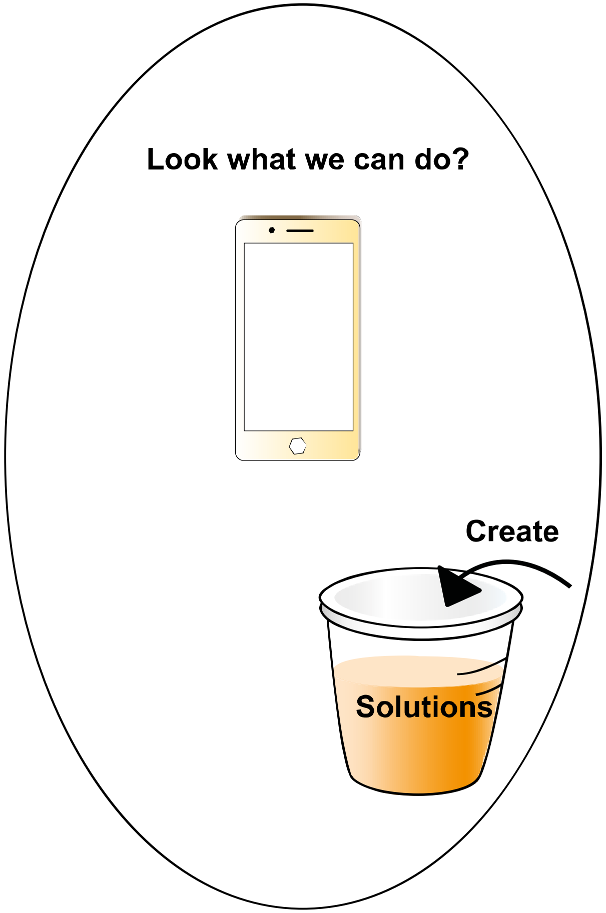
7. Create the solution –
The Solution Domain of Information

The company's world



Learning objectives

- ▶ Six tactics for value-driven concept development
- ▶ The Re-use tactic
- ▶ The Re-fine tactic
- ▶ The Re-duce tactic
- ▶ The Re-inforce tactic
- ▶ The Re-form tactic
- ▶ The Re-place tactic
- ▶ How to apply the different tactics
- ▶ Concept development
- ▶ Focused brainstorming
- ▶ Use the Mini-Ariz to solve Value increasing challenges
- ▶ Establish the System architecture
- ▶ Detailed design of the final product
- ▶ Summary

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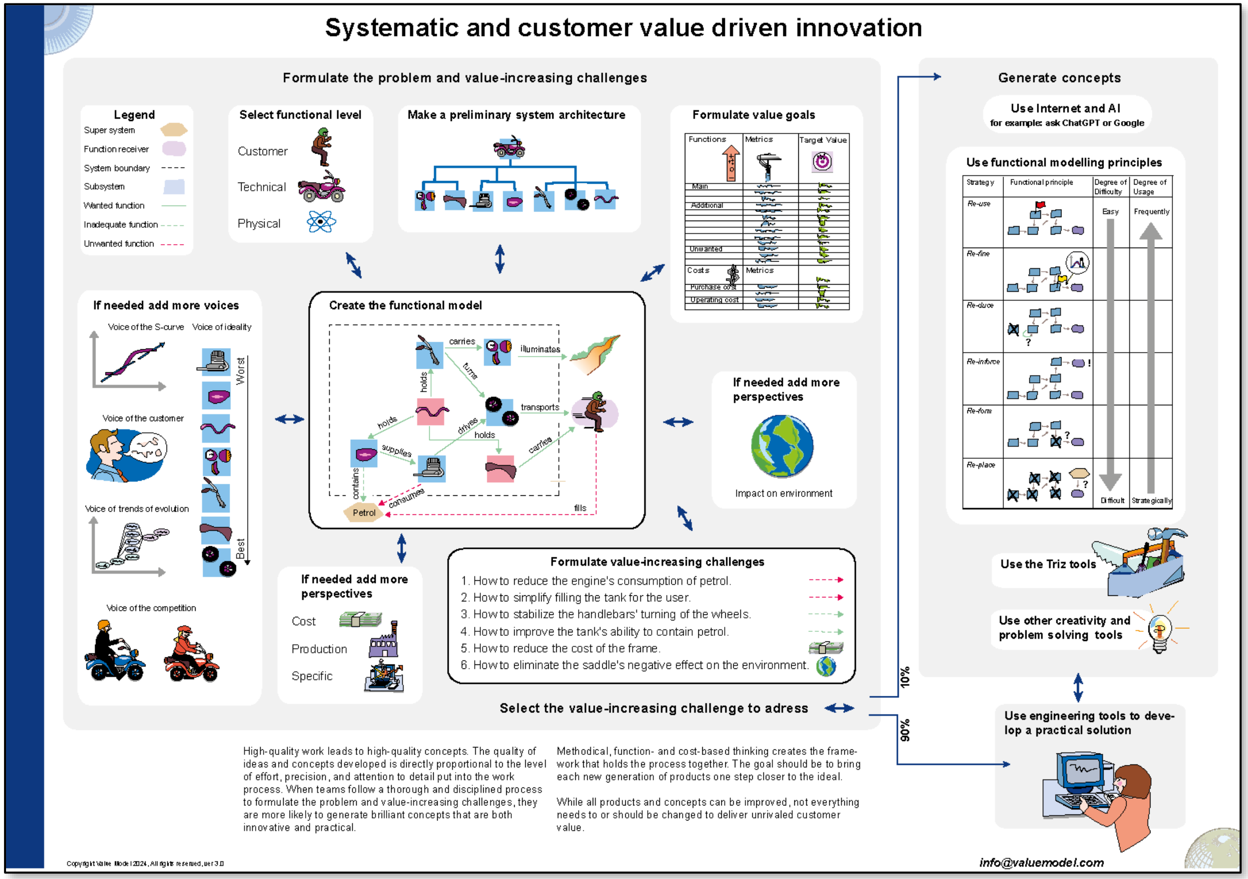
Writer's Witty Words

> ***Truly innovative solutions stand out from the crowd with their simplicity and their clever ability to reduce feature conflicts.***
>
> Per Lindstedt

Road Map



Systematic and customer value driven innovation

Formulate the problem and value-increasing challenges

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

Generate concepts

Use Internet and AI
for example: ask ChatGPT or Google

Use functional modelling principles

Strategy	Functional principle	Degree of Difficulty	Degree of Usage
Re-use		Easy	Frequently
Re-fine			
Re-duce			
Re-inforce			
Re-form			
Re-place		Difficult	Strategically

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.

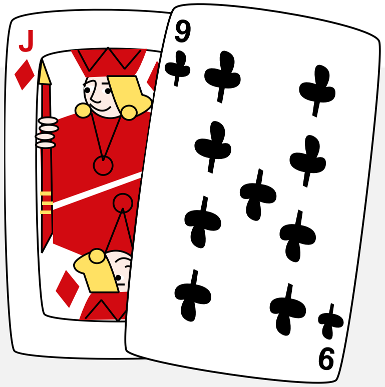
info@valuemodel.com

Download the Road Map for free.

Six tactics for value-driven concept development

Card counting is an advanced playing technique for blackjack which:

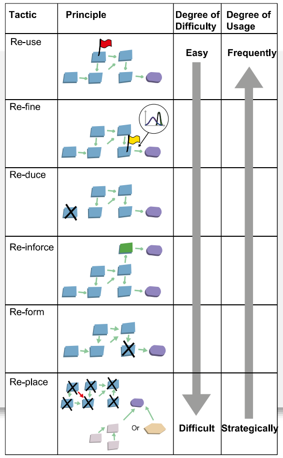
- increases the probability of winning.
- requires both knowledge and skill from the player.
- is banned from the casinos.



Functional modeling tactics are for product development, what card counting is for blackjack.

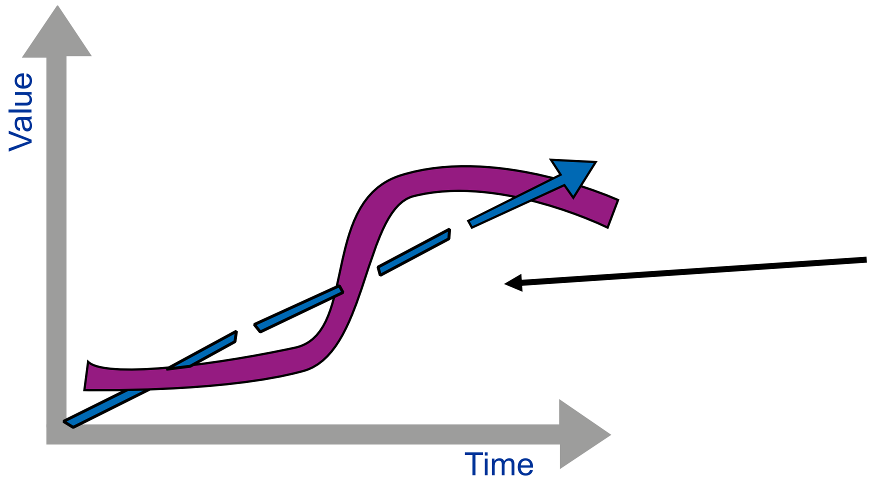
Six tactics are an advanced technique for value-driven concept development which:

- increase the probability of winning.
- require both knowledge and skill from the developers.
- are applied by very few companies.

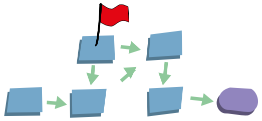
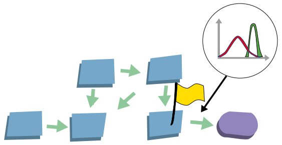
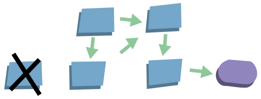
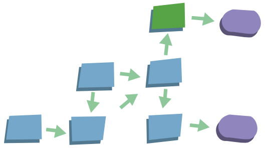


Tactic	Principle	Degree of Difficulty	Degree of Usage
Re-use		Easy	Frequently
Re-fine			
Re-duce			
Re-inforce			
Re-form			
Re-place	Or	Difficult	Strategically

Stay on the existing S-curve



Doing better

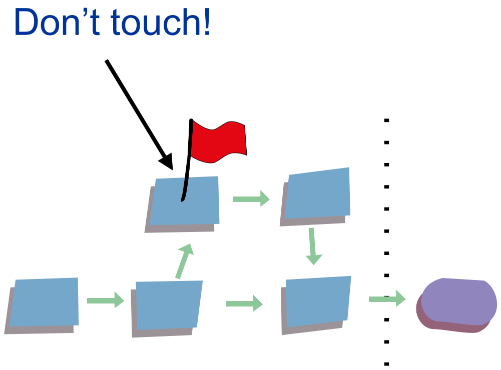
Tactic	Principle
Re-use	
Re-fine	
Re-duce	
Re-inforce	

The goal is to maximize improvements of customer value with minimum changes to the benchmark.

The Re-use tactic

The Re-use tactic:

- subsystems that are robust and have high value are carried over in the new product.
- utilize the internal and external loop.
- resist the macho attitude while trusting the learning curve.

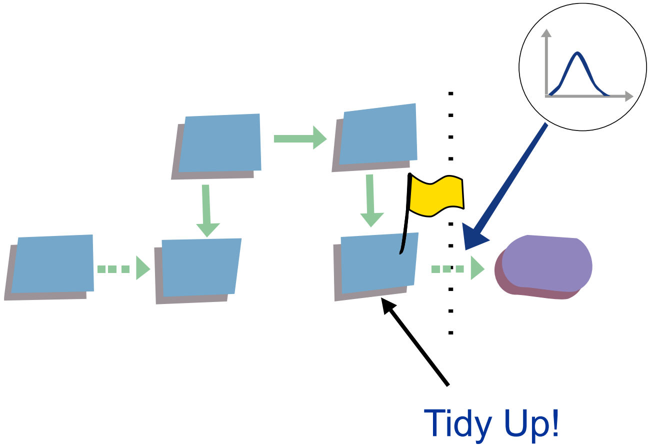


The myth that creating a WoW product requires starting from scratch on a blank sheet of paper and thinking outside the box is just that - a myth.

The Re-fine tactic

The Re-fine tactic:

- eliminates the drawbacks of nearly perfect subsystems.
- identifies candidates for re-use in future products.
- uses powerful tools such as simulations, CAD, Robust Design, FMEA, DFX, and more.

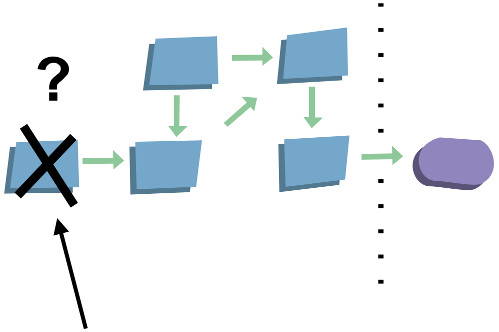


The Re-fine tactic is crucial to any continuous improvement strategy, such as Six Sigma, Kaizen, Quality Circles, or Total Quality Management.

The Re-duce tactic

The Re-duce tactic:

- streamlines the design by removing subsystems with low value.
- eliminates functional providers that are outdated quick fixes for past problems.
- acknowledges that non-existing subsystems have the highest value.



