MATRIZ Official

THE INTERNATIONAL TRIZ OFFICIAL ASSOCIATION

THE 2nd INTERNATIONAL CONFERENCE

ITC 2024

October 14-17, 2024, Dubai, OAE

MATRIZ OFFICIAL PROCEEDINGS: COLLECTION OF CONFERENCE PRESENTATIONS

Editor: *Valeri Souchkov*

Organized by

The International TRIZ Official Association MATRIZ Official

TRIZ Association of Asia

TRIZ Asia

ISSN: 2950-5224

ISBN: 978909039756

Proceedings of the 2nd MATRIZ Official International TRIZ Conference ITC-2024: Collection of Presentations

October 14-17, 2024, Dubai, OAE

Organized by the International TRIZ Official Association – MATRIZ Official, TRIZ Association of Asia, TRIZ Association of Asia

269 pages.

ISSN: 2950-5224

ISBN: 978 909 038 0766

Editor: Valeri Souchkov, TRIZ Master

The collection of presentations «*Proceedings of the 2nd MATRIZ Official International TRIZ Conference ITC-2024*».

The conference is intended for TRIZ specialists and users: academics, engineers, inventors, innovation professionals, and teachers.

The present book of Proceedings includes presentations related to the research and development of TRIZ, best practices with TRIZ, cases of practical application of TRIZ, and issues of TRIZ training and education.

All presented presentations had bed being peer-reviewed before presenting at the conference and further publication.

Series «***Proceedings of the MATRIZ Official International TRIZ Conferences*”.**
ISSN: 2950-5224 ; ISBN: 978909039756

Prepared and Published by the International TRIZ Official Association – MATRIZ Official, Rue Copernic 48, Brussels, Belgium

www.matriz-official.net

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Presents

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INTERNATIONAL TRIZ CONFERENCE

14 -17 OCT'24 | DUBAI

Radisson Blu Hotel, Dubai Canal View

GEA SmartPacker CX400 D-ZIP

Dr. Robert Adunka
(TRIZ Consulting Group GmbH, Germany)

Gerd Hübner
(GEA Food Solutions Germany GmbH)

Manfred Weidlich
(GEA Group Services GmbH, Germany)

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EUROGATE

Problem-oriented Nine Screen Approach

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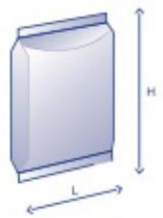
Scenario

GEA is a manufacturer of packaging machines. The task was to create a new vertical packaging machine that could be installed in the standard footprint of the old machine. In addition, this machine should be able to produce different bag styles, run up to twice as fast and allow a quick changeover from one style to the next.

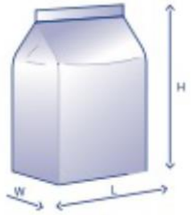
How can all these requirements be met by the new machine?

Different bag styles



Pillow Bag

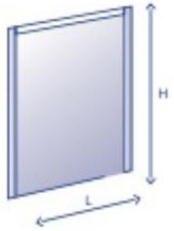
Gusset Bag



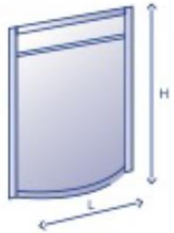
Block Bottom Bag

QuattroSeal bag

QuattroSeal bag with mid. seal



3 Sided Seal bag



D-Zip bag

BAG SELECTOR

	Pillow	Gusset	Blockbottom	Envelope	Quatro	Doystyle
Protein	●		●	●	●	●
Frozen (vegetables/French fries)	●		●		●	●
Fresh (salad/cheese)	●		●	● cheese only	●	● cheese only
Confectionery	●	●	●	●	●	●

● available as standard

Aim of the workshop

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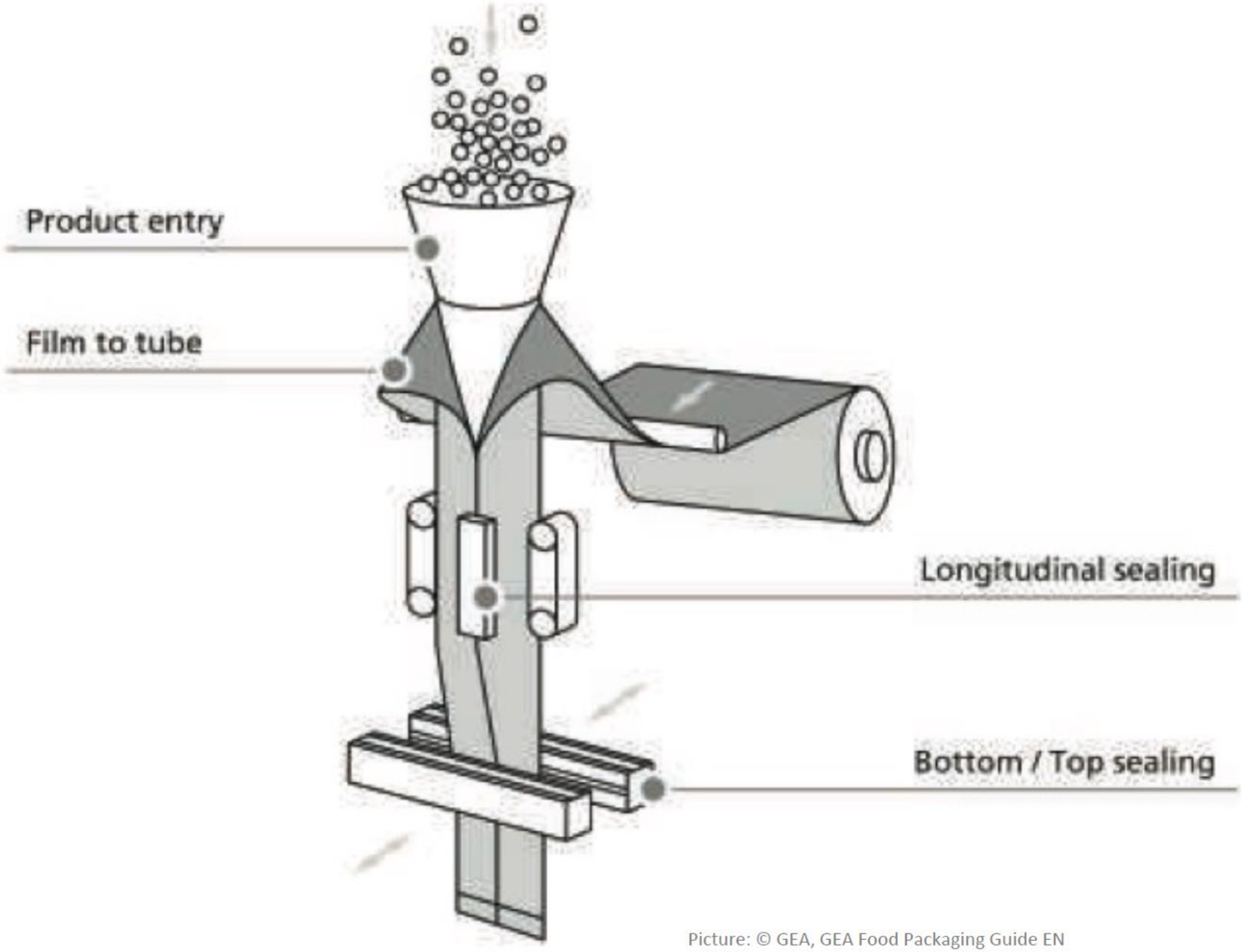
Aim:

Concept of a vertical packaging machine capable to produce D-Zip packages at highest possible speed and quality

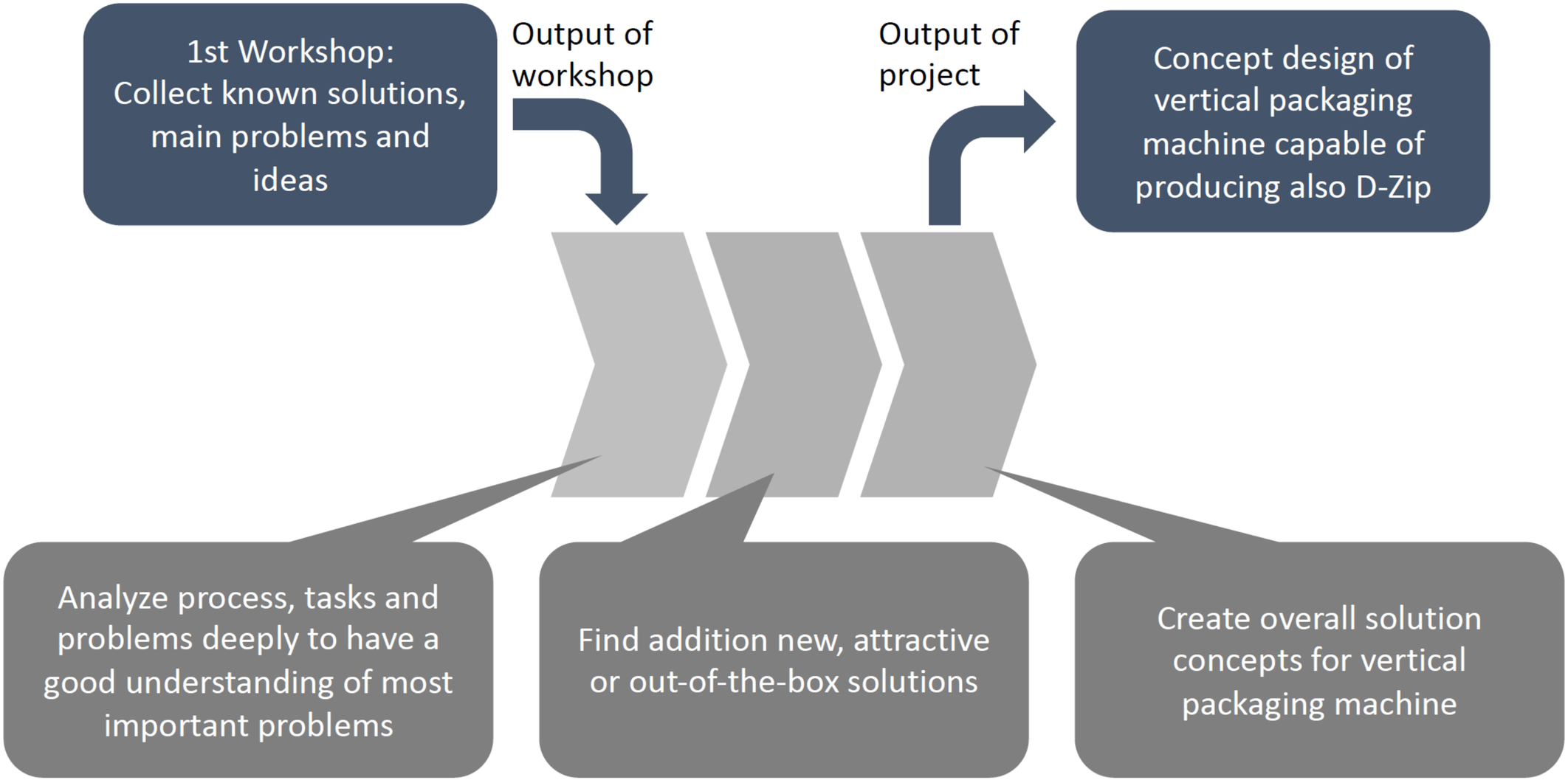
Constraints:

- Process from forming shoulder to cutting of bag
- Must be able to produce **known bag styles** (pillow, gusset, block-bottom, quattro, doy-style, envelope) as well as **new special bag styles** (d-zip without bottom seal, d-zip with bottom seal, three-sided seal)
- Should have approximately the footprint of standard machine
- Speed: min. 100 packages per minute



Picture: © GEA, GEA Food Packaging Guide EN

Overall project (duration 1 year)



Tools used in the coaching approach

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First 3 days (Kick-Off + 2 days core team):

- Brainwriting
- Gallery method
- Innovation Situation Questionnaire (I-TRIZ, Ideation)
- Cause-Effect-Diagram according to Ideation (I-TRIZ)
- Process Analysis (graphical and tabular)
- Weighted Evaluation for comparison of the overall concepts

Second workshop:

- Detailing concepts: Overall layout, Preseal Zip, Sealing, Zip-Handling
- Evaluation methods
- Patent circumvention of three patents with function analysis and trimming
- Cause and Effects Chains Analysis (CECA) for fixed position knife

Third workshop:

