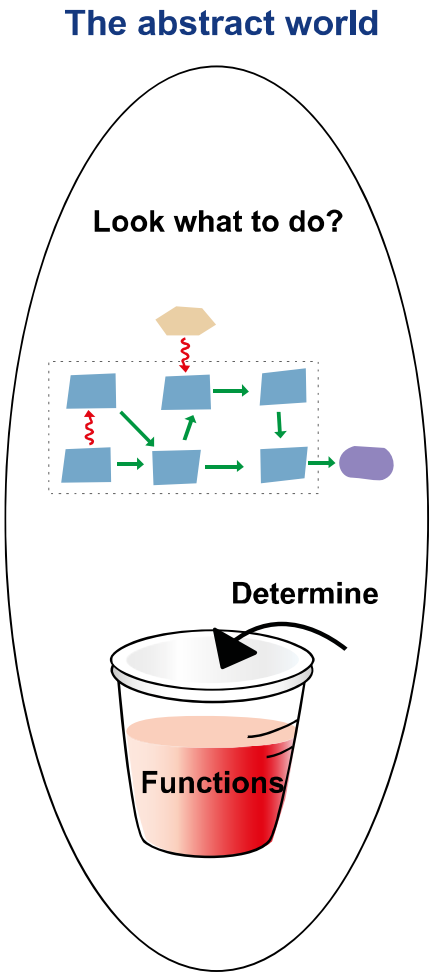
6. Determine the Functions – The Functions Domain of Information



Learning objectives

- The Importance of the Information Domain Functions
- Link to Value Analysis and Value Engineering
- The syntax for formulating functions
- The Classification of Functions
- Strategies to Increase Customer Value
- Value charts – A way to measure value
- Making Functional Models
- Functional models at different hierarchical levels
- Listen to all the remaining Voices
- Establish your benchmark
- Identify Value increasing challenges
- Value-based selling
- Functional model's role in FMEA
- Summary

Writer's Witty Words

Products will expire but the functions will endure.

Per Lindstedt

***The watch** tells the time*

16th Century

20th Century

21th Century

?

22th Century

Global trends

Global trend:

- customers are increasingly uninterested in owning products. They only want to pay for the functionality.
- the move from a linear to a circular economy will enhance this trend.

City cycles Fort Lauderdale, Florida

Photo by Per Lindstedt

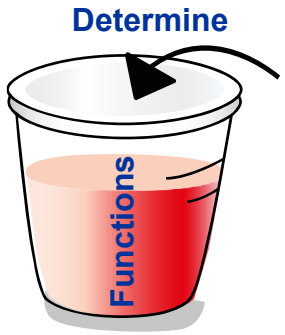
Examples:

- city cycles
- carpools
- timesharing
- white goods, pay per laundry
- cloud computing
- cloud storage
- vintage clothes
- …

Determine functions – *"the magic"*

Functions:

- turns customer value into a concrete and practical tool that is stable over time.
- enables the creation of a measurable approximation of customer value.
- serves as a benchmark against competing products and solutions.
- creates a shared understanding of how the product works, making collaboration more effective.
- acts as a framework for ongoing product improvement focusing on innovation efforts.
- bridges the gap between marketing professionals and engineers.

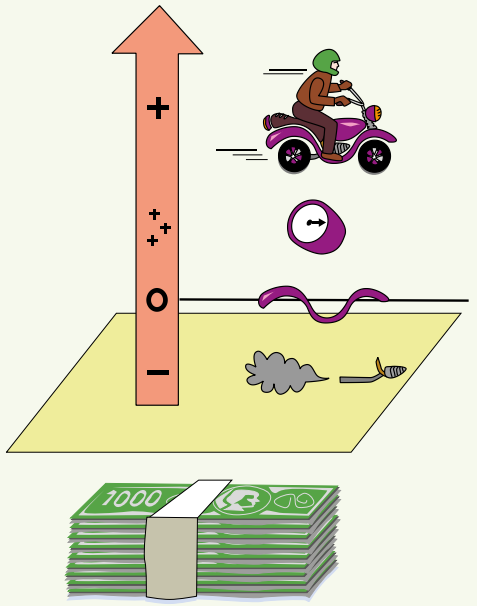


Value Engineering/Analysis

Definition Value Engineering (VE):

- is a systematic method aimed at improving the value of a product by analyzing its functions and costs.

Value Model has developed VE into a practical tool.

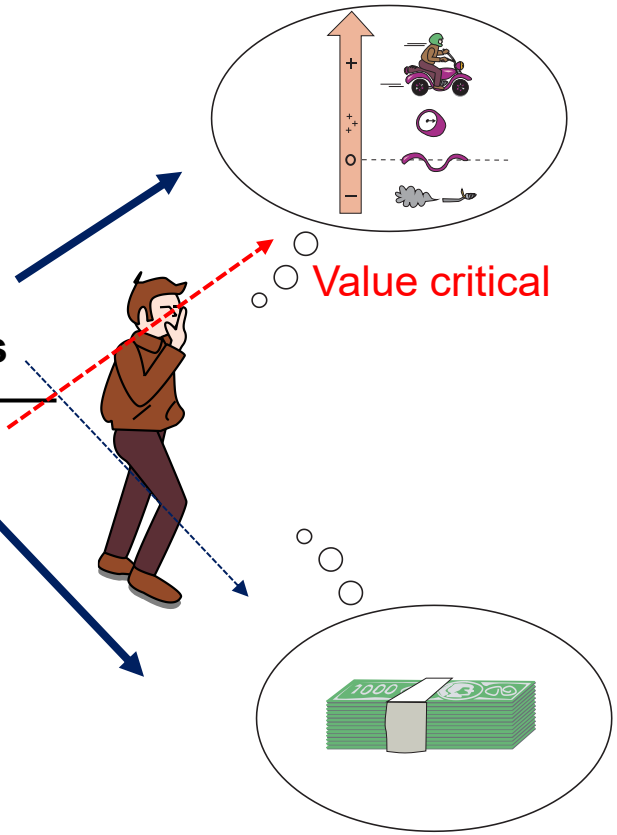


Functional and cost-based thinking

Most needs and some resources are converted into functions.

$$\text{Customer value} = \frac{\text{Satisfaction of needs}}{\text{Use of resources}}$$

Most resources and some needs are converted into costs.

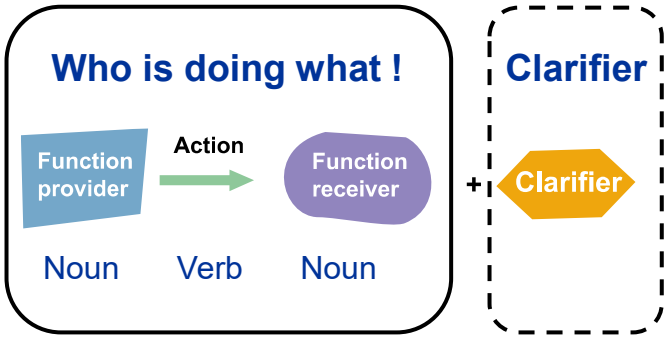


Formulate functions

The fewer words you use, the sharper your mind must be.

The magic thrives in a minimalist approach:

