UNIVERSITÀ
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Concept generation

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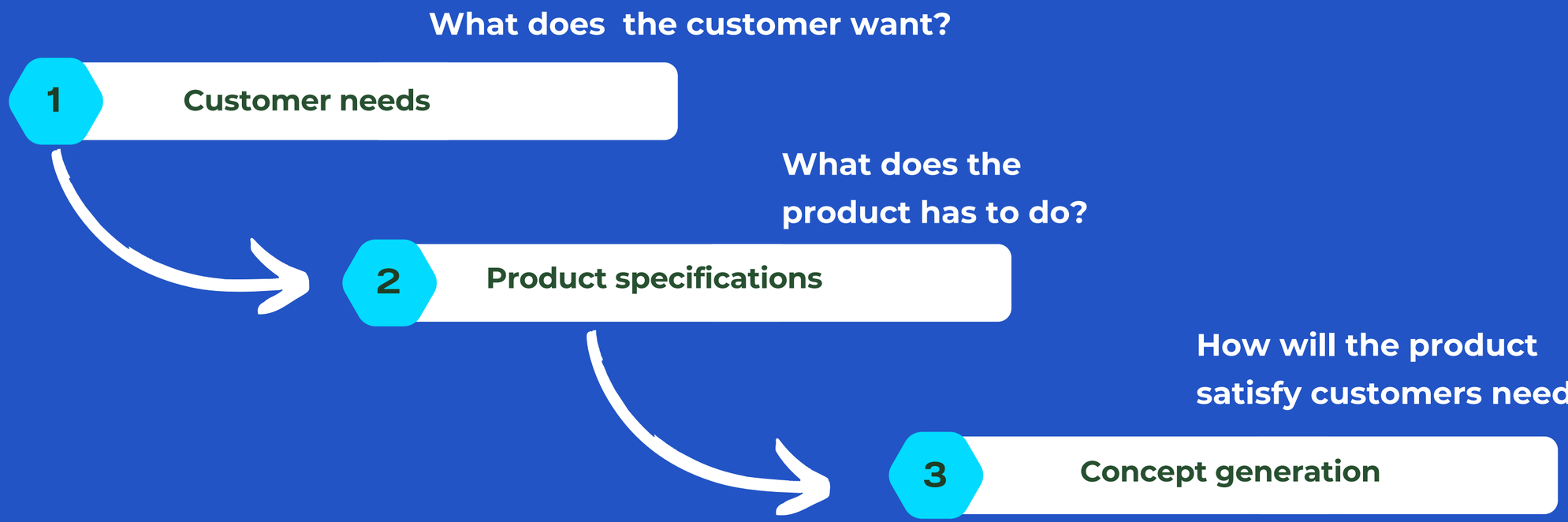
Introduction

Have you ever had the idea of creating a product ?

Where would you start from ?

- Production
- Research
- Design

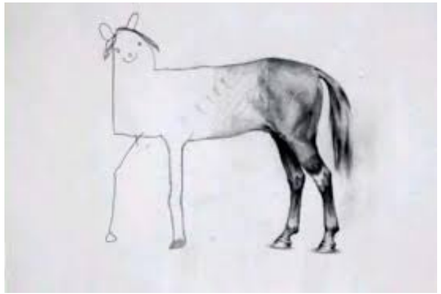
Introduction



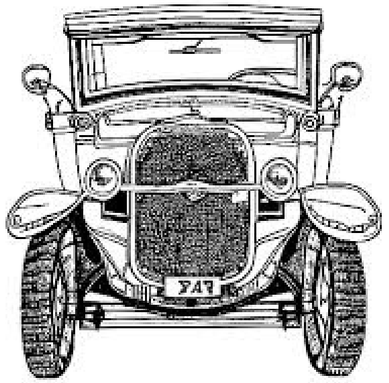
The concept generation process begins with a set of customer needs and target specifications and is the stage where the customer's needs are translated into form of the final product.

Customer needs

- It expresses what customers want or need from a product/service.
- It uses the "customer's language."
- It is often subjective and generic, providing an initial indication of the requirements, subjective interpretation.



“If I had asked my customers what they wanted, they would have said: a faster horse.”
Cit. HENRY FORD



Customer needs

Courtesy of Specialized Bicycle Components

EXHIBIT 6-1
One of Specialized's existing mountain bikes with a suspension fork.

EXHIBIT 6-2
Customer needs for the suspension fork and their relative importance (shown in a convenient spreadsheet format).

No.		Need	Imp.
1	The suspension	reduces vibration to the hands.	3
2	The suspension	allows easy traversal of slow, difficult terrain.	2
3	The suspension	enables high-speed descents on bumpy trails.	5
4	The suspension	allows sensitivity adjustment.	3
5	The suspension	preserves the steering characteristics of the bike.	4
6	The suspension	remains rigid during hard cornering.	4
7	The suspension	is lightweight.	4
8	The suspension	provides stiff mounting points for the brakes.	2
9	The suspension	fits a wide variety of bikes, wheels, and tires.	5
10	The suspension	is easy to install.	1
11	The suspension	works with fenders.	1
12	The suspension	instills pride.	5
13	The suspension	is affordable for an amateur enthusiast.	5
14	The suspension	is not contaminated by water.	5
15	The suspension	is not contaminated by grunge.	5
16	The suspension	can be easily accessed for maintenance.	3
17	The suspension	allows easy replacement of worn parts.	1
18	The suspension	can be maintained with readily available tools.	3
19	The suspension	lasts a long time.	5
20	The suspension	is safe in a crash.	5

Product specification

Product specifications

01

WHAT ARE SPECIFICATIONS

02

WHEN SPECIFICATIONS ARE ESTABLISHED

03

TARGET SPECIFICATIONS

04

FINAL SPECIFICATIONS

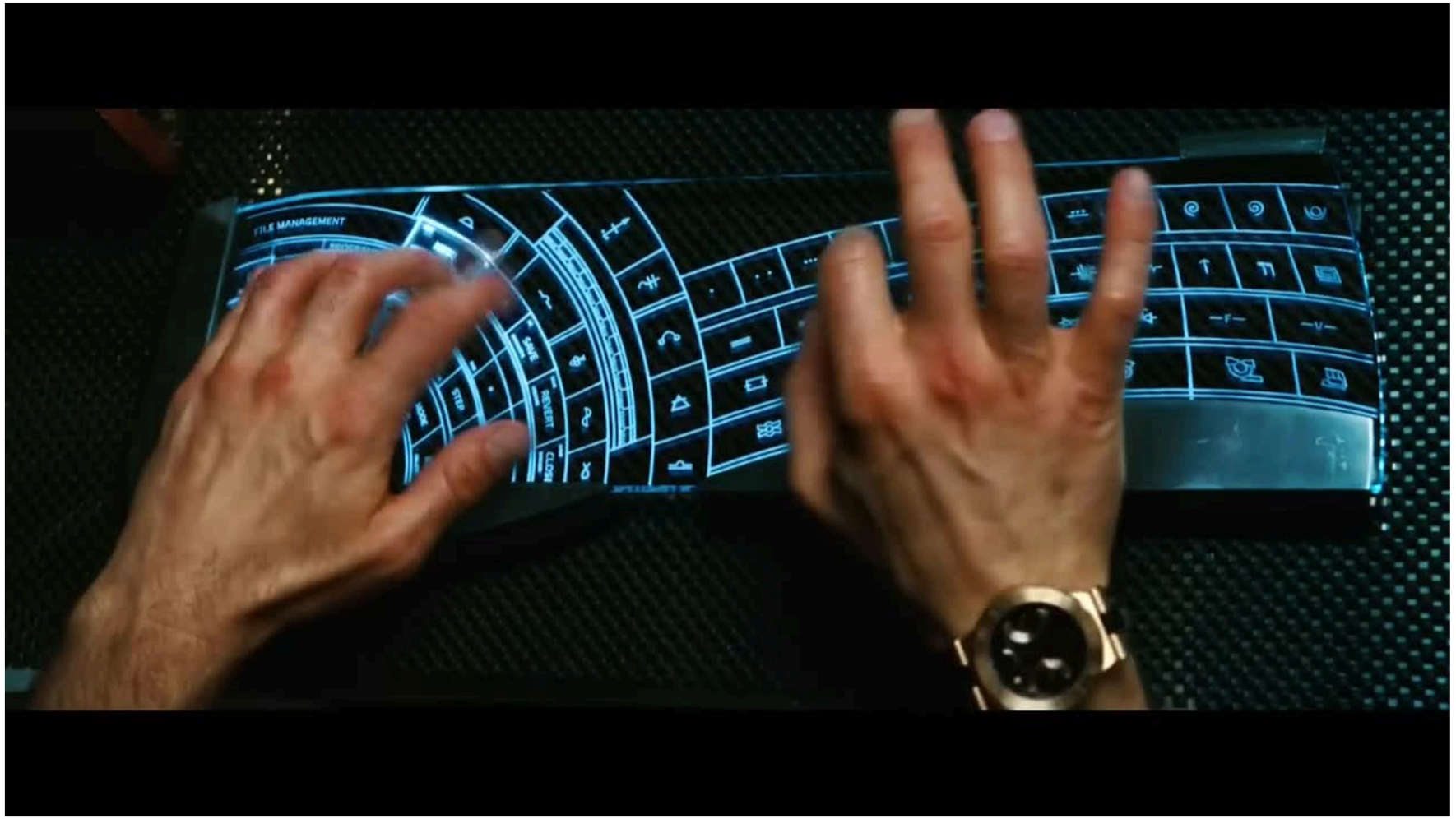
What are product specifications?

Product specifications are the collection of individual details that provide a precise description of what the product is required to do.

No.	Metric	Unit	Value
1	Attenuation from dropout to handlebar at 10 Hz	dB>	12
2	Spring preload	N	600–650
3	Maximum value from the Monster	g	<3.4

A specification consists of a metric and a value.
Example: "Average time to assemble a bike" is a metric, while "less than 75 sec" is its value.
Values are labeled with appropriate units and can be expressed as numbers, ranges, or features.

The complete set of individual specifications forms the product specifications.