- Cause and Effects Chains Analysis (CECA) for quality of bag shape

Problem areas, first ideas and improved ideas list

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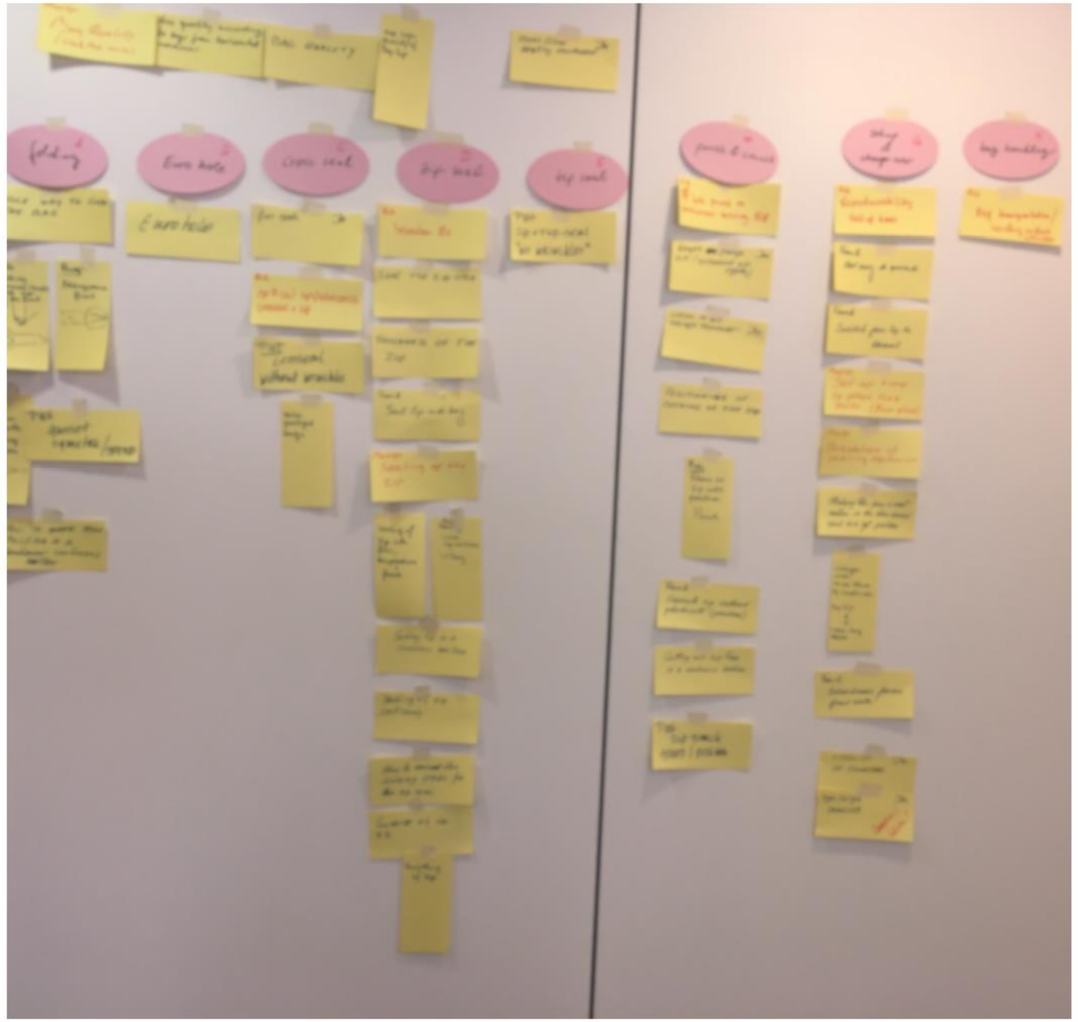
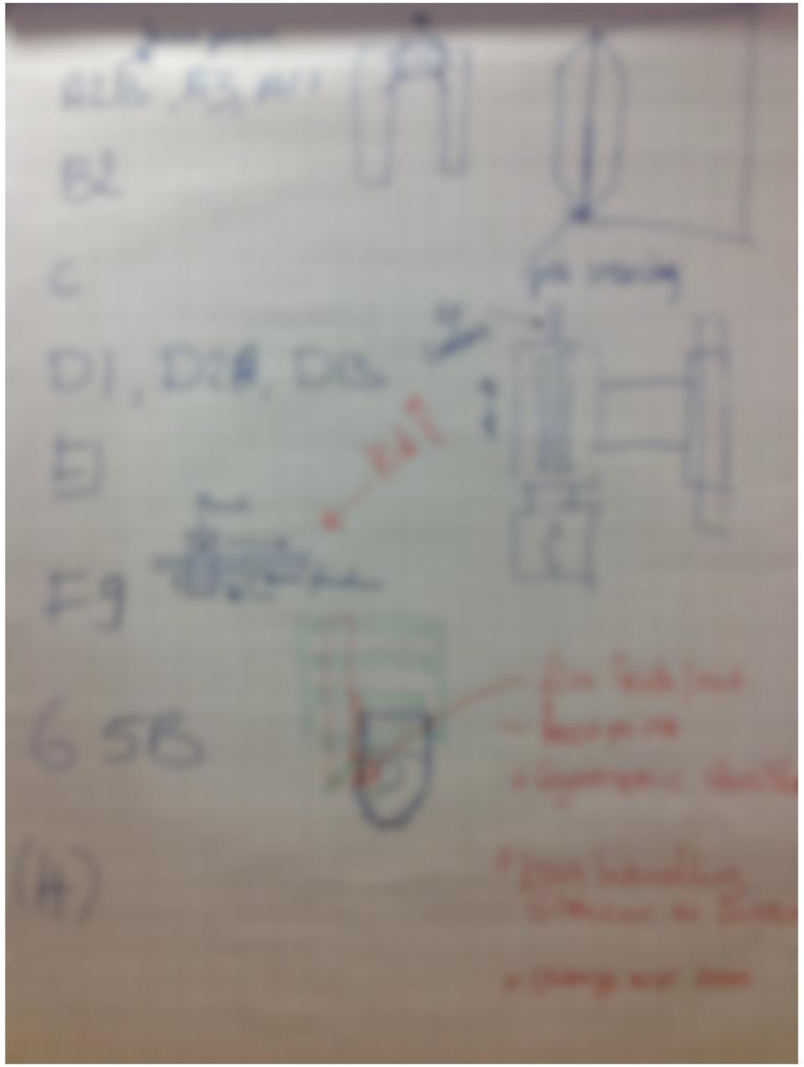
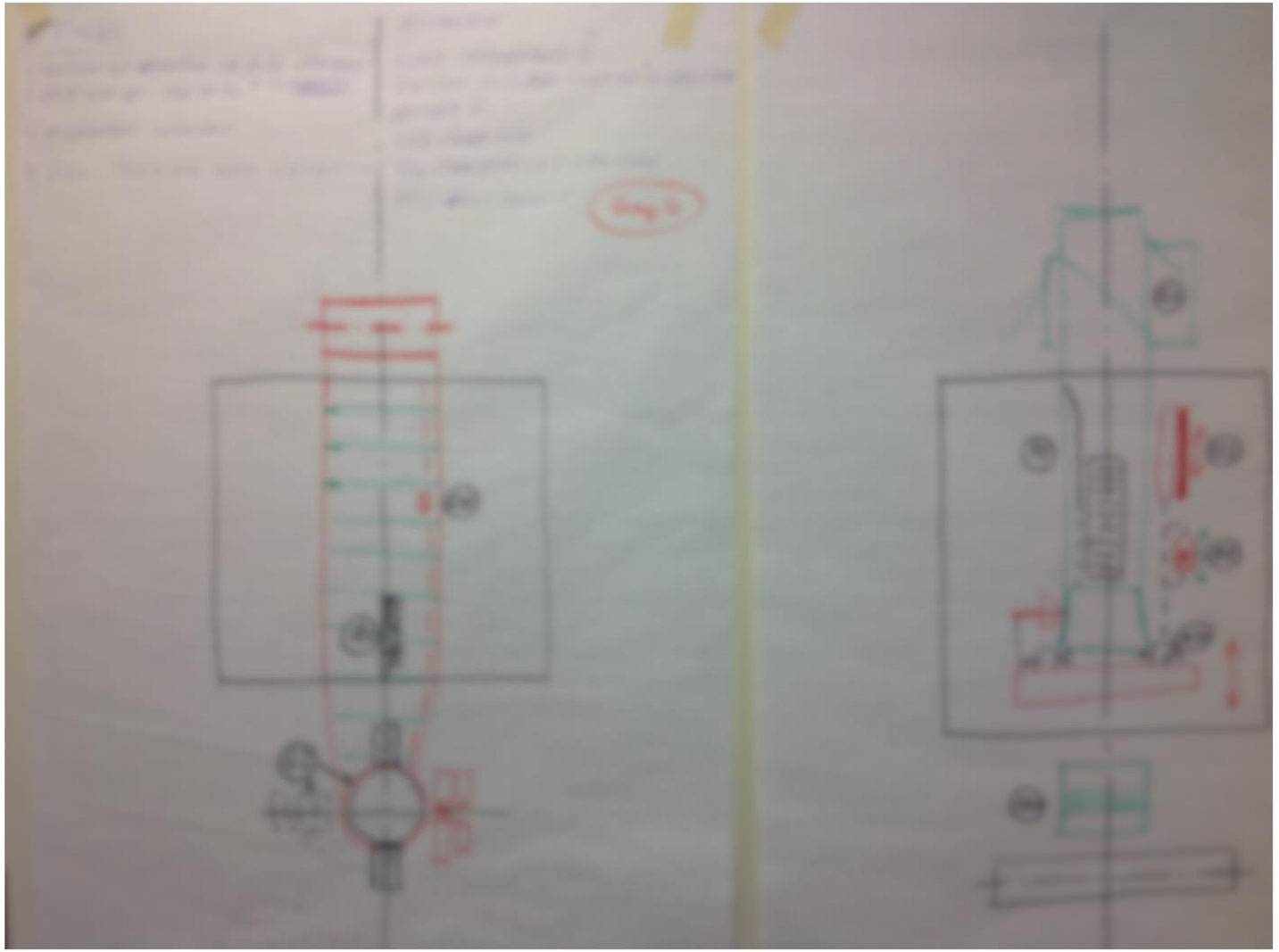
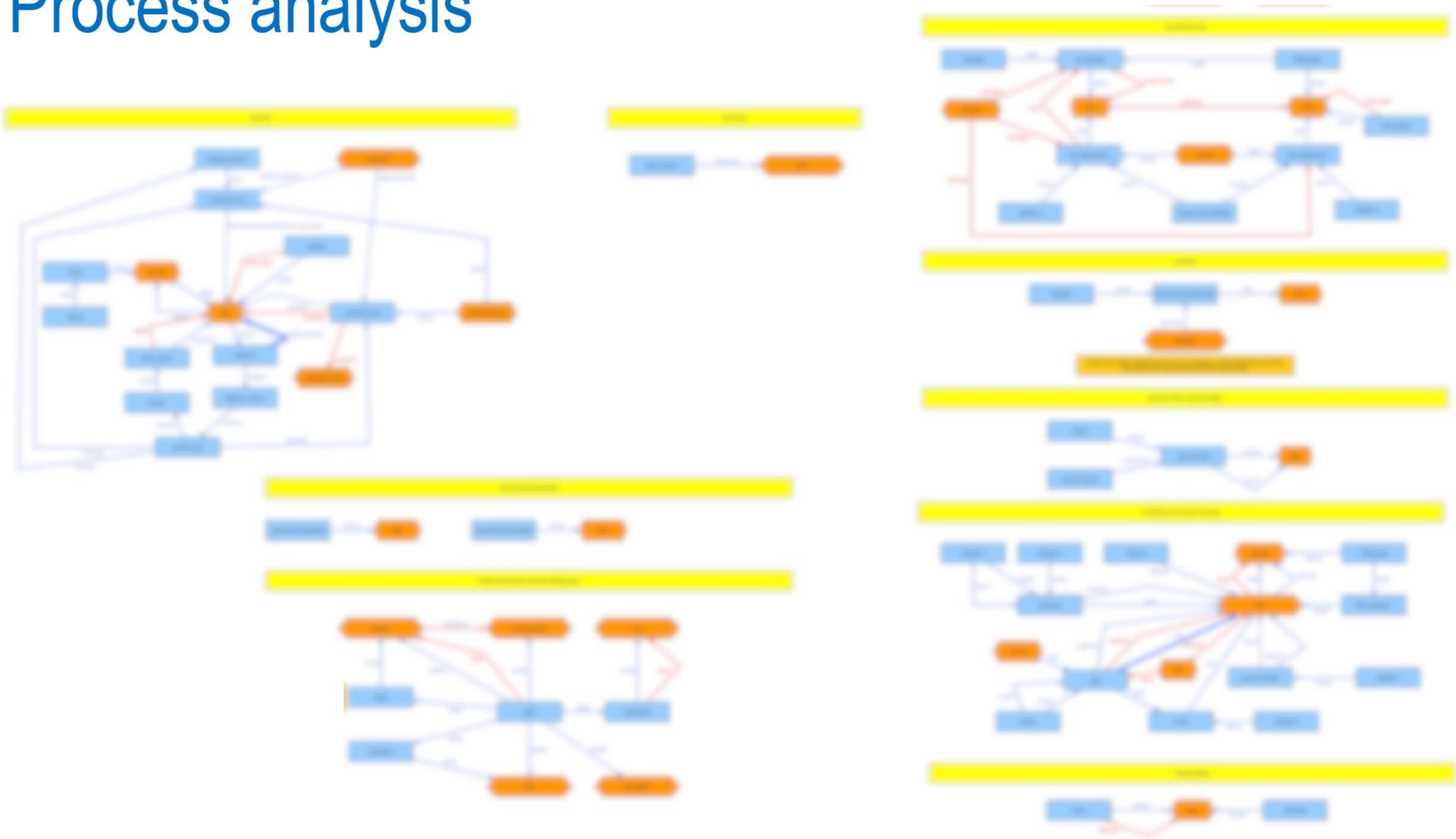


First overall concepts





Process analysis



Innovation Situation Questionaire

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ISQ was used to compile the information.

The diagram according to I-TRIZ helped to find a decision that could not be found before with other analyses.

Evaluation Concepts Sealing

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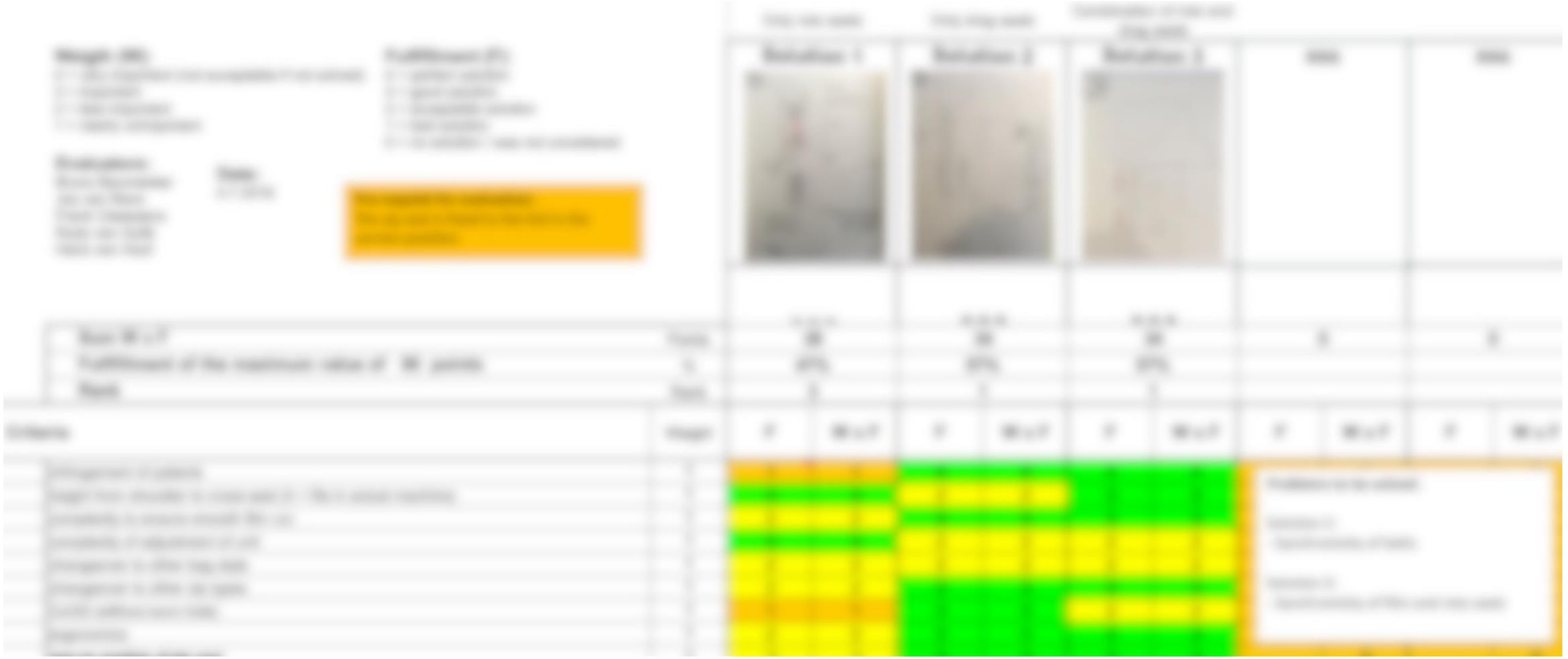
2 solutions are best ranked, problems to be solved addressed



GEA SmartPacker CX400 D-Zip

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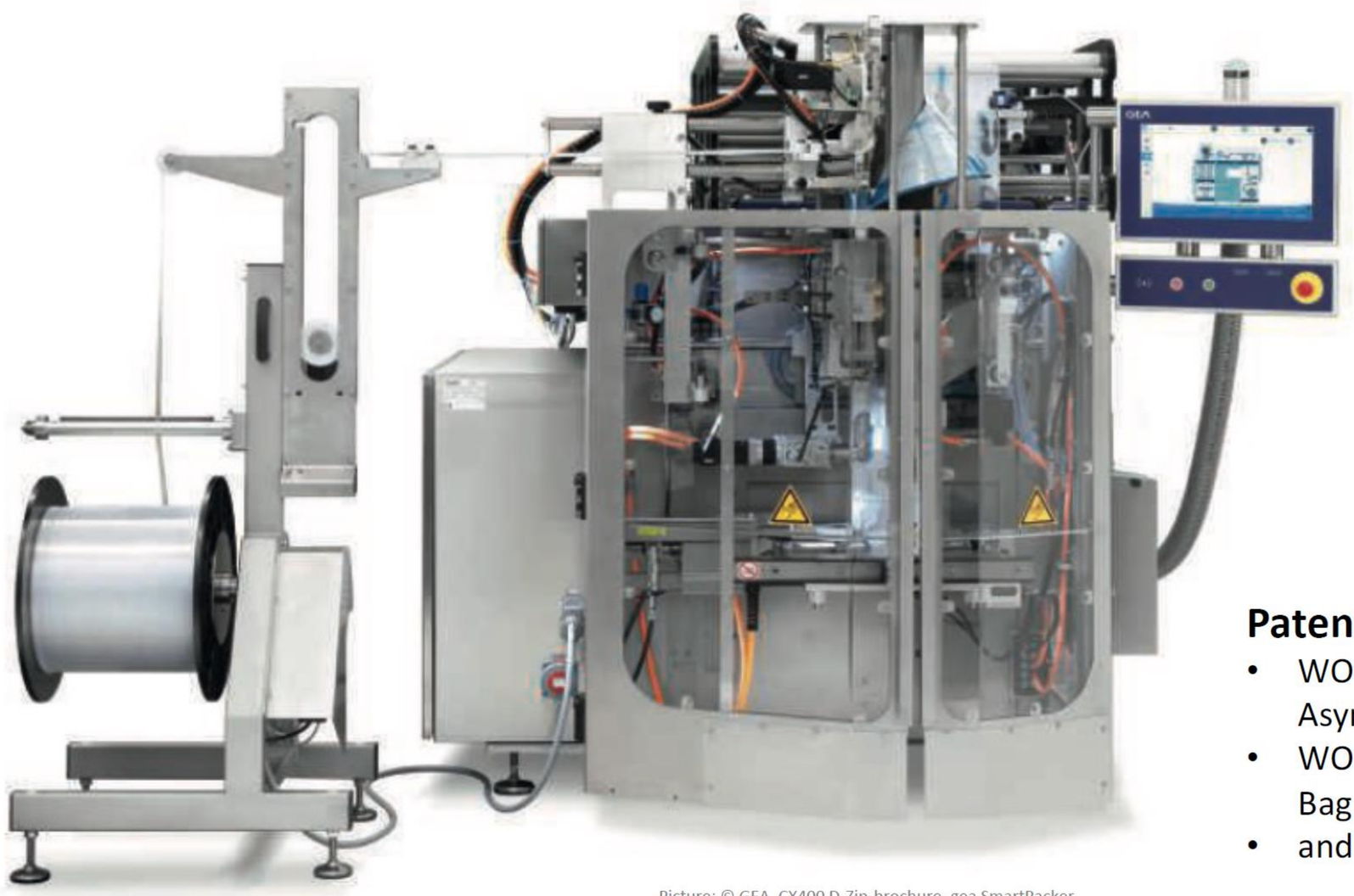

Picture: © GEA, CX400 D-Zip-brochure, gea SmartPacker

Patents filed:

- WO 2022096453 A1:
  Asymmetrical form shoulder - D-Zip
- WO 2020078869 A1:
  Bag with a segment of a re-closure means - D-Zip
- and other

