Is there an existing customer base?" "Is the potential big enough to warrant the resource we need to expand?"

Screening and evaluation - Initial screen criteria

Key Evaluation Criteria	
Channel fit	"Do we have existing customers who might be interested, or do we have to find new customers?"

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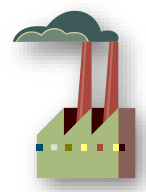
Screening and evaluation - Initial screen criteria

Key Evaluation Criteria	
Manufacturing	"Can we use existing resources?" "Will we require new equipment, skills, etc.?"



Screening and evaluation - Initial screen criteria

Key Evaluation Criteria	
Financial	"Expected investment required and rate of return?" Simple rate of return – no inflation taken into account Real rate of return – inflation is taken into account

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Screening and evaluation - Initial screen criteria

Key Evaluation Criteria	
Strategic fit	"Does it support our short-term and long-term plans for the business?"

Screening and evaluation - Initial screen criteria

- The key evaluation criteria given in the table on the previous slides can be developed further using a **scoring model** or **weighted checklist**
  - i.e. each factor is scored on a scale; **a relative weight given to the importance of that factor** is used as a multiple, and the weighted scores for all factors are added
- The ideas/concepts with the **highest scores** will move forward to the **next stage**
- Those with **low scores** will be discarded or stored in an ideas database for future consideration and development

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Weighted checklist

Factor *(not all factors included)*	Weight	Idea 1		Idea 2	
		Score	Weighted score	Score	Weighted score
Technical	2				
R&D balance	2				
Competitive rationale	5				
Patentability	1				
Market stability	4				
Synergy	6				
TOTAL					

Define weight for each factor

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Weighted checklist

Factor *(not all factors included)*	Weight	Idea 1		Idea 2	
		Score	Weighted score	Score	Weighted score
Technical	2	1			
R&D balance	2	3			
Competitive rationale	5	6			
Patentability	1	2			
Market stability	4	4			
Synergy	6	7			
TOTAL					

Give score to each factor

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Weighted checklist

Factor *(not all factors included)*	Weight	Idea 1		Idea 2	
		Score	Weighted score	Score	Weighted score
Technical	2	1	2x1=2		
R&D balance	2	3	2x3=6		
Competitive rationale	5	6	5x6=30		
Patentability	1	2	1x2=2		
Market stability	4	4	4x4=16		
Synergy	6	7	6x7=42		
TOTAL			**98**		

Multiply score by weight and sum weighted scores

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Weighted checklist

Idea 1 has higher weighted score than Idea 2

Factor *(not all factors included)*	Weight	Idea 1		Idea 2	
		Score	Weighted score	Score	Weighted score
Technical	2	1	2x1=2	8	2x8=16
R&D balance	2	3	2x3=6	2	2x2=4
Competitive rationale	5	6	5x6=30	1	5x1=5
Patentability	1	2	1x2=2	5	1x5=5
Market stability	4	4	4x4=16	3	4x3=12
Synergy	6	7	6x7=42	4	6x4=24
TOTAL			**98**		**66**

Appendix A

Concept-Screening Matrix Example

This matrix was created and used by a development team designing a collar to hold weights onto a barbell.