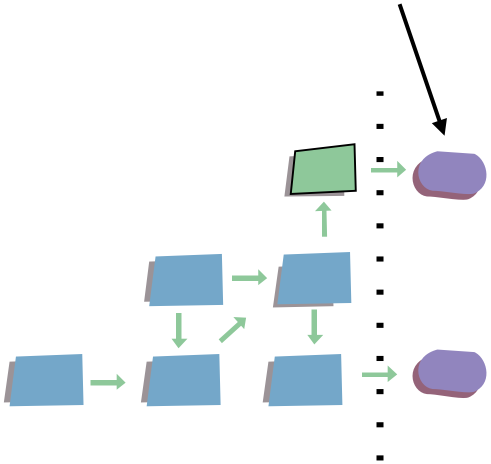
Shape Up or be designed away!

By regularly reviewing and trimming your products, they will remain competitive, efficient, and effective over time.

The Re-inforce tactic

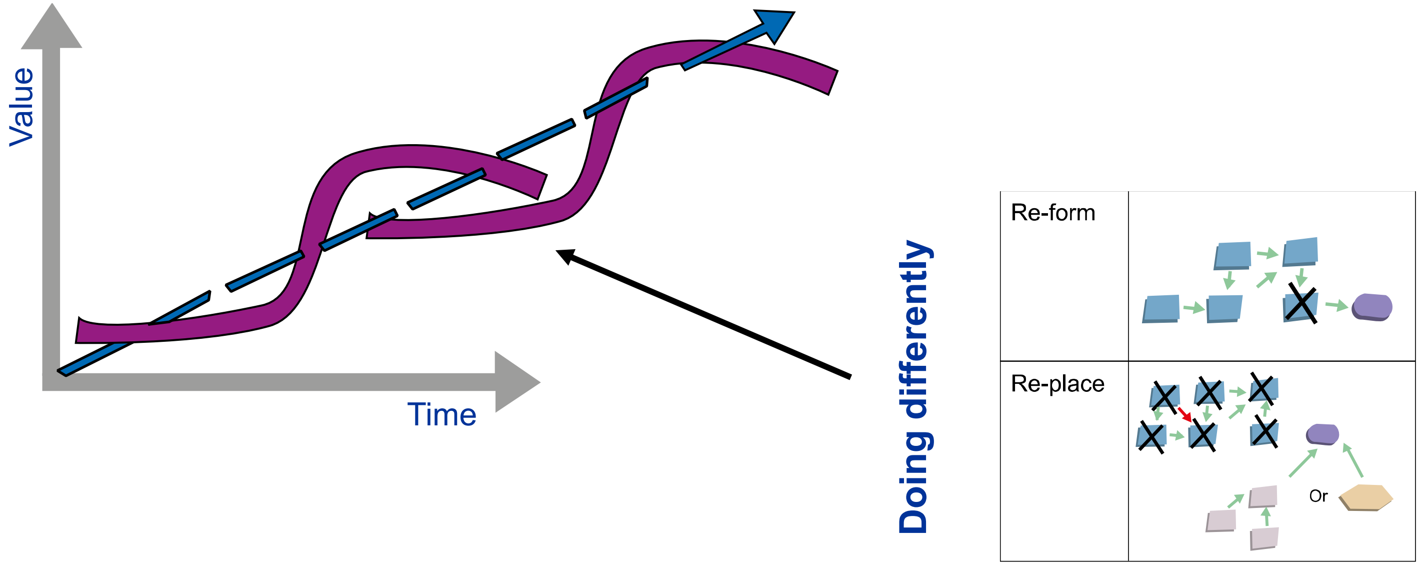
Re-inforce tactic:

- avoid using it as a quick-fix solution to solve problems.
- can provide opportunities for new Additional functions.
- must be used judiciously.



The Re-inforce tactic drives up cost and complexity, but unfortunately, it is still the most popular tactic used by development engineers.

The next S-curve



What is it that is impossible today, but would rewrite the rules if we could make it happen?

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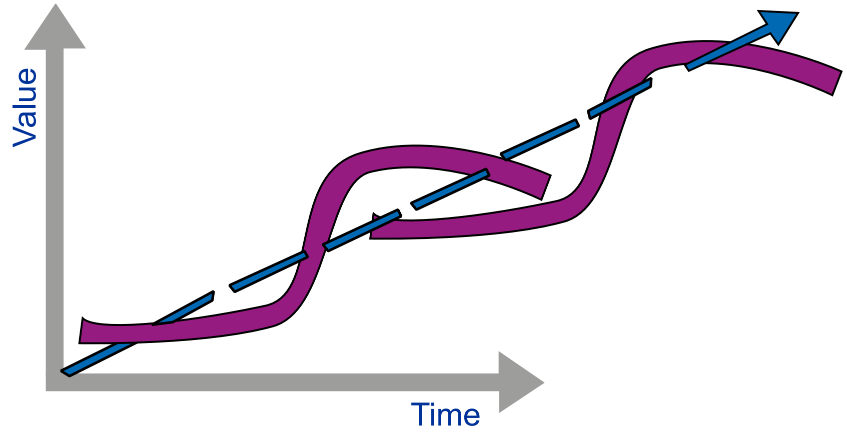
Moving to the next – S-curve



Typical mistakes made:

- spending all resources on defending the existing solution.
- the new solution has many faults and shortcomings, so the potential is underestimated.
- struggling to handle changes in the power structure within the organization.

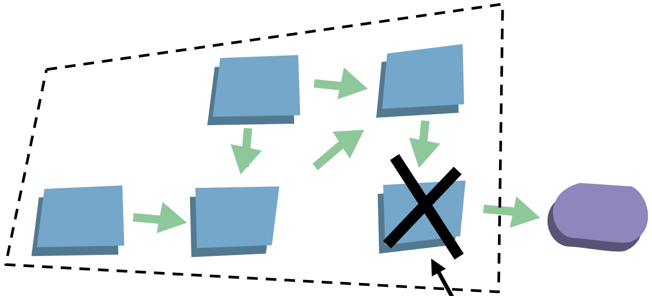
Only few organization survive a shift to the next S-curve.

When success blinds us, it becomes the foundation for future failures.

Re-form tactic

The Re-form tactic:

- aims to bring about transformative changes.
- is a powerful approach that has given birth to many innovative WoW products.
- can be complex and challenging to implement.



Modify the core!

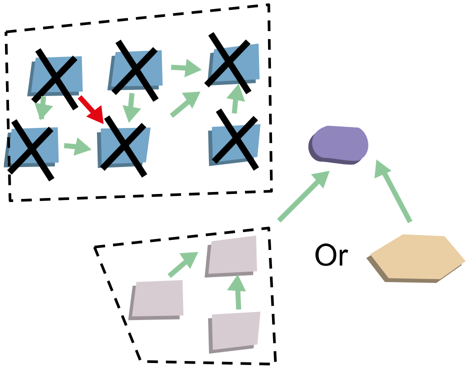
The re-form tactic thrives on curiosity, openness to new ideas, a willingness to take risks, and a spirit of experimentation.

The re-place tactic

Your product and business face constant challenges from two directions:

- the supersystem at higher hierarchical levels.
- competing solutions and rivals at the same level.

You have to build internal competition into your company's DNA.



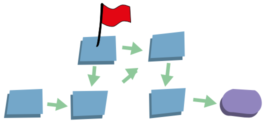
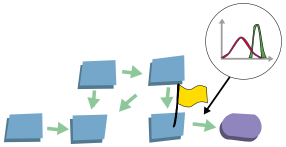
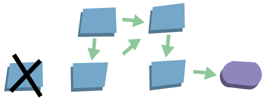
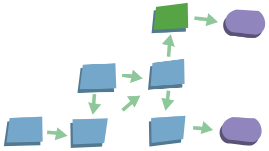
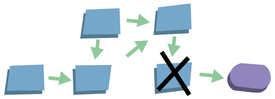
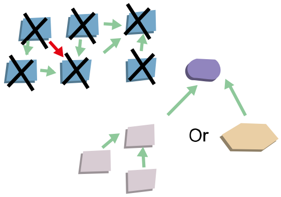
If your existing product goes extinct, it'll be because you were just too good with the new one.

The six tactics

The six tactics offer a high-level view, highlighting patterns and helping you rise above all the noise:

- try to use a minimum of three tactics in all development projects.
- all tactics must be carried out with a certain degree of regularity in your organization.

A company that masters these tactics will outperform its competitors in the long run.

Tactic	Principle	Degree of Difficulty	Degree of Usage
Re-use		**Easy**	**Frequently**
Re-fine			
Re-duce			
Re-inforce			
Re-form			
Re-place		**Difficult**	**Strategically**

The common mode of action in problem-solving

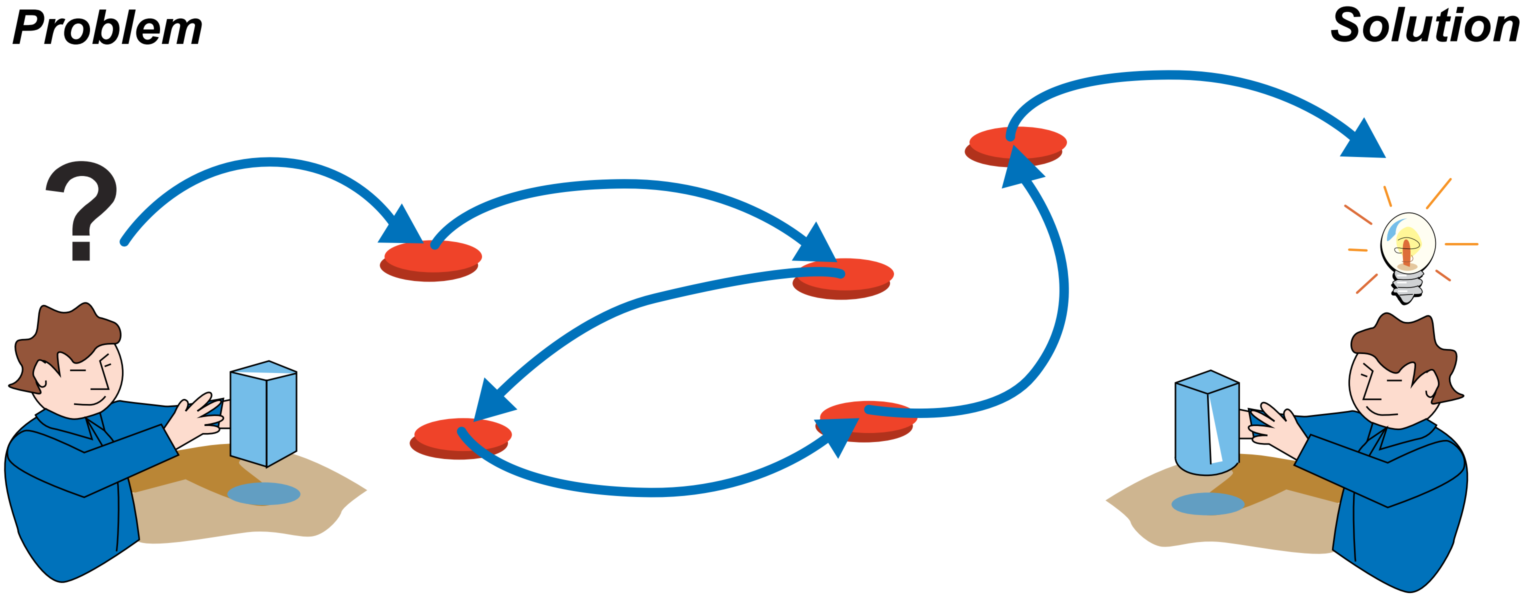
Problem

Solution

Challenges of direct problem-to-solution approaches:

- to go directly from problem to solution is common in brainstorming sessions.
- can work if you are fortunate.
- increasingly difficult when addressing complex problems.

The power of problem reformulation

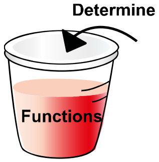


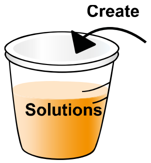
Key Features of Problem reformulation:

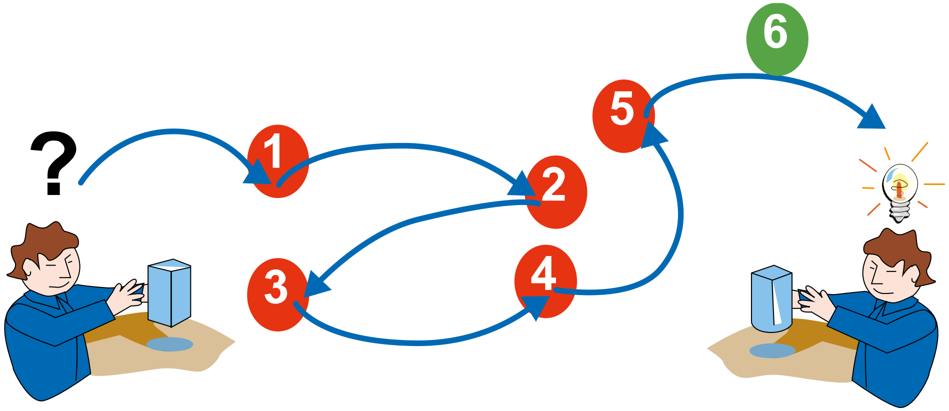
- breaks existing paradigms.
- divides the problem into smaller, manageable steps.
- expands the solution space and your options for resolution.
- encourages viewing the problem from new perspectives.