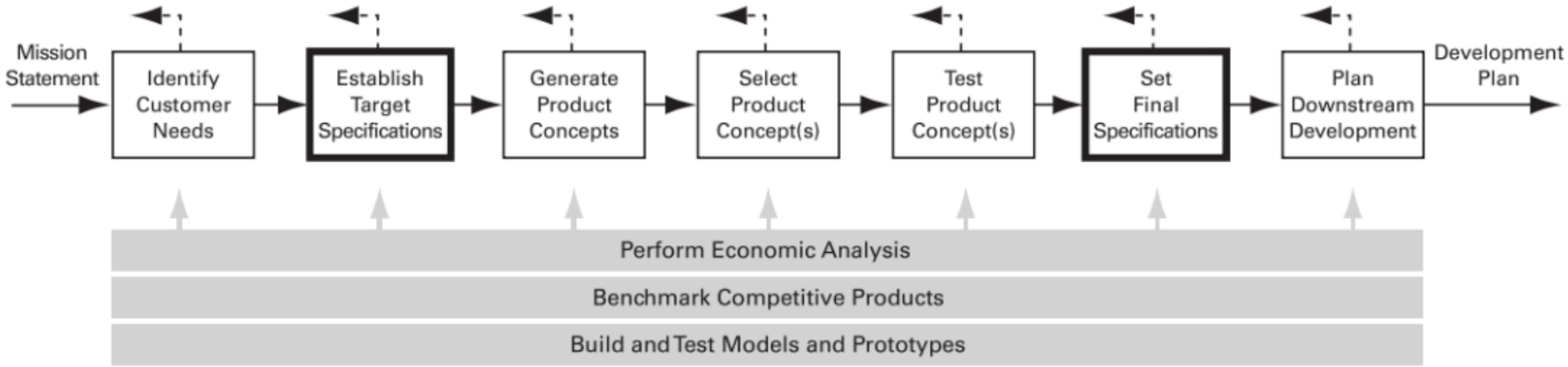


"We need a solution that can fly at high speeds" (metric: speed, value: a specific number).
"It’s important that it withstands attacks, such as gunshots" (metric: impact resistance, value: a certain level of force, penetration strength of the armor).
"We’re looking for a system that can provide life support for long durations" (metric: life support autonomy, value: a specific duration).

When are product specifications defined?

For **simple products**, specifications are set once and followed exactly.

For **technology-intensive products**, specifications are defined at least twice: first as target specifications based on customer needs, then adjusted later based on technological constraints (final specifications).



Target specification

SPECIFICATIONS ARE ESTABLISHED AFTER CUSTOMER NEED HAVE BEEN IDENTIFIED BUT BEFORE PRODUCT COCEPTS HAVE BEEN GENERATED AND THE MOST PROMISNG ONE(S) SELECTED.

PREPARE THE LIST OF METRICS

COLLECT COMPETITIVE BENCHMARKING INFO

SET IDEAL AND MARGINALLY ACCEPTABLE TARGET VALUES

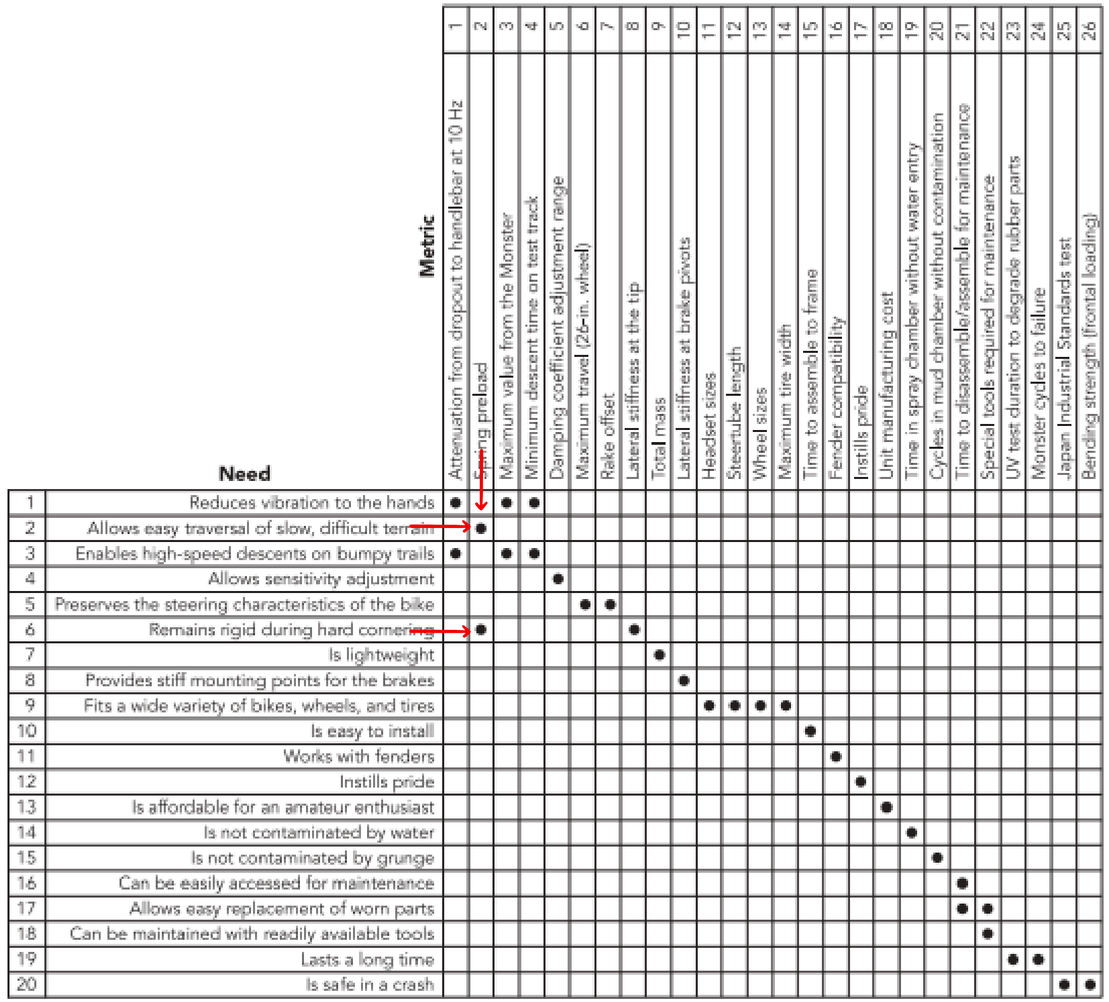
REFLECT ON THE RESULTS AND THE PROCESS

Step 1: list of metrics

The **Needs-Metrics Matrix** shows the relationship between customer needs and product metrics.

A mark in a cell indicates a connection between a specific need and a metric.

It is a key component of the **House of Quality,** a graphical tool used in Quality Function Deployment (QFD).



	Need	Metric	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
			Attenuation from dropout to handlebar at 10 Hz	Spring preload	Maximum value from the Monster	Minimum descent time on test track	Damping coefficient adjustment range	Maximum travel (26-in. wheel)	Rake offset	Lateral stiffness at the tip	Total mass	Lateral stiffness at brake pivots	Headset sizes	Steertube length	Wheel sizes	Maximum tire width	Time to assemble to frame	Fender compatibility	Instills pride	Unit manufacturing cost	Time in spray chamber without water entry	Cycles in mud chamber without contamination	Time to disassemble/assemble for maintenance	Special tools required for maintenance	UV test duration to degrade rubber parts	Monster cycles to failure	Japan Industrial Standards test	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																										●	●

EXHIBIT 6-5 The needs-metrics matrix.

Step 1: list of metrics

The most effective metrics directly measure **how well the product meets customer needs**. To develop them, each need should be analyzed individually to determine specific, measurable product characteristics that reflect satisfaction.

Guidelines for Creating Metrics:
1) Include common comparison criteria to ensure relevance and usability.
2) Ensure measurability so performance can be objectively assessed.
3) Align with customer needs to maintain a user-focused approach.

Metric No.	Need Nos.	Metric	Imp.	Units
1	1, 3	Attenuation from dropout to handlebar at 10 Hz	3	dB
2	2, 6	Spring preload	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 (26-in. 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 without water entry	5	s
20	15	Cycles in mud chamber without 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	hr
24	19	Monster cycles to failure	5	Cycles
25	20	Japan Industrial Standards test	5	Binary
26	20	Bending strength (frontal loading)	5	kN

EXHIBIT 6-4 List of metrics for the suspension. The relative importance of each metric and the units for the metric are also shown. "Subj." is an abbreviation indicating that a metric is subjective.

Step 2: collection of competitive benchmarking informations

Collecting data on competitors is crucial for positioning decisions.

The result is a competitive benchmarking chart, which can be added to the metrics spreadsheet.

Though time-consuming, this process is essential for informed decision-making.

Metric No.	Need Nos.	Metric	Imp.	Units	ST Tritrack	Maniray 2	Rox Tahx Quadra	Rox Tahx Ti 21	Tonka Pro	Gunhill Head Shox
1	1, 3	Attenuation from dropout to handlebar at 10 Hz	3	dB	8	15	10	15	9	13
2	2, 6	Spring preload	3	N	550	760	500	710	480	680
3	1, 3	Maximum value from the Monster	5	g	3.6	3.2	3.7	3.3	3.7	3.4
4	1, 3	Minimum descent time on test track	5	s	13	11.3	12.6	11.2	13.2	11
5	4	Damping coefficient adjustment range	3	N-s/m	0	0	0	200	0	0
6	5	Maximum travel (26-in. wheel)	3	mm	28	48	43	46	33	38
7	5	Rake offset	3	mm	41.5	39	38	38	43.2	39
8	6	Lateral stiffness at the tip	3	kN/m	59	110	85	85	65	130
9	7	Total mass	4	kg	1.409	1.385	1.409	1.364	1.222	1.100
10	8	Lateral stiffness at brake pivots	2	kN/m	295	550	425	425	325	650
11	9	Headset sizes	5	in.	1.000 1.125	1.000 1.125 1.250	1.000 1.125	1.000 1.125 1.250	1.000 1.125	NA
12	9	Steertube length	5	mm	150 180 210 230 255	140 165 190 215	150 170 190 210	150 170 190 210 230	150 190 210 220	NA
13	9	Wheel sizes	5	List	26 in.	26 in.	26 in.	26 in. 700C	26 in.	26 in.

EXHIBIT 6-6 Competitive benchmarking chart based on metrics.

Columns = competitive products
Rows = metrics established in STEP 1.

Step 2: collection of competitive benchmarking informations

Columns = competitive products
Rows = metrics established in STEP 1.

Perceived satisfaction based.

The importance of a metric is based on the importance of the needs it represents. If a metric is tied to one need, it inherits that need's importance rating. If it relates to multiple needs, its importance is determined by evaluating the significance of those needs and their **relationships**, which is best done through team discussion rather than a strict formula.

When there are few specifications and their relative importance is crucial, **conjoint analysis** can be a helpful method.