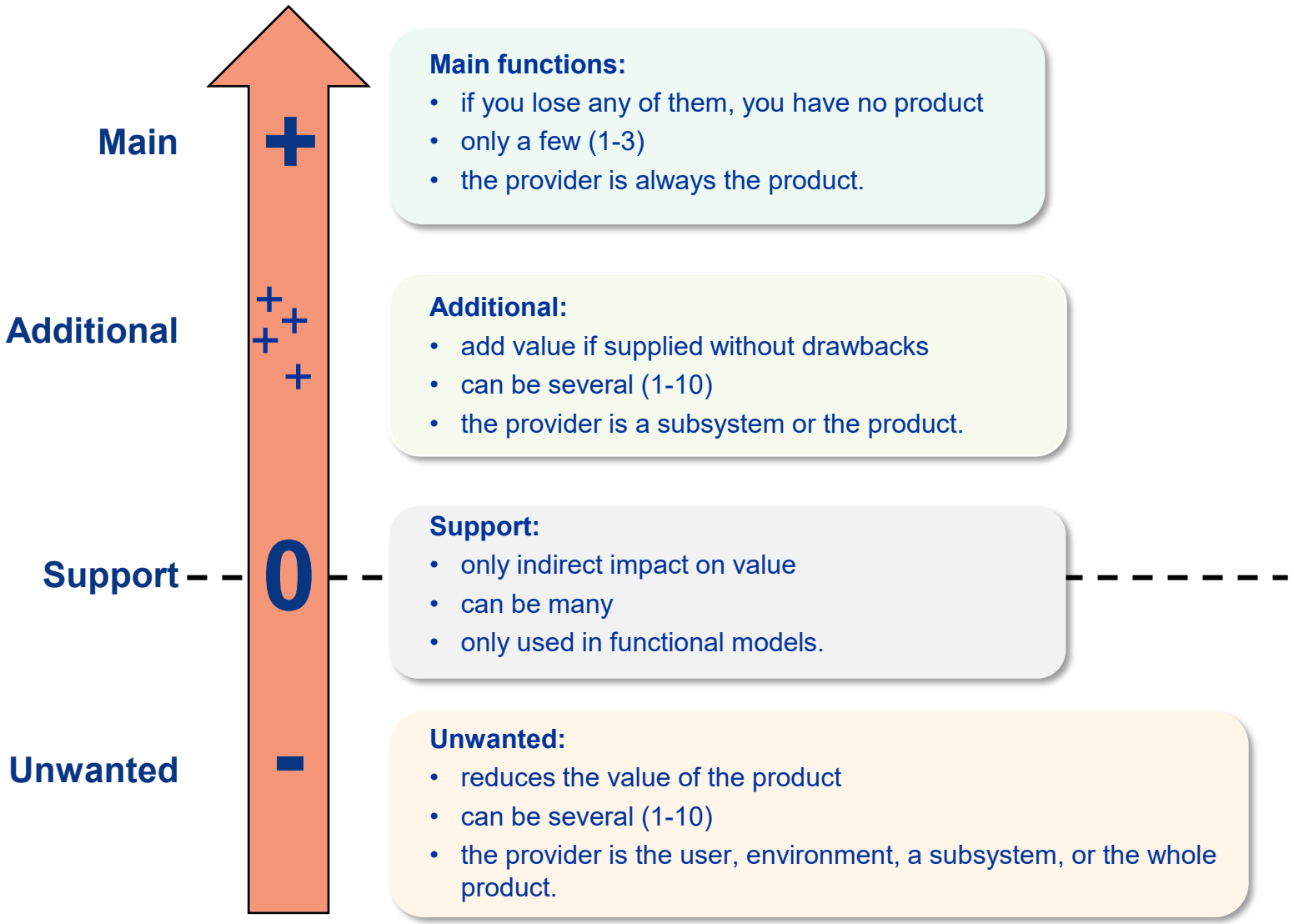
- strip it down to the essentials
- eliminate adjectives and adverbs
- use only a three-word syntax: *noun-verb-noun*
- add a clarifier if needed.



Examples:

- ***a membrane*** *reduces pressure peaks (in the piping)*
- ***a bottle*** *encloses liquids (during transport and storage)*
- ***a logotype*** *conveys status and image.*

Classification of functions



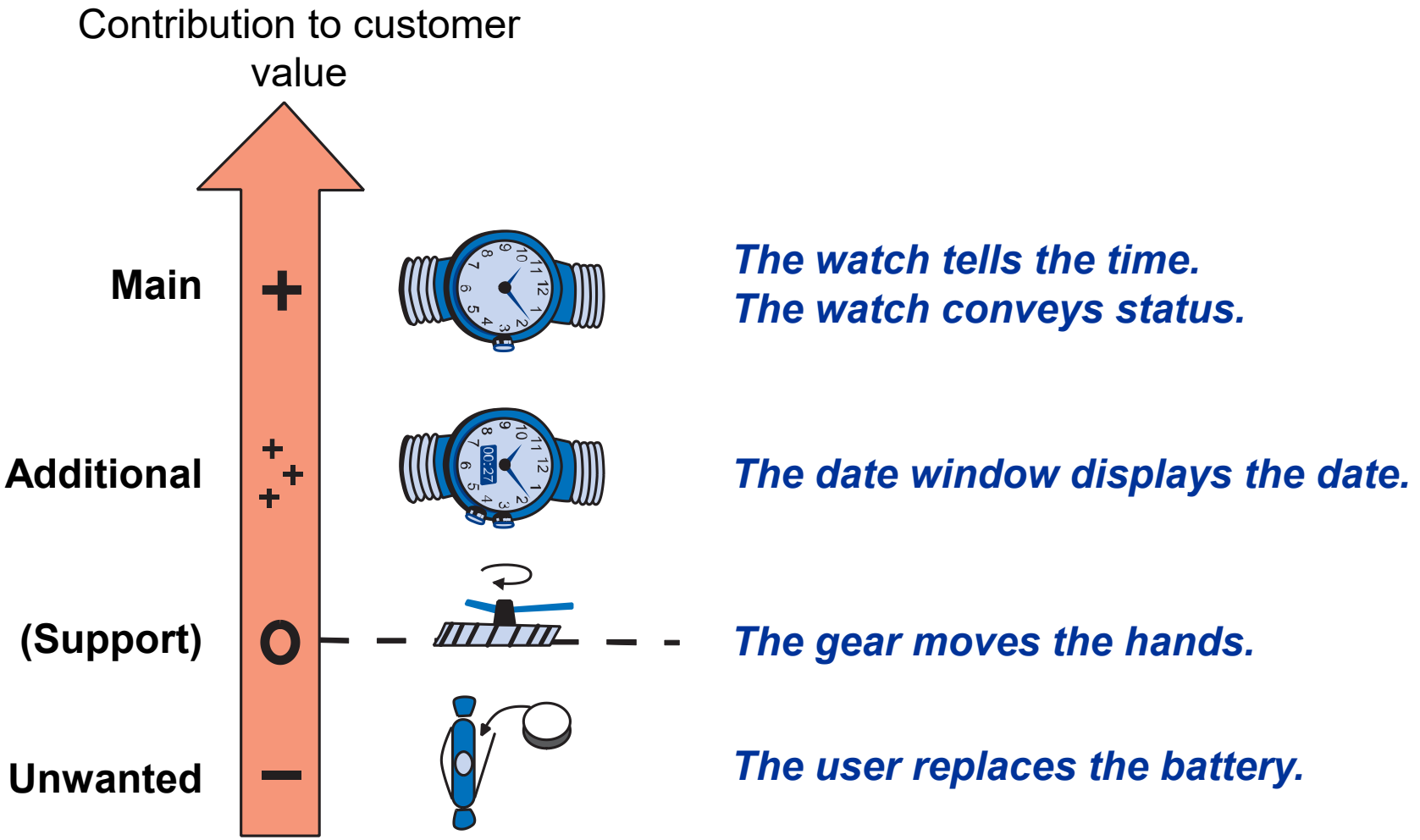
Main functions:
- if you lose any of them, you have no product
- only a few (1-3)
- the provider is always the product.

Additional:
- add value if supplied without drawbacks
- can be several (1-10)
- the provider is a subsystem or the product.

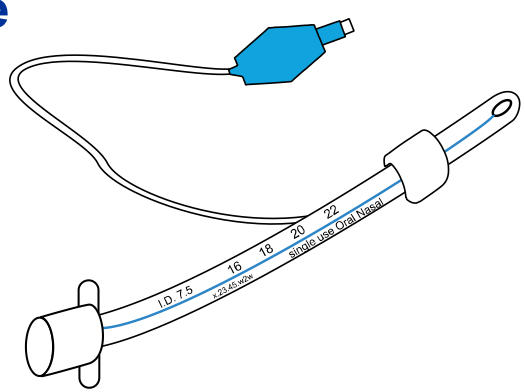
Support:
- only indirect impact on value
- can be many
- only used in functional models.

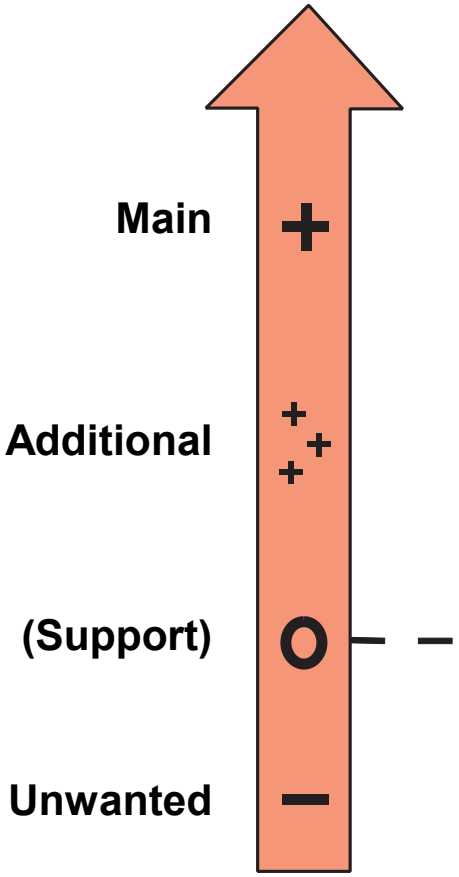
Unwanted:
- reduces the value of the product
- can be several (1-10)
- the provider is the user, environment, a subsystem, or the whole product.