Selection Criteria	Concepts: Handcuff	Master Lock	Velcro Belt	Rubber Belt	Alligator Clip	4-Part Latch (REF)	Torsional Spring	Screw Type	Wing Nut	Clothespin	Hose Clamp	C-Clamp	Spring-Loaded Bar	Magnetic Plates	Threaded Bar
Functionality															
Lightweight	+	0	+	+	+	0	+	–	–	+	0	0	+	+	0
Fits different bars	+	0	+	+	+	0	0	0	0	+	0	+	0	–	0
Weights secured laterally	0	0	–	–	0	0	0	–	+	–	0	0	–	0	+
Convenience															
Tighten from end/side	0	0	0	0	0	0	–	–	–	0	–	0	+	+	–
Does not roll	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Change weights without removing collar	0	0	0	0	0	0	0	0	0	0	0	0	+	+	0
Convenience of placement when changing weights	0	0	+	+	0	0	–	–	–	0	–	0	+	+	–
Ergonomics															
Secure/release (one motion)	+	0	–	–	+	0	–	–	–	0	–	–	+	–	–
Low force to secure/release	0	0	0	0	–	0	–	0	0	0	0	0	+	–	0
RH/LH usage	0	0	0	0	0	0	0	–	–	0	–	–	0	0	–
Not slippery when wet	0	0	+	+	0	0	0	0	0	0	0	0	+	+	0
Use with one hand	+	0	0	0	+	0	0	0	0	0	0	0	+	+	0
Durability															
Longevity	–	–	–	–	0	0	0	+	0	0	+	+	–	–	+
Other															
Cost of raw materials	0	0	+	+	0	0	0	0	–	+	0	0	–	–	–
Manufacturability	0	–	+	+	0	0	0	+	–	+	+	0	–	–	–
Uses existing weight bars	0	0	0	0	0	0	0	0	0	0	0	0	–	0	–
Sum +'s	4	0	6	6	4	0	1	2	1	4	2	2	8	6	2
Sum 0's	11	14	7	7	11	16	11	8	8	11	10	12	3	4	7
Sum –'s	1	2	3	3	1	0	4	6	7	1	4	2	5	6	7
Net Score	3	–2	3	3	3	0	–3	–4	–6	3	–2	0	3	0	–5
Rank	1	10	1	1	1	7	12	13	15	1	10	7	1	7	15

[7]

Concept-Scoring Matrix Example

A development team generated this matrix while selecting a new concept for a spillproof beverage holder to be used on boats. Note that in this case the team chose not to define a single concept as the reference for all of the selection criteria.

		Concept A		Concept C		Concept F		Concept I		Concept J		Concept K		Concept O	
Selection Criteria	**Weight**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**
Flexible Use	20														
Use in different locations	15	7	105	7	105	8	120	6	90	6	90	5	75	7	105
Holds different beverages	5	5	25	5	25	3	15	4	20	5	25	3	15	3	15
Maintains Drink Condition	15														
Retains temperature of drink	13	5	65	5	65	5	65	1	13	5	65	5	65	5	65
Prevents water from getting in	2	5	10	7	14	5	10	5	10	5	10	5	10	5	10
Survives Boating Environment	5														
Doesn't break when dropped	1	6	6	6	6	9	9	7	7	5	5	9	9	6	6
Resists corrosion from sea spray	2	7	14	7	14	8	16	8	16	5	10	9	18	7	14
Floats when it falls in water	2	5	10	6	12	8	16	4	8	5	10	8	16	7	14
Keeps Drink Container Stable	20														
Prevents spilling	7	3	21	4	28	3	21	5	35	5	35	3	21	3	21
Prevents bouncing in waves	6	7	42	8	48	7	42	5	30	5	30	7	42	7	42
Will not slide during pitch/roll	7	5	35	5	35	5	35	5	35	5	35	5	35	5	35
Requires Little Maintenance	5														
Easily stored when not in use	1	7	7	6	6	8	8	9	9	4	4	8	8	7	7
Easy to maintain a clean appearance	2	6	12	6	12	3	6	4	8	5	10	5	10	6	12
Allows liquid to drain out bottom	2	5	10	5	10	5	10	5	10	5	10	5	10	5	10
Easy to Use	15														
Usable with one hand	5	7	35	7	35	7	35	6	30	5	25	7	35	7	35
Easy/comfortable to grip	5	8	40	8	40	6	30	5	25	5	25	6	30	8	40
Easy to exchange beverage containers	2	5	10	5	10	5	10	8	16	5	10	5	10	5	10
Works reliably	3	3	9	3	9	3	9	3	9	4	12	4	12	3	9
Attractive in Environment	10														
Doesn't damage boat surface	5	8	40	8	40	8	40	8	40	8	40	6	30	8	40
Attractive to look at	5	7	35	8	40	3	15	4	20	5	25	5	25	8	40
Manufacturing Ease	10														
Low-cost materials	4	5	20	4	16	7	28	8	32	4	16	8	32	6	24
Low complexity of parts	3	4	12	3	9	7	21	4	12	3	9	8	24	5	15
Low number of assembly steps	3	5	15	5	15	8	24	3	9	3	9	8	24	6	18
Total Score			578		594		585		484		510		556		587
Rank			4		1		3		7		6		5		2

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Screening and evaluation – 2. Customer screen