No.	Need	Imp.	ST Tritrack	Maniray 2	Rox Tahx Quadra	Rox Tahx Ti 21	Tonka Pro	Gunhill Head Shox
1	Reduces vibration to the hands	3	•	••••	••	•••••	••	•••
2	Allows easy traversal of slow, difficult terrain	2	••	••••	•••	•••••	•••	•••••
3	Enables high-speed descents on bumpy trails	5	•	•••••	••	•••••	••	•••
4	Allows sensitivity adjustment	3	•	••••	••	•••••	••	•••
5	Preserves the steering characteristics of the bike	4	••••	••	•	••	•••••	•••••
6	Remains rigid during hard cornering	4	•	•••	•	•••••	•	•••••
7	Is lightweight	4	•	•••	•	•••	••••	•••••
8	Provides stiff mounting points for the brakes	2	•	••••	•••	•••	•••••	••
9	Fits a wide variety of bikes, wheels, and tires	5	••••	•••••	•••	•••••	•••	•
10	Is easy to install	1	••••	•••••	••••	••••	•••••	•
11	Works with fenders	1	•••	•	•	•	•	•••••
12	Instills pride	5	•	••••	•••	•••••	•••	•••••
13	Is affordable for an amateur enthusiast	5	•••••	•	•••	•	•••	••
14	Is not contaminated by water	5	•	•••	••••	••••	••	•••••
15	Is not contaminated by grunge	5	•	•••	•	••••	••	•••••
16	Can be easily accessed for maintenance	3	••••	•••••	••••	••••	•••••	•
17	Allows easy replacement of worn parts	1	••••	•••••	••••	••••	•••••	•
18	Can be maintained with readily available tools	3	•••••	•••••	•••••	•••••	••	•
19	Lasts a long time	5	•••••	•••••	•••••	•••	•••••	•
20	Is safe in a crash	5	•••••	•••••	•••••	•••••	•••••	•••••

EXHIBIT 6-7 Competitive benchmarking chart based on perceived satisfaction of needs. (Scoring more "dots" corresponds to greater perceived satisfaction of the need.)

Step 3: definition of the target value

- **Ideal value**: the best possible result the team could hope for.
- **Marginally acceptable value**: the minimum value that still makes the product commercially viable.

There are five ways to express these target values:

1. **At least X:** sets a lower bound; higher values are better.
2. **At most X:** sets an upper bound; smaller values are better.
3. **Between X and Y:** sets both lower and upper limits.
4. **Exactly X:** specifies one precise value (usually avoided as it's too restrictive).
5. **A set of discrete values:** limits the value to a predefined set of options.

Metric No.	Need Nos.	Metric	Imp.	Units	Marginal Value	Ideal Value
1	1, 3	Attenuation from dropout to handlebar at 10 Hz	3	dB	>10	>15
2	2, 6	Spring preload	3	N	480–800	650–700
3	1, 3	Maximum value from the Monster	5	g	<3.5	<3.2
4	1, 3	Minimum descent time on test track	5	s	<13.0	<11.0
5	4	Damping coefficient adjustment range	3	N-s/m	0	>200
6	5	Maximum travel (26-in. wheel)	3	mm	33–50	45
7	5	Rake offset	3	mm	37–45	38
8	6	Lateral stiffness at the tip	3	kN/m	>65	>130
9	7	Total mass	4	kg	<1.4	<1.1
10	8	Lateral stiffness at brake pivots	2	kN/m	>325	>650
11	9	Headset sizes	5	in.	1.000 1.125	1.000 1.125 1.250
12	9	Steertube length	5	mm	150 170 190 210	150 170 190 210 230
13	9	Wheel sizes	5	List	26 in.	26 in. 700C
14	9	Maximum tire width	5	in.	>1.5	>1.75
15	10	Time to assemble to frame	1	s	<60	<35
16	11	Fender compatibility	1	List	None	All
17	12	Instills pride	5	Subj.	>3	>5
18	13	Unit manufacturing cost	5	US$	<85	<65
19	14	Time in spray chamber without water entry	5	s	>2300	>3600
20	15	Cycles in mud chamber without contamination	5	k-cycles	>15	>35
21	16, 17	Time to disassemble/assemble for maintenance	3	s	<300	<160
22	17, 18	Special tools required for maintenance	3	List	Hex	Hex
23	19	UV test duration to degrade rubber parts	5	hr	>250	>450
24	19	Monster cycles to failure	5	Cycles	>300k	>500k
25	20	Japan Industrial Standards test	5	Binary	Pass	Pass
26	20	Bending strength (frontal loading)	5	kN	>7.0	>10.0

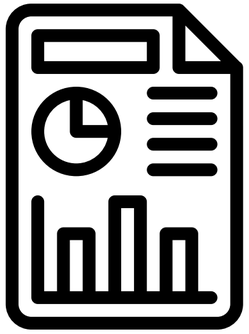
EXHIBIT 6-8 The target specifications. Like the other information systems, this one is easily encoded with a spreadsheet as a simple extension to the list of specifications.

Step 4: reflect on the result and the process

The team may require some iteration to agree on the targets. **Reflection** after each iteration helps to ensure that the results are consistent with the goals of the project.

Questions to consider include:

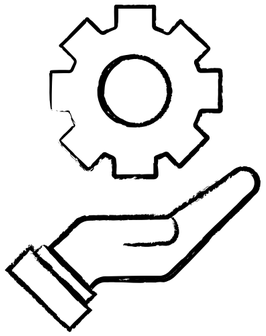
- **Are team members pushing unrealistic targets to drive higher performance?**
- **Should the team offer multiple product options to serve different market segments, or is one version sufficient?**
- **Are all critical specifications included, and do they ensure commercial success?**



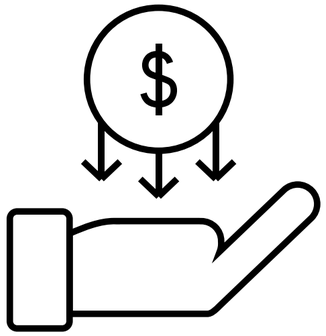
Set final specifications

Initial broad specifications must be refined now into more precise ones, involving production constranints. This step is complicated by inherent trade-offs, releted **technical and cost issues**.

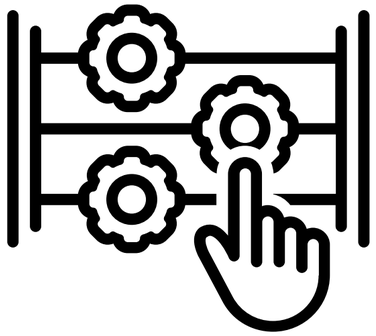
The process of setting final specifications is composed of **5 different steps**:



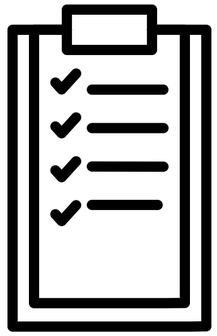
Develop technical models



Develop cost model



Refine specifications



Flow down specifications

Reflect on the results and process

Technical models

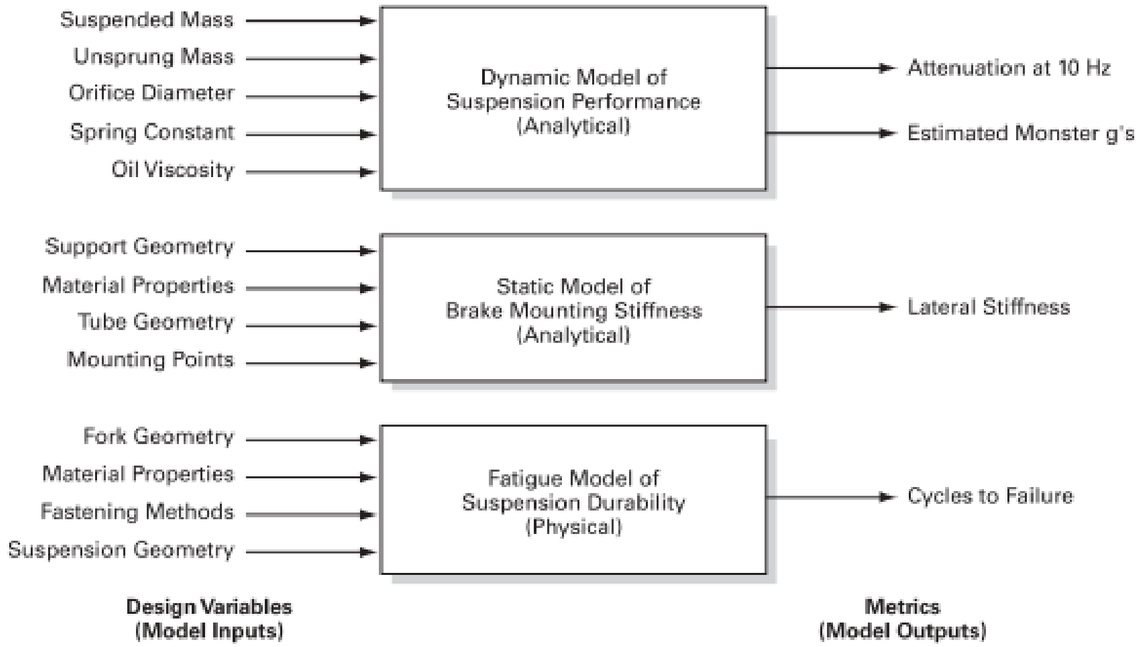


EXHIBIT 6-9 Models used to assess technical feasibility. Technical models may be analytical or physical approximations of the product concept.

A **technical model** helps predict metric values based on design choices, avoiding costly physical tests.

Cost model

The goal is to ensure the product can be manufactured within the **target cost**.

The team makes a rough **cost estimate** for assembly and production.

Purchasing experts and production engineers assist in this process.

The **bill of materials (BOM)** acts as a cost prediction tool, using past experience and supplier insights.