Example Watch



Example Endotracheal Tube





The endotracheal tube *supports breathing (for the patient).*

The endotracheal tube *protects the lungs (from gastric contents).*

The tube mark indicates *the position (for the emergency physician).*

*(**The connector connects** to the ventilator, and many more.)*

The cuff harms *the tracheal wall.*

The endotracheal tube *causes patient infection/irritation.*

The emergency physician *places and removes the endotracheal tube.*

Functional levels

+

++
++
+

0

-

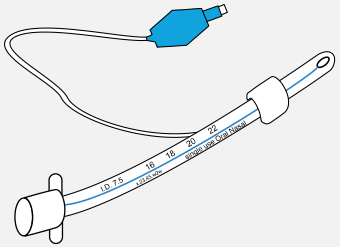
Customer level – what the customer wants and experiences

The endotracheal tube supports breathing (of the patient).

Drives customer value

Technical level – how it works

*The **endotracheal tube** transports gases* (between the lungs and the ventilator).



Drives product improvements

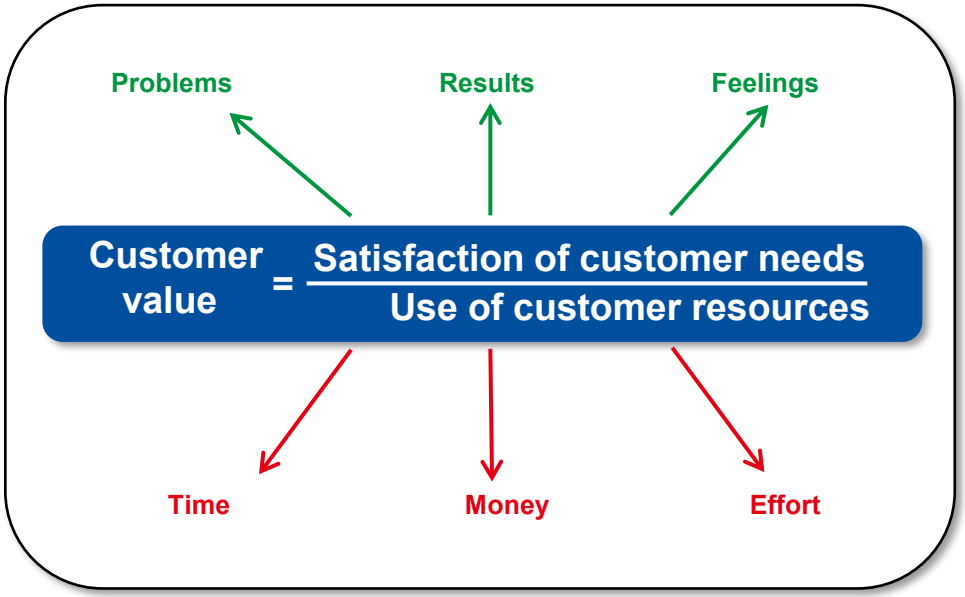
Physical level – what we want to happen

- *The **endotracheal tube** encloses gas molecules.*

Drives innovation

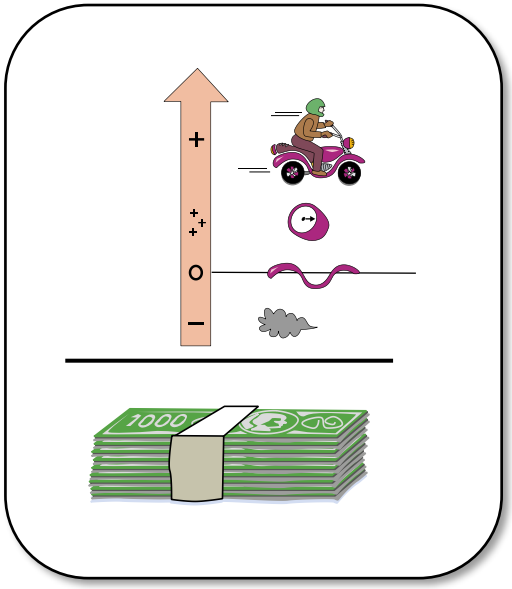
Interpret and Measure Customer Value

Subjective customer needs are in the minds of the customers.



Translation

Abstract functions and cost-based thinking are in the mind of the engineer.



Capture

Needs

Emergency Emma

Determine

Functions

"Increased ventilation."

"Safe to place and remove."

"Convenient for the patient."

"Quick to enter and secure".

"Reduced secondary infections."

"Economical to buy and use."

Main

Additional

Unwanted

\+

\+ \+ \+

0

–

The endotracheal tube *supports breathing (for the patient).*

The endotracheal tube *protects the lungs (from gastric contents).*

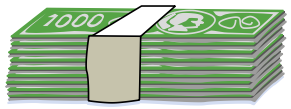
The tube mark *indicates the position (for the emergency physician).*

The cuff *harms the tracheal wall.*

The endotracheal tube *causes patient infection/irritation.*

The emergency physician *places and removes the endotracheal tube.*

One function may impact several needs
and several functions may be needed to solve a need.

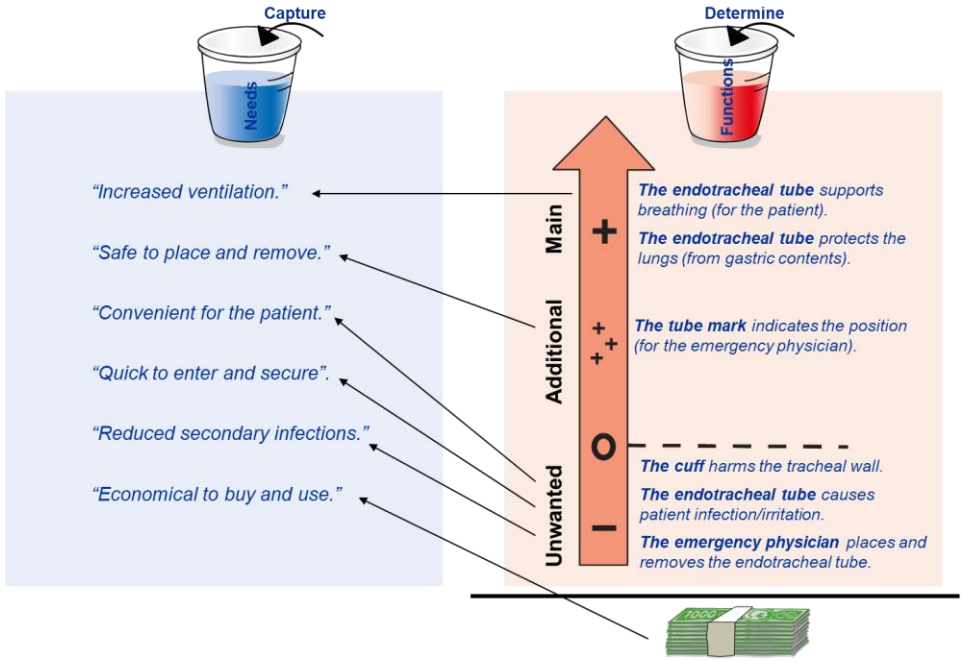


Functions satisfy customer needs

A customer's needs can only be satisfied through the interaction of one or several functions working together to meet one or more needs.

The interactions between functions and needs are a complicated web of connections.

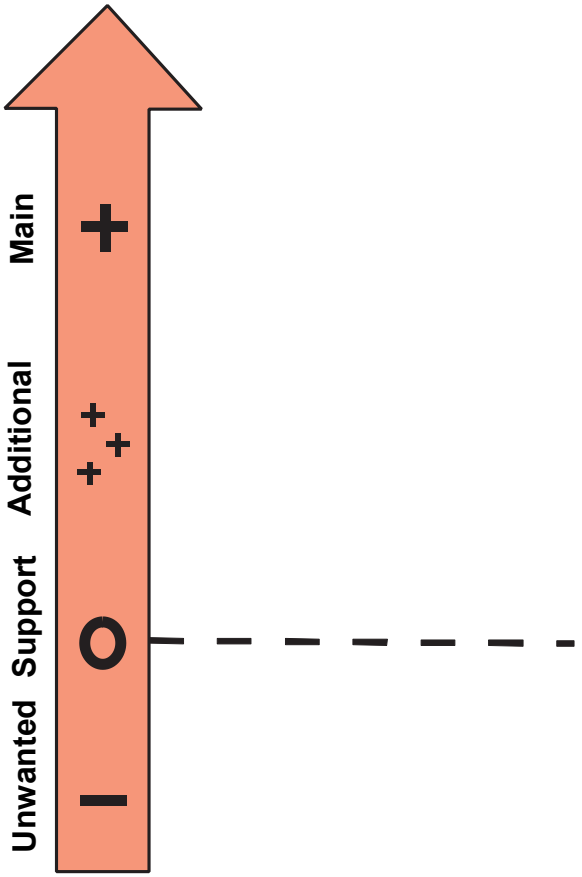
Sorting out all the connections is unfeasible. Focus exclusively on what is value-critical.