GEA SmartPacker CX400 D-ZIP

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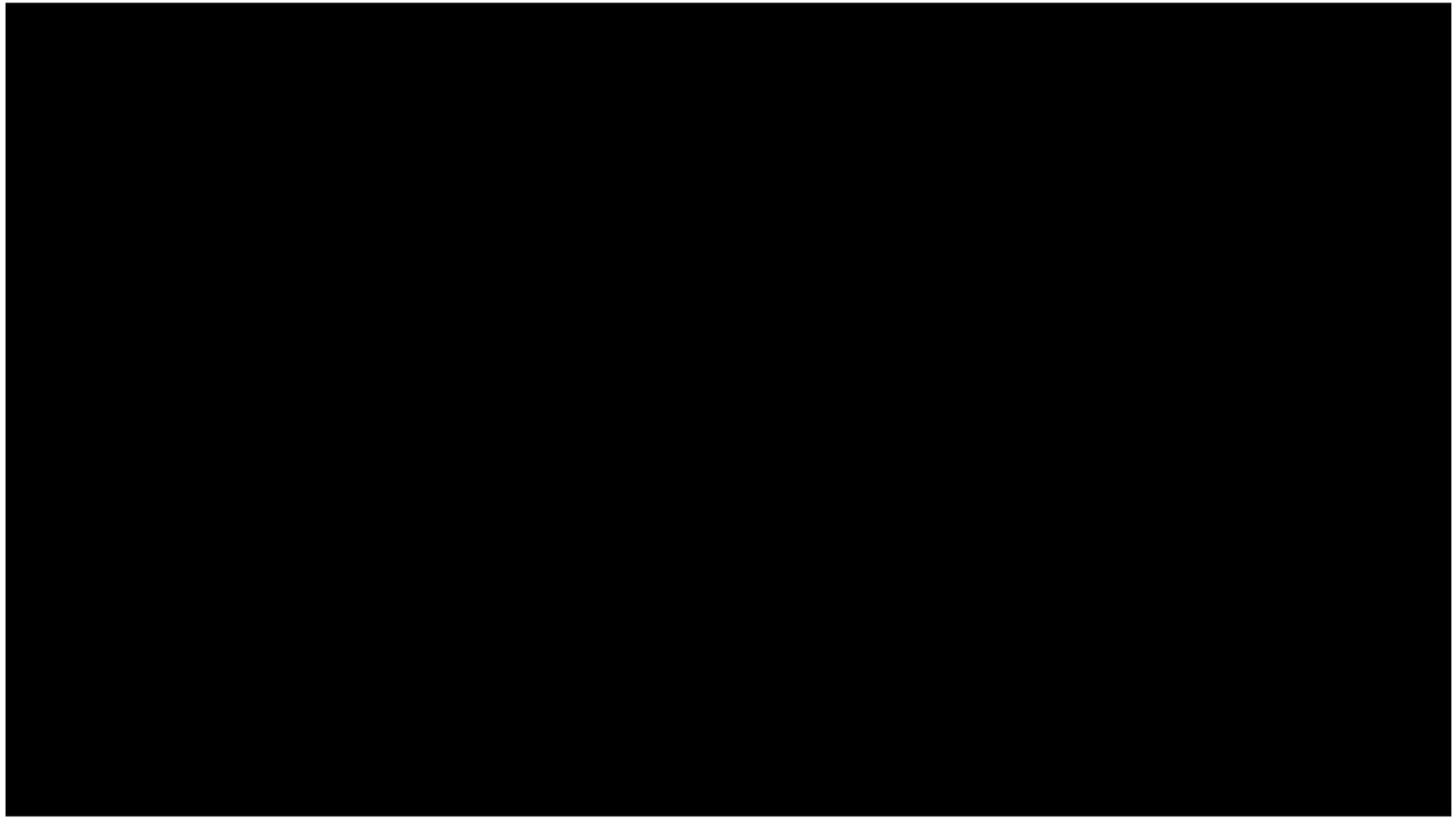
YouTube https://www.youtube.com/watch?v=OVg9hFu_XJU



Lessons learned from the example

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- The creative tools of TRIZ are used more for individual work. In the workshops to coordinate the approach, the problem analyzing tools are mainly used to develop a shared understanding of the problem.
- The coaching approach means that the development group can always consult with a method expert. Rudimentary knowledge of the method by the developers is desirable.
- TRIZ helps to get over difficult parts of the project, in between a lot of normal development work must be done.

Area of application of TRIZ:

Project accompanied in the early stages of product development: Starting from a one-day workshop where many people could give their idea input, a small developer group continued to work over a few months. Further small workshops to coordinate the approach as needed.

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Seasonal Impact of Impulse Purchase of Glassdoor Fridge Items

Devaprasanth B
(IIITD, Delhi,INDIA)

Manivannan S
(IIITD, Delhi, INDIA)

Vijayalakshmi
(IIITD, Delhi,INDIA)

Dr. Anuj Grover
(IIITD, Delhi,INDIA)

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WHAT IS THE PROBLEM?

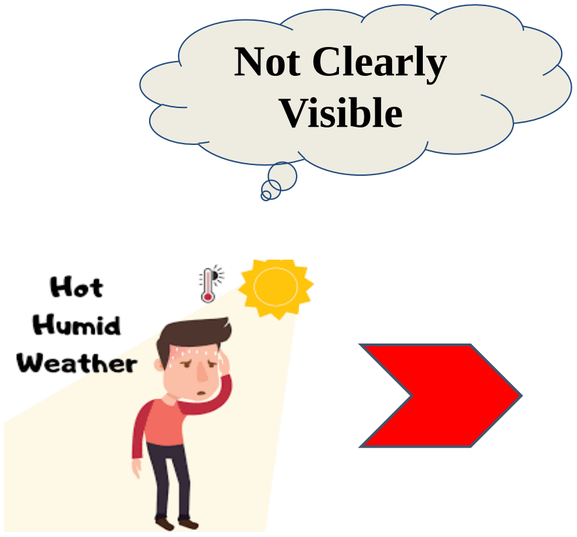
Problem Source : L&T Technology Services

Problem Identified In:

- Seasonal Drop in Sales of products Displayed in Glass Door Refrigerators

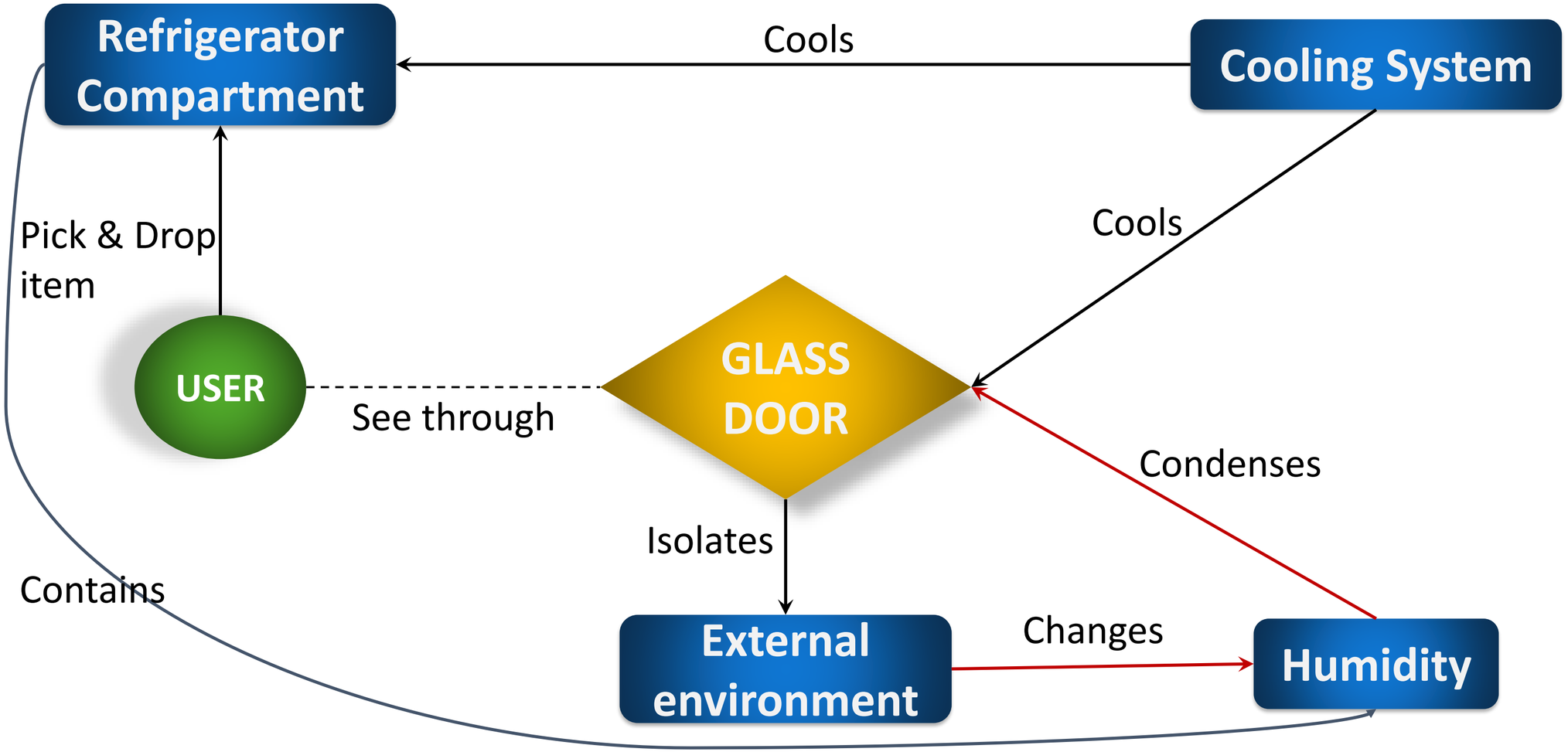
THE PROBLEM:


NATURAL PANEER
Paneer
Sakthi
SET CURD
CURD
PROFIT

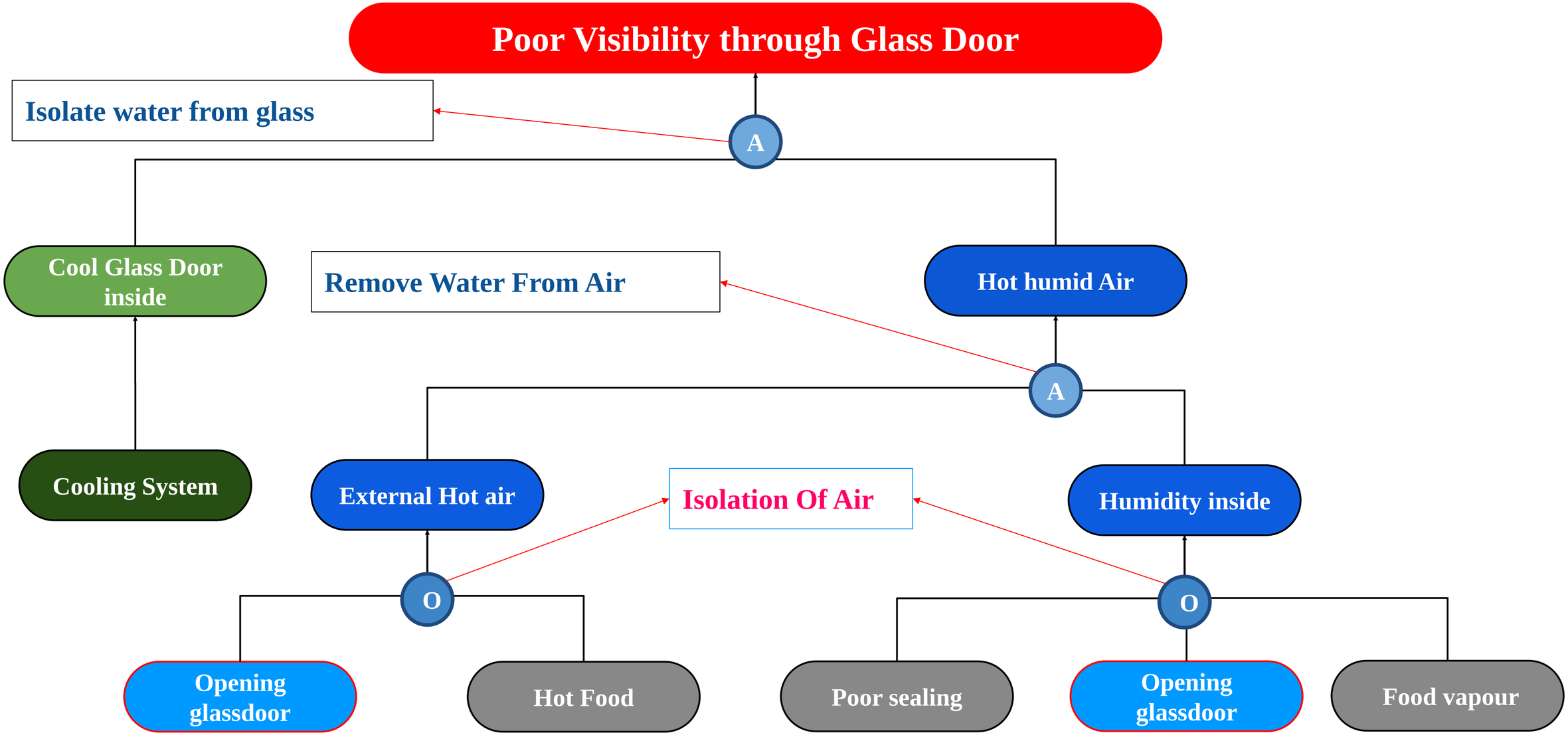

Not Clearly Visible
Hot
Humid
Weather


IMPULSIVE BUYING

FUNCTIONAL MODEL:



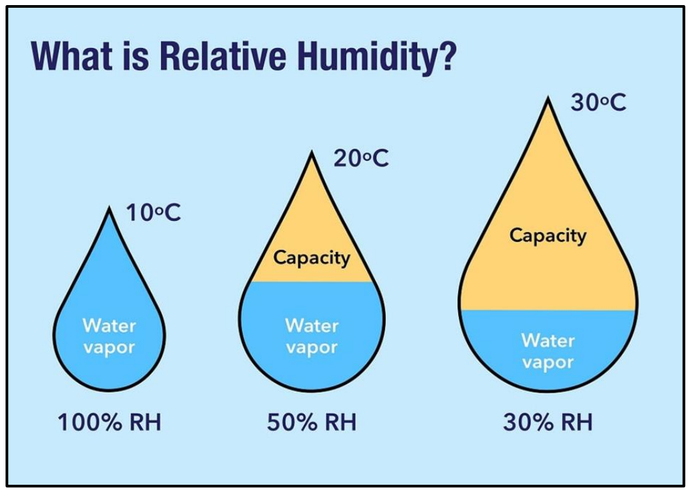
CAUSE EFFECT CHAIN ANALYSIS:



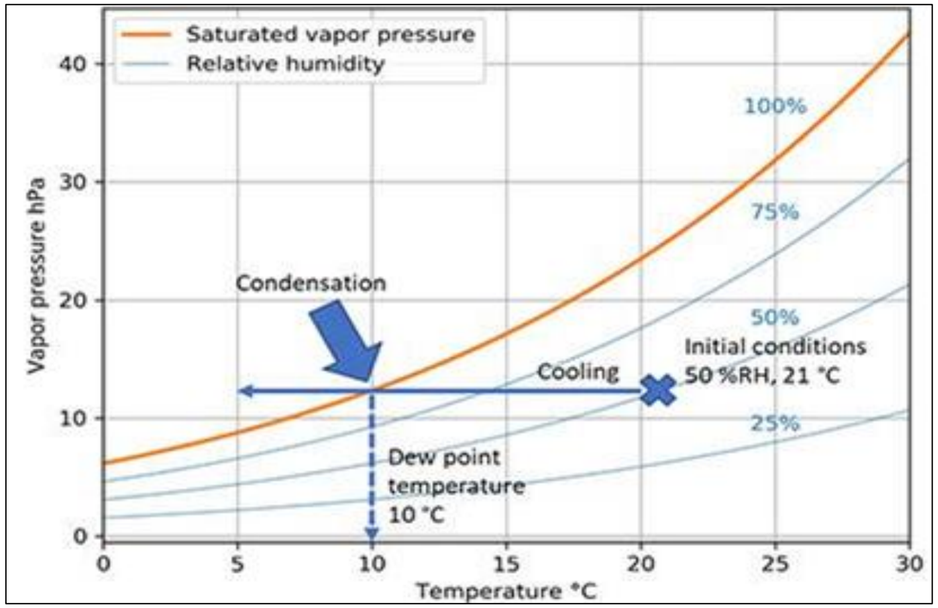
PHYSICS BEHIND THE PROBLEM:

Dew Point => Tdp = Tn - [100 - R.H] / 5

Where
Tdp – Dew Point in degree Celsius
Tn – Current temperature of air inside refrigerator (in °C)
R.H – Relative humidity (%)



T α (1 / R.H)



IDENTIFICATION OF PROBLEM:

Main Issue:

Mixture of hot humid air with cold air inside the refrigerator when the door is opened.