Step number 3, 4 and 5 will be done during the class in the next lessons

Component	Qty/ Fork	High ($ ea.)	Low ($ ea.)	High Total ($/fork)	Low Total ($/fork)
Steertube	1	2.50	2.00	2.50	2.00
Crown	1	4.00	3.00	4.00	3.00
Boot	2	1.00	0.75	2.00	1.50
Lower tube	2	3.00	2.00	6.00	4.00
Lower tube top cover	2	2.00	1.50	4.00	3.00
Main lip seal	2	1.50	1.40	3.00	2.80
Slide bushing	4	0.20	0.18	0.80	0.72
Slide bushing spacer	2	0.50	0.40	1.00	0.80
Lower tube plug	2	0.50	0.35	1.00	0.70
Upper tube	2	5.50	4.00	11.00	8.00
Upper tube top cap	2	3.00	2.50	6.00	5.00
Upper tube adjustment knob	2	2.00	1.75	4.00	3.50
Adjustment shaft	2	4.00	3.00	8.00	6.00
Spring	2	3.00	2.50	6.00	5.00
Upper tube orifice cap	1	3.00	2.25	3.00	2.25
Orifice springs	4	0.50	0.40	2.00	1.60
Brake studs	2	0.40	0.35	0.80	0.70
Brake brace bolt	2	0.25	0.20	0.50	0.40
Brake brace	1	5.00	3.50	5.00	3.50
Oil (liters)	0.1	2.50	2.00	0.25	0.20
Misc. snap rings, o-rings	10	0.15	0.10	1.50	1.00
Decals	4	0.25	0.15	1.00	0.60
Assembly at $20/hr		30 min	20 min	10.00	6.67
Overhead at 25% of direct cost				20.84	15.74
Total				$104.19	$78.68

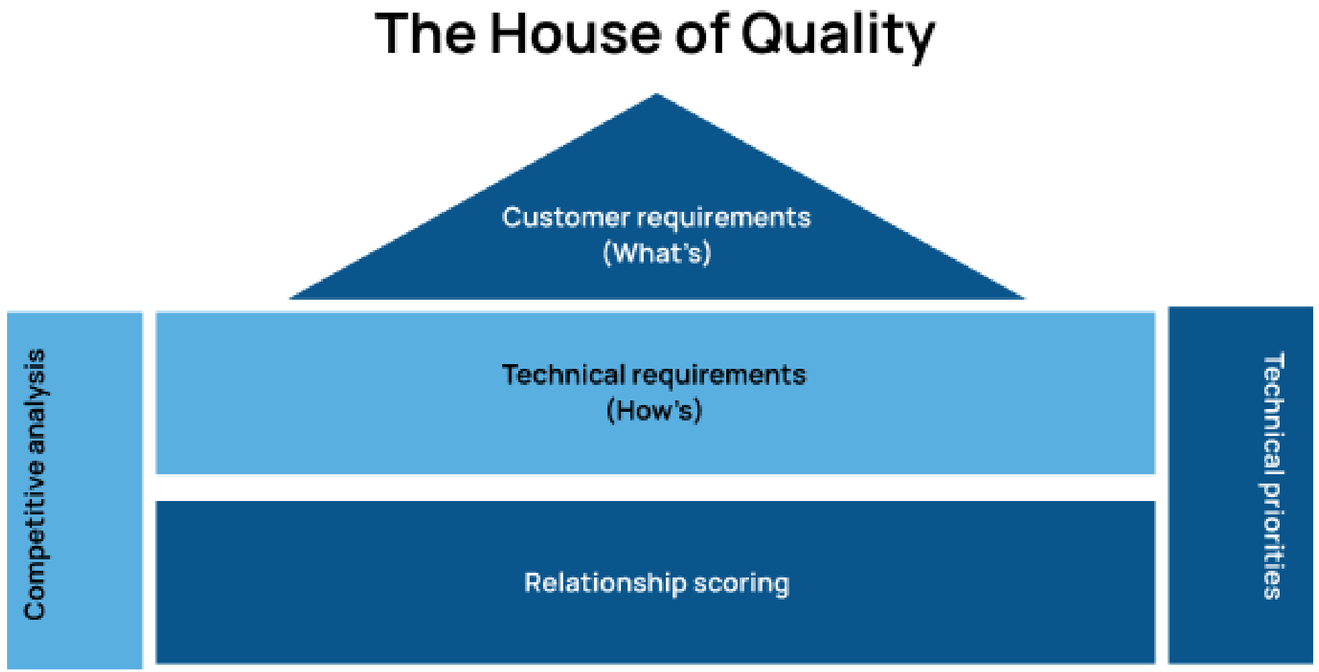
EXHIBIT 6-10 A bill of materials with cost estimates. This simple cost model allows early cost estimates to facilitate realistic trade-offs in the product specifications.


DISPLAY

House of quality

House of quality

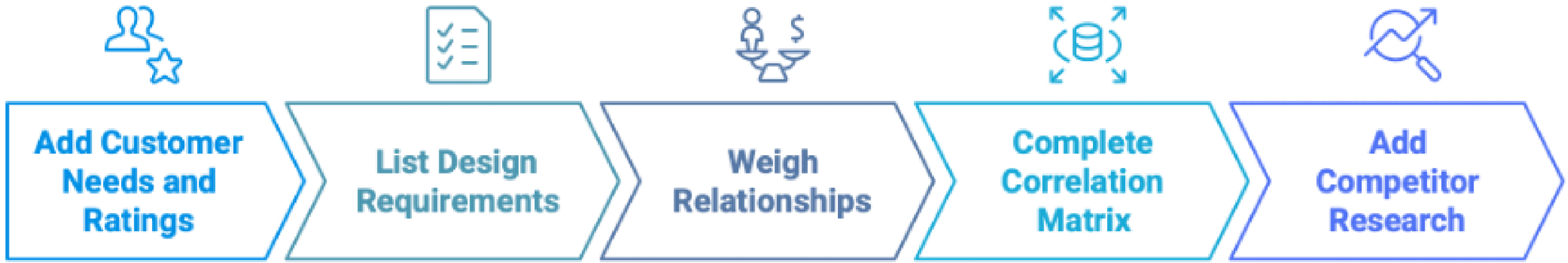
It is a fundamental design tool of Quality Function Deployment (QFD), originally developed in Japan over the years. It is a matrix that connects Customer Attributes (CAs) with Engineering Characteristics (ECs).



House of quality: Principle

The foundation of the house of quality is the belief that products should be designed to reflect customers' desires and tastes–so marketing people, design engineers, and manufacturing staff must work closely together from the time a product is first conceived

Building the HOQ



1. Add customer needs and ratings

Identify and list the customer needs on the left side of Matrix. These should be clearly expressed from the customer's perspective.

Determine the relative importance of each customer need using market research data and enter it in an adjacent column. Use an appropriate rating scale to quantify the importance.

Customer Need	**Rating** (1 to 5)	**Percentage (%)**
Compact and easy to carry device	4	11
Lightweight device	5	14
Simple and easy-to-use device	4	11
Functioning without unexpected issues	5	14
The phone is cost-effective	3	8
Clear visibility of text and images	5	14
Sufficient battery life between charges	5	14
Sharp photos and videos	5	14

What are the customer needs in Iron Man?

ANSWER

- **Survival** in hostile environments and dangerous situations. This translates into the **need for physical protection against various threats**.

- **Self-defense and offensive capabilities.** The armor must provide systems to actively counter threats.

- **Mobility and escape capabilities.** The need to "stay alive" requires the **ability for rapid movement, including flight.**

- **Life support** to ensure survival in specific situations.

2. Product specifications

Once the customer's needs are understood, the team must identify measurable and specific ‘engineering characteristics’ that can influence the perception of the customer's attributes. These are expressed in the company's technical language

These characteristics are listed at the top of the matrix, forming the ‘head’ of the house

Camera resolution (megapixels) and video quality (4K fps)
Battery life (hours)
Screen resolution (pixels) and brightness (nits)
Production cost (euro)
Failure rate (percentage)
Taps per task (number)
Device weight (g)
Dimensions (cm)


APL

What are the product specifications in Iron Man?

ANSWER

- **Impact Resistance:**
  - Metric: Level of force or type of impact resisted.
  - Value: A certain number of Newtons, resistance to projectiles of a certain caliber, etc. (as suggested by "It must withstand certain types of attack").
- **Flight Speed:**
  - Metric: Maximum speed.
  - Value: A certain number of Mach or kilometers per hour (as suggested by "It must fly at a certain speed").
- **Life Support Duration:**
  - Metric: Duration of life support.
  - Value: A certain number of hours or minutes (as suggested by "It must provide life support for a certain period").
- **Offensive Power:**
  - Metric: Type and power of integrated weapons.
  - Value: Description of weapons (e.g., repulsor rays with a certain firepower), number of ammunition, etc. (deduced from the need for "self-defense and offense").

3. Building the Relationship Matrix

This matrix is located in the centre of the house and shows the relationship between customer attributes and engineering characteristics

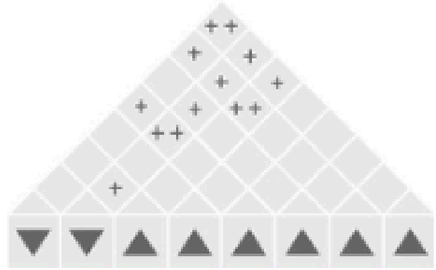
A linear scale (e.g. 1, 2, 3) would make it more difficult to distinguish between an important and a moderate relationship. Using large jumps between values helps teams to make clearer choices.

			Dimensions (cm)	Device weight (g)	Taps per task (number)	Failure rate (percentage)	Production cost (euro)	Screen resolution (pixels) and brightness (nits)	Battery life (hours)	Camera resolution (megapixels) and video quality (4K fps)
Compact and easy to carry device	4	11	9	9	1	0	1	1	0	0
Lightweight device	5	14	3	0	0	0	0	0	0	3
Simple and easy-to-use device	4	11	0	3	0	9	1	0	0	0
Functioning without unexpected issues	5	14	0	9	9	3	3	1	3	0
The phone is cost-effective	3	8	1	9	9	3	9	3	3	3
Clear visibility of text and images	5	14	1	1	1	3	0	9	0	0
Sufficient battery life between charges	5	14	1	3	9	9	3	0	9	0
Sharp photos and videos	5	14	0	9	0	3	9	3	0	9

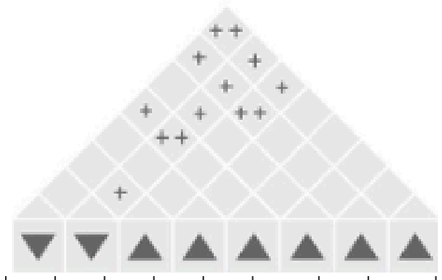
4. Complete the Correlation Matrix

It shows the correlation between different engineering characteristics. The team assesses whether the improvement of one engineering characteristic has a positive, negative or no impact on the other engineering characteristics.

These correlations are important for identifying potential trade-offs or synergies between different engineering choices.