Strategies to increase value

Your options:

1. Increase the Main function's performance — without letting anything else slip.
2. Increase performance of, or add new, Additional functions — without letting anything else slip.
3. Reduce performance of, or eliminate, Unwanted functions — without letting anything else slip.
4. Eliminate Support functions and thereby the complexity and cost of the system — without letting anything else slip.
5. There are no more options.



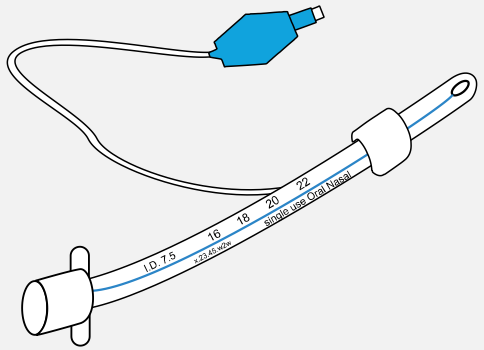
Performance

Performance is a measure of how well a function is executed.

It consists of measurable answers to a number of the following questions:

- How much?
- How good?
- How long-lasting?
- How high?
- How many?
- How frequent?
- How accurate?
- How safe?
- How secure?
- How powerful?
- How clean?
- How efficient?
- How adaptable?
- How sustainable?
- Under what conditions?
- How reliable?
- How user-friendly?
- How scalable?
- How responsive?
- How accessible?
- …?

The endotracheal tubes *supports breathing (for the patient).*



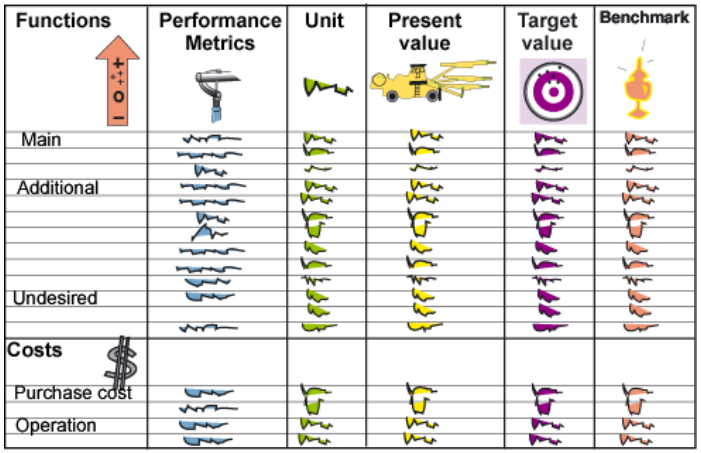
You need more than one metric to fully measure most aspects of a function.

Why Value Charts?

Typical advantages include:

- Enables the creation of a measurable approximation of customer value.
- Clarifies strengths and weaknesses.
- Provides a clear structure for target setting, long-term planning, and benchmarking.
- Serves as a foundation for value-based selling.

Value Charts



Shifts the focus from technical details to what customers truly treasure.

What is a Value Chart?

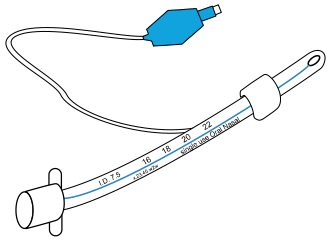
Value Charts:

- a range of 50 to 150 metrics is necessary to describe a measurable approximation of the functionality in most products.
- approximately 10% of all metrics are considered value-critical.
- only 1-3% of all metrics are suitable for demonstrating value to customers, often called *"Money Bags."*

Value Charts

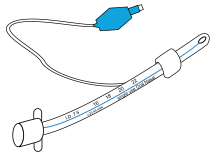
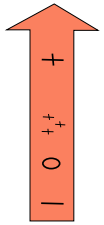
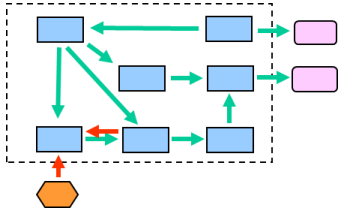
Functions	Performance Metrics	Unit	Present value	Target value	Benchmark
Main					
Additional					
Undesired					
Costs					
Purchase cost					
Operation					

Example Value Chart



	Function Function provider → Action → Function receiver	Main / Additional / Unwanted (+ ++ o −)	Metric	Unit m	Present value	Target value	Value Focus
	Noun - verb - noun	Type of function	System of measurement	m is a unit of length	Number	Number	Focus area
1	The endotracheal tubes supports breathing	Main function	Inner diameter	mm	7,0 - 8,5	5,5 - 8,5	
2			Murhy Eye size	diameter - mm	2,5	2,5	
3			Length	mm	270 - 300	270 - 300	
4			Connector	Type/mm	Standard 15 mm	Standard 15 mm	
5			Air resistance	kPa/L/s	0,4 -0,6	0,4-0,6	
6			Standards	Type	ANS / ISO5361 - 99	ANS / ISO5361 - 99	
7			Intubation	Type	Oral	Oral	
8	The endotracheal tubes protects lungs	Main function	Tracheal wall pressure	kPa	1,9 -2,5	1,9 - 2,2	Patient critical
9	The tube marks enhance positioning	Additional funtion	Tube marks	Number	2	6	
10			X-ray visualization	Type	Radio opaque line	Radio opaque line	
11			Tube size indicator	Yes/No	Yes	Yes	
12			Tube length indication	In mm	No	Yes	
13	The cuff harms the tracheal wall	Unwanted function	Cuff diameter	mm	10	20 to be investigated	
14			Cuff contact area	?	?	?	No measurability
15			Type	Volume/Pressure	HV-LP	HV-LP	
16			Inflation volume	mL	5-10	5-10	
17	The endotracheal tubes casue patient infection/irritation	Unwanted function	Material	Type	PVC DEHP	PVC DEHP free	
18			Outer diameter	mm	9	9	
19			Packing	Type	Sterile	Sterile	
20			VAP infections	%	6 - 52	6 - 25	Money bag

Concrete to abstract

Problem level	Problem	Solution principle	Method used in math	Analogy product development
Simple	The cost of a Hot Dog is 25 SEK. How many can you buy for 100 SEK.	Concrete	Mental arithmetic Solution = 4	Think in products 
Medium	The **S**ausage cost 20 SEK more than the **B**read. What is the cost of the **B**read.	Abstract	Algebra S+B=25 S-B=20 2B=25-20 Bread = 2,5 SEK	Think in functions 
Difficult	How far can you throw a hot dog if your out put velocity is 20 m/s.	Model	Equations  $R = v^2 \sin 2\alpha / g$ Distance: 40 m	Think in models 

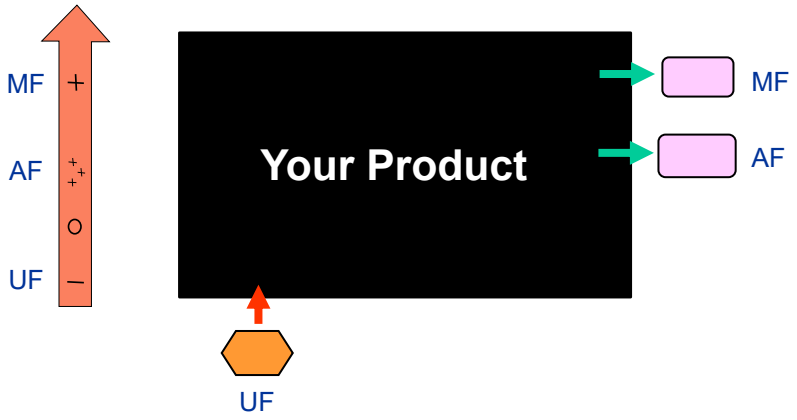
A two-step process

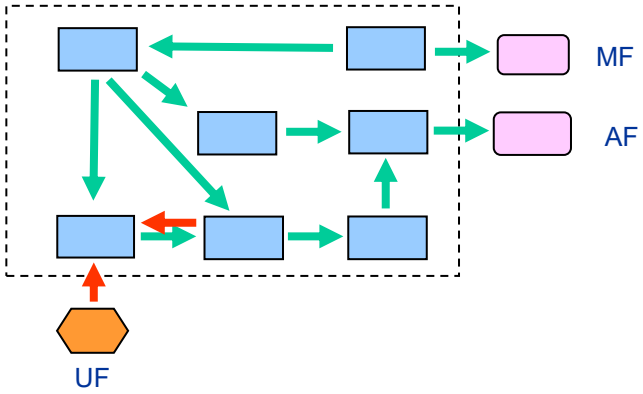
Black Box

- put yourself in the customer's shoes and identify the functions influencing value.

Transparent Box

- visualize and analyze how the product or system generates the functions.