1. **Primary : Isolation of Air**
2. **Secondary : Remove water from Air**
3. **Tertiary : Isolation of water from glass**

SOLUTION IDENTIFICATION:

Implemented Function Oriented Search [FOS] to Find the solution:

PARAMETERS CONSIDERED:

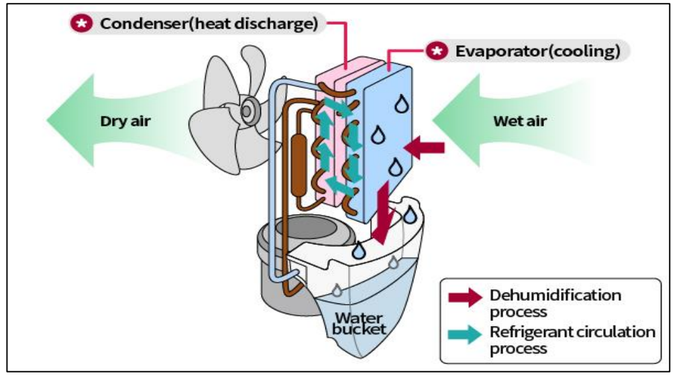
LEADING INDUSTRIES:

Hydrophobic Coating:

Hydromer, Inc, Saint-Gobain

Humidity Control mechanism:

Mitsubishi Electric, LG

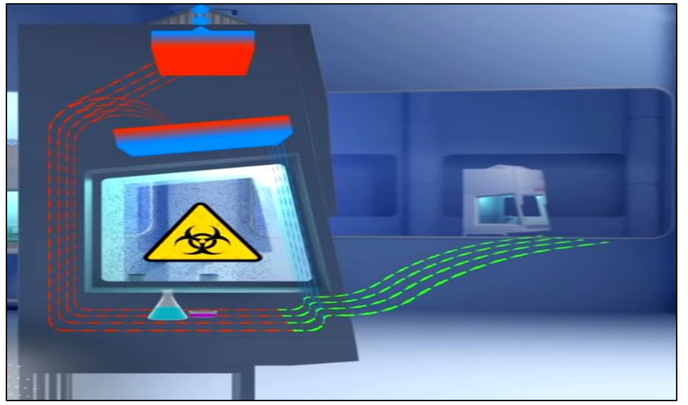


Rear window defroster:

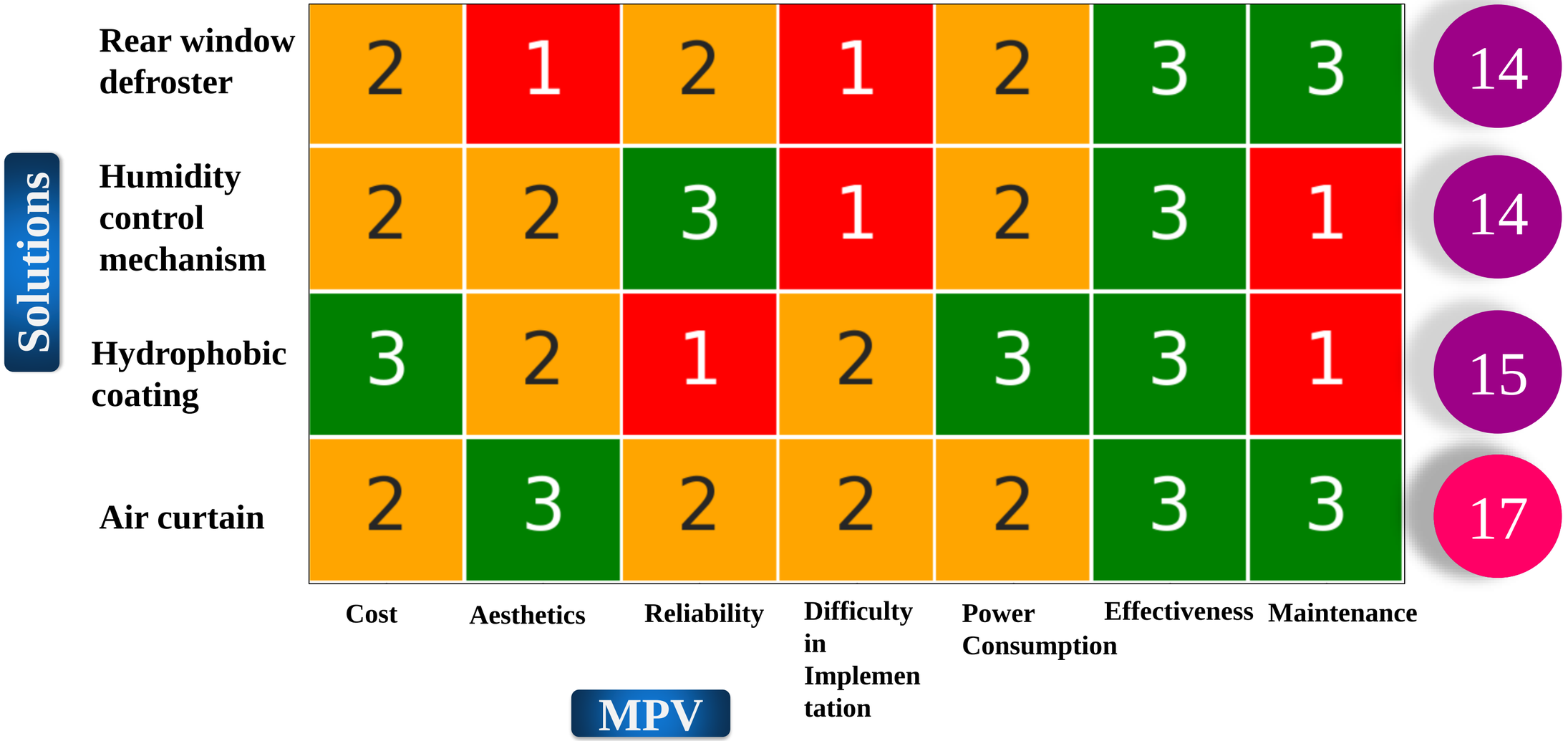
Kia, Tata Motors

Air Curtain:

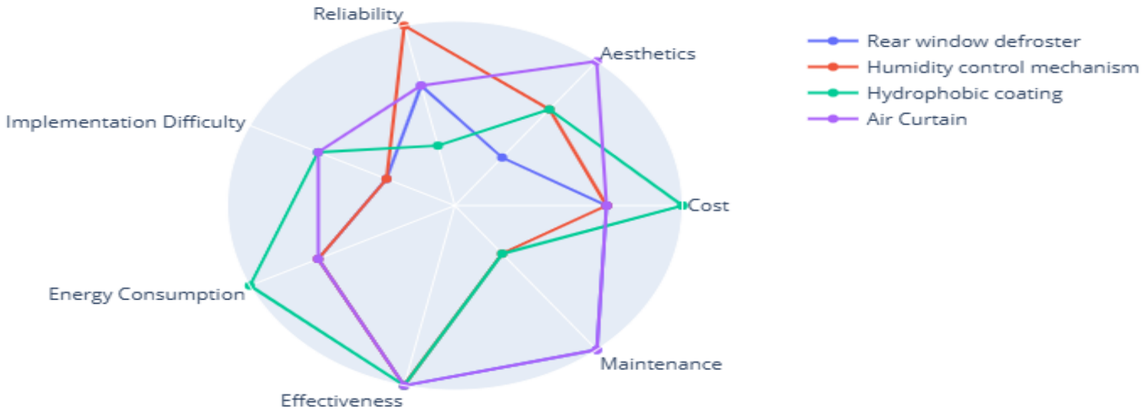
Lamsystems

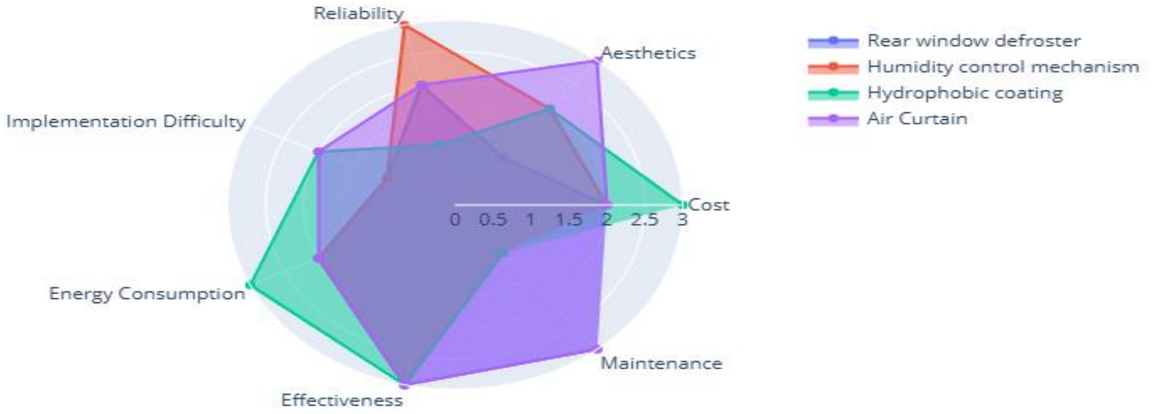


CRITERIA METHOD:



RADIAL PLOT OF SOLUTIONS:





PRACTICAL IMPLEMENTATION:

Implementation of Vertical Air Curtain:

- **Initial Setup**: A vertical air curtain was added to isolate the refrigerator's internal air from the external environment.
- **Curtain Length**: The vertical orientation was chosen to cover the entire opening, resulting in a longer distance that the air curtain must span to minimize air exchange.

Secondary Problem with Vertical Air Curtain Implementation:

- **Inconsistent Air Flow**: The extended vertical setup leads to uneven distribution of air, requiring higher energy consumption.
- **Partial Air Containment**: The air curtain may not fully prevent air exchange, resulting in temperature fluctuations.

SOLUTION TO SECONDARY PROBLEM:

- **Horizontal Air Curtain Placement**: Shift the air curtain orientation from vertical to horizontal to reduce the distance it needs to cover.

Advantages:

- **Stronger Air Curtain and Efficiency:** The shorter horizontal span creates a stronger air barrier, improving isolation and enhancing temperature stability.

Additional Advantage:

- **Reduced Power Consumption:** Hot and cold air are less likely to mix, reducing the load on cooling systems and further decreasing energy use.

THANK YOU!

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Model for preparing future innovation leaders

Nadezda Feygenson

(Development Director of MIR TRIZ, Seoul, South Korea)

Natalia Chernoivanova

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Marina Skiba

(Representative of MIR TRIZ in Kazakhstan, Astana, Kazakhstan)

Ekaterina Nekhaeva

(Vice-President of MATRIZ Official, Novosibirsk, Russia)

Olena Gredynarova

(Director of the private institution «Lyceum of Intellectual Creativity 'Eidos', Zaporizhzhya», Ukraine)

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Outline

1. An existing contradiction in one of the lines of society development

2. Possible solution to the controversy

3. Conclusions and recommendations - demonstrating a model for preparing future innovation leaders

- ✓ Impact of development
- ✓ Existing development
- ✓ Anticipating development

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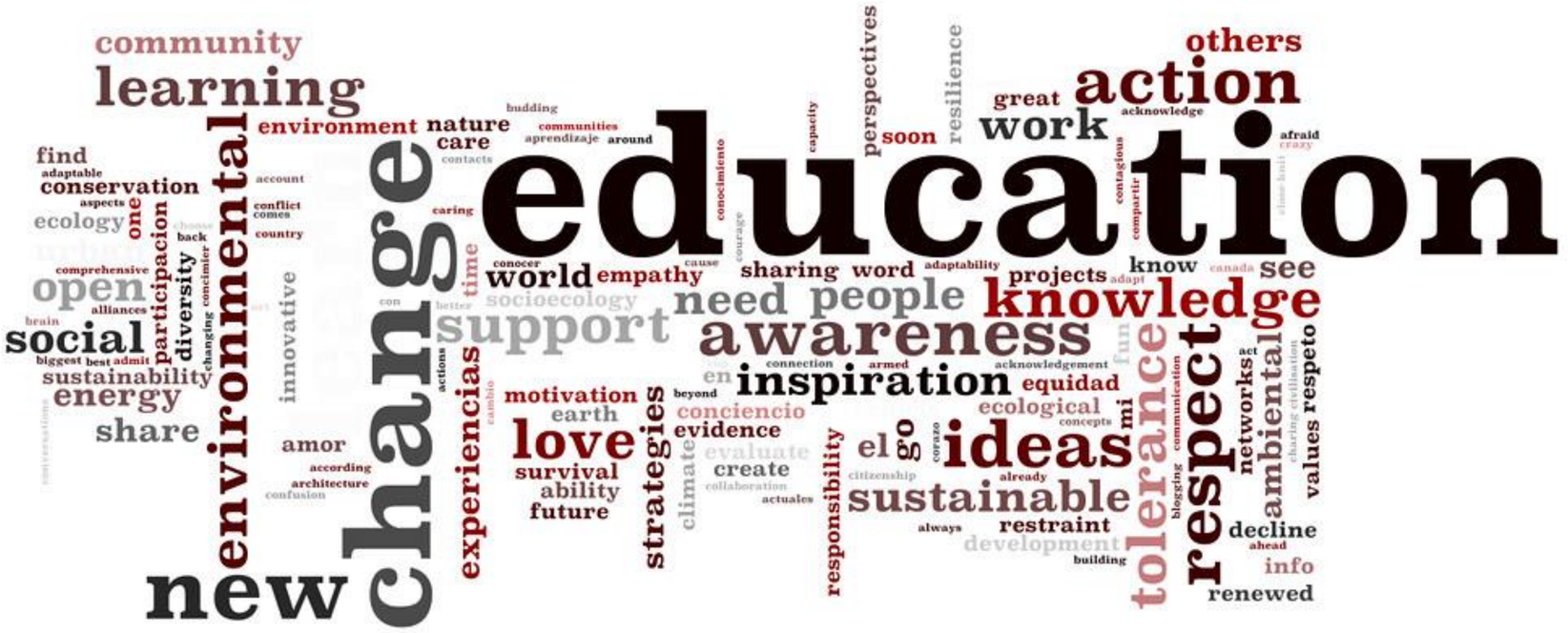
- The education system must be able to respond quickly to new social requirements and be able to work for the future.



A resolution of the contradiction is required

- Requirement

Reality

Origins of TRIZ in Education

Methodological developments on TRIZ in education began in the 1980s.

And continue to this day

Creating technology

Engineering

Universal TRIZ models

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1+1=10 / When is it possible?

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Teacher

- New knowledge and skills
- Introduction of new creative teaching methods
- Preparing a new generation of technology leaders
- Increasing motivation for teaching and learning

Parents

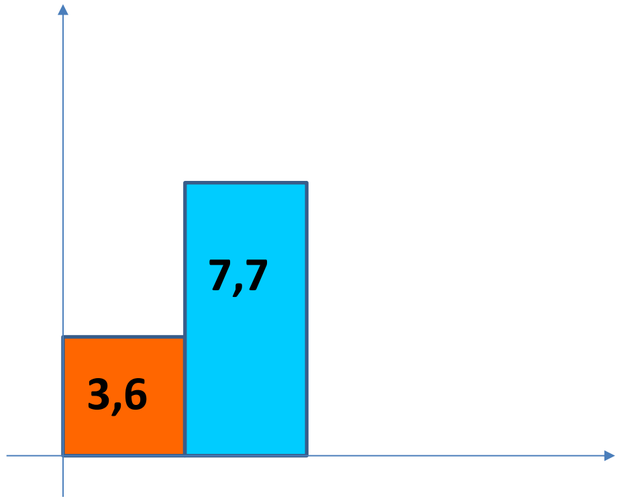
- Development of one's own thinking and its translation
- Development of the child's personality and the necessary competencies required by external conditions
- Solving life's problems

Children

- Formation of divergent and critical thinking
- Developing a bold controlled imagination
- Soft skills development
- Development of memory, attention, rich speech
- Increasing motivation to learn

The outcomes of Creative Learning Practices

- Conducting the study «Incorporating Innovation in the Educational Process» from 1989 to 2006 (children from 6 to 10 years old)



Experimental classes

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Svetlana Guin, PhD, BY BLR

Pedagogical Innovations

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Development of new pedagogical models and methods for the study of educational subjects based on TRIZ technology

Marat Gafitulin, PhD, RF

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«Levels of cognition»
«Levels of creativity»
«Geometric solids»
«Bee» - a methodology for developing pupils' independence when studying their native language
and others

The results of TRIZ training of students in Korea

Q: Was TRIZ helpful in developing thinking power and creativity?	strongly agreed	agree	not sure	disagree	strongly disagree
Response (%)	68	32	0	0	0