The power of problem reformulation

1. Select functional level
2. Formulate functions
3. Make simplified system architecture
4. Draw the functional model
5. Formulate value-increasing challenges
6. Go for the SOLUTION!

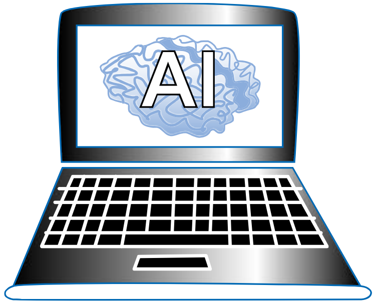






6. Go for the solution

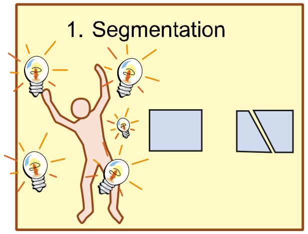
AI tools

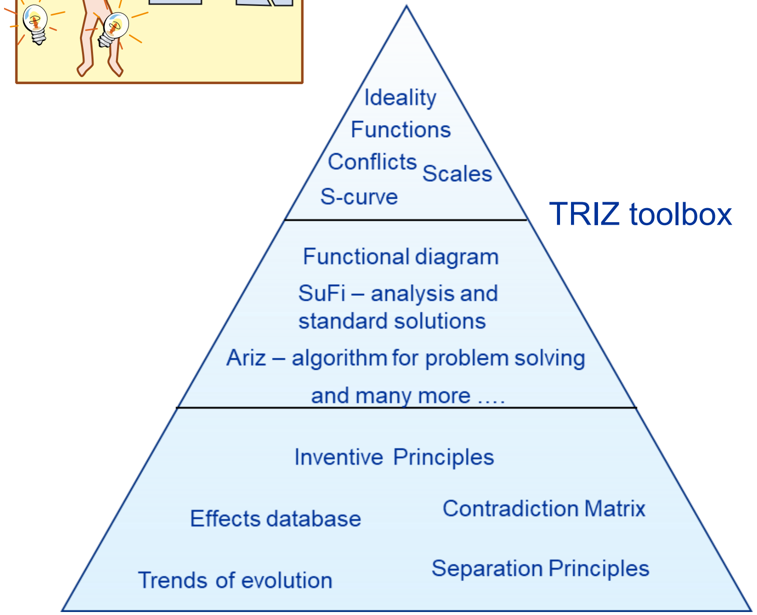


My best recommendations:

- utilize the complete TRIZ toolbox.
- employ the Value Model Mini-ARIZ.
- try powerful AI tools.
- conduct a focused brainstorming inside a new, clearly defined *“Box.”*

Focused brainstorming





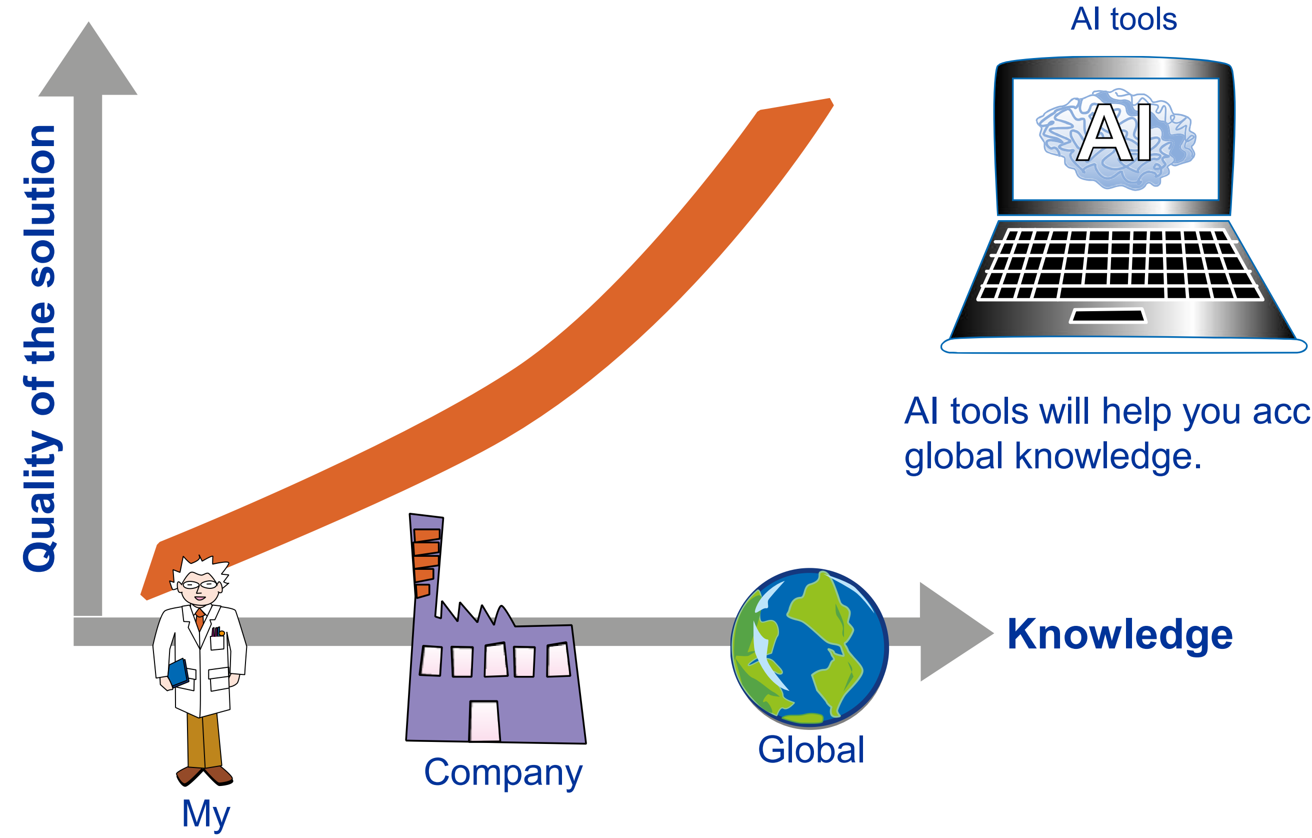
TRIZ toolbox

Ideality
Functions
Conflicts
Scales
S-curve

Functional diagram
SuFi – analysis and standard solutions
Ariz – algorithm for problem solving
and many more ….

Inventive Principles
Effects database
Contradiction Matrix
Trends of evolution
Separation Principles

Don´t reinvent the wheel



AI tools will help you access global knowledge.

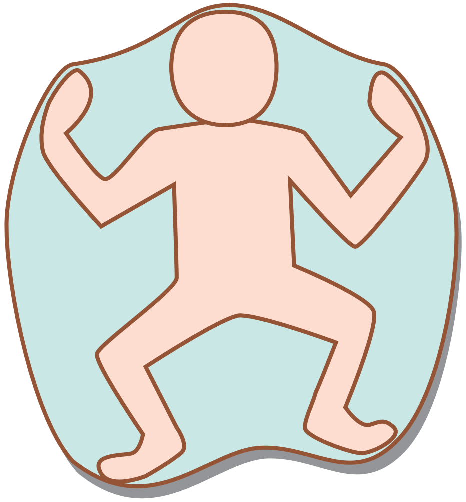
Chances are high, someone else has already solved your challenge.

Inside the *“Box”*

Why do we so easily get trapped in the box?

- chasing quick fixes.
- sticking to old paradigms.
- not wanting to challenge the organization.
- facing a shortage of time and resources?

Break the paradigm



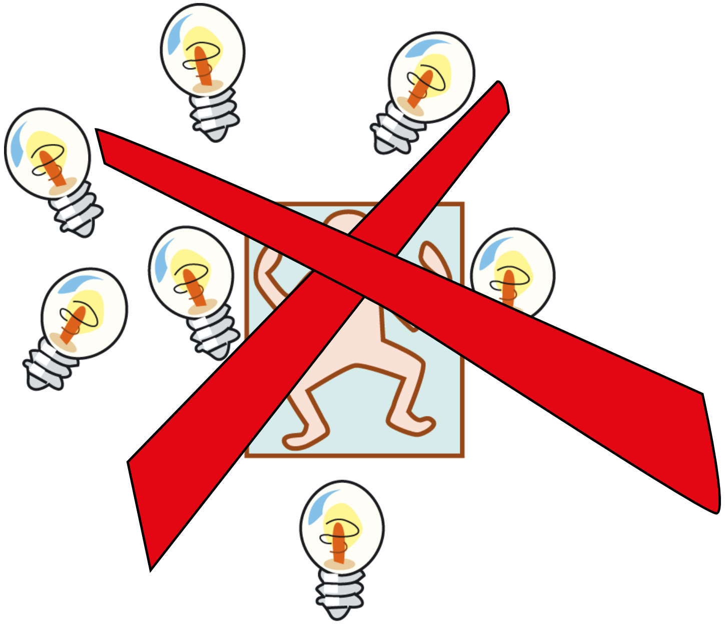
Many recommend free brainstorming and encourage people to;

“think outside the box.”

Think outside “*the box*”

Why going wild and thinking outside the box doesn’t work:

- silly ideas are welcomed, making the whole process ridiculous.
- only raw and very general ideas are generated.
- it becomes cluttered with too many ideas.
- there are problems sorting out where to go next.
- it usually ends up leading to nothing.

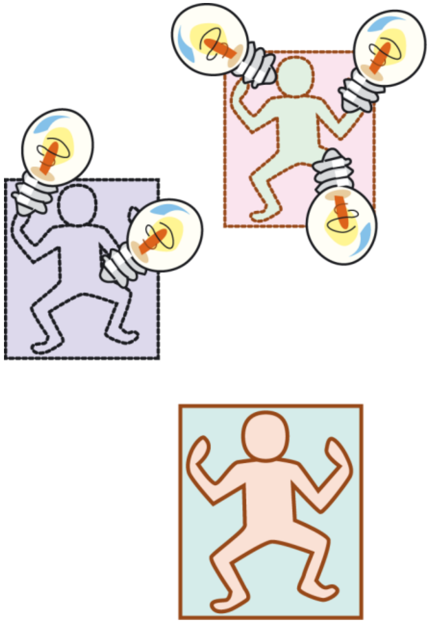


Going wild and thinking outside of the box produces mostly brain farts.

Think inside a *"new box"*

The power of Brainstorming inside a new box:

- provides structure and clarity to the brainstorming process.
- generates more precise and refined ideas.
- simplifies the task of sorting out less viable concepts.

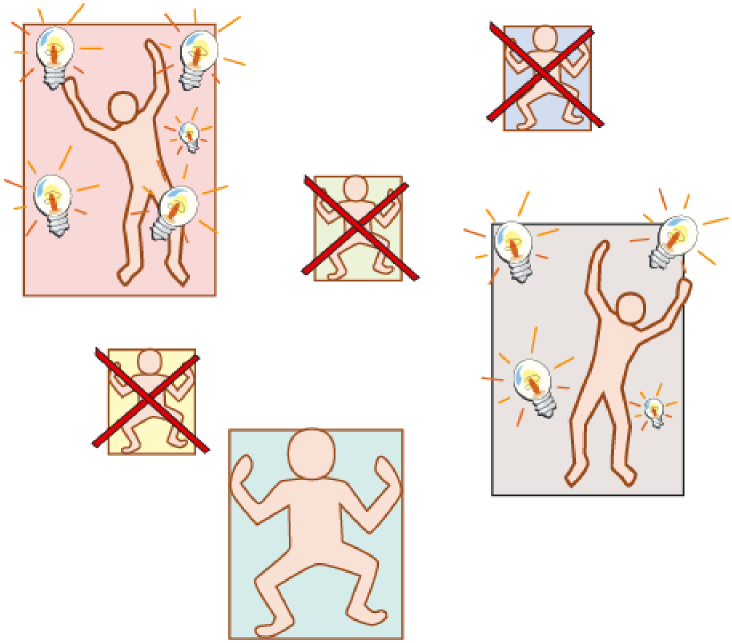


By forcing people into a new box people have never considered, you force them to "*think outside the existing box but inside a more promising box.*"

Promising new boxes

History has taught us that some boxes are more promising than others, including:

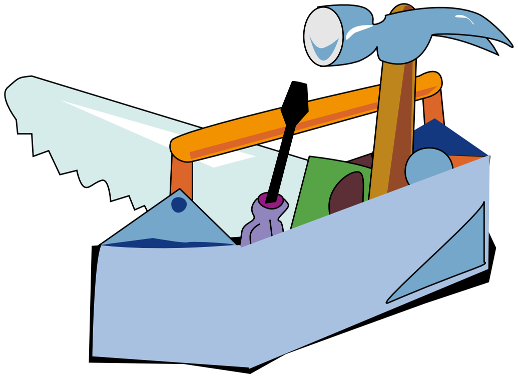
- analogies such as biomimicry.
- inventive principles in TRIZ.