- Screening continues with **customer screening**
- An informal discussion with **customers** to explain a concept
- This is a difficult stage - a **prototype** is a useful discussion and explanation tool, especially where customers are **non-technical** or are just **end-users**

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Screening and evaluation - 3. Technical screen

Technical screen, technical testing can range from

- informal technical **discussions** with experts, to
- extensive **analysis** by a 3rd party, i.e. an independent consultant to give a non-biased view that would consider the external environment and state of the art

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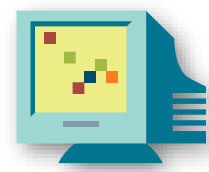
Screening and evaluation - 4. Final screen

- Involves the use of screening models and computer assessment programs
- Weightings given, scoring etc. done at this stage
  - (*further development of that undertaken at stage 1 of screening*)



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Screening and evaluation - 5. Business analysis

- May involve construction of
  - preliminary **marketing** plans,
  - **technical** plans,
  - **financial** reviews and
  - projected **budgets**
- Potentially **new problems** are identified at this stage, but this is beneficial as it avoids unnecessary investment

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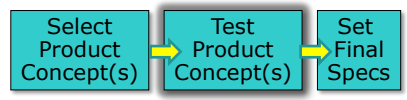
Phase 1 – Concept Development - **Concept testing**

- One or more concepts are then **tested** to
  - verify that the **customer needs** have been met
  - assess the **market potential** of the product and any **shortcomings** that need further development
- If customer response is **poor**, then the project may be **terminated,** or some earlier activities **repeated**



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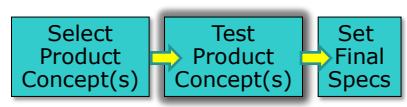
Phase 1 – Concept Development - **Concept testing**

There are 7 steps to this process

1. **Define the purpose of the concept test**
2. Choose a survey population
3. Choose a survey format
4. Communicate the concept
5. Measure customer response
6. Interpret the results
7. Reflect on the results and process

For example:
- Which concepts should we take further?
- How can the concept better meet customer needs?
- How many are likely to be sold?



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Phase 1 – Concept Development - **Concept testing**

There are 7 steps to this process

1. Define the purpose of the concept test
2. **Choose a survey population**
3. Choose a survey format
4. Communicate the concept
5. Measure customer response
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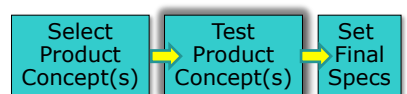
- Choose a survey population that reflects the target market(s)
- Ensure that the survey sample size is right



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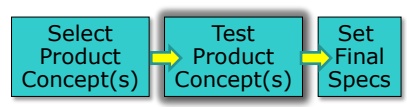
For example:
- Face-to-face
- Phone
- Mail
- E-mail
- Internet

But be aware that each of these gives some sample bias



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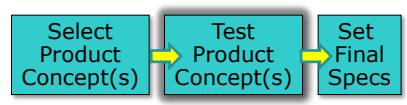
For example:
- Verbal description
- Drawing/photo
- Video
- Simulation
- Prototype



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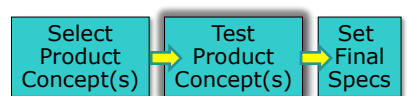
For example, on purchase intent:
- Definitely would buy
- Probably would buy
- Might or might not buy
- Probably would not buy
- Definitely would not buy



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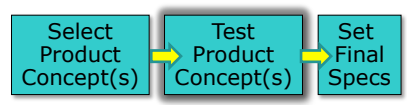
For example:
- Likely demand for product in first year



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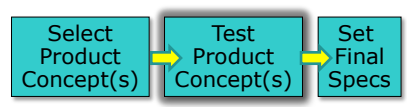

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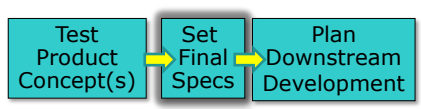
Phase 1 – Concept Development - **Setting final specifications**

- Target **specifications** are **revisited** after a concept has been selected and tested
- The team must commit to specific values of the **metrics** reflecting
  - the **constraints inherent** in the product concept
  - **limitations** identified through technical **modelling** and
  - **trade-offs** between cost and performance



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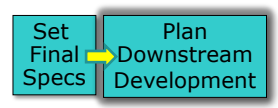
Phase 1 – Concept Development – **Project planning**