Yong Won Song, Professor, KR

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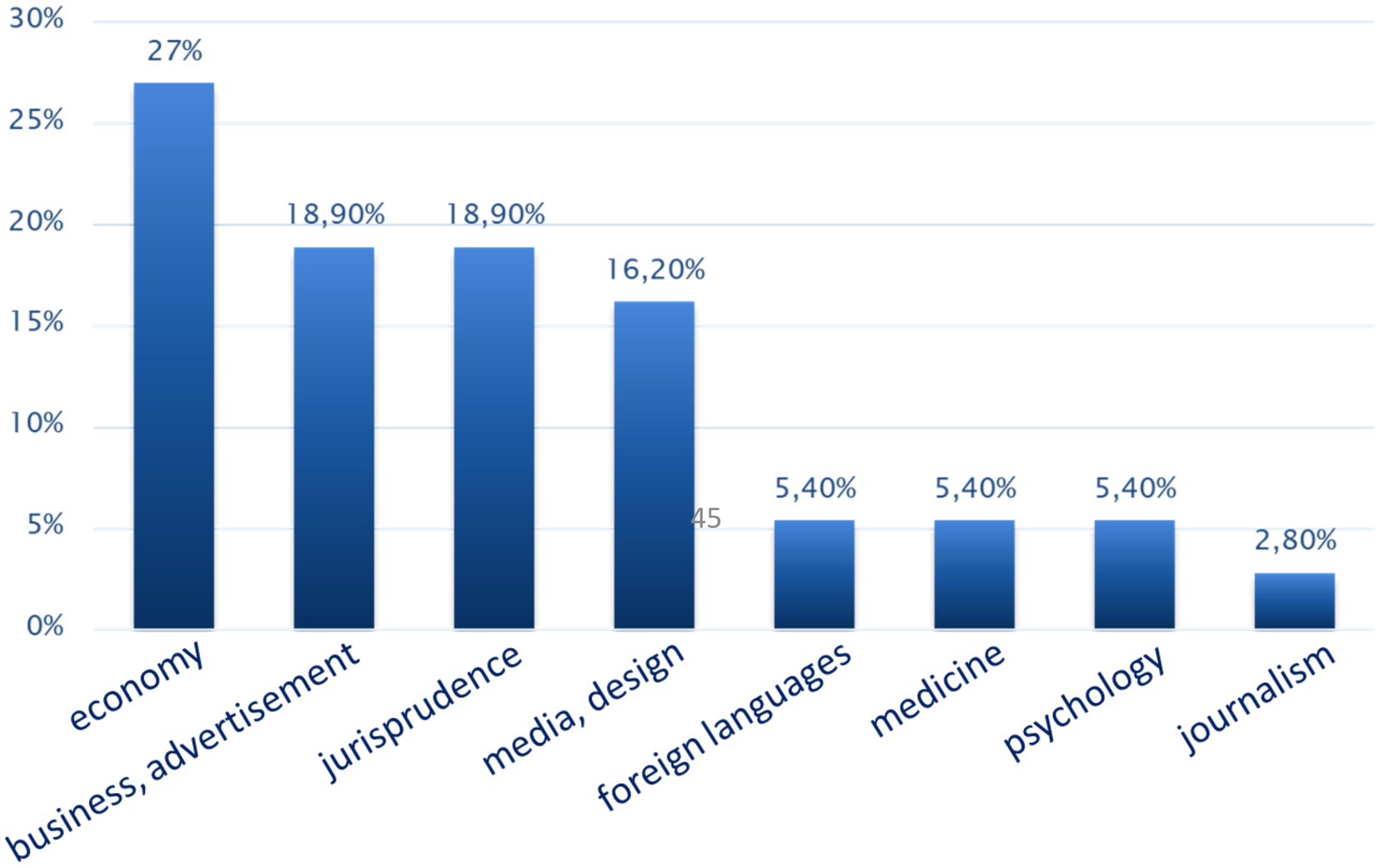
After taking the TRIZ course, the students agreed that their ability to solve problems has been improved dramatically and they came to have confidence in solving various problems they would face later in everyday life. All the students reached a conclusion that TRIZ was helpful, which means TRIZ education has a bright future in Korea, where many universities seek the good creative thinking methodology.

The realizing the potential of graduates (TRIZ+)



Olena Gredynarova, Ph.D., UA

Integration of TRIZ into the school curriculum of Eidos School allowed students to realize their creative abilities in their professions

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Composition of the Methodological Council of the International Institute for TRIZ Development in Education

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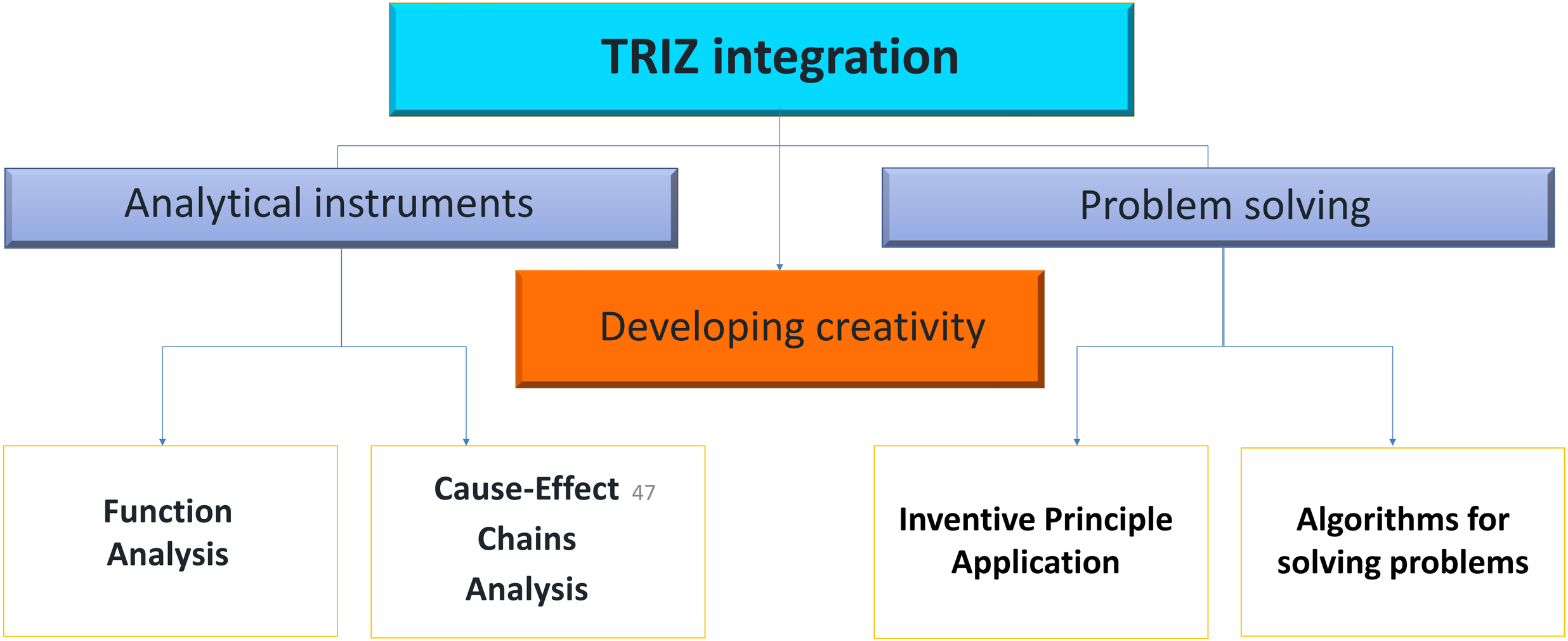
TRIZ integration
Analytical instruments
Problem solving
Developing creativity
Function Analysis
Cause-Effect Chains Analysis
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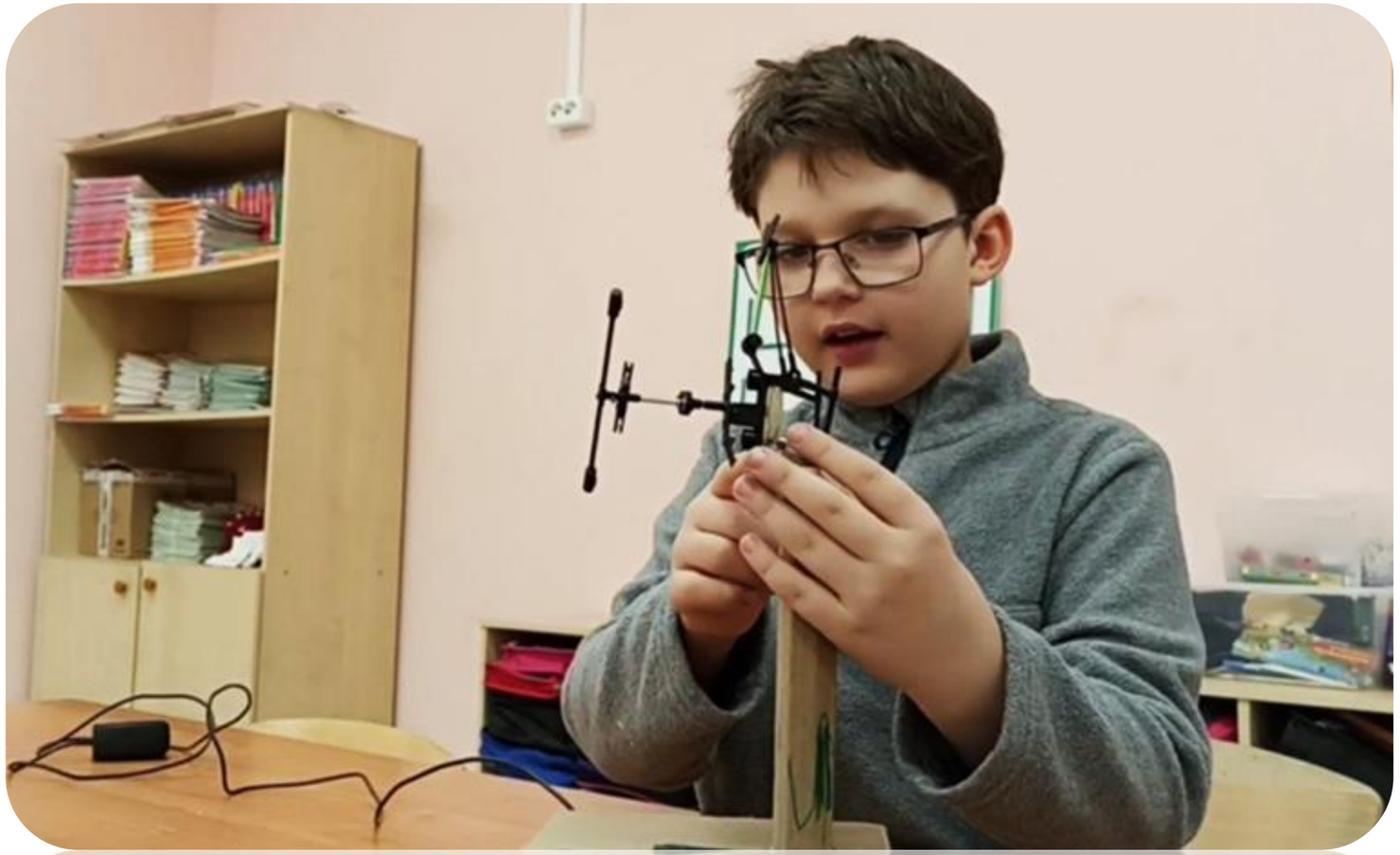
Inventive Principle Application
Algorithms for solving problems

First face-to-face event on TRIZ in education

- Organizing training sessions on TRIZ in education within the framework of the International Conference MATRIZ Official, as well as participation of alumni as speakers

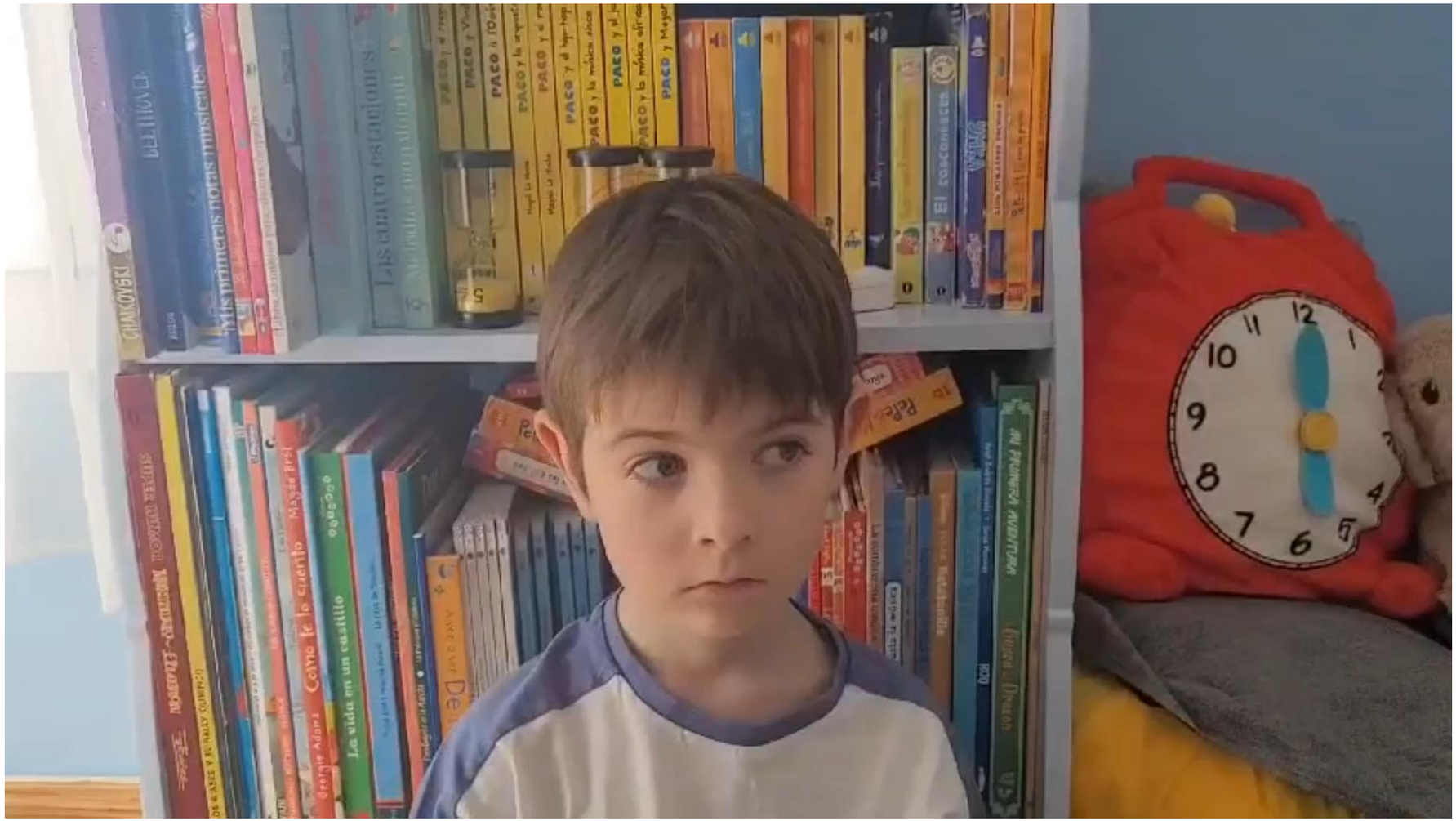
More than 800 participants from 27 countries

Festival of innovative projects "WORLD OF CHILDREN'S IDEAS"



250 participants from Belarus, Montenegro, Spain, Sweden, Russia, Estonia, South Korea, UAE and other countries

Feedback from parents and children after TRIZ classes



Feedback from parents and children after TRIZ classes

Feedback from parents and children after TRIZ classes

Integration of TRIZ into mathematics and languages

98% of graduating students achieve high level results in math Olympiads, and are accepted to prestigious schools, Johns Hopkins University, Harvard University, Stanford University

- Math Kangaroo
- State Mu Alpha Theta Math Contest
- Math Challenge Tournament
- The AMC 8 is a contest for students in grades 8 and below, hosted annually by the American Mathematics Competitions (AMC) to students all over the United States
- MathCounts - a national middle school mathematics competition
- Stanford Math Tournament

Irina Deryugina, Representative MIR TRIZ, USA.

Creating innovations involving business customers

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Engineering solution
Start-up

Olga Shamina, Representative MIR TRIZ, Ph.