Triz – a powerful toolbox

TRIZ is a toolbox for inventive solutions that:

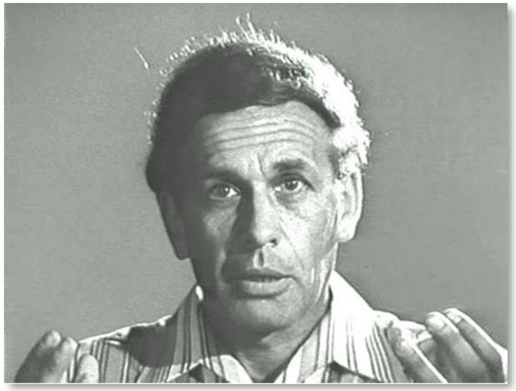
- is based on global patent analysis.
- helps solve complex technological challenges.
- provides access to global knowledge and development patterns.
- contains proven solutions for overcoming value-increasing challenges.



Historical background - Triz

TRIZ stands for the Russian acronym for the Theory of Inventive Problem Solving:

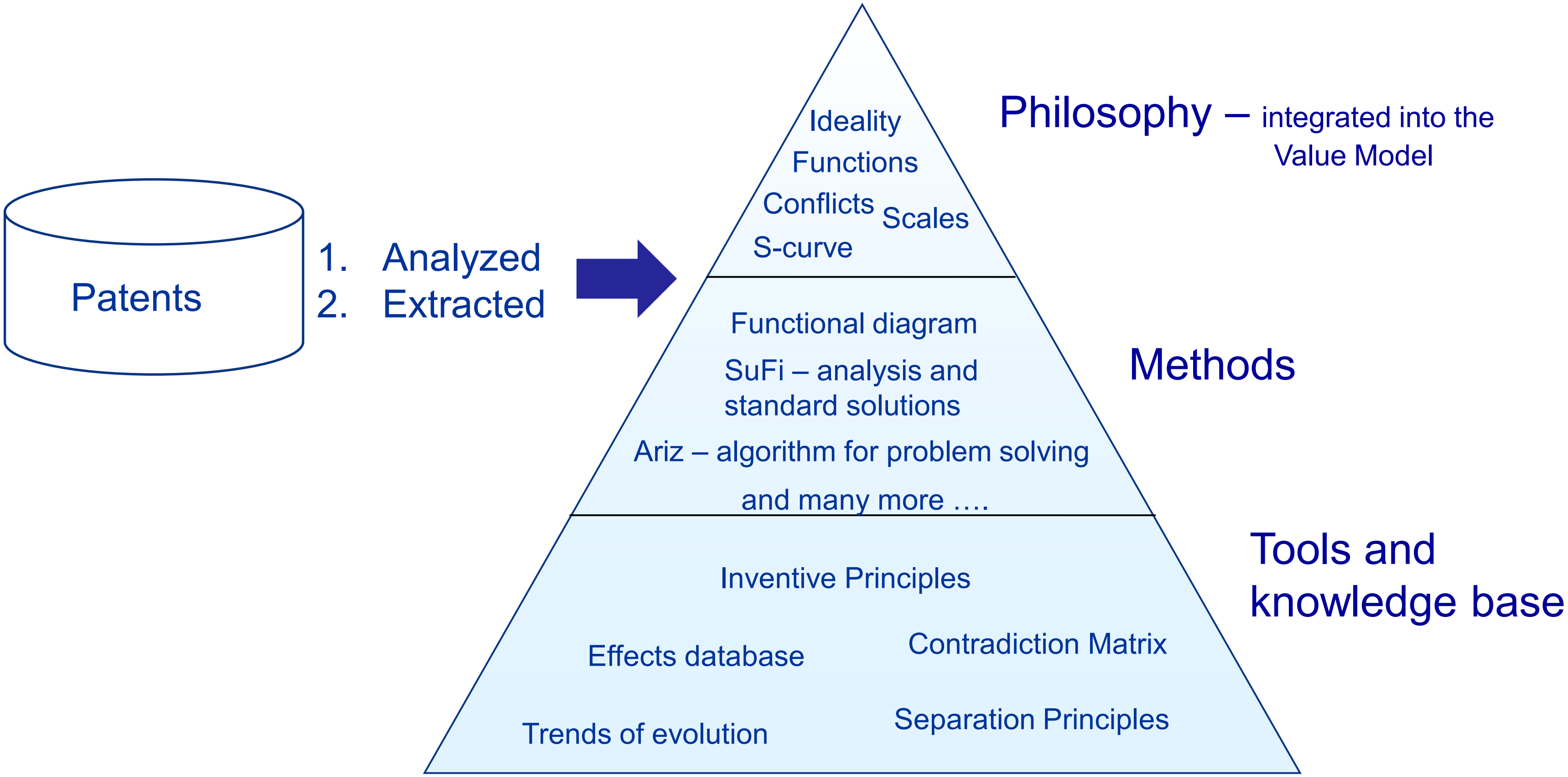
- developed in the former Soviet Union under the guidance of Genrich Altshuller (1926–1998).
- based on the study of approximately 2.5 million patents.
- migration to the West began in the mid-1990s.
- now utilized worldwide, with maybe South Korea being the largest user.



Courtesy of the TRIZ Group

He is on YouTube at https://www.youtube.com/watch?v=0wNKDwbyLmE

Triz - basic Components



Patents

1. Analyzed
2. Extracted

Ideality

Functions

Conflicts

Scales

S-curve

Philosophy – integrated into the Value Model

Functional diagram

SuFi – analysis and standard solutions

Ariz – algorithm for problem solving

and many more ….

Methods

Inventive Principles

Effects database

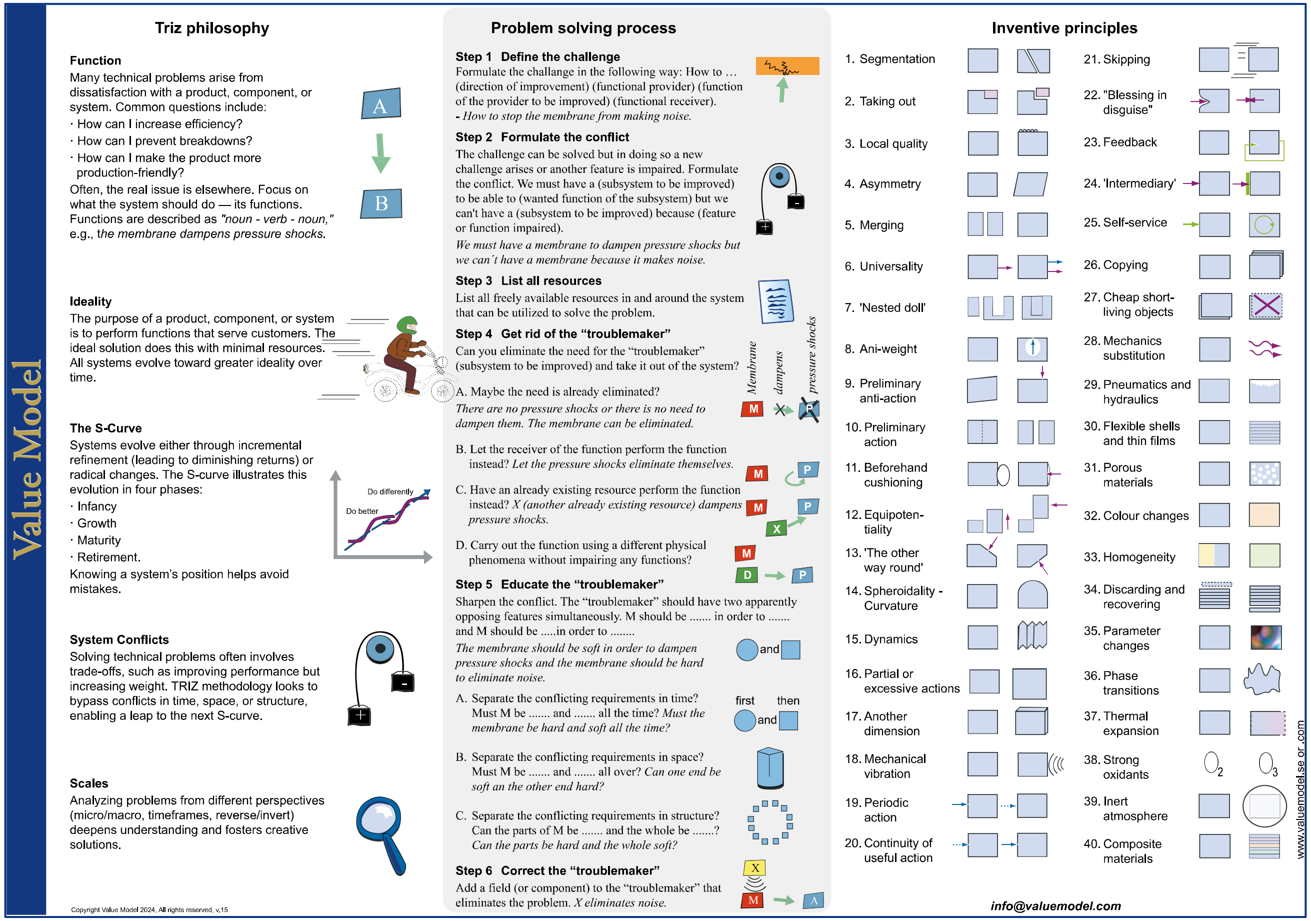
Contradiction Matrix

Trends of evolution

Separation Principles

Tools and knowledge base

Triz Road map



Value Model

Triz philosophy

Function

Many technical problems arise from dissatisfaction with a product, component, or system. Common questions include:

- How can I increase efficiency?
- How can I prevent breakdowns?
- How can I make the product more production-friendly?

Often, the real issue is elsewhere. Focus on what the system should do — its functions. Functions are described as *"noun - verb - noun,"* e.g., t*he membrane dampens pressure shocks*.

Ideality

The purpose of a product, component, or system is to perform functions that serve customers. The ideal solution does this with minimal resources. All systems evolve toward greater ideality over time.

The S-Curve

Systems evolve either through incremental refinement (leading to diminishing returns) or radical changes. The S-curve illustrates this evolution in four phases:

- Infancy
- Growth
- Maturity
- Retirement.

Knowing a system's position helps avoid mistakes.

System Conflicts

Solving technical problems often involves trade-offs, such as improving performance but increasing weight. TRIZ methodology looks to bypass conflicts in time, space, or structure, enabling a leap to the next S-curve.

Scales

Analyzing problems from different perspectives (micro/macro, timeframes, reverse/invert) deepens understanding and fosters creative solutions.

Problem solving process

Step 1 Define the challenge

Formulate the challange in the following way: How to … (direction of improvement) (functional provider) (function of the provider to be improved) (functional receiver).

- *How to stop the membrane from making noise.*

Step 2 Formulate the conflict

The challenge can be solved but in doing so a new challenge arises or another feature is impaired. Formulate the conflict. We must have a (subsystem to be improved) to be able to (wanted function of the subsystem) but we can't have a (subsystem to be improved) because (feature or function impaired).

We must have a membrane to dampen pressure shocks but we can´t have a membrane because it makes noise.

Step 3 List all resources

List all freely available resources in and around the system that can be utilized to solve the problem.

Step 4 Get rid of the "troublemaker"

Can you eliminate the need for the "troublemaker" (subsystem to be improved) and take it out of the system?

A. Maybe the need is already eliminated?

There are no pressure shocks or there is no need to dampen them. The membrane can be eliminated.

B. Let the receiver of the function perform the function instead? *Let the pressure shocks eliminate themselves.*

C. Have an already existing resource perform the function instead? *X (another already existing resource) dampens pressure shocks.*

D. Carry out the function using a different physical phenomena without impairing any functions?

Step 5 Educate the "troublemaker"

Sharpen the conflict. The "troublemaker" should have two apparently opposing features simultaneously. M should be .... in order to .... and M should be .....in order to ....

The membrane should be soft in order to dampen pressure shocks and the membrane should be hard to eliminate noise.

A. Separate the conflicting requirements in time? Must M be .... and .... all the time? *Must the membrane be hard and soft all the time?*

B. Separate the conflicting requirements in space? Must M be .... and .... all over? *Can one end be soft an the other end hard?*

C. Separate the conflicting requirements in structure? Can the parts of M be .... and the whole be ....? *Can the parts be hard and the whole soft?*

Step 6 Correct the "troublemaker"

Add a field (or component) to the "troublemaker" that eliminates the problem. *X eliminates noise.*

Inventive principles

1. Segmentation
2. Taking out
3. Local quality
4. Asymmetry
5. Merging
6. Universality
7. 'Nested doll'
8. Ani-weight
9. Preliminary anti-action
10. Preliminary action
11. Beforehand cushioning
12. Equipotentiality
13. 'The other way round'
14. Spheroidality - Curvature
15. Dynamics
16. Partial or excessive actions
17. Another dimension
18. Mechanical vibration
19. Periodic action
20. Continuity of useful action
21. Skipping
22. "Blessing in disguise"
23. Feedback
24. 'Intermediary'
25. Self-service
26. Copying
27. Cheap short-living objects
28. Mechanics substitution
29. Pneumatics and hydraulics
30. Flexible shells and thin films
31. Porous materials
32. Colour changes
33. Homogeneity
34. Discarding and recovering
35. Parameter changes
36. Phase transitions
37. Thermal expansion
38. Strong oxidants
39. Inert atmosphere
40. Composite materials

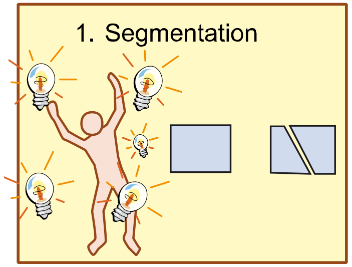
www.valuemodel.se or .com

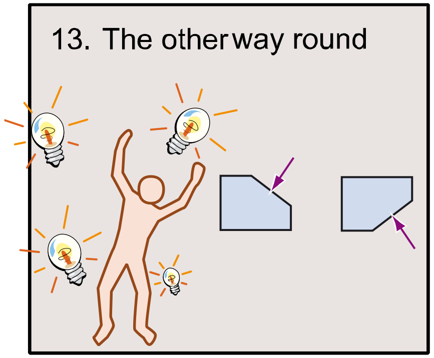
info@valuemodel.com

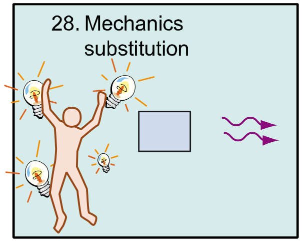
Can be downloaded for free.