			Dimensions (cm)	Device weight (g)	Taps per task (number)	Failure rate (percentage)	Production cost (euro)	Screen resolution (pixels) and brightness (nits)	Battery life (hours)	Camera resolution (megapixels) and video quality (4K fps)
Compact and easy to carry device	4	11	9	9	1	0	1	1	0	0
Lightweight device	5	14	3	0	0	0	0	0	0	3
Simple and easy-to-use device	4	11	0	3	0	9	1	0	0	0
Functioning without unexpected issues	5	14	0	9	9	3	3	1	3	0
The phone is cost-effective	3	8	1	9	9	3	9	3	3	3
Clear visibility of text and images	5	14	1	1	1	3	0	9	0	0
Sufficient battery life between charges	5	14	1	3	9	9	3	0	9	0
Sharp photos and videos	5	14	0	9	0	3	9	3	0	9



5. Add competitor research

			Dimensions (cm)	Device weight (g)	Taps per task (number)	Failure rate (percentage)	Production cost (euro)	Screen resolution (pixels) and brightness (nits)	Battery life (hours)	Camera resolution (megapixels) and video quality (4K fps)	Tristell	Vital	Stub Plus	Story phone
Compact and easy to carry device	4	11	9	9	1	0	1	1	0	0	3	2	1	5
Lightweight device	5	14	3	0	0	0	0	0	0	3	2	2	1	4
Simple and easy-to-use device	4	11	0	3	0	9	1	0	0	0	5	2	3	2
Functioning without unexpected issues	5	14	0	9	9	3	3	1	3	0	2	3	5	1
The phone is cost-effective	3	8	1	9	9	3	9	3	3	3	2	5	4	3
Clear visibility of text and images	5	14	1	1	1	3	0	9	0	0	1	1	3	1
Sufficient battery life between charges	5	14	1	3	9	9	3	0	9	0	2	5	3	3
Sharp photos and videos	5	14	0	9	0	3	9	3	0	9	5	2	2	4

We compare customer perceptions of the company's products and those of its competitors against the customer attributes identified in the first step

6. Developing objectives for engineering features

			Dimensions (cm)	Device weight (g)	Taps per task (number)	Failure rate (percentage)	Production cost (euro)	Screen resolution (pixels) and brightness (nits)	Battery life (hours)	Camera resolution (megapixels) and video quality (4K fps)	Tristell	Vital	Stub Plus	Story phone
Compact and easy to carry device	4	11	9	9	1	0	1	1	0	0	3	2	1	5
Lightweight device	5	14	3	0	0	0	0	0	0	3	2	2	1	4
Simple and easy-to-use device	4	11	0	3	0	9	1	0	0	0	5	2	3	2
Functioning without unexpected issues	5	14	0	9	9	3	3	1	3	0	2	3	5	1
The phone is cost-effective	3	8	1	9	9	3	9	3	3	3	2	5	4	3
Clear visibility of text and images	5	14	1	1	1	3	0	9	0	0	1	1	3	1
Sufficient battery life between charges	5	14	1	3	9	9	3	0	9	0	2	5	3	3
Sharp photos and videos	5	14	0	9	0	3	9	3	0	9	5	2	2	4
Rating			76	133	132	99	110	78	69	69				
Percentage of importance			10%	17%	17%	13%	15%	10%	9%	9%				

Based on an understanding of customer requirements, the relationships between customer requirements and engineering features, competitive evaluation and the relationships between engineering features, measurable objectives are set for each engineering feature. These objectives will guide the product design and development process.

Case study

Innovation at Timberland: thinking outside the shoe box

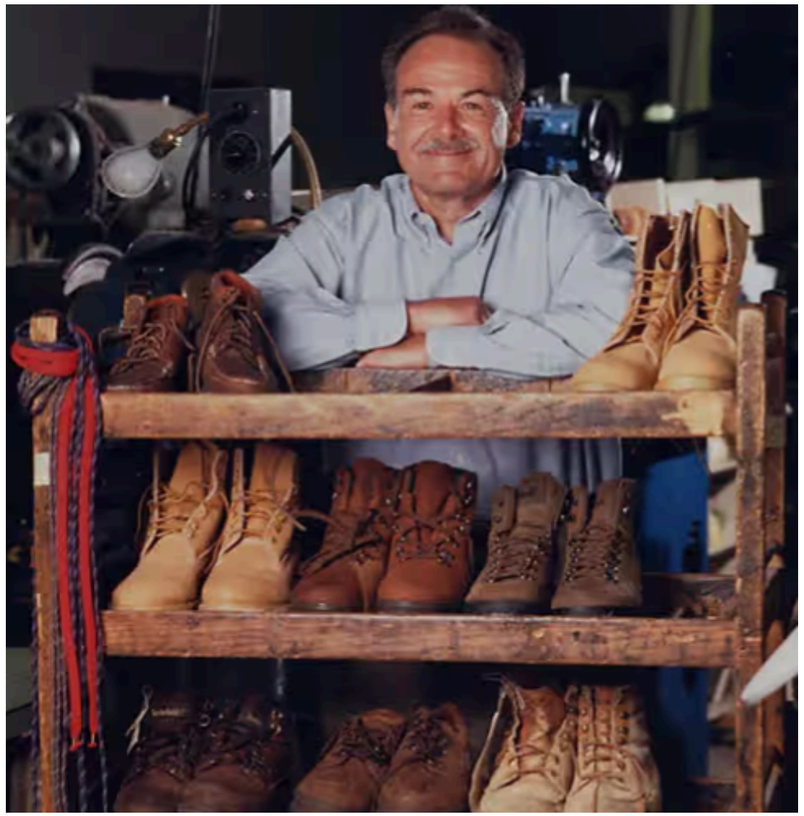
A study case from Harvard business school.

The beginnings of Timberland

In 1918, Nathan Swartz, the son of a cobbler (calzolaio) who emigrated from Odessa, Ukraine, due to the impending war, began his career in Boston, Massachusetts, as an stitching trainee.

In 1952, Swartz purchased half of the Abington Shoe Company. By 1955, he acquired the remaining share of the company

In 1973, the Timberland brand was created to identify the waterproof leather shoes produced by the company. In 1976, the first major advertising campaign was launched.



Timberland - 3 big ideas

Workboots

Boat shoes

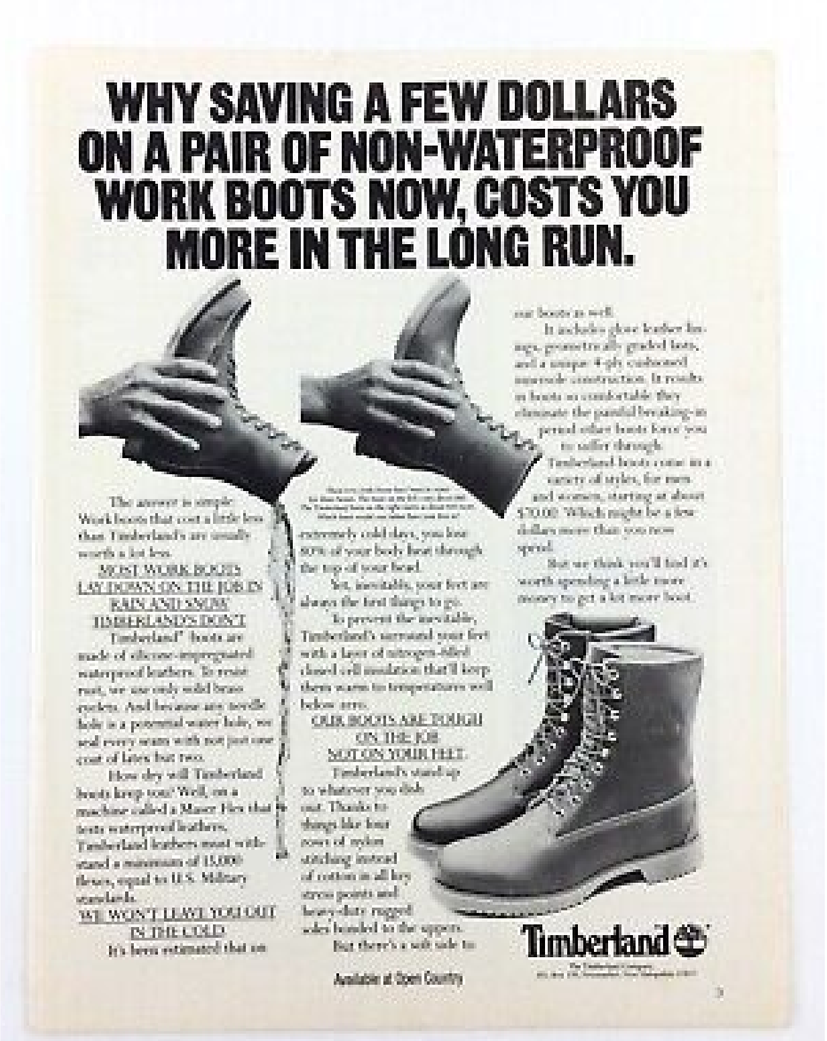
Hiking boots

Workboots

Until 1960s, work boots didn’t have proper waterproofing and insulation. Also durability was limited.

Sidney Swartz discovered that by adding silicone to the boots, he could create a groundbreaking silicone-treated leather.

In 1973, Sidney observed that sports companies were using logos to brand their shoes. He adopted a similar strategy for his boots, calling them "Timberland," which helped establish a distinct brand identity and set it apart from competitors.



Boat shoes

Timberland boots gained popularity among college students (during 70's). A new point of view: the boot as a winter necessity rather than just for work. Need to other solutions to move from a seasonal product.

Timberland developed a versatile casual shoe ideal for both boating adventures and urban walks. it’s a business oriented on the summer season.

Expansion: customers, inspired by Timberland's advertisements featuring jeans alongside boats, began seeking these styles, driving the brand to extend its offerings beyond footwear.

Hiking boots

In the 1980s, hiking boots surged in popularity, capturing the attention of outdoor enthusiasts.

Timberland revolutionized the market by applying cutting-edge technology, initially developed for running shoe midsoles, to hiking footwear.

This innovation led to the creation of the Euro Hiker, which pioneered the "day hiking" category. This milestone firmly established Timberland as a leading force in outdoor footwear, setting new standards for style and functionality.