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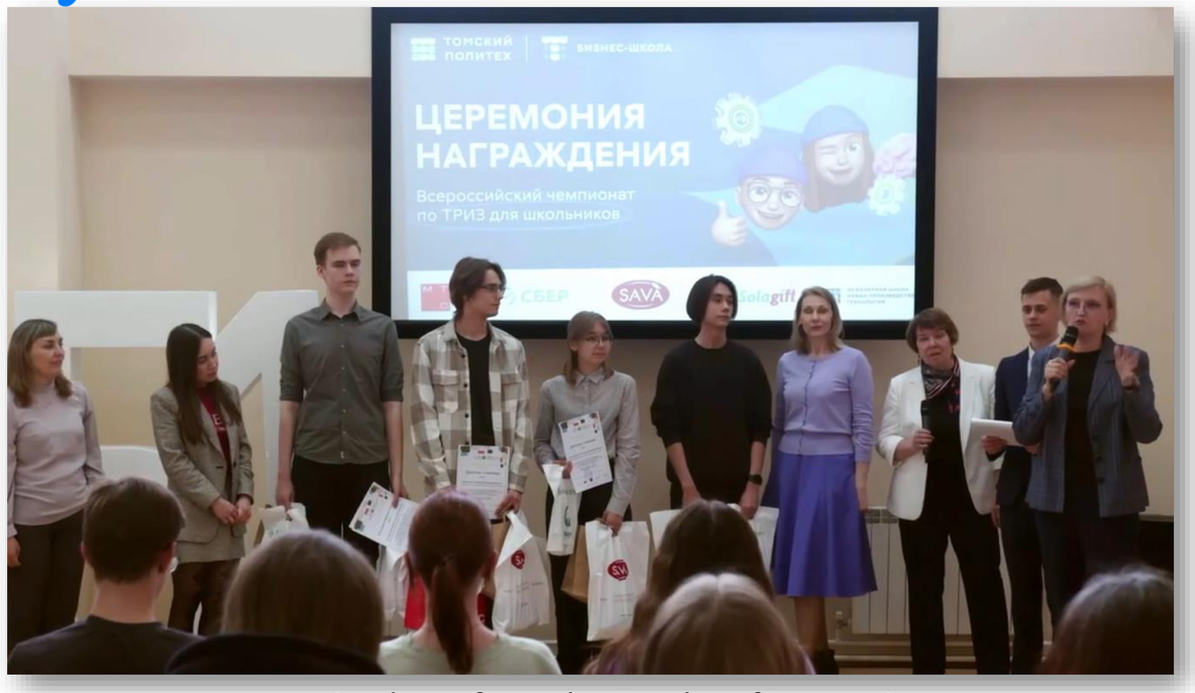

Students from the Faculty of Innovatics

Achievements of MIR TRIZ alumni

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- Addressing pedagogical problems
- Integrating of TRIZ technology into new spheres: career guidance, educational neuroscience, sports orientation
- Creating of educational games by MIR TRIZ alumni
- Changing professional activities and starting my own Children's Learning Club
- Writing a book on creativity
- Creating an adolescent training program and its implementation to attract graduates to the steel industry

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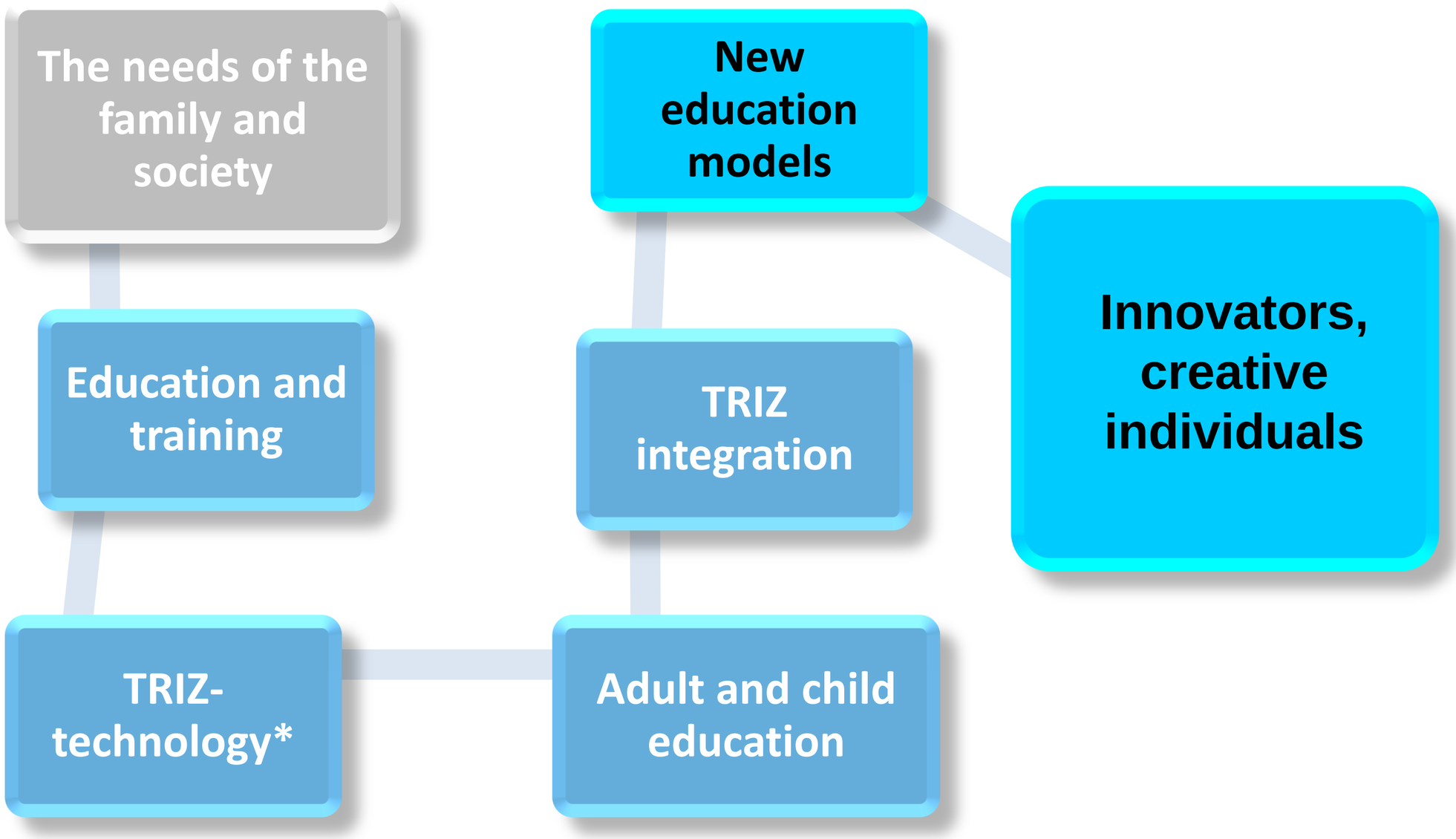
Conclusions and recommendations



Results of TRIZ integration in Education

- - Ability to think structurally and analyze problems using a systematic approach.
- - Ability to identify problems and contradictions, determine the reasons for their occurrence.
- - Search for hidden opportunities in ordinary things and phenomena.
- - Application of algorithms and methods of creative thinking development.
- - Self-confidence and self-reliance when faced with unforeseen situations and challenges.
- - Readiness for rapid changes in technology and society, adaptation to new challenges of the modern world.

Inference

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«Creativity - is a universal human function that leads to all forms of self-expression» - A. Maslow

«Human beings can be creative in their social relationships, in their ability to communicate with others, in their ability to experiment in any field of knowledge» - Anderson

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«If someone manages to solve a truly creative problem, to fully experience the state of insight, he experiences a powerful emotional rise, which can be compared to religious ecstasy or love» - A. Einstein

Thank you!

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Presents

ITC 2024

INTERNATIONAL TRIZ CONFERENCE

14 -17 OCT'24 | DUBAI

Radisson Blu Hotel, Dubai Canal View

Tyre manufacturing process innovation - TRIZ approach

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Tyre – The evolution

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BC 3000 – Metal Reinforced Chariot wheel

BC 3500 – Mesopotamia – Bronze age

Metal Reinforced low weight wheel

1845 – Robert William Thomson – Pneumatic Tyres (Air-filled)

1888 – John Boyd Dunlop, First functional Tyre

1905 – ‘Tread’ Tyre , protecting carcass from direct road contact

1945 – First ‘Radial’ Tyre, fuel efficient and improved performance

2012 – Non-Pneumatic Tyre (NPT)

1979 – ‘Run-Flat’ Tyre

2017- SMART

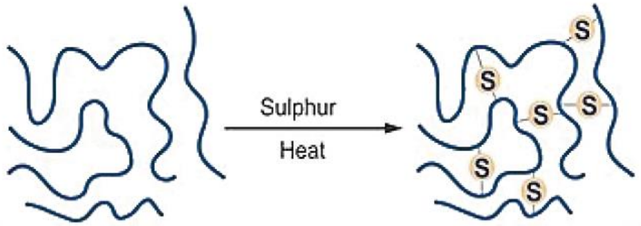
2023- SMART

Tyre Curing Process

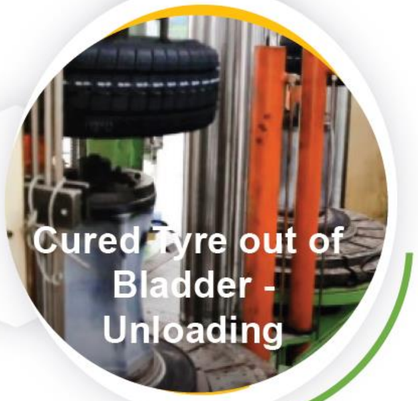
- 1839 - Charles Goodyear,
  by accidentally dropping sulphur with some India rubber on a hot stove.
- More elastic with improved properties

Heated by **Steam** from inside and further pressurised by **Nitrogen**

Vulcanization / Curing



Car tyre : 15 to 25 min.
Truck tyre : 55 to 65 min.



Problem Definition

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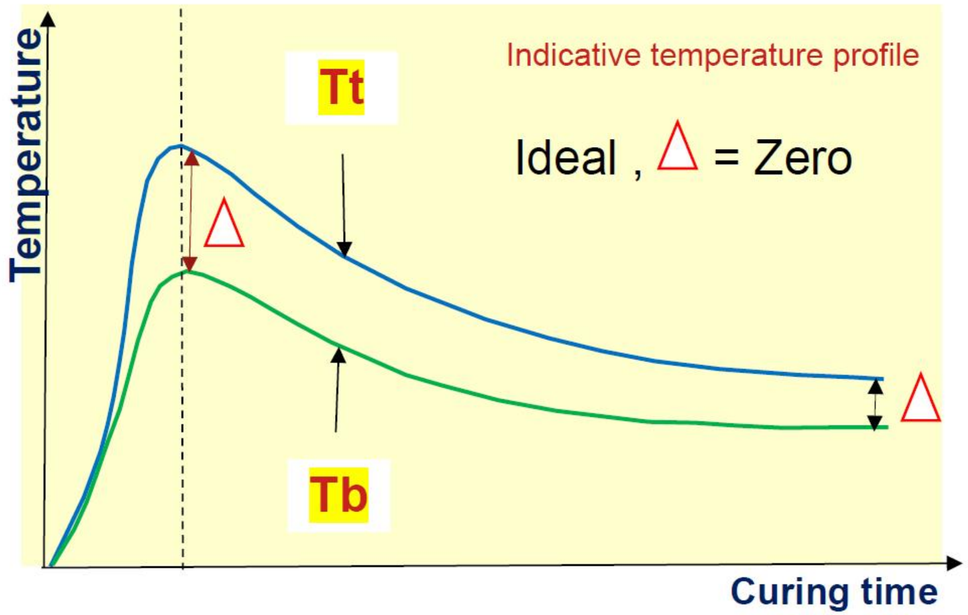
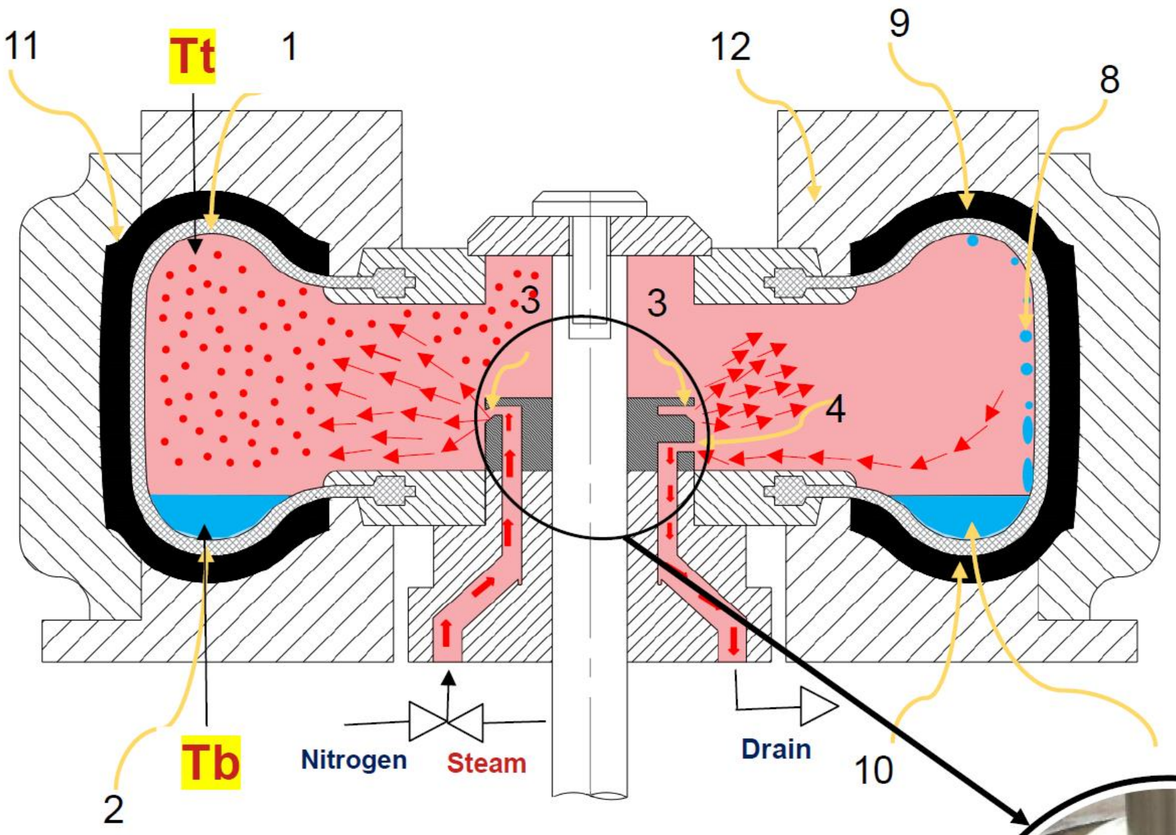
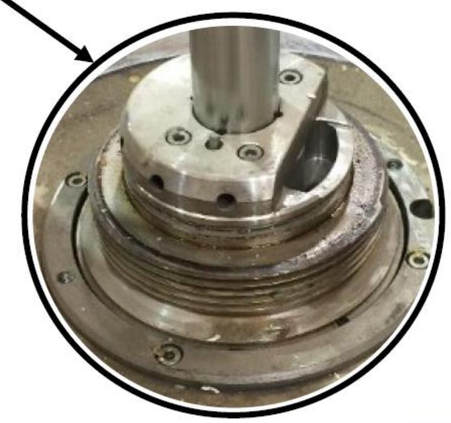
Tt / Tb : Temperature at mid-Tyre inner top / bottom



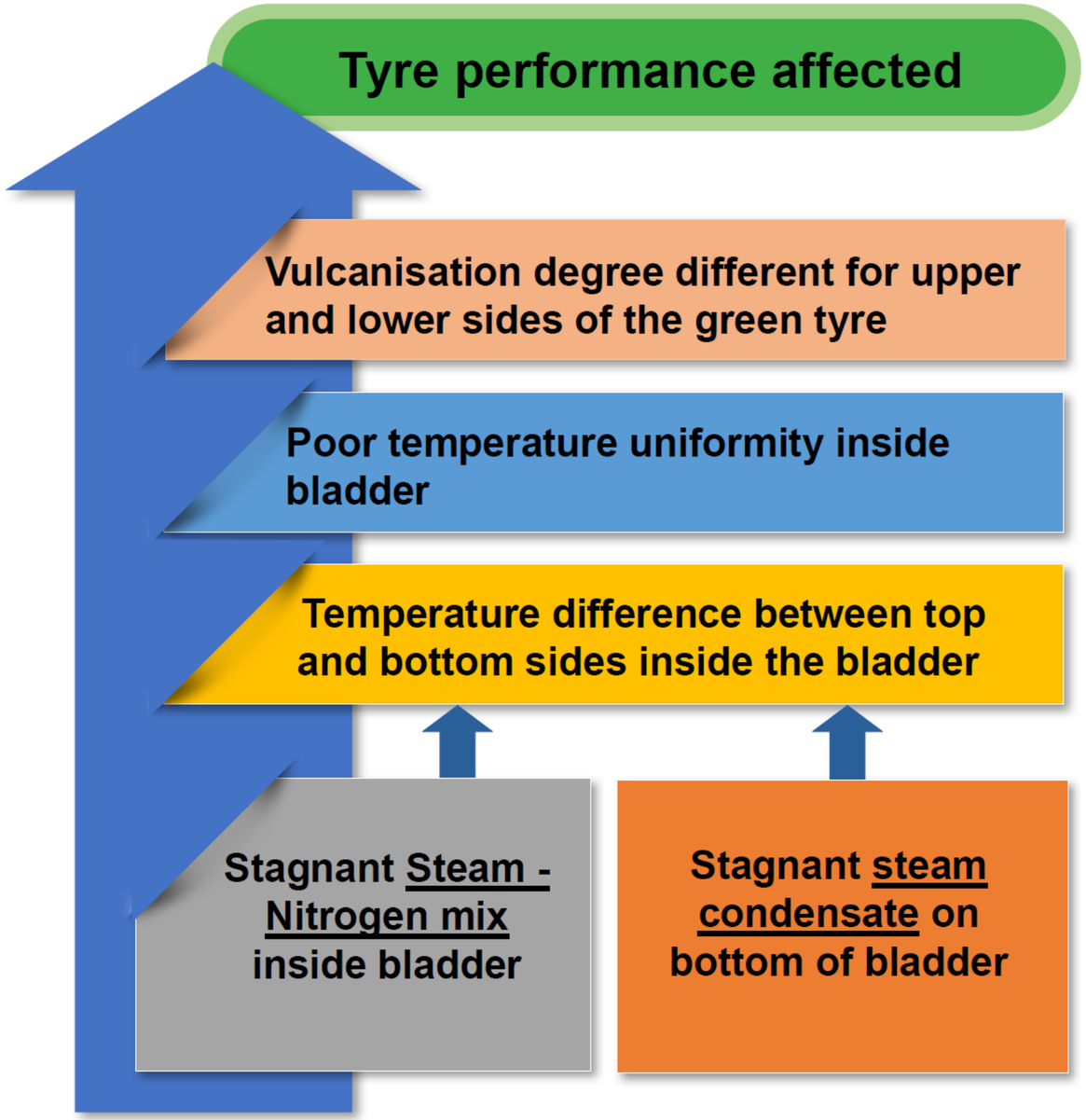


	System Components		
1	Bladder Top	5	Steam
2	Bladder bottom	6	Nitrogen
3	Inlet Port	7	Condensate
4	Outlet Port	8	Water droplet