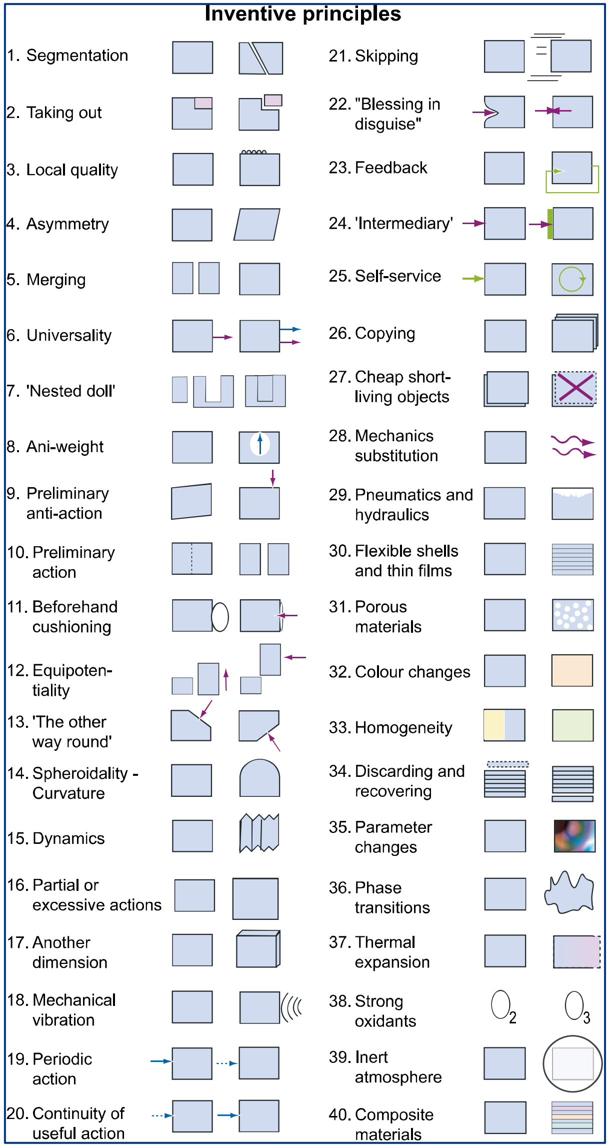
Inventive principles - Triz

It is highly probable that the solution to your challenge is concealed within one of the principles, making it ideal for focused brainstorming.









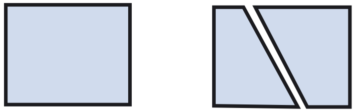
Inventive principles

1. Segmentation
2. Taking out
3. Local quality
4. Asymmetry
5. Merging
6. Universality
7. 'Nested doll'
8. Ani-weight
9. Preliminary anti-action
10. Preliminary action
11. Beforehand cushioning
12. Equipotentiality
13. 'The other way round'
14. Spheroidality - Curvature
15. Dynamics
16. Partial or excessive actions
17. Another dimension
18. Mechanical vibration
19. Periodic action
20. Continuity of useful action
21. Skipping
22. "Blessing in disguise"
23. Feedback
24. 'Intermediary'
25. Self-service
26. Copying
27. Cheap short-living objects
28. Mechanics substitution
29. Pneumatics and hydraulics
30. Flexible shells and thin films
31. Porous materials
32. Colour changes
33. Homogeneity
34. Discarding and recovering
35. Parameter changes
36. Phase transitions
37. Thermal expansion
38. Strong oxidants
39. Inert atmosphere
40. Composite materials

Example inventive principle - 1. Segmentation

Segmentation is one of the most commonly used principles for innovative solutions:

- divide the product into several subsystems to enhance functionality and manageability.
- enable the parts to *"move"* relative to each other, allowing for improved adaptability and performance.



Roxtec 1990

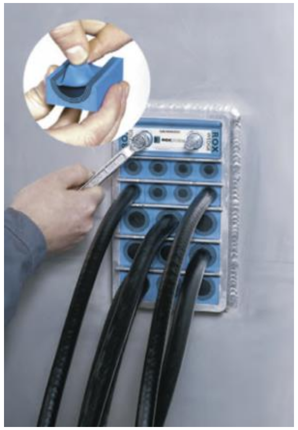
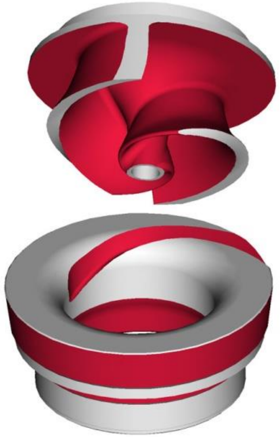


Photo used with permission of Roxtec

Xylem 2013



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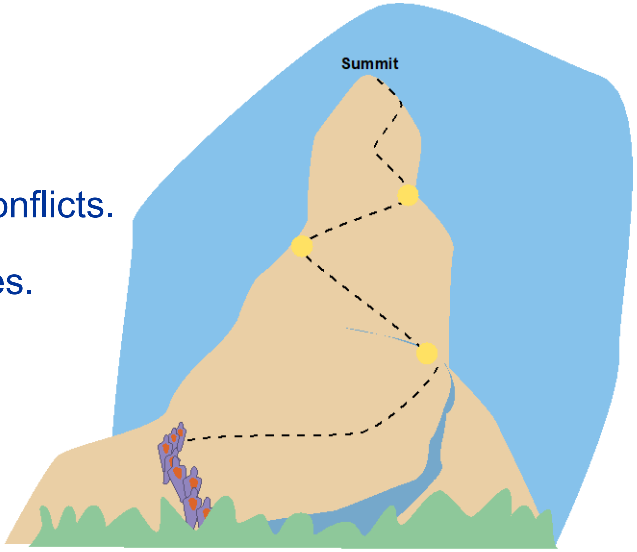
TRIZ - Trends of evolution

The trends of evolution can be classified into ten principal areas, each one containing several subsections. For example:

- mono to poly systems.
- rigid to segmented and flexible systems.
- improved utilization of existing resources.
- applying separation principles to overcome feature conflicts.
- use more effective phenomena and physical principles.

Mount Customer Value



Products utilize different trends, but all products are on the way to the summit.

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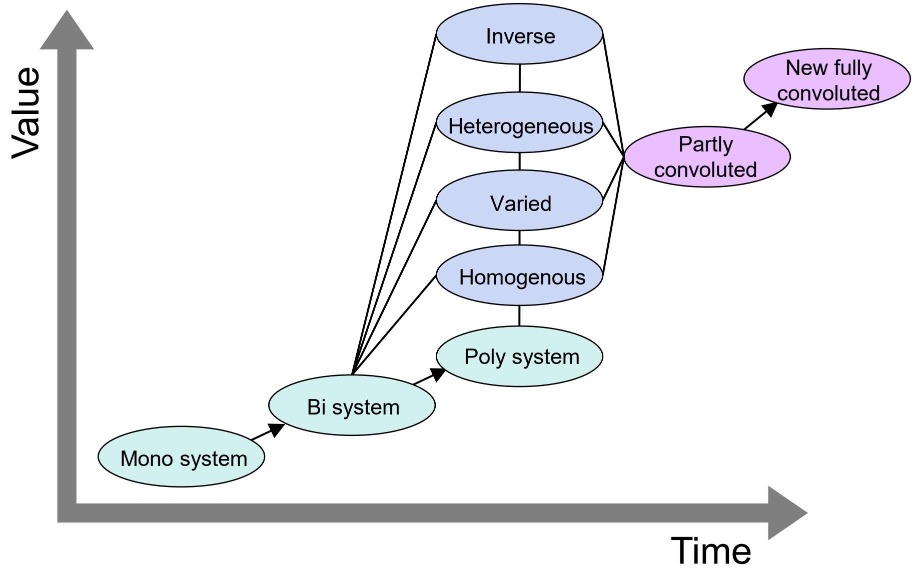
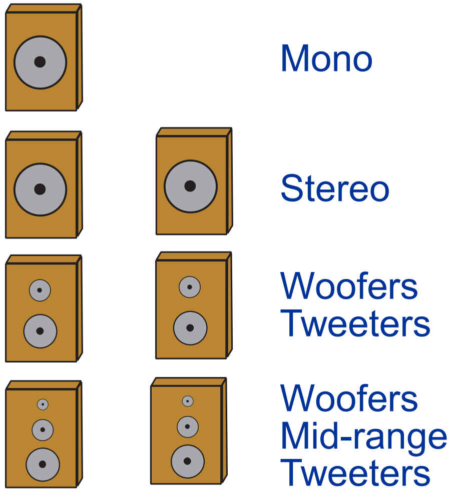
Example - From mono to bi and poly products

Very common trend!



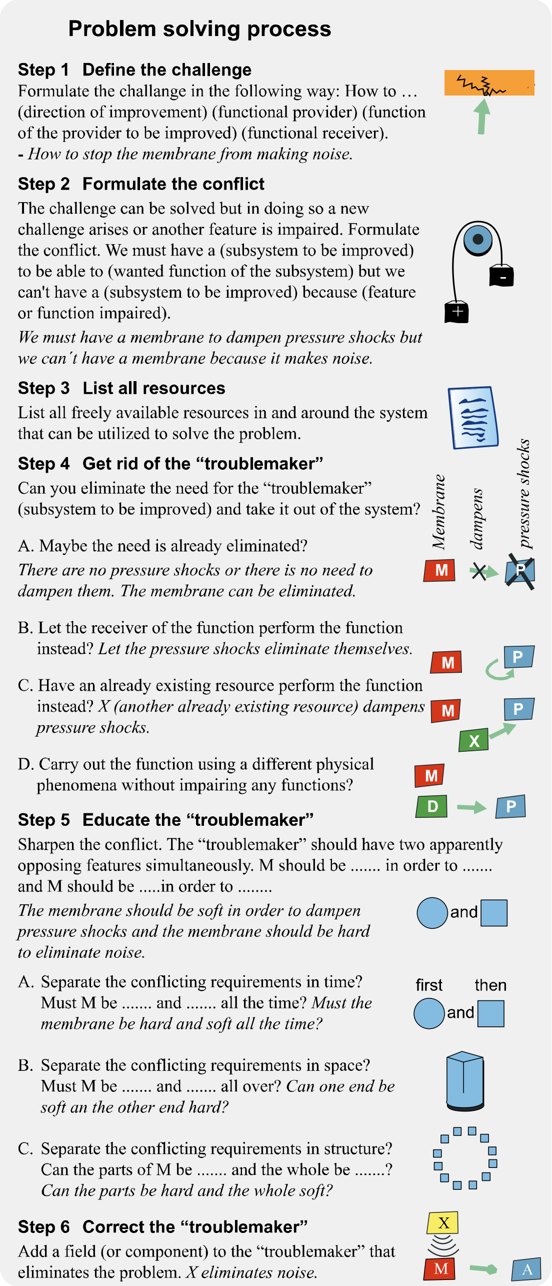
Loudspeakers



Introduction to Mini-ARIZ

The Mini-ARIZ:

- is a simplified version of the full ARIZ.
- is less powerful for solving technical challenges.
- offers greater intuitiveness and ease of learning.
- excellent first step to learning the full ARIZ.



Problem solving process

Step 1 Define the challenge

Formulate the challange in the following way: How to … (direction of improvement) (functional provider) (function of the provider to be improved) (functional receiver).

- *How to stop the membrane from making noise.*

Step 2 Formulate the conflict

The challenge can be solved but in doing so a new challenge arises or another feature is impaired. Formulate the conflict. We must have a (subsystem to be improved) to be able to (wanted function of the subsystem) but we can't have a (subsystem to be improved) because (feature or function impaired).

We must have a membrane to dampen pressure shocks but we can´t have a membrane because it makes noise.

Step 3 List all resources

List all freely available resources in and around the system that can be utilized to solve the problem.

Step 4 Get rid of the "troublemaker"

Can you eliminate the need for the "troublemaker" (subsystem to be improved) and take it out of the system?

A. Maybe the need is already eliminated?

There are no pressure shocks or there is no need to dampen them. The membrane can be eliminated.

B. Let the receiver of the function perform the function instead? *Let the pressure shocks eliminate themselves.*

C. Have an already existing resource perform the function instead? *X (another already existing resource) dampens pressure shocks.*

D. Carry out the function using a different physical phenomena without impairing any functions?

Step 5 Educate the "troublemaker"

Sharpen the conflict. The "troublemaker" should have two apparently opposing features simultaneously. M should be .... in order to .... and M should be .....in order to ....