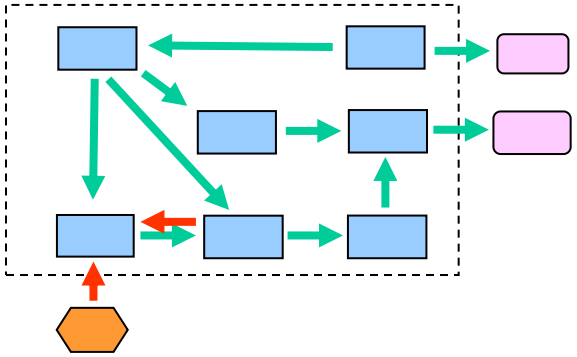


Functional models map the world of logic, not the world of physics.

Functional model

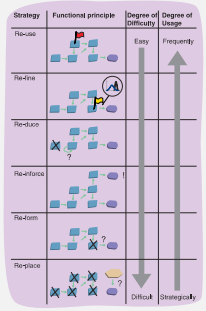
Advantages of the functional model:

- establishes a shared understanding of the product and its subsystems.
- identifies where value is created or lost.
- ranks subsystems by importance.
- provides a starting point for concept development.
- acts as an entry point to other tools.



All have a functional core.

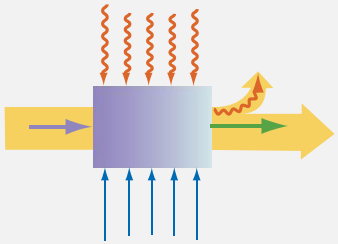
Tactics
- Functional modelling



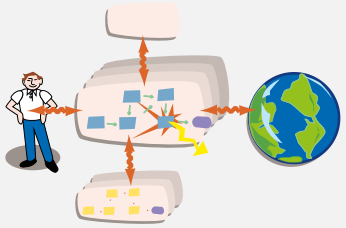
Problem solving and innovation
- Triz

Triz
Theory of Inventive Problem Solving

Quality and robustness
- Design of experiment
- Taguchi methods



Failure prevention
- FMEA



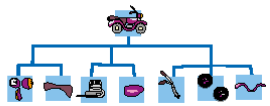
Systematic and customer value driven innovation

Formulate the problem and value-increasing challenges

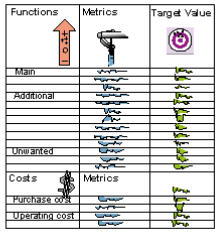
Legend
- Super system
- Function receiver
- System boundary
- Subsystem
- Wanted function
- Inadequate function
- Unwanted function

Select functional level
- Customer
- Technical
- Physical

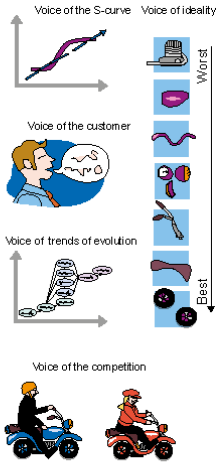
Make a preliminary system architecture



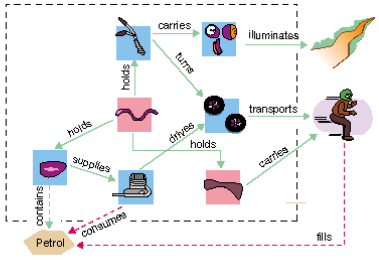
Formulate value goals



If needed add more voices



Create the functional model



If needed add more perspectives

Impact on environment

If needed add more perspectives
- Cost
- Production
- Specific

Formulate value-increasing challenges
1. How to reduce the engine's consumption of petrol.
2. How to simplify filling the tank for the user.
3. How to stabilize the handlebars' turning of the wheels.
4. How to improve the tank's ability to contain petrol.
5. How to reduce the cost of the frame.
6. How to eliminate the saddle's negative effect on the environment.

Select the value-increasing challenge to adress

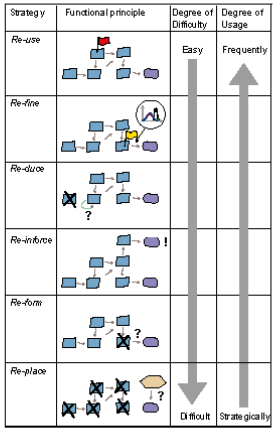
10%

90%

Generate concepts

Use Internet and AI
for example: ask ChatGPT or Google

Use functional modelling principles



Use the Triz tools

Use other creativity and problem solving tools

Use engineering tools to develop a practical solution

High-quality work leads to high-quality concepts. The quality of ideas and concepts developed is directly proportional to the level of effort, precision, and attention to detail put into the work process. When teams follow a thorough and disciplined process to formulate the problem and value-increasing challenges, they are more likely to generate brilliant concepts that are both innovative and practical.

Methodical, function- and cost-based thinking creates the framework that holds the process together. The goal should be to bring each new generation of products one step closer to the ideal.

While all products and concepts can be improved, not everything needs to or should be changed to deliver unrivaled customer value.

info@valuemodel.com

Download the Road Map at www.valuemodel.com

Creating a functional model

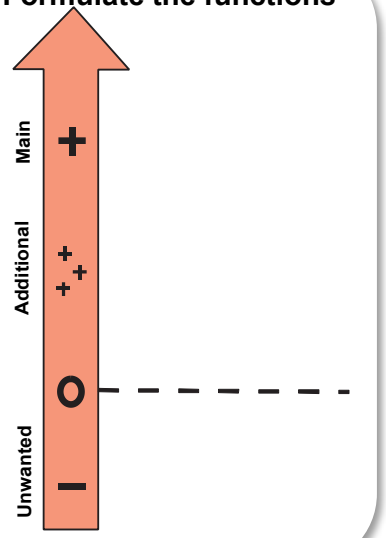
Select functional level

Customer

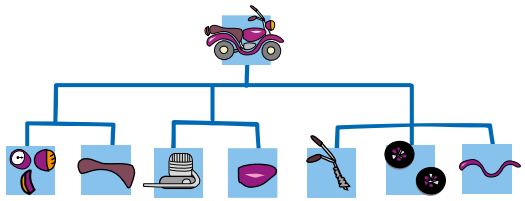
Technical

Physical

Formulate the functions



Make a preliminary system architecture



Iterative process as we learn and understand more !

Symbols

Functional receiver – main or additional function. Outside system boarder.

Functional provider which is part of system. Inside system boarder.

Functional receiver – unwanted function. Outside system boarder.

Super system – part of surrounding or other system hierarchy.

Wanted function.

Wanted function with inadequate performance.

Unwanted function.