	Super system Components		
9	Tyre inner top	12	Mold
10	Tyre inner bottom		Air
11	Tyre outer		Gravity



Problem Statement – Key issues and Objective



There is a great need for a technique for uniform vulcanisation of the 'green' tyre by improving the overall temperature uniformity inside the bladder

- This is a case study of the application of TRIZ modelling and analysis to define key problems , identify root causes and find solution directions as an example of effective application in a critical manufacturing process.
- Industry practices , current technologies and patents are also mentioned to compare with derived solution concepts

Function Analysis of the system– a snapshot during the curing process

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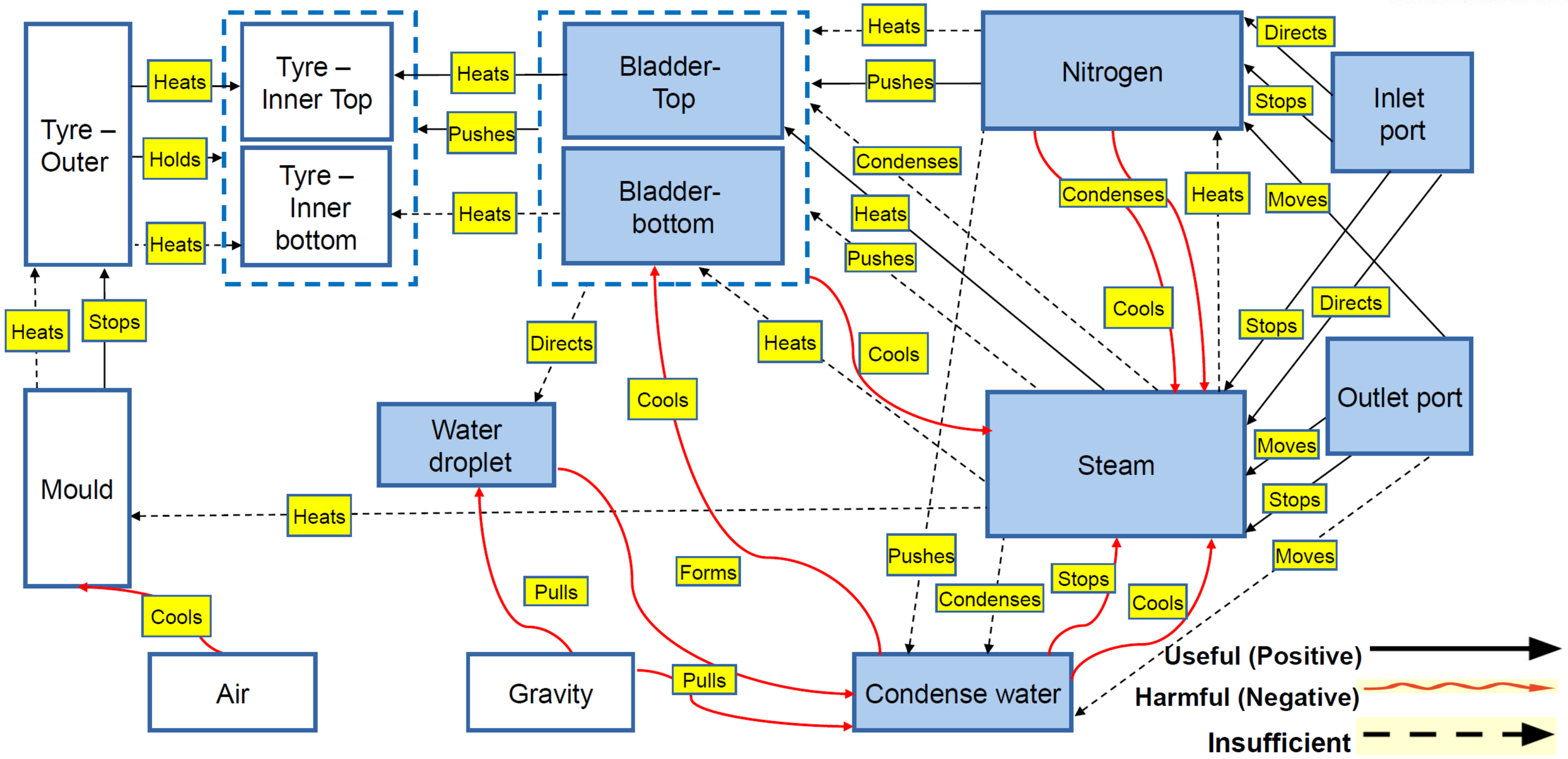
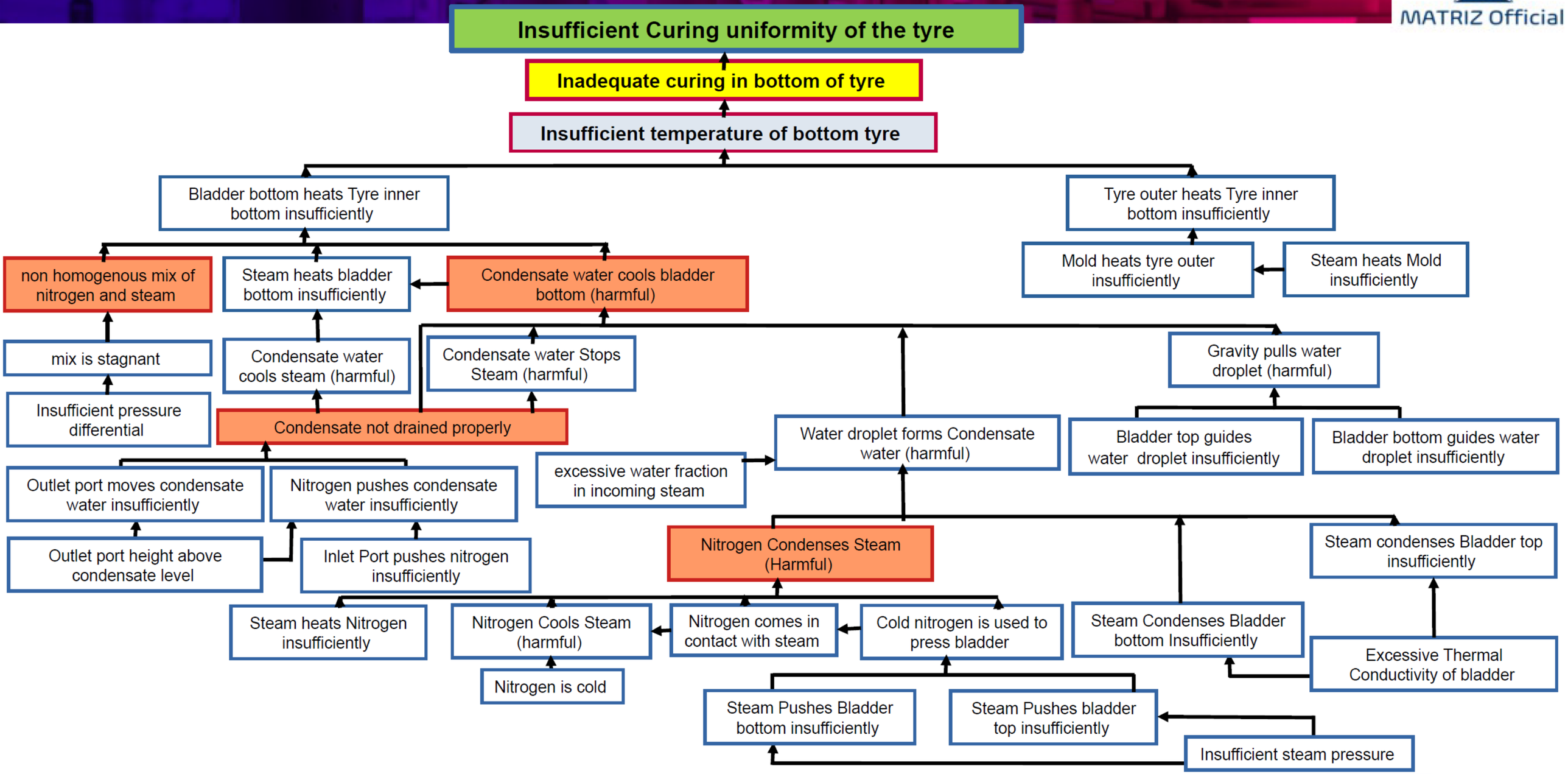


Cause Effect Chain Analysis



Key problems based-on FA and CECA

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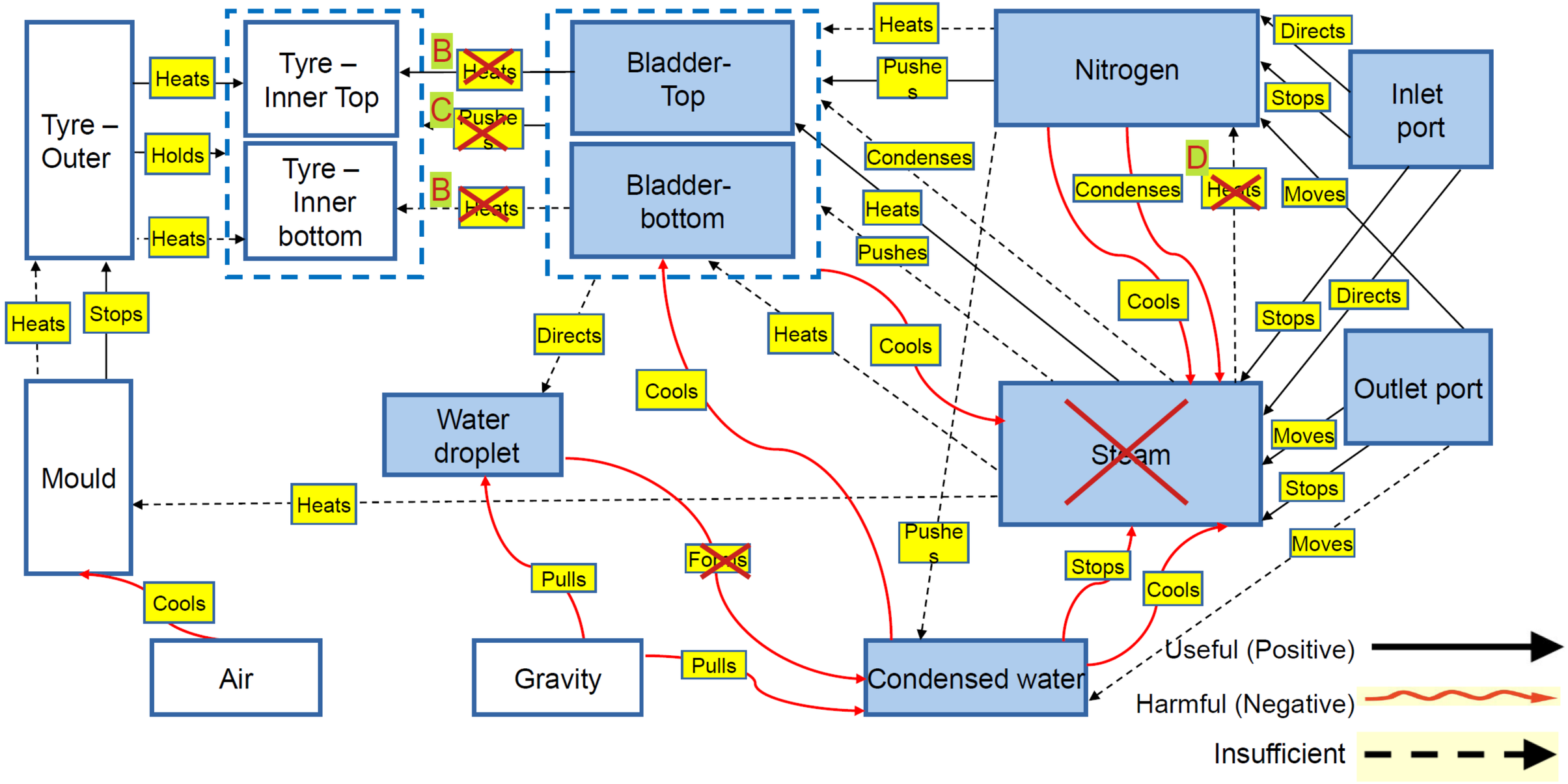
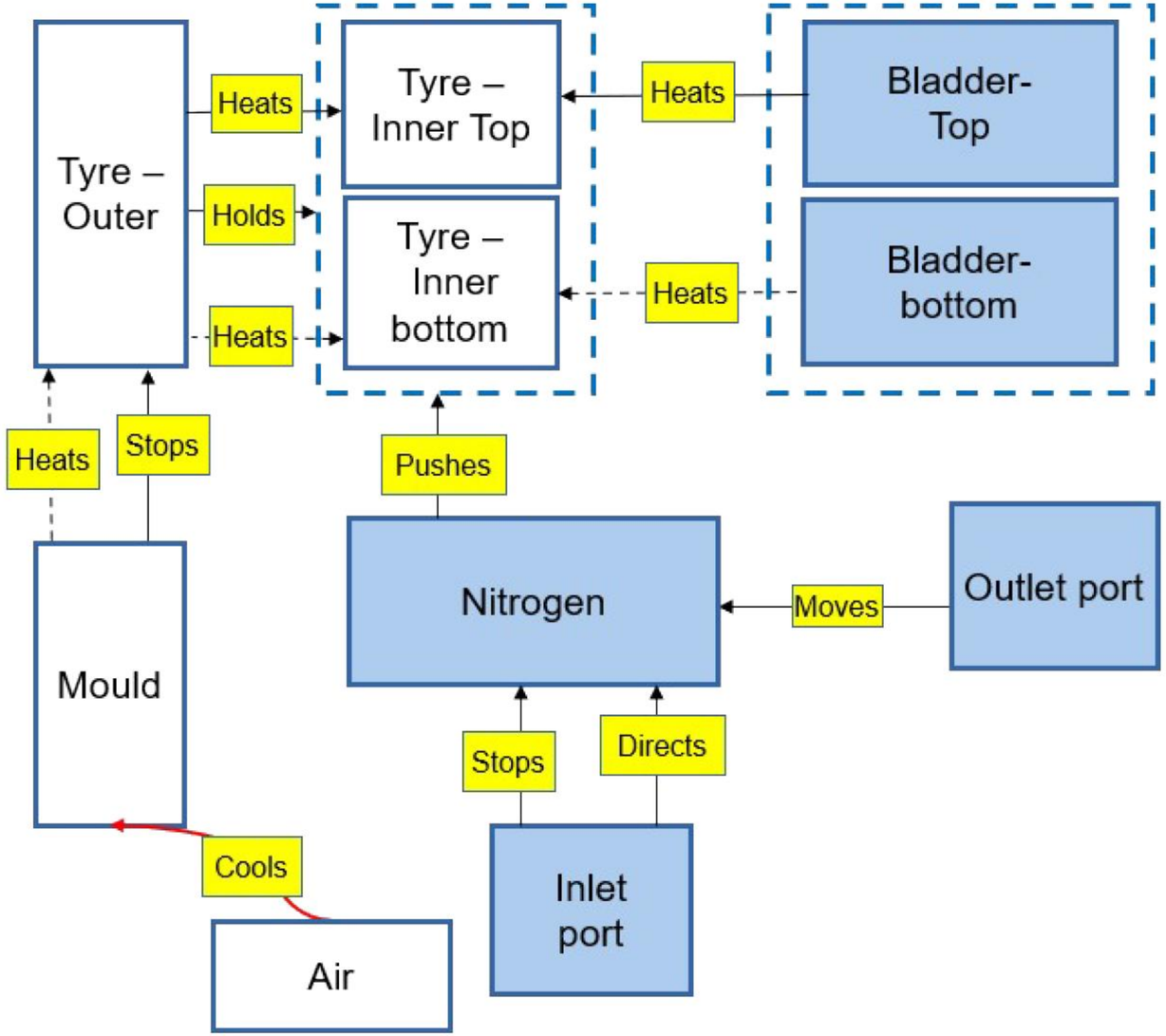
Trimmings	Key Disadvantages	Key Problems	Responsible Components (Add / Remove)
1	Steam condensate on bladder bottom ‘stops’ steam (Barrier for steam-to-bladder heat transfer)	How to reduce steam forming condensate water?	Condensate water, bladder bottom
		How to make outlet port move condensate water continuously?	Condensate water, outlet port
2	Nitrogen condenses steam	How to reduce Nitrogen cooling steam?	Nitrogen , Steam
		How to prevent Nitrogen contacting steam?	
3	Non-homogenous mix of Nitrogen and Steam	How to reduce Nitrogen-Steam stagnation?	Nitrogen , Steam