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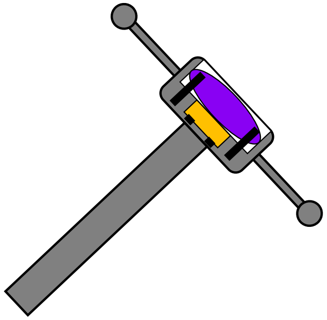
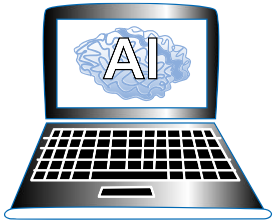
Add a field (or component) to the "troublemaker" that eliminates the problem. *X eliminates noise.*

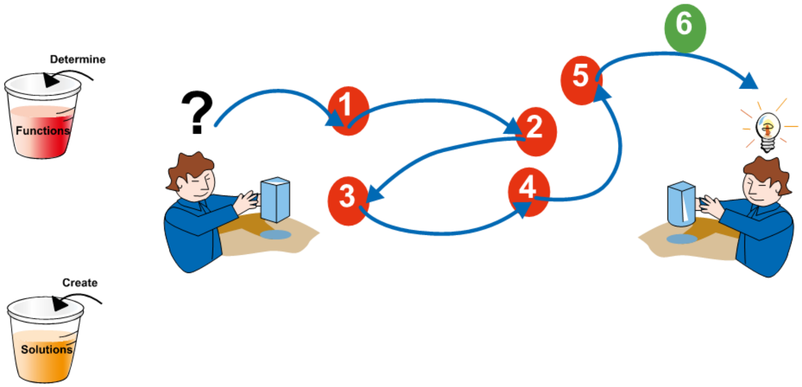
Airbag-example

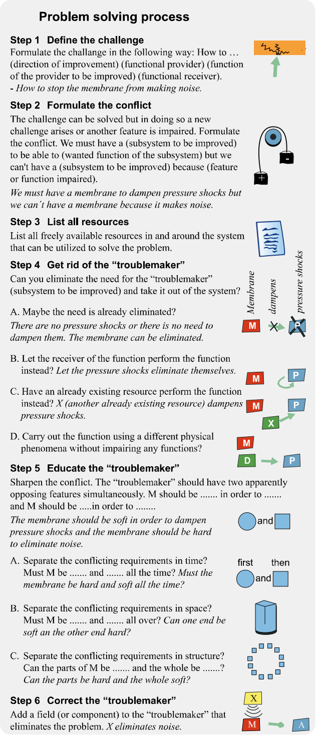


This example will exemplify this principle for solving value-increasing challenges.



1. **Select functional level**
2. **Formulate functions**
3. **Make simplified system architecture**
4. **Draw the functional model**
5. **Formulate value-increasing challenges**
6. **Go for the SOLUTION!**





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Step 1 Define the challenge
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- *How to stop the membrane from making noise.*

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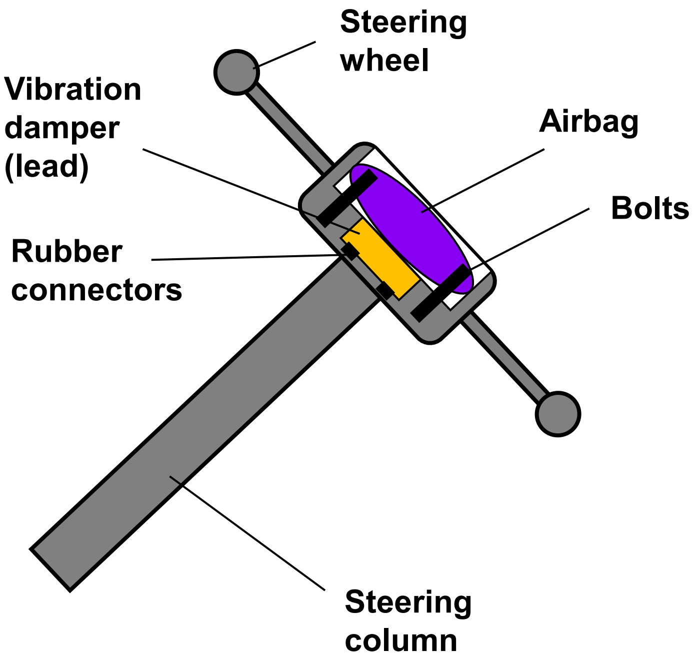
Step 6 Correct the "troublemaker"
Add a field (or component) to the "troublemaker" that eliminates the problem. *X eliminates noise.*

Example - Airbag



Compact cars are usually powered by four-cylinder engines that have intense second order vibrations.

A compact car was equipped with a driver air bag. The steering column without the air bag had its natural frequency well outside the idle RPM, but bolting the heavy (~1.6 kg) air bag to the steering wheel substantially reduced its natural frequency. As a result, the steering wheel started shaking with large amplitudes at the idle engine RPM.

The shake was so intense that the car could not be put into production before a dynamic vibration absorber (~0.5 kg of lead) was installed inside of the steering wheel and attached to the steering column by tuned rubber connectors. The lead absorber reduced the shake marginally.

To abate the shake effectively, the absorber had to be at least 4-5 times heavier (2-2.5 kg), but there was no space available for so large chunk of lead. The situation triggers customers’ complaints and high warranty costs.

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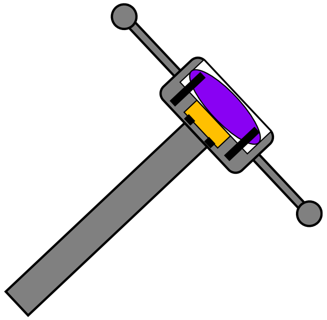
1. Select functional level



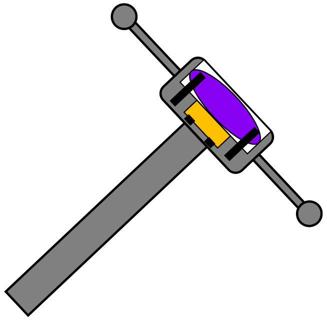
Customer The steering system controls the car.

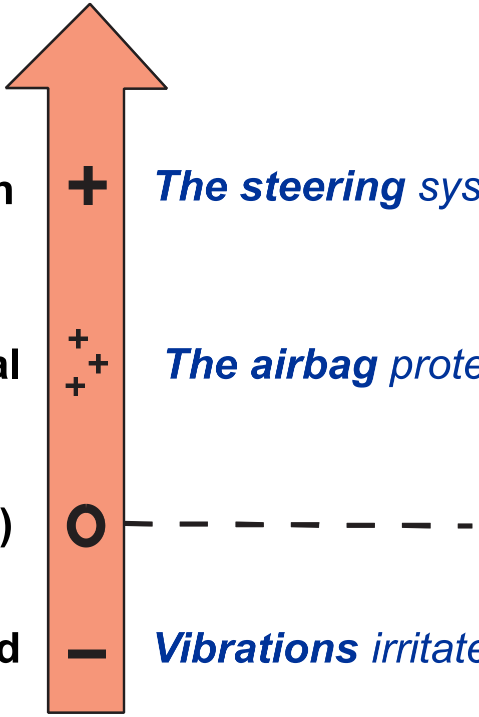
Selected.

Technical The steering wheel turns the steering column.

Physical The torque (rotation) turns the front wheels.

2. Formulate the functions





Main + *The **steering** system controls the **car.***

Additional + + + *The **airbag** protects the **driver.***

(Support) O

Unwanted − ***Vibrations** irritate the **driver.***

Goal - to eliminate the unwanted function.

3. Simplified System architecture

Super super system (Outside system)

- Car
- Road
- …

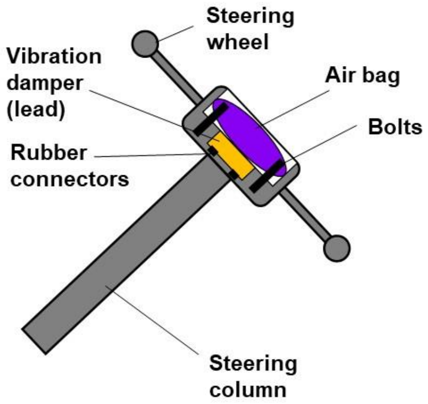
Super system (Outside system)

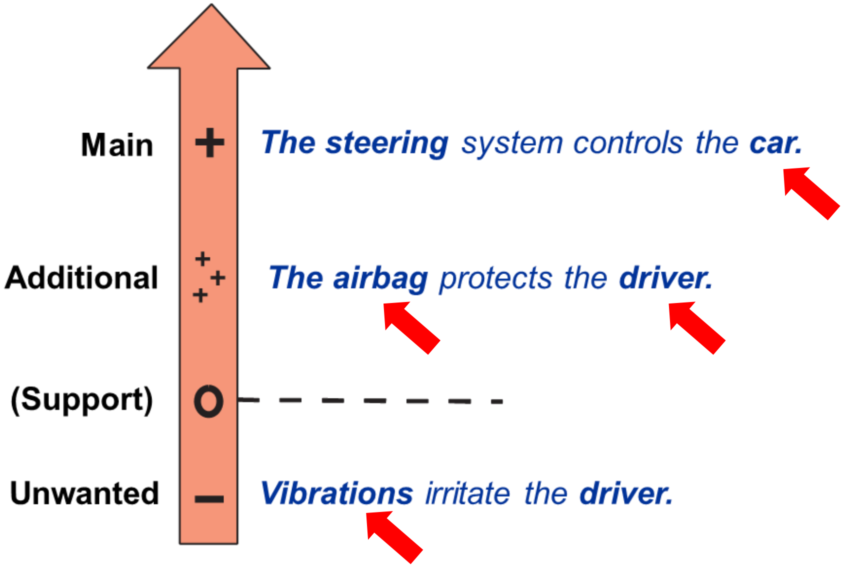
- Engine
- Driver
- Front wheels
- Body

….

System level (Steering system)

- Steering wheel
- Steering column
- Airbag (airbag + bolts)
- Rubber connectors
- Vibration damper (lead)
- Vibrations (Not on bill of materials)





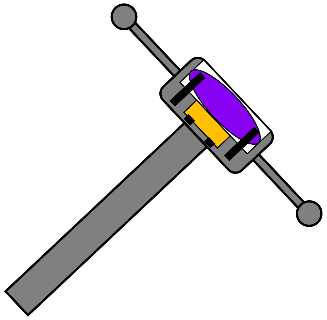
Main + ***The steering*** *system controls the* ***car.***

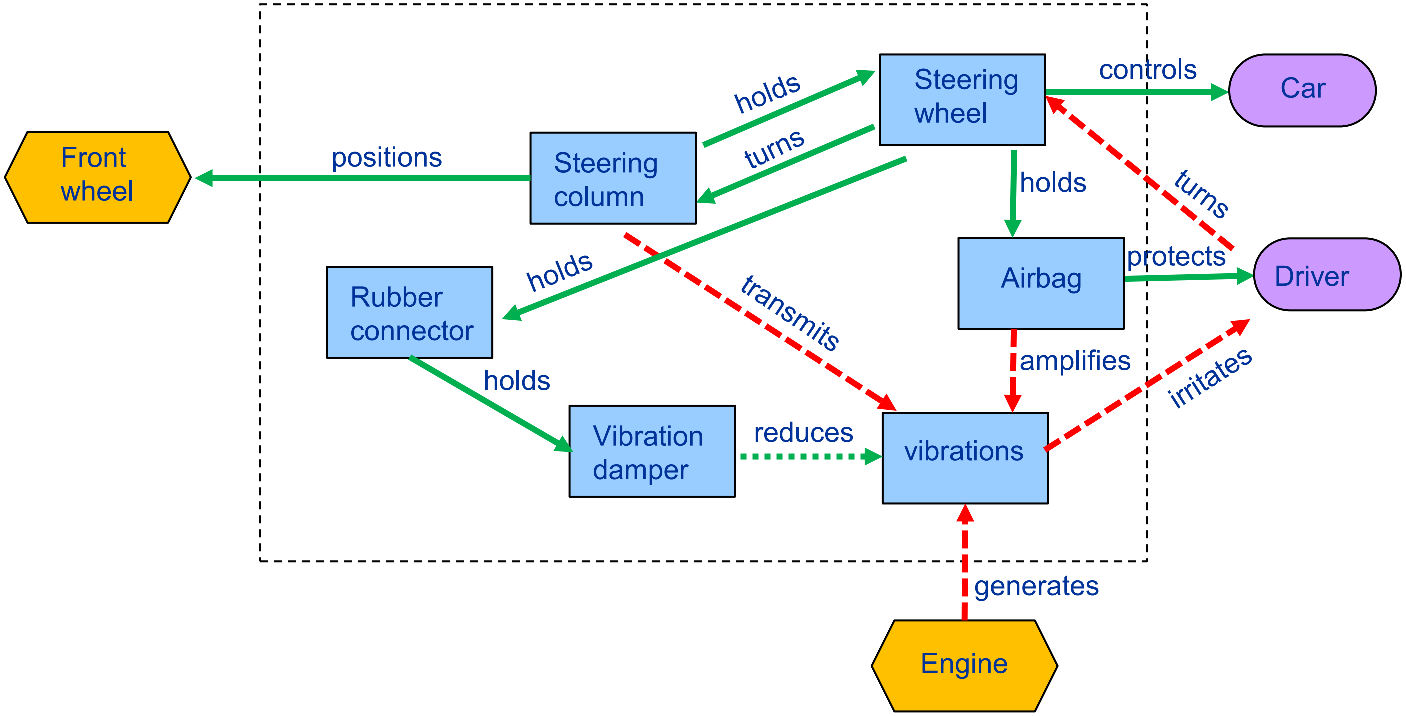
Additional +++ ***The airbag*** *protects the* ***driver.***