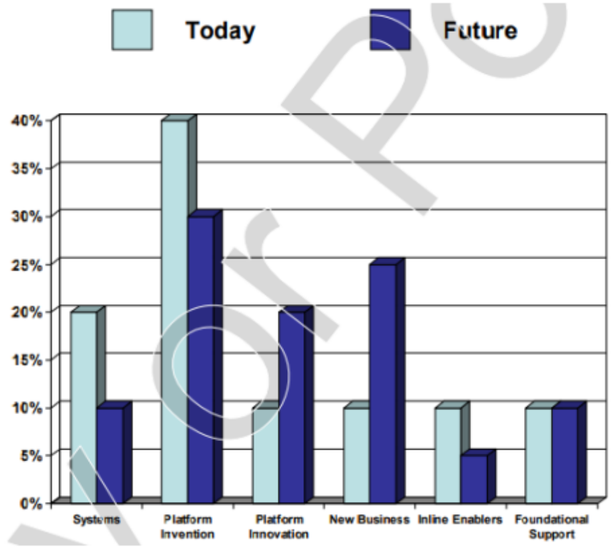
Travel gear concept

What is travel gear concept? It’s a modular approach to footwear that separated the aesthetic and the core fucntion of a shoe and made them interchangeable.

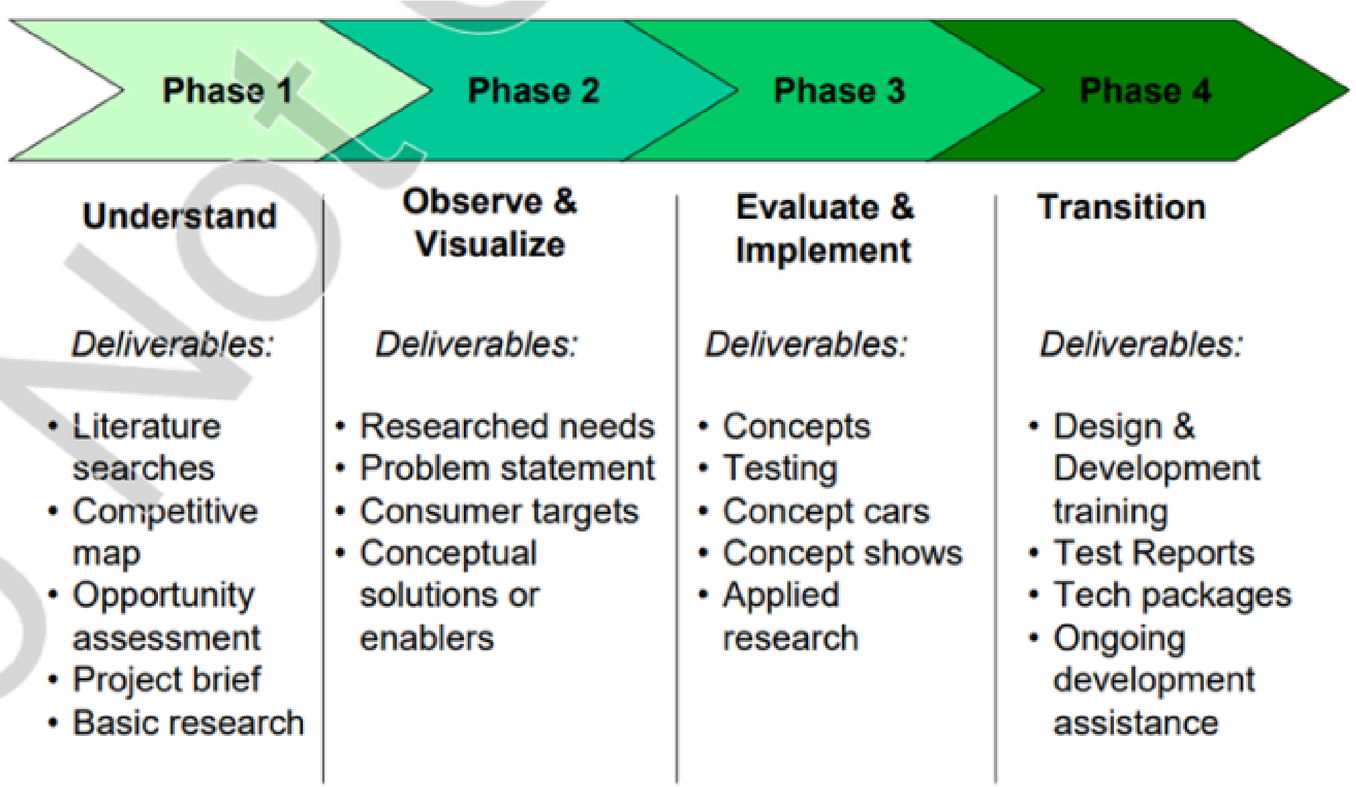
Timberland in 2005 developed a new concept to address the common dilemma travelers face when deciding how many and which shoes to pack.

Travel Gear didn't work.
Timberland had to redefine their mission because travel gear was a failure.

Concepts were grouped by intended impact: Platform invention, systems & enablers.
This organization helped in understanding whether they were spending too much time on enablers and failing to create innovative ideas.

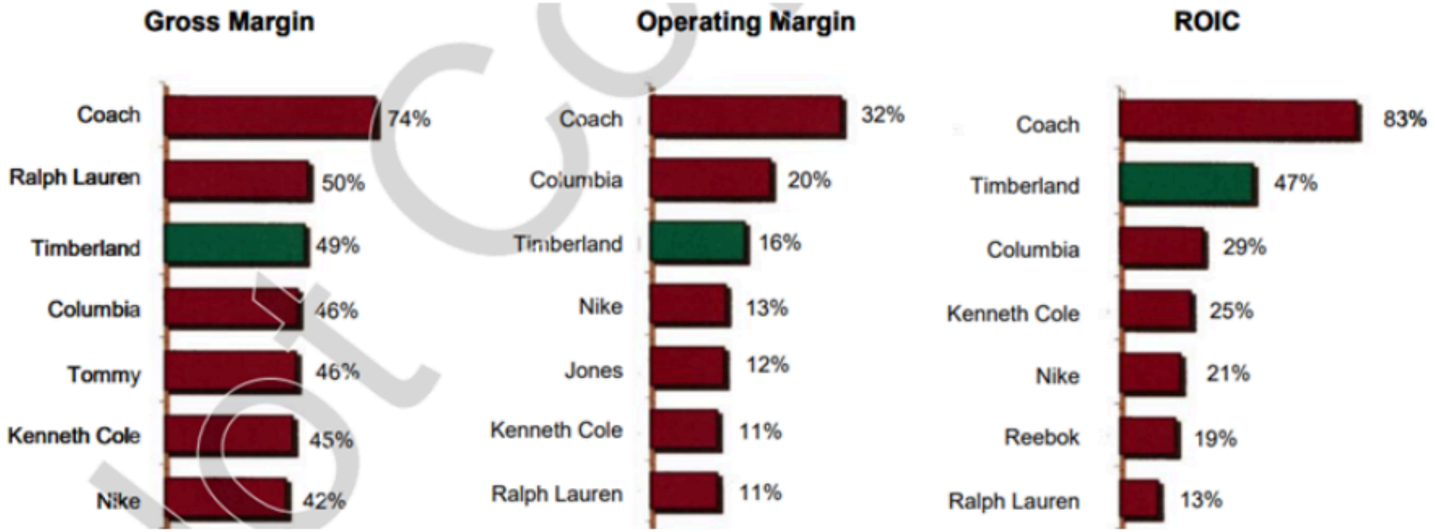


New innovation process



To fix inefficiences in innovation, which led to the failure of the travel gear project, Timberland designed a clear four-step process.

Economic results



From 1998 to 2004, Timberland well performed, with those economic results:

- revenues from $862 million to $1.5 billion (+74%).
- profits from $95 million to $234 million (+146%)
- market capitalization from $523 million to $2.2 billion (+320%)