Example

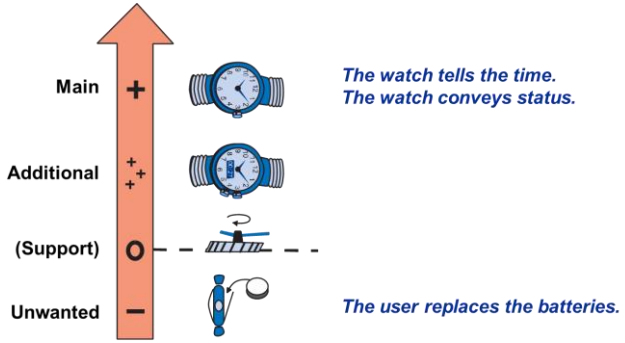
Select functional level

Customer 

Technical 

Physical 

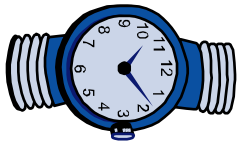
Formulate the functions

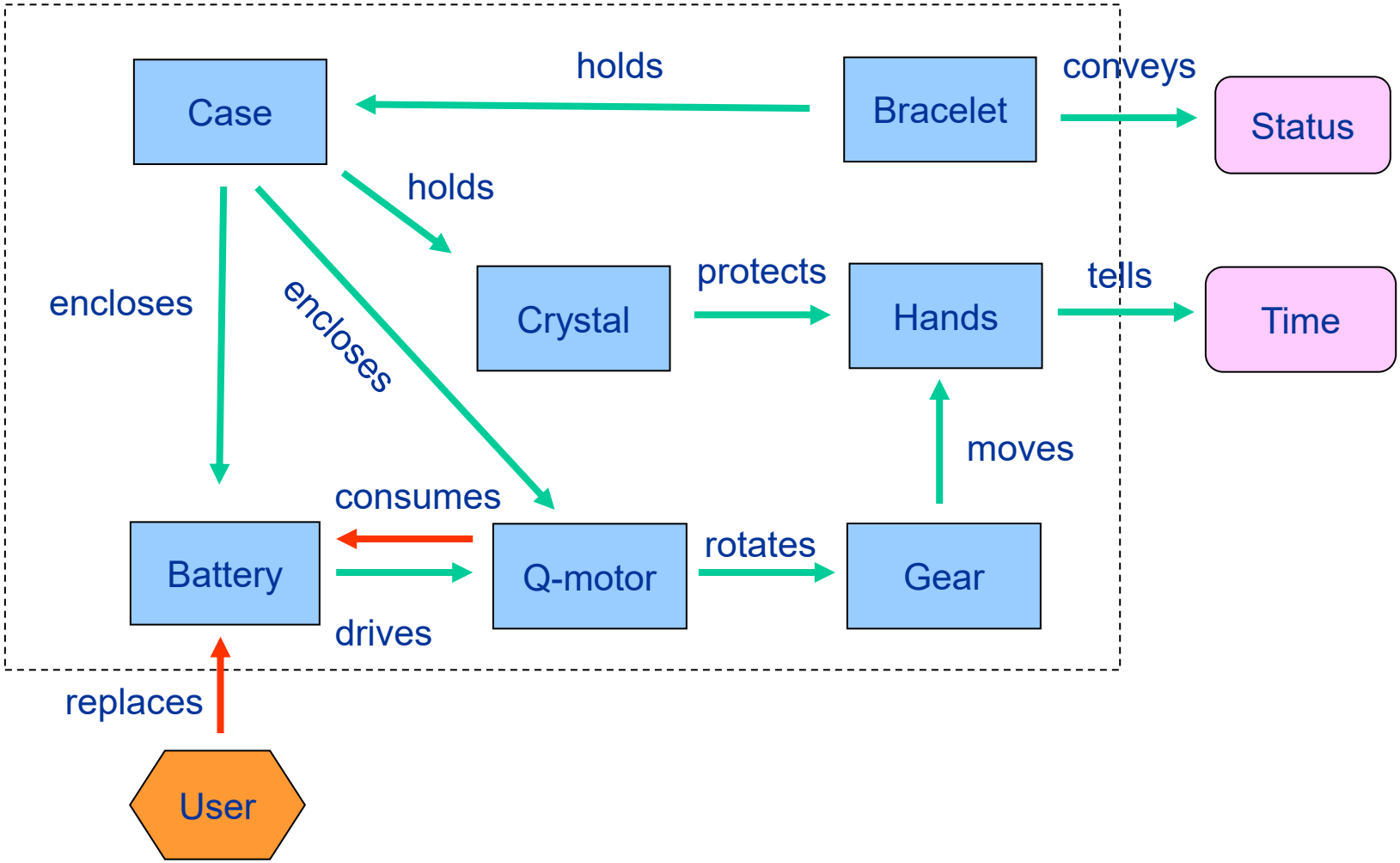


Make a preliminary system architecture:

- Batteries
- Bracelet
- Hands
- Case
- Q-motor
- Crystal
- Gear

Example - Watch



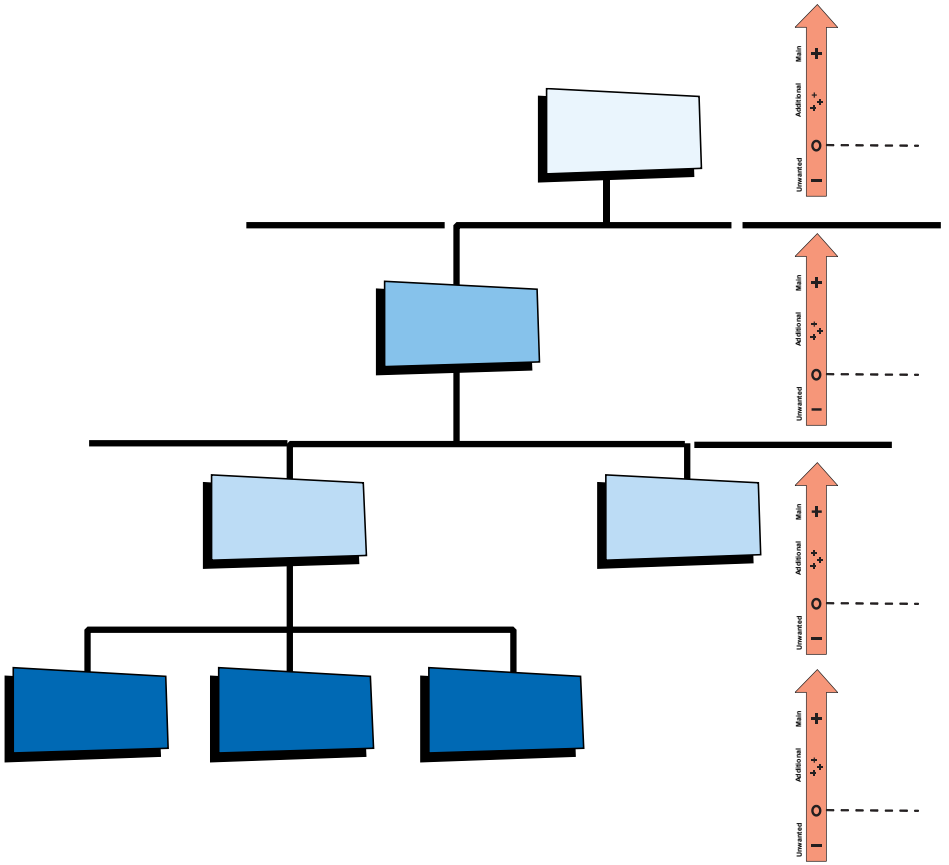


Functions at different hierarchical levels

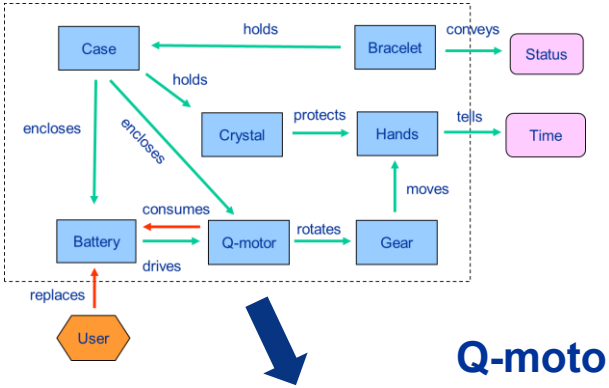
A fundamentally similar structure exists across all hierarchical levels.

Lower hierarchical levels:

- mitigate Unwanted functions at higher levels.
- have fewer Main functions.
- have no Additional functions.
- have Unwanted functions.
- are remnants of quick fixes implemented.



Functional models are nesting dolls



Functional models work like nesting dolls. Each subsystem can be broken down into its own functional model, which in turn can be broken down further.

Q-motor

Q-motor casing

encloses

Crystal oscillator

generates

Timing signal

controls

Integrated circuit

creates

Electrical pulses

powers

powers

drives

Battery

consumes

drives

Step motor

rotates

Gear

In a functional model, virtual functional providers may exist outside your bill of materials.

The model can be simplified instead of being cluttered with arrows.

Example Endotracheal tube

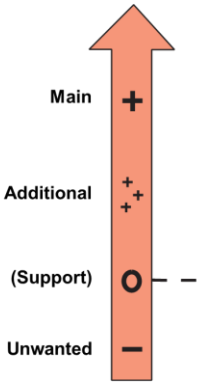
Select functional level

Customer 

Technical 

Physical 

Formulate the functions



The endotracheal tube *supports breathing (for the patient).*

The endotracheal tube *protects the lungs (from gastric contents).*

The tube mark indicates *the position (for the emergency physician).*

(The connector connects *to the ventilator, and many more.)*

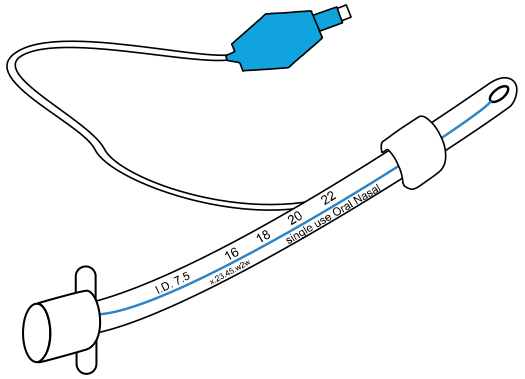
The cuff harms *the tracheal wall.*

The endotracheal tube *causes patient infection/irritation.*

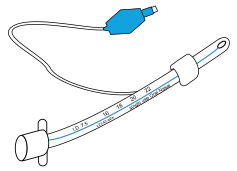
The emergency physician *places and removes the endotracheal tube.*

Make a preliminary system architecture:

- tube (PVC)
- pilot (balloon, tube and valve)
- cuff
- murphy (murphy eye)
- bevel
- marks (length and vocal cord)
- line (radio opaque line)



Example – Endotracheal tube



The remaining Voices?