(Support) O

Unwanted – ***Vibrations*** *irritate the* ***driver.***

4. Draw the functional model





Steering wheel

Car

Steering column

Front wheel

Airbag

Driver

Rubber connector

Vibration damper

vibrations

Engine

controls

holds

turns

positions

holds

holds

turns

protects

transmits

amplifies

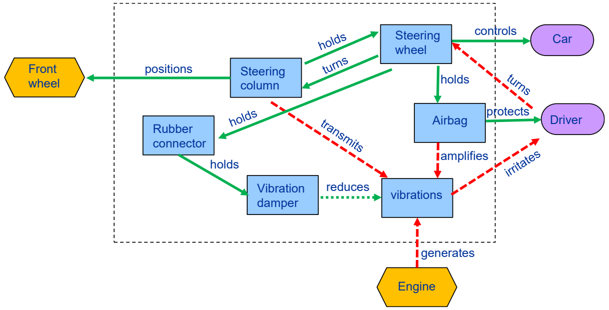
irritates

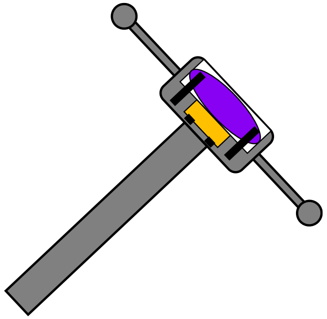
holds

reduces

generates

5. Formulate value-increasing challenges





Mini-problem (the system remains unchanged or even simplified)

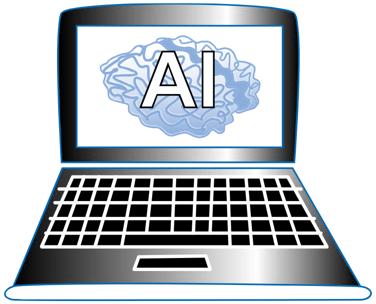
1. *How to prevent vibrations from irritating the driver?*
2. *How to prevent the airbag from amplifying vibrations?*
3. *How to increase the vibration damper's ability to reduce vibrations?*
4. *How to stop the steering column from transmitting vibrations?*
5. *How to eliminate the need for the driver to turn the steering wheel?*

Maxi-problem (the problem is solved at a higher hierarchical level)

1. *How to stop the engine from generating vibrations?*

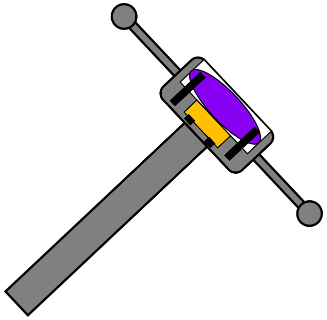
All your options!

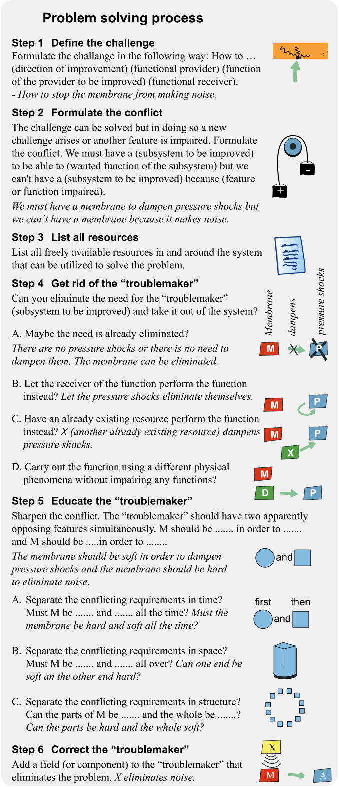
6. Go for solution



This will demonstrate how you can use:

- A powerful AI tool to generate innovative solutions.
- The Mini-ARIZ to create effective solutions.





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Step 6 Correct the "troublemaker"

Add a field (or component) to the "troublemaker" that eliminates the problem. *X eliminates noise.*

Use of AI tools

Suggested solutions by AI:

1.Damping materials: Use damping materials or inserts inside or around the airbag.

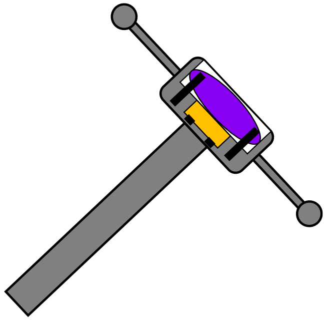
2.Tune the airbag pressure: Adjust the internal pressure of the airbag.

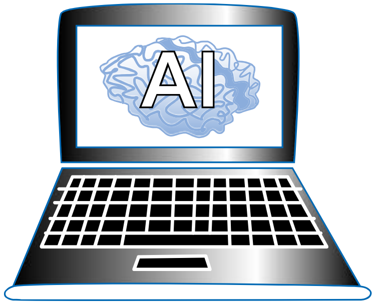
3.Isolate the airbag from vibration sources: Use vibration isolators or mounts to separate the airbag from the source of vibrations.

4.Frequency matching (tuning): Match the natural frequency of the airbag system with a non-critical frequency.

5.Multi-Chamber airbag design: Implement a multi-chamber or compartmentalized airbag design.

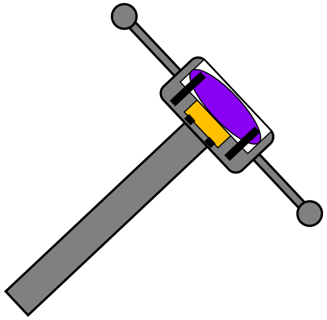
6.Use active vibration control systems: In advanced applications, use active vibration control systems like active suspension systems.





More powerful in the future!

Use the Mini-ARIZ



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Membrane
dampens
pressure shocks
M
P

A. Maybe the need is already eliminated? *There are no pressure shocks or there is no need to dampen them. The membrane can be eliminated.*

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○ and □

A. Separate the conflicting requirements in time? Must M be .... and .... all the time? *Must the membrane be hard and soft all the time?*

first then
○ and □

B. Separate the conflicting requirements in space? Must M be .... and .... all over? *Can one end be soft an the other end hard?*

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Add a field (or component) to the "troublemaker" that eliminates the problem. *X eliminates noise.*

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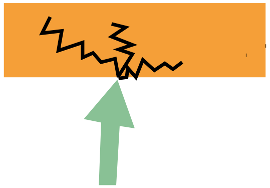


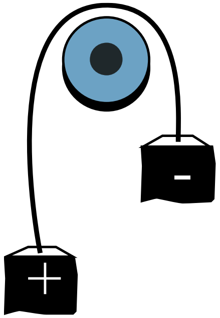
Formulate the challenge in the following way:

- How to (define direction of improvement) (subsystem to be improved) (function of the subsystem to be improved).

3. How to increase the vibration damper's ability to reduce vibrations?

Number 3 of Value-increasing challenges.

Step 2 Formulate the conflict



The challenge can be solved but in doing so a new challenge arises or another feature is impaired. Formulate the conflict:

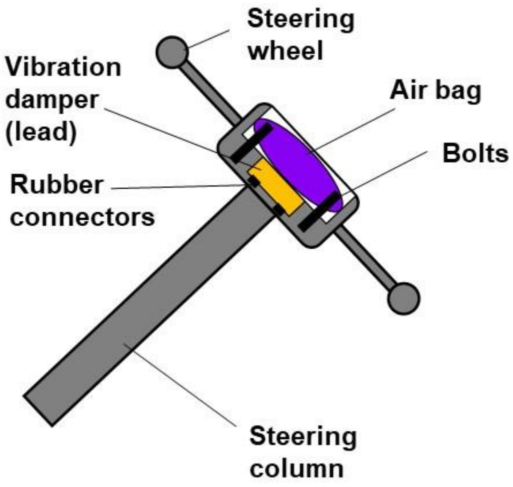
- We must have a (subsystem to be improved) to be able to (wanted function of the subsystem) but we can't have a (subsystem to be improved) because (feature or function impaired).

We must have a vibration dampener to be able to reduce vibrations, but we can´t have a vibration dampener because its to big.

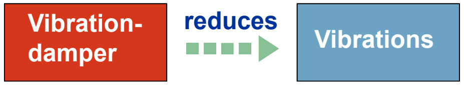
Step 3 List all resources

List all freely available resources in and around the system that can be utilized to solve the problem.

- Steering wheel
- Steering column
- Airbag
- Bolts
- Rubber connectors
- Vibration damper (lead)
- Vibrations
- Driver
- Car
- Engine
- Void
- Electricity
- Gravitation
- Rotation (of steering wheel)
- Many systems in the car …

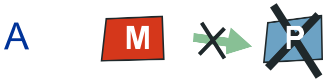


Step 4 Get rid of the troublemaker

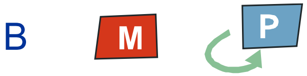


Can you eliminate the need for the “troublemaker” (subsystem to be improved) and take it out of the system?

A. Maybe the need is already eliminated?
There are no vibrations or there is no need to reduce them. The vibration dampener can be eliminated.

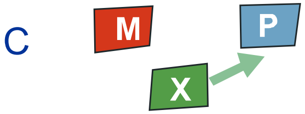


B. Let the receiver of the function perform the function instead?
Let the vibrations reduce themselves.

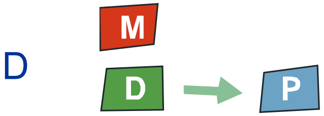


C. Have an already existing resource perform the function instead?

- *Steering wheel reduces vibrations.*
- *Steering column reduces vibrations.*
- *Airbag reduces vibrations.*
- *Rubber connectors reduces vibrations.*
- *Driver reduces vibrations.*
- *System already existing in the car reduces vibrations.*
- *X (a new component) reduces the vibrations.*



D. Carry out the function using a different physical phenomena without impairing any functions?



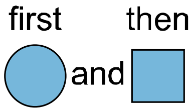
Step 5 Educate the troublemaker

Sharpen the conflict. The “troublemaker” should have two apparently opposing features simultaneously. M should be .... to .... and M should be .....in order to ....

- *The vibration dampener should be big (heavy) to reduce vibrations, and the vibrations dampener should be small(light) to fit into the steering wheel.*

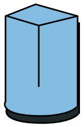
Separate the conflicting requirements in time? Must M be .... and .... all the time?

- *Must the vibrations dampener be big and small all the time?*



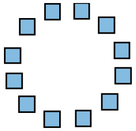
Separate the conflicting requirements in space? Must M be .... and .... all over?

- *Can one part (end) of the dampener be big and another part (end) be small?*



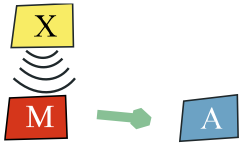
Separate the conflicting requirements in structure? Can the parts of M be .... and the whole be ....?

- *Can the parts be small and the whole big?*



Step 6 Correct the troublemaker

Add a field (or component) to the "troublemaker" that eliminates the problem.



X reduce vibrations.

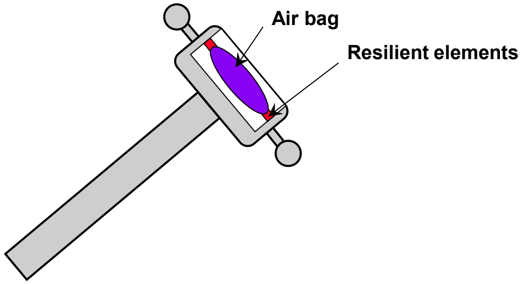
X a new component (subsystem) introduced in the system or using an existing component in the car outside the system.

Solutions – presented by the Triz Group

Solution Step 4 C (Inside system)

- Use of the air bag as the vibration absorber mass by attaching it to the steering wheel via tuned resilient elements.

- The lead-based absorber can be eliminated , thus reducing both costs and environmental hazards.



Solution Step 4 C (Outside system)

- Alternative solutions is to use the battery or the spare wheel as vibration absorbers.