- The **final activity** of concept development
- The team
  - creates a detailed development **schedule**
  - devises a strategy to **minimise** development time and
  - identifies the **resources** required to complete the project



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Phase 1 – Concept Development - **Contract book**

- The Contract book – contains
  - Mission statement
  - Customer needs
  - Details of the selected concept
  - The product specifications
  - The economic analysis of the product
  - The development schedule
  - The project staffing
  - The budget

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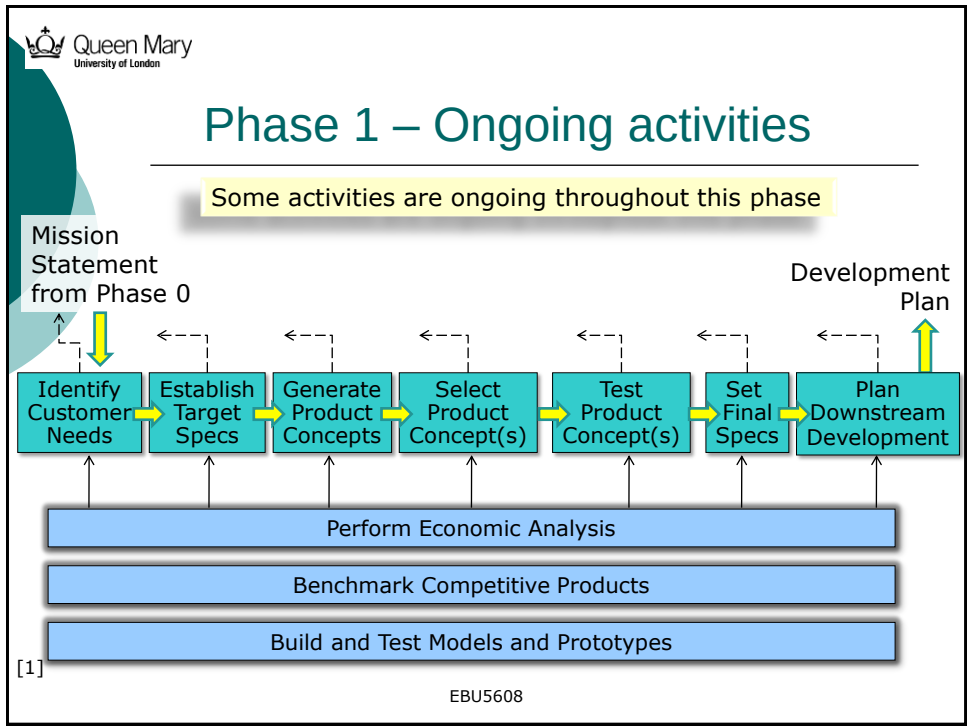
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Phase 1 – Ongoing activities
Some activities are ongoing throughout this phase
Mission Statement from Phase 0
Development Plan
Identify Customer Needs
Establish Target Specs
Generate Product Concepts
Select Product Concept(s)
Test Product Concept(s)
Set Final Specs
Plan Downstream Development
Perform Economic Analysis
Benchmark Competitive Products
Build and Test Models and Prototypes
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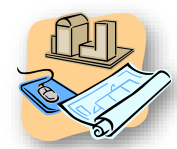
Phase 1 – Concept Development - **Economic analysis**

- This **model** is used to
  - justify **continuation** of the overall development programme and
  - resolve specific **trade-offs** among **development** costs and **manufacturing** costs
- This is one of the **ongoing** activities in the concept development phase
- The initial economic analysis is done **before** the project commences
- It is **updated** as new information becomes available

Phase 1 – Concept Development – **Benchmarking & modelling**

- **Benchmarking** of competitive products
  - An understanding of **competitive** products
  - Can be a rich source of **ideas** for the product and production process design
- **Modelling** and **prototyping**
  - Every stage of **development** process involves various forms of models and prototypes



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Reading

- **Core Textbook** (Ulrich & Eppinger, 7th Edition)
  - Chapter 6. Product Specifications
    pages 95 – 119
  - Chapter 7. Concept Generation
    pages 121 – 147
  - Chapter 8. Concept Selection
    pages 149 – 169
  - Chapter 9. Concept Testing
    pages 171 – 187