***The Voice of the**:*

- ✓ *customer*
- ✓ *functions*
- • *S-curve*
- • *product*
- • *technology*
- • *money and resources*
- • *time*
- • *competition*
- • *environment*
- • *organization*
- • *…..*

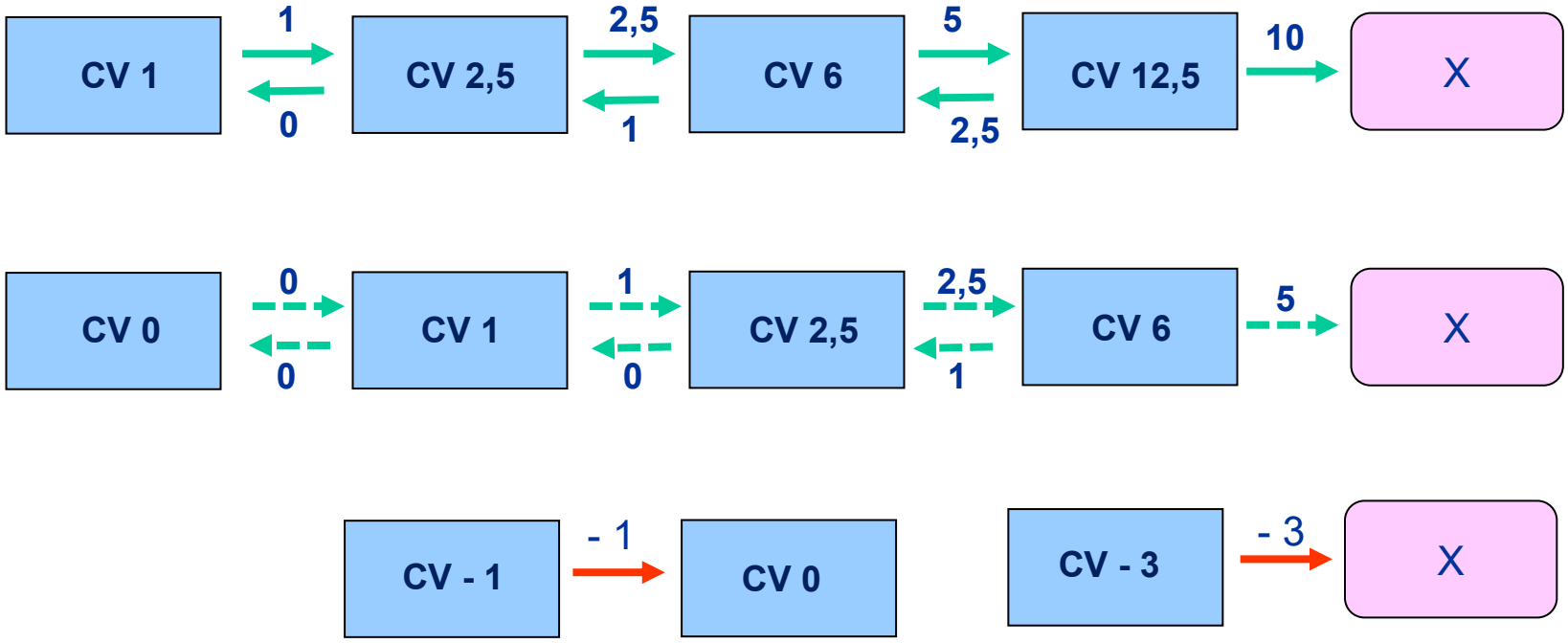
recommends you to ….?

The Gold Digger's Dilemma

One voice can be crucial, or all additional have no importance whatsoever.

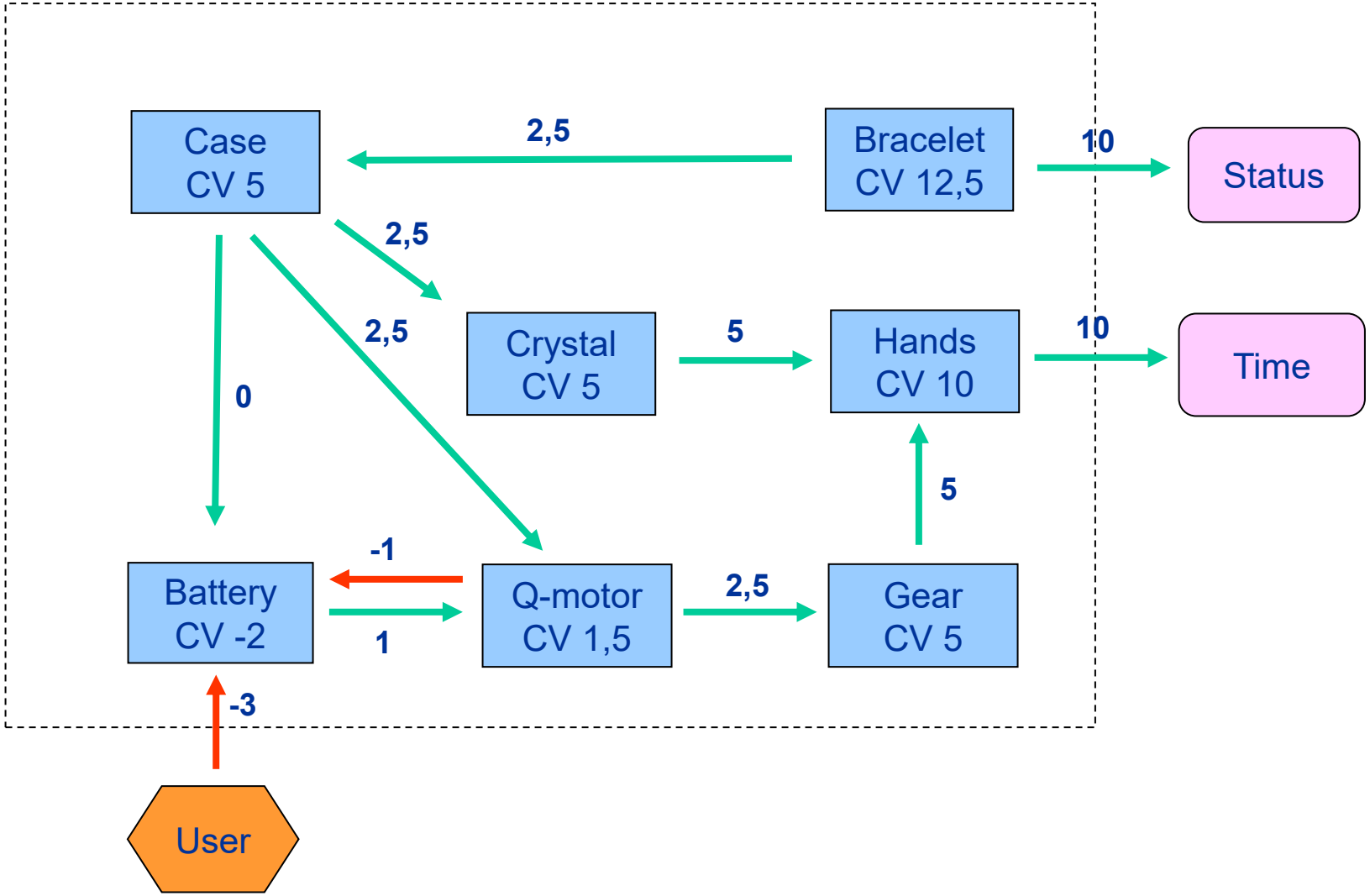
Contribution Value, CV

Contribution to value for different functional providers.



Treat these values as guidelines and conduct a plausibility assessment once the entire model is complete.

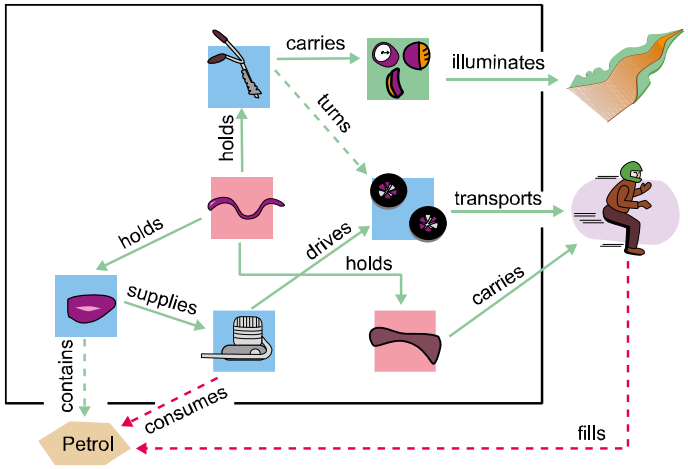
Example – CV Watch



The benchmark

Establish your benchmark:

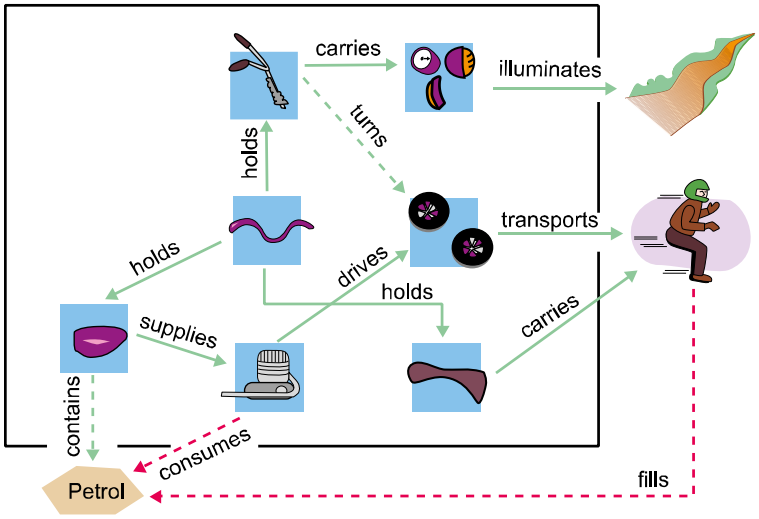
- it depicts challenges from different 'voices'
- it contains a combination of known elements that can be safely used to create the new product
- it is the best that the world can collectively achieve today
- every company has the potential to reach this level



The benchmark is the baseline, but a WoW product delivers higher customer value.