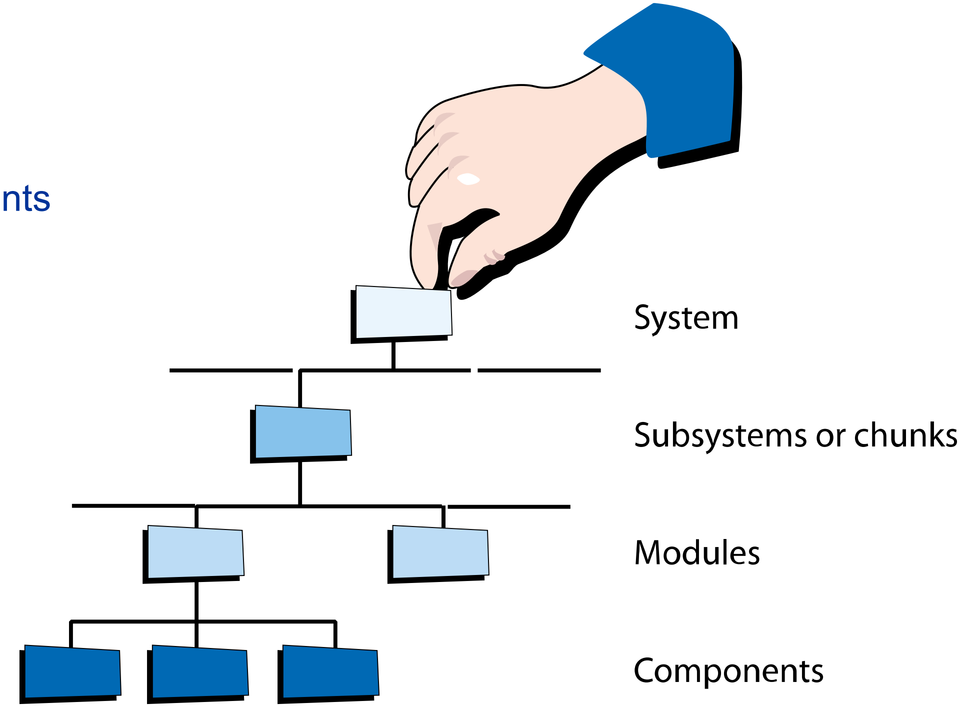
Company investigations:

- Mounting the airbag on resilient elements didn't affect the performance of the airbag.
- The steering wheel vibrations could be reduced by 6 to 7 times.
- This solution was implemented.

System Architecture

Understanding System Architecture:

- a structuring of the different functional elements in a product into separate building blocks.
- like an invisible hand, it is critical for future success.
- requires a holistic perspective to avoid sub-optimization.



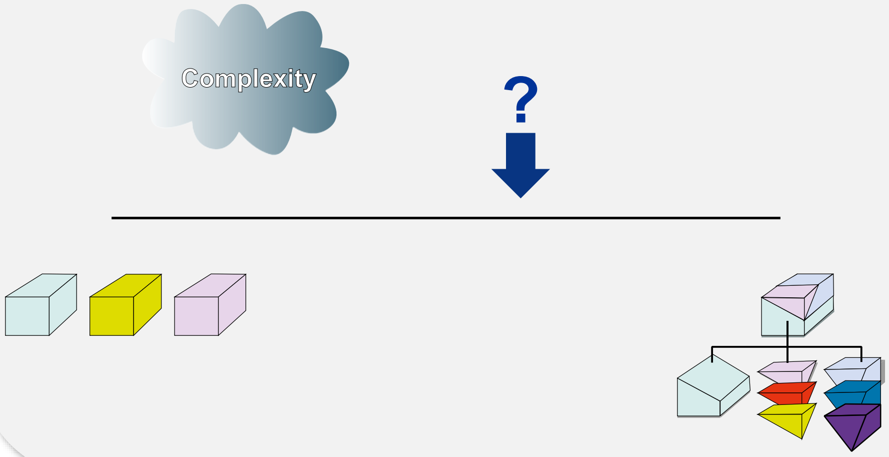
The system architecture can guide your project and business case around potential pitfalls or steer it straight into trouble.

From totally integral to fully modular

Complexity of compromising four incompatible goals for the product architecture:

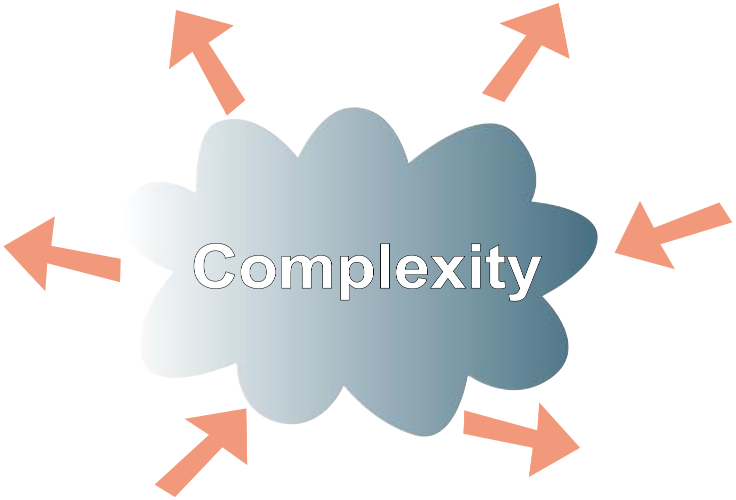
1. increase the customer value of the product.
2. reduce product intricacy.
3. simplify production, distribution, and maintenance.
4. place minimal demands on the organization’s resources and competence.

Find your optimum position on the scale!



You can't avoid complexity, but you can change its nature.

Transforming complexity



Transform complexity by twisting and turning the following questions:

- Eliminate: What can be removed?
- Integrate: What can be combined?
- Separate: What needs to be divided?
- Standardize: What can be made uniform?

Fully Modular Architecture

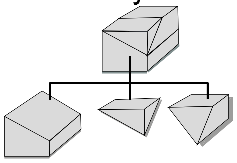
Modular Architecture may provide:

- shorter lead times in both development and production.
- lower costs associated with streamlined processes.
- improved quality through standardized components.
- enhanced customer adaptation to meet diverse needs.

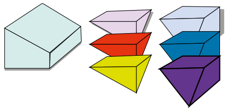
However, a Modular architecture is not without drawbacks and costs.

Framework

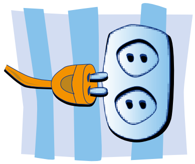
1. Defined system architecture



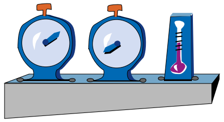
2. Defined modules



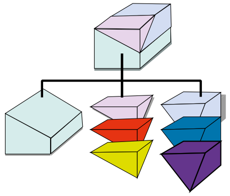
3. Fixed (bined) interfaces



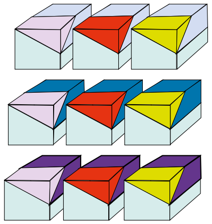
4. Established test standards



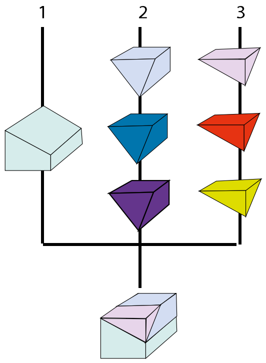
Flexibility



Number of variants



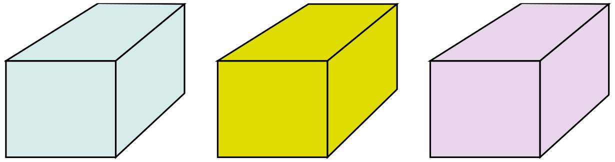
Parallel flows



Totally Integral

Benefits of an Integrated Architecture:

- higher customer value through tailored solutions and enhanced satisfaction.
- faster development by streamlining processes and reducing bottlenecks.
- fewer restrictions and limitations, allowing for greater innovation and flexibility.



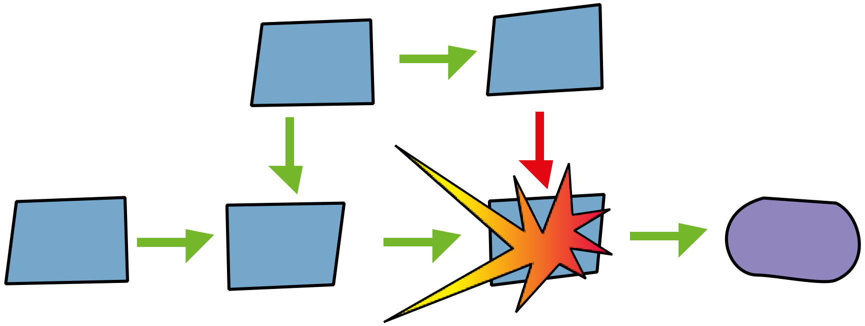
However, an Integral architecture is not without drawbacks and costs.

Failure Mode and Effects Analysis (FMEA)

FMEA is a systematic approach for identifying and managing risks in your product, with the functional model of your final concept serving as the best guide.

A failure mode is a functional deviation; for example:

- no function
- function occurs too early
- function occurs too late
- excessive function performance
- inadequate function performance
- intermittent function
- opposite/anti-function
- unexpected function.



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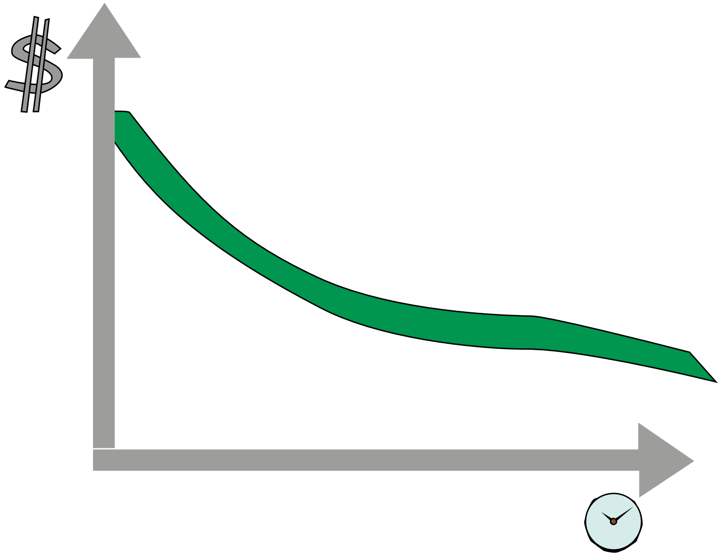
The learning curve



Leveraging the Learning Curve:

- dedicate time for learning and debugging.
- track improvement as output doubles.
- check target alignment to ensure objectives are being met.

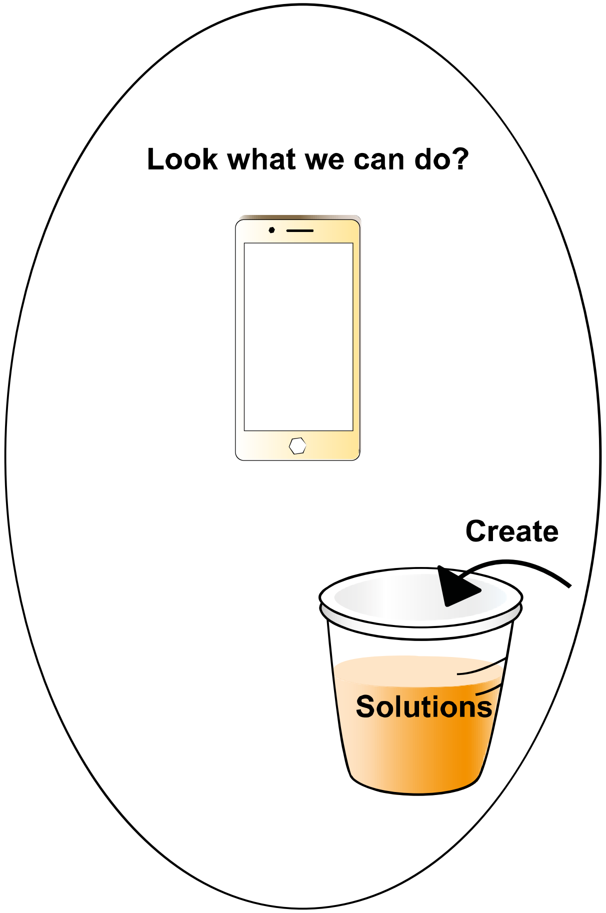
Cost reduction is typically between 5% to 20% every time the volume is doubled.

What goes into the bucket?

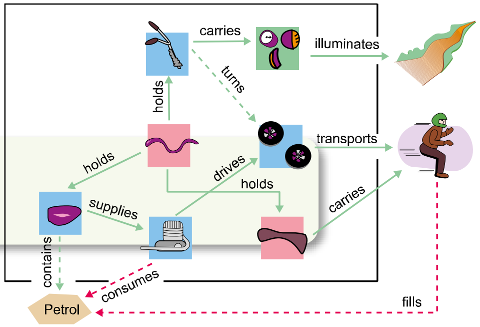
Value-critical information in the Solution Domain of information may include:

- careful selection and use of several of the six tactics.
- modification of your benchmark solving critical value-increasing challenges.
- use of several powerful creative tools, including TRIZ.
- a system architecture that change the complexity to your advantage.
- a structured FMEA based on your final functional model.
- leveraging the learning curve to drive down costs.

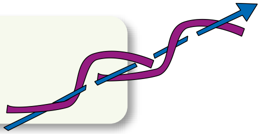
The company’s world



Summary

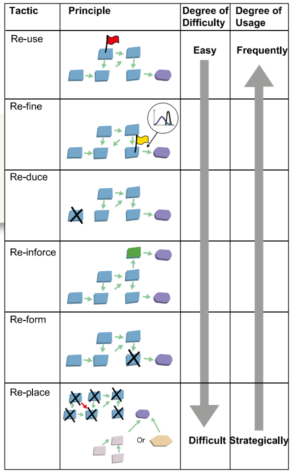


Set the benchmark as your goal to exceed.



Define your overall strategy – Doing better or Doing Different?

Try to use a minimum of three tactics in every development project.



Tactic	Principle	Degree of Difficulty	Degree of Usage
Re-use		Easy	Frequently
Re-fine			
Re-duce			
Re-inforce			
Re-form			
Re-place	Or	Difficult	Strategically

Triz offers an extensive toolbox for solving difficult value-increasing challenges.