2nd POSITION IN THE RETURN OF INVESTMENT CAPITAL

3rd POSITION FOR OPERATING MARGIN

6th POSITION IN THE INDUSTRY FOR REVENUE GENERATION

Timberland now

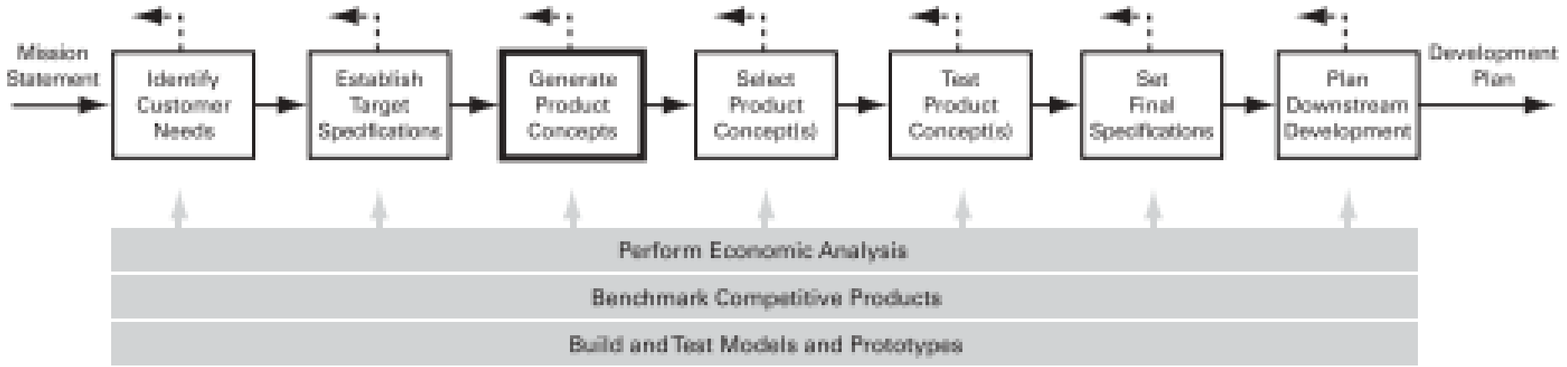
Source: V.F. Corp Annual Report

Concept generation

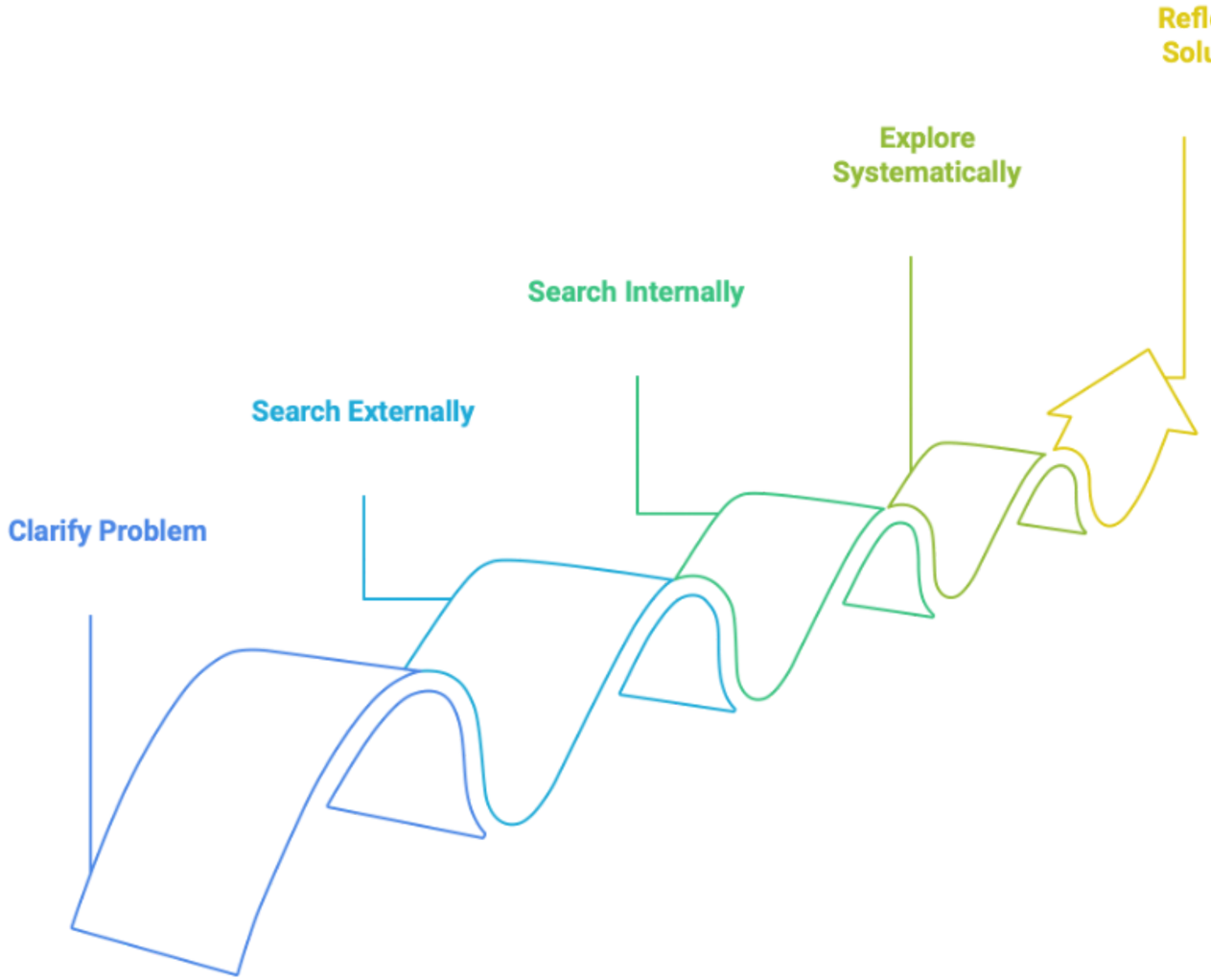
The activity of Concept Generation

A **product concept** is a clear and concise summary of a product's technology, working principles, and design. **It explains how the product intends to meet customer needs.** This concept is often represented through sketches or rough 3D models, sometimes accompanied by brief textual descriptions.

Concept Generation process of a product, starts with identifying customer needs and target specifications. It then leads to a collection of potential product concepts, from which the team will choose the final design. In most cases, a well-organized development team will create hundreds of ideas, with only 5 to 20 being seriously considered during the selection phase.



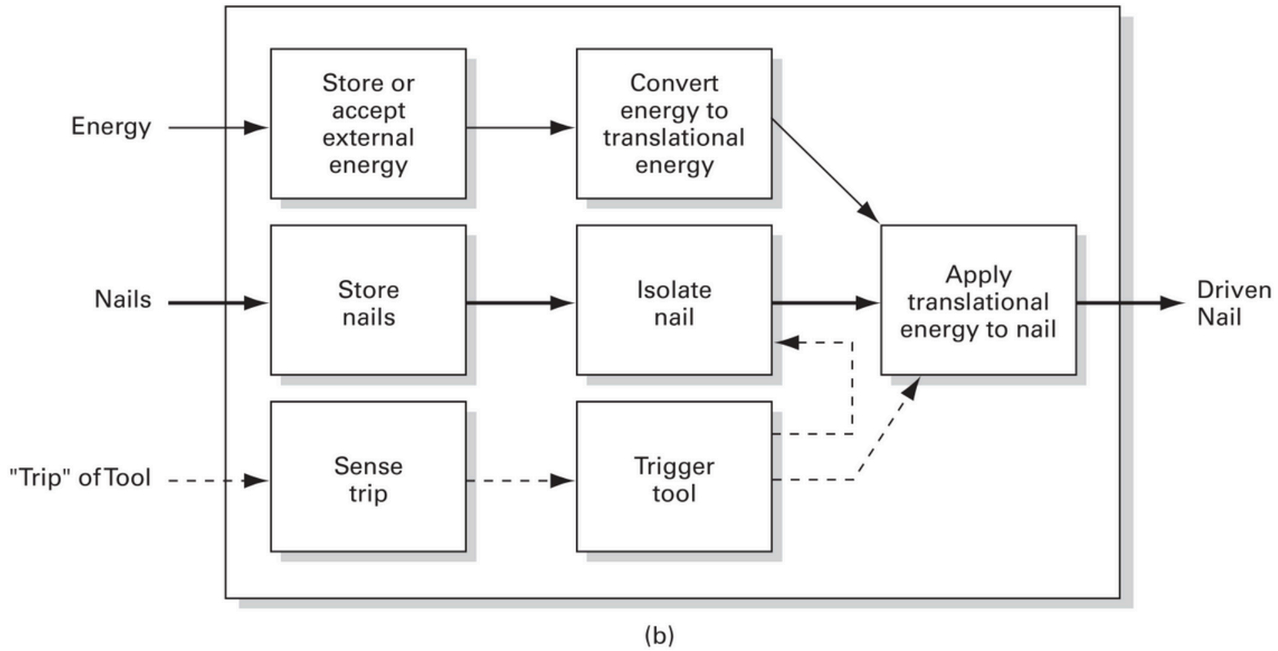
5 steps for concept generation



STEP 1: Clarify the problem

This step focuses on developing a general understanding of the problem and breaking it down into **sub-problems**.

Problem decomposition divides a complex issue into simpler, manageable parts.
This approach allows for a more focused and effective problem-solving process.



(b)

EXHIBIT 7-4 Function diagram of a handheld nailer arising from a functional decomposition: (a) overall "black box"; (b) refinement showing subfunctions.

Problem decomposition

Consider an ice cream scoop.

When using it, the scoop separates a portion of ice cream, shapes it into a rounded form, moves it from the container, and finally places it into a bowl or cone.

Each of these steps: separating, shaping, transporting, and depositing, represents a distinct function that can be broken down as part of a functional decomposition process.

STEP 2: Search Externally

The goal is to identify **existing solutions** for both the main problem and its sub-problems. This step involves gathering information from various external sources, such as:

- Interviewing lead users;
- Consulting experts;
- Searching patents;
- Reviewing published literature;
- Benchmarking related products.

STEP 3: Search internally

This phase leverages **personal and team knowledge to generate solution concepts.**

Guidelines for Effective Idea Generation:

- Suspend judgment – Avoid evaluating ideas too soon;
- Generate many ideas – Quantity leads to quality;
- Embrace infeasible ideas – They can inspire innovative solutions;
- Use visual and physical tools – Sketches, diagrams, and prototypes aid creativity.

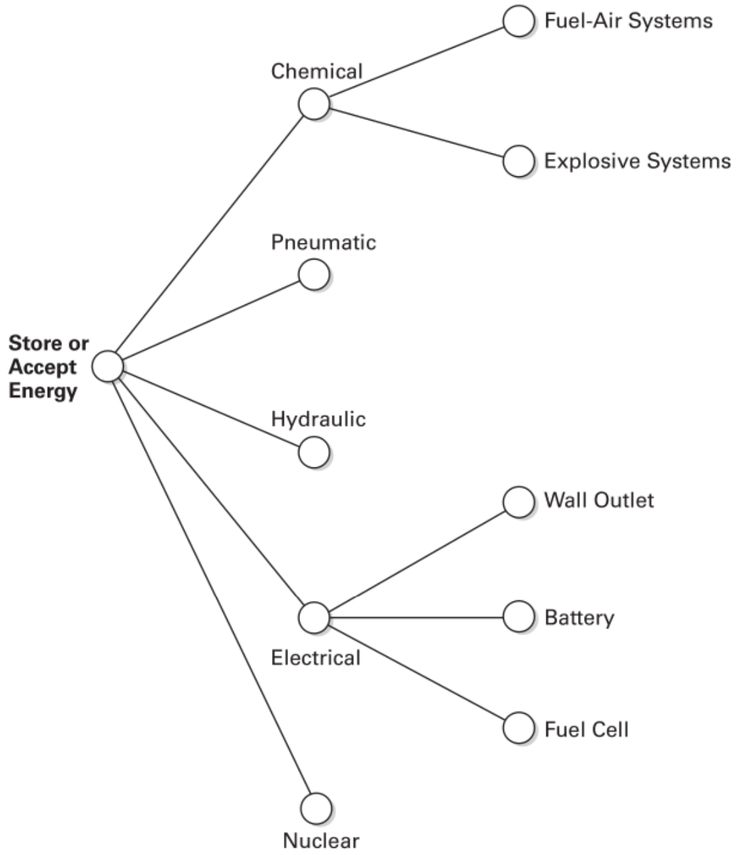
STEP 4: Explore Systematically

- **Exploring possibilities**: Systematically arranging and synthesizing solution fragments from internal and external sources.

- **Strategic thinking tools**: Helps the team structure ideas, assess alternatives, and refine concepts.

The **concept classification tree** is a tool used to divide possible solutions into distinct classes, making it easier to compare and refine options.

EXHIBIT 7-7
A classification tree for the nailer energy source concept fragments.