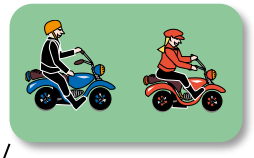
Establish your benchmark

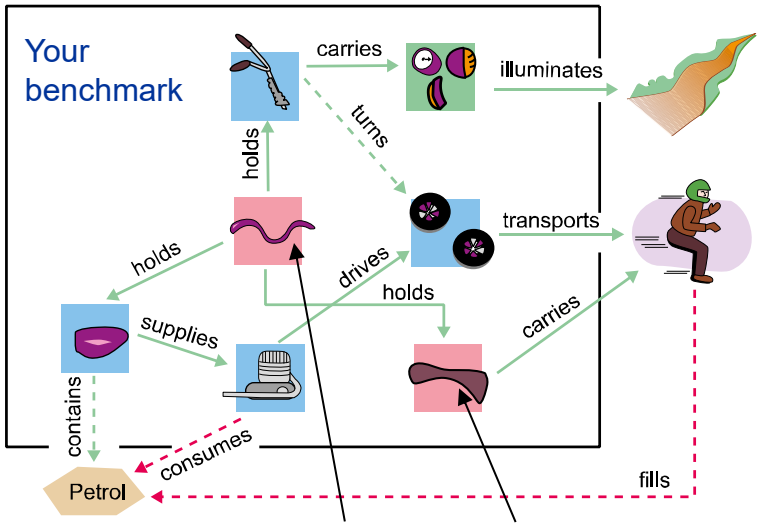
From the functional domain

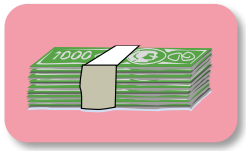


From other voices

Solution from competition







Cost issues

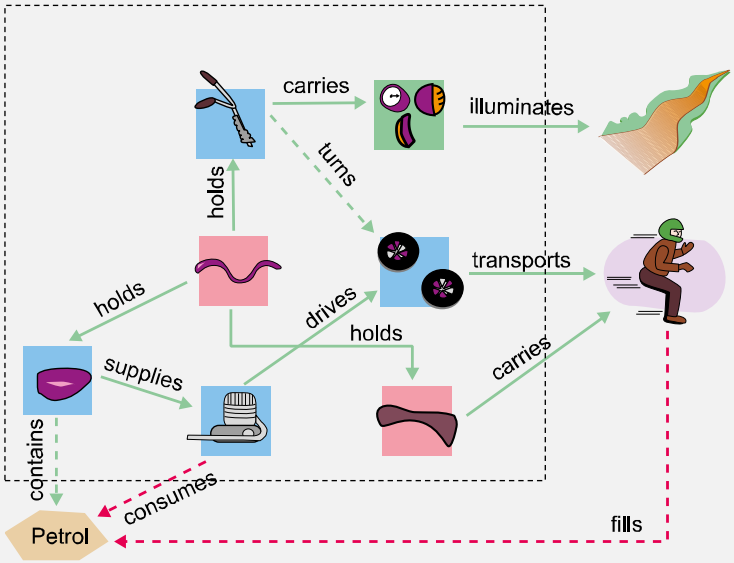
Environmental issues

Value Increasing Challenges

Formulate your value-increasing challenges that will enhance your benchmark's value if solved.

It may include:

- elimination of Unwanted functions.
- improvements of wanted functions with inadequate performance.
- elimination of subsystems with a low-value contribution.
- fixing subsystems with problems or issues.
- enhancement of any other shortcomings in the benchmark.



1. How to reduce the engine's consumption of petrol.
2. How to simplify filling the tank for the user.
3. How to stabilize the handlebars' turning of the wheels.
4. How to improve the tank's ability to contain petrol.
5. How to reduce the cost of the frame.
6. How to eliminate the saddle's negative effect on the environment.

Value Based selling

Value-Based Selling:

- demonstrates superior total value compared to competitors.
- provides a business case to justify the purchase of your product.
- frames value in terms that are meaningful to key decision-makers.

Simplified example

1. Voice of the customer from interviews:

- *“Reduced secondary infections”*

2. Formulate function

- Unwanted: *The endotracheal tubes cause patient infection.*

3. Create measurability

- Metric: VAP infected patients (ventilator-associated pneumonia)
- Unit: %
- Present value: 6-52 new target 2-25

Make a simple model to demonstrate the impact on the customer.

Simplified example

Emergency Emma

Customer most use their own data in the model.

Number of patients			**Typical number**
Number of patients treated with endotraceal tubes	per year	1500	1500
Average VAP infected patient today	%	12	6-52
Reduction of infected patiens using Silver coated tubes	%	6	50%
Reduced number of infected patients	per year	**90**	

Cost per patient			
Average extra days in mechanical ventilation (ICU)	Days	3	5
Cost per day of mechanical ventilation	USD	1000	1200
Savings ICU	USD	**270000**	

Average extra days in hospital	Days	7	10
Cost per day in hospital	USD	550	600
Savings in hospital stay	USD	**346500**	

Total savings	**million USD**	**0,6165**

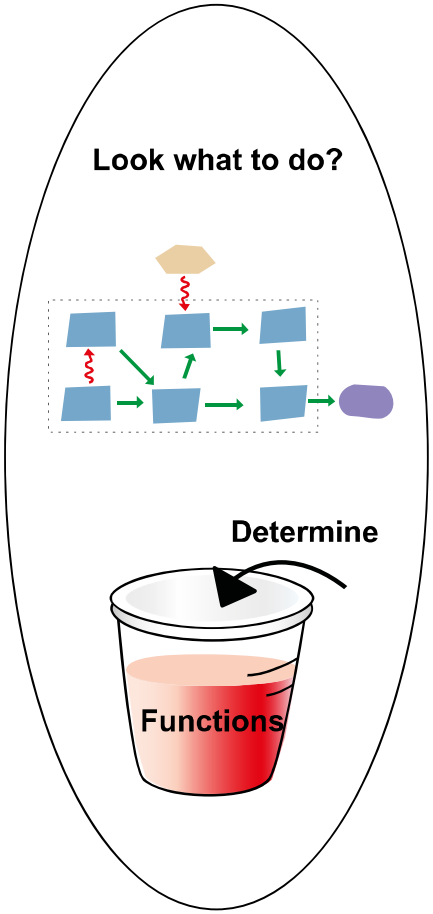
And 1 live saved !

What went into the bucket?

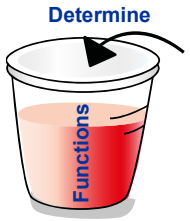
Value-critical information in the Functions Domain may include:

- a formulation of the Main, Additional, and Unwanted functions.
- a comprehensive Value Chart with easy-to-use metrics.
- a Value Chart populated with metrics specific to your product and benchmarks.
- an analysis of your Value Chart to pinpoint value-critical metrics.
- metrics suitable for value-based selling, often referred to as “Money Bags.”
- a functional model of your product and the benchmark.
- all functional providers ranked from best to worst.
- one or several functional models at lower hierarchical levels for weak functional providers.
- additional and relevant voices integrated into your functional model.
- a comprehensive list of all value-increasing challenges in the benchmark.
- a functional model of the final concept to be used for the Failure Modes and Effects Analysis (FMEA).

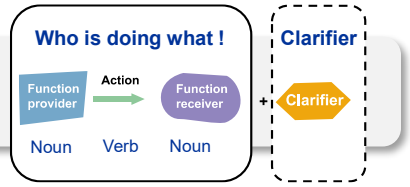
The abstract world



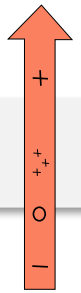
Summary



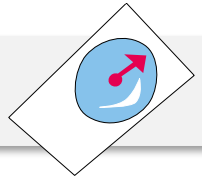
The syntax forces you to sharpen your mind.



Only three types of functions impact customer value directly.



Only four strategies exist to enhance customer value.



The functional model is the entry point to many tools.