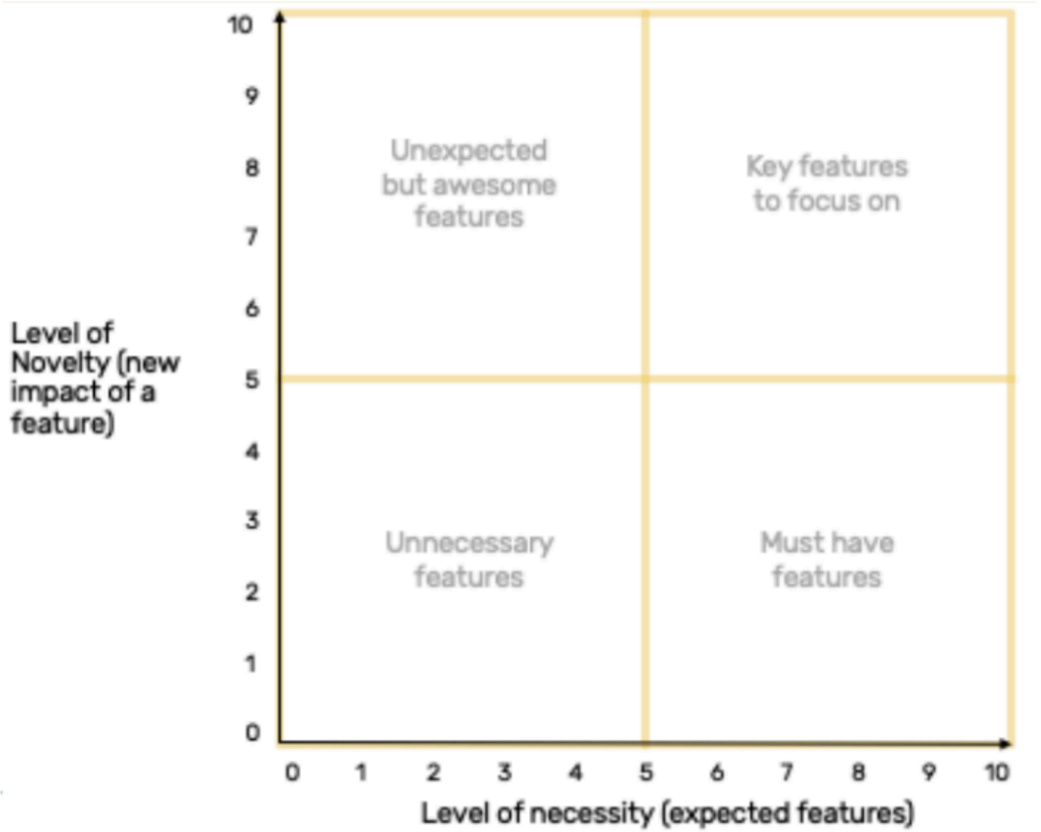
Innovation Battlefield: a framework for evaluating and selecting the most promising solutions.

Step-by-step guide

Step 1: Have a **group discussion and identify a potential solution** that you want to explore in more detail (10 min).

Step 2: Individually list 5–10 features that you think should be a part of this solution (10 min).

Step 3: Individually place those features on the innovation battlefield based on how much pleasure each feature is to the customer and how indispensable the feature is (10 min).



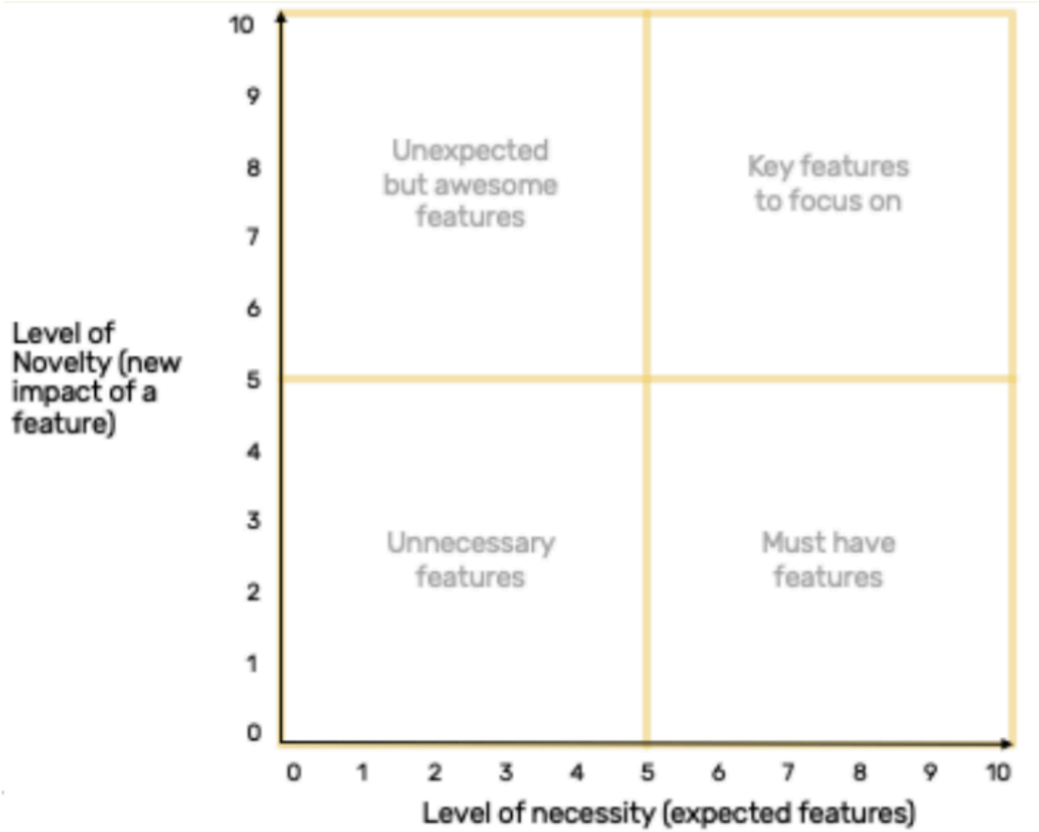
Innovation Battlefield: a framework for evaluating and selecting the most promising solutions.

Step-by-step guide

Step 4: Focus on the upper quadrants and discuss all features in it. Try to be as critical as possible and challenge each other about the value a feature brings or how easy it is to test (20 min).

Step 5: Have a group discussion and decide whether you want to move forward with the proposed solution or repeat the exercise with another solution (10 min).

Tip: You should end with no more than 8 features in both upper quadrants combined.



STEP 5: Reflect on the Solutions and the Process

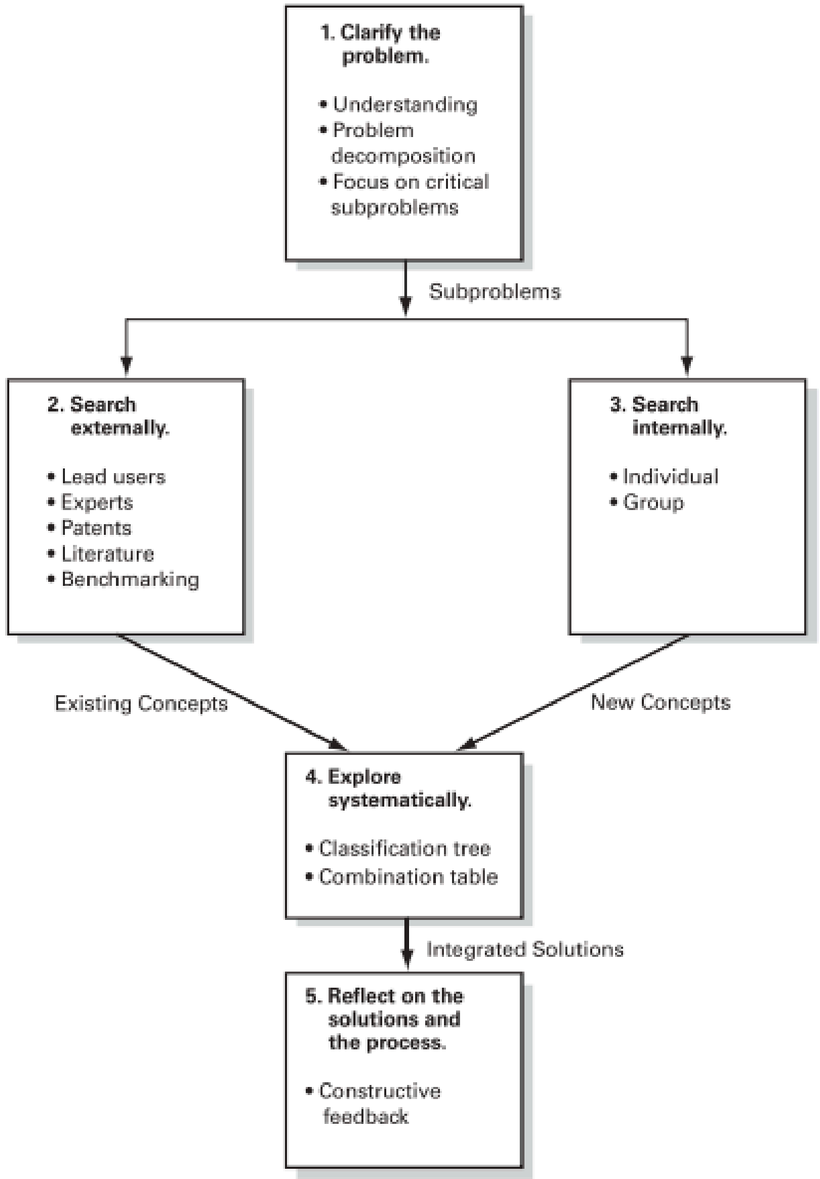
Continuous Reflection: Reflection should be an ongoing process, not just the final step.

Key Questions for Evaluation:

- **Are there alternative ways to break down the problem?**
- **Have external sources been thoroughly explored?**
- **Have all team members' ideas been considered?**

5 steps

EXHIBIT 7-3
The five-step concept generation method.



Takeaways

Takeaways

Product specification

- Product development process focus on meeting customer needs through precise specifications.
- Establishing target specifications in four steps: preparing a metrics list, collecting competitive benchmarking data, setting ideal and acceptable target values, and reflecting on the process.
- five-step process to refining specifications: developing technical models, defining specifications, addressing trade-offs, reviewing results, and finalizing specifications.

Concept generation

- five-step concept generation method: clarifying the problem, searching externally (e.g., user feedback, literature), searching internally (e.g., team brainstorming), exploring systematically with classification tools, and reflecting on solutions for improvement.
- The process enhance creativity, reducing oversight and leveraging diverse expertise. It emphasizes iterative team reflection.
- Professionals skilled in concept generation are in high demand due to its value in product development.

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Thank you for the attention.

EL AYADI OSSAMA
BENARD LULI

MARCO VITALI
BRIGATO ALESSANDRO