Trimming exercise - Steam



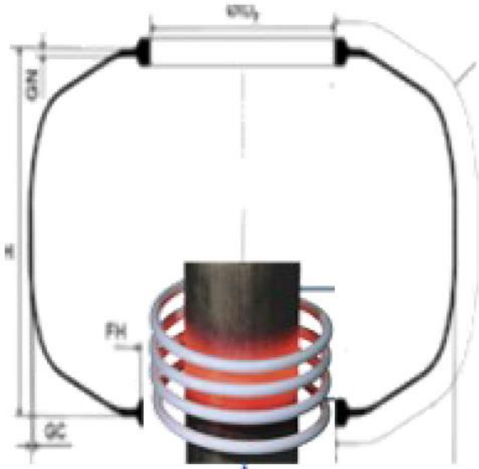
Steam-trimmed model and solution



Patents can be found on electromagnetic heating of Nitrogen / bladder

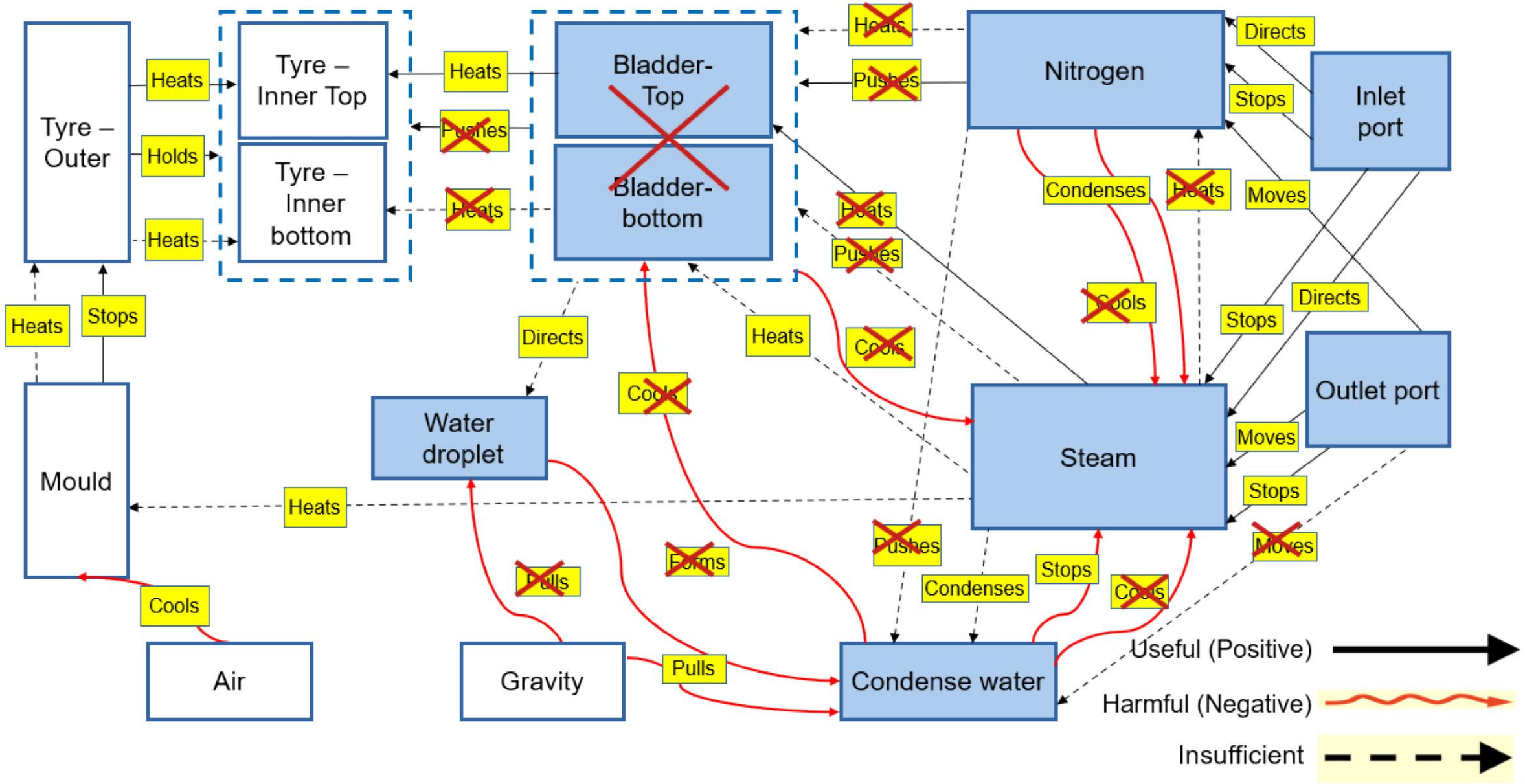
Self-heated / non-contact heating of bladder

Electro-magnetically-heated bladder

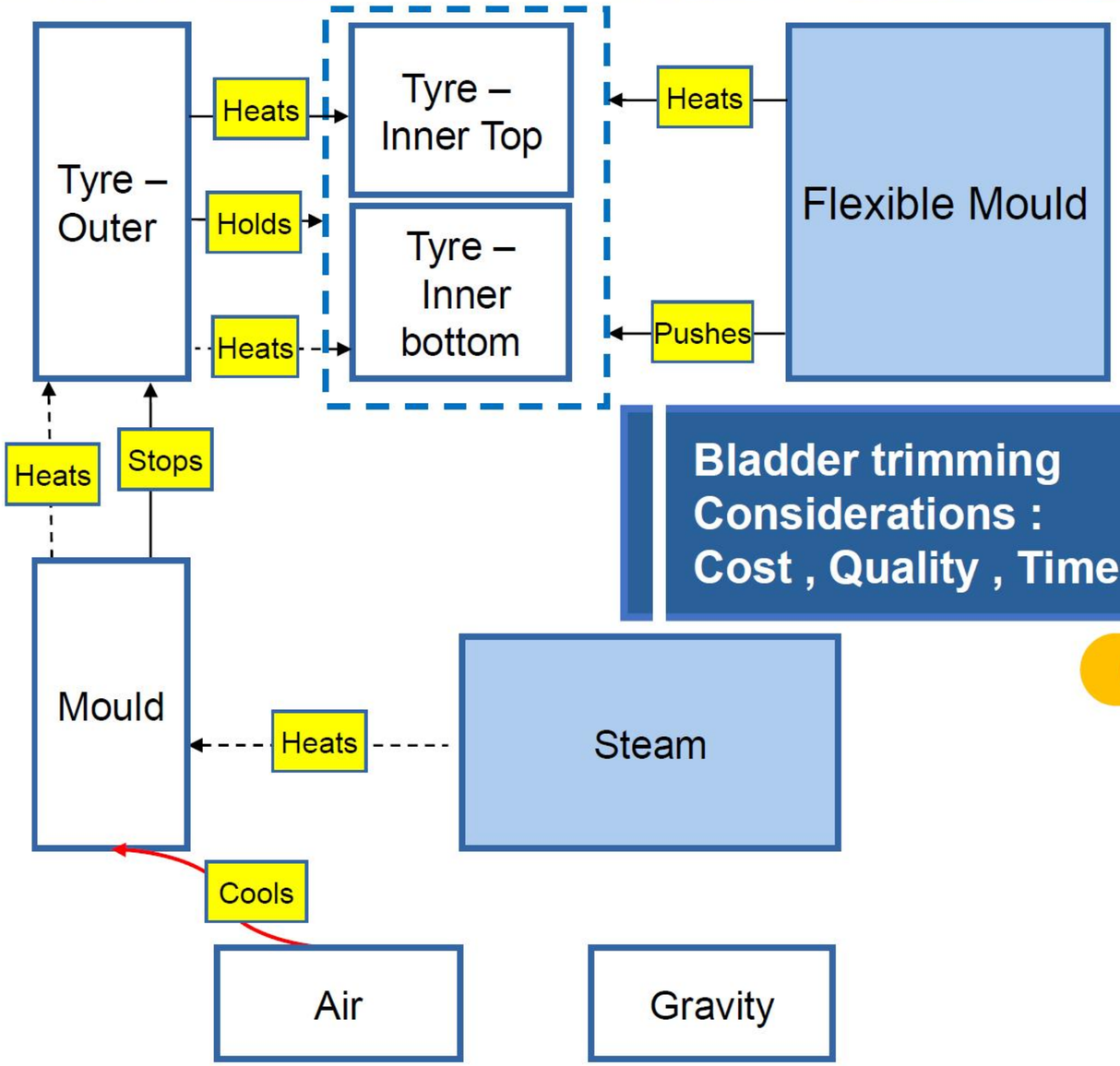


Inject Nitrogen instead of Steam

Trimming exercise - Bladder



Bladder-trimmed model and solution

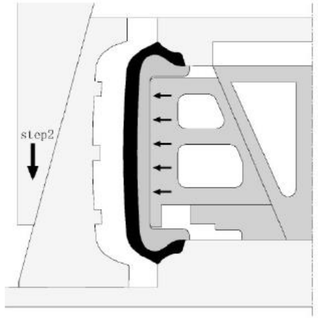


- **Flexible mould inside :**
  - Pressurise inner tyre
  - Heating inner tyre

Bladder trimming Considerations : Cost , Quality , Time

- **Poor heat transfer → Cycle time**
- **Limited life → Cost , Replacement time**
- **Failures → Quality , Safety**

One example is : Direct Pressure Curing Technology*



*Zhang,J.,Tan,J.,Liu,X., and Yang,W.(2016).Energy saving curing and precision manufacturing technology of tires.AIP Conf. Proc.,1713,130002

Key Problems for Technical Contradiction - Examples

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01

IF Cold nitrogen is present

THEN Tyre gets pressurised for curing

BUT Temperature goes down

	Specific	Generalised
Improving Parameter	Pressurisation	Tension / Pressure
Worsening Parameter	Cooling	Temperature

Recommended Inventive Principles:

35. Parameter changes 39. Inert atmosphere
19. Periodic action 2. Taking out

Chosen Principle : Parameter changes

Solution directions

Raise Nitrogen temperature before or inside the bladder

02

IF There is no gravity

THEN Condensate will not collect at bottom

BUT Mould system is more complex

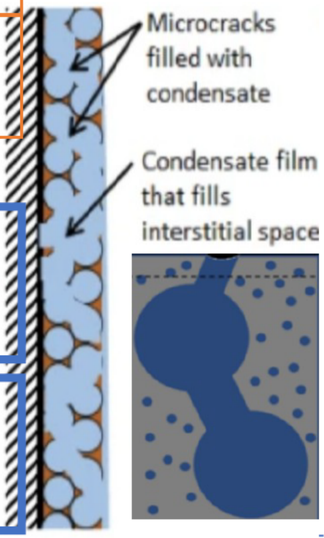
	Specific	Generalised
Improving Parameter	No condensate collection at bottom	Amount of substance
Worsening Parameter	Mould system complexity	Complexity of a device

Recommended Inventive Principles:

3. Local quality 13. 'The other way round'
27. Cheap short-living objects 10. Preliminary action

Chosen Principle : Local quality

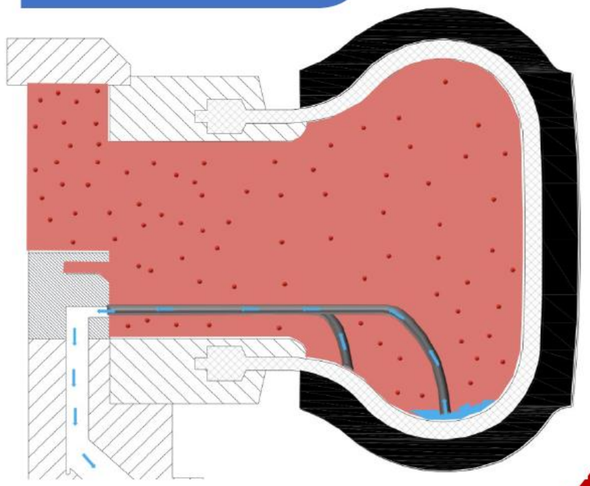
An open cell foam texture inside bladder for water droplets to be collected and not trickle down



Key Problems for Physical Contradiction

MATRIZ Official

Example 1



Flexible port reaching-out to the condensate collection area

Solutions : Segmentation

An extra layered bladder in bottom portion. This could be inflated to drain the condensate as and when required

Direction

Separation in space

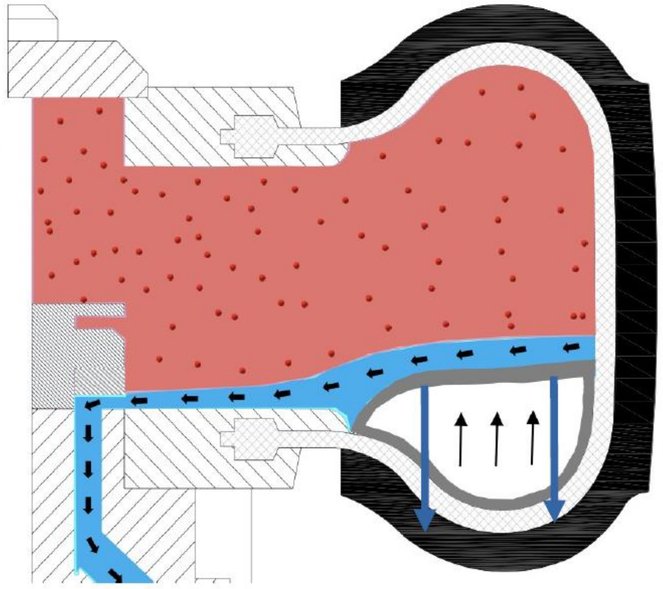
Way to Resolve

Separating contradictory demands

Inventive Principles

1. Segmentation 2. Taking out 3. Local quality 7. 'Nesting doll' 4. Asymmetry 17. Another dimension

Condensate port height should be LOW in order to drain continuously
BUT ;
Condensate port height should be HIGH in order to reduce manufacturing complexity



Key Problems for Physical Contradiction

MATRIZ Official

Example 2

Preliminary anti-action: Intermittent opening of inlet and outlet for condensate removal

Preheating of bladder to reduce condensation

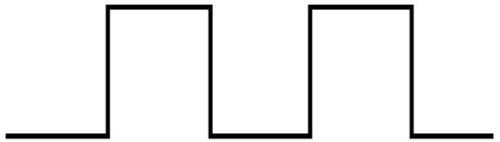
Dynamics: Inlet steam open when outlet closed instead of keeping inlet and outlet closed during steam hold

Solutions : Segmentation

Direction

Separation in Time

Inlet / Outlet - Open



Inlet / Outlet - Close

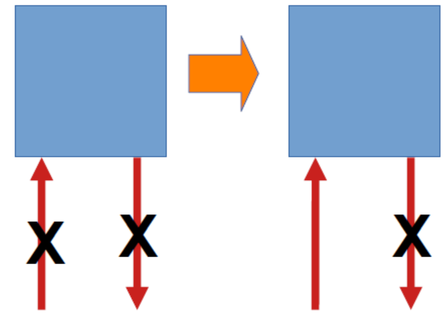
Way to Resolve

Separating contradictory demands

Inventive Principles

15. Dynamics 34. Discarding and recovering 10. Preliminary action 9. Preliminary anti-action 11. In-advance 'cushioning'

Steam condensation should be HIGH In order to transfer more heat
BUT ;
Steam condensation should be LOW In order to prevent water barrier film



Steam IN

Steam IN

Substance Field Analysis – by 76 Inventive standards

MATRIZ Official

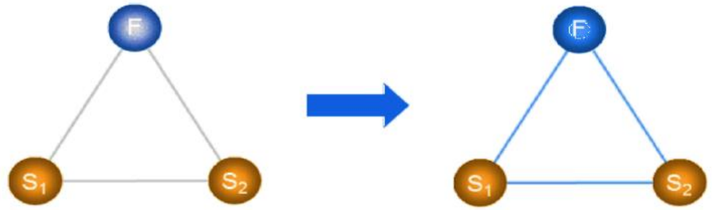
Key Disadvantage 1

"Outlet port moves Condensate water insufficiently"

Identified Problem

Outlet port unable to drain water as outlet port is above water level

Problem solving approach : Standard 1.1.1 (1.1.1.2) A



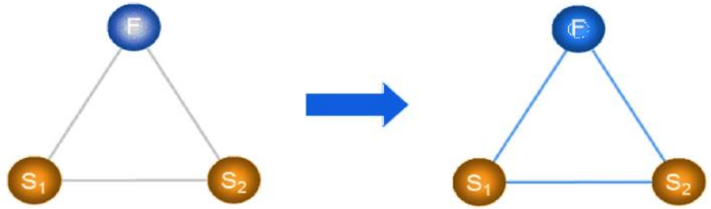
Condensate Outlet port

The object is subjected to the action of a physical field to move water up against gravity

Solutions

1. Use capillary effect to draw condensate-up
2. Use mechanical field (pressure) to push condensate to the outlet port
3. Use mechanical field (physical) to move condensate up to outlet port : rotate the mould system - dynamic

Problem solving approach : Standard 1.1.1 (1.1.1.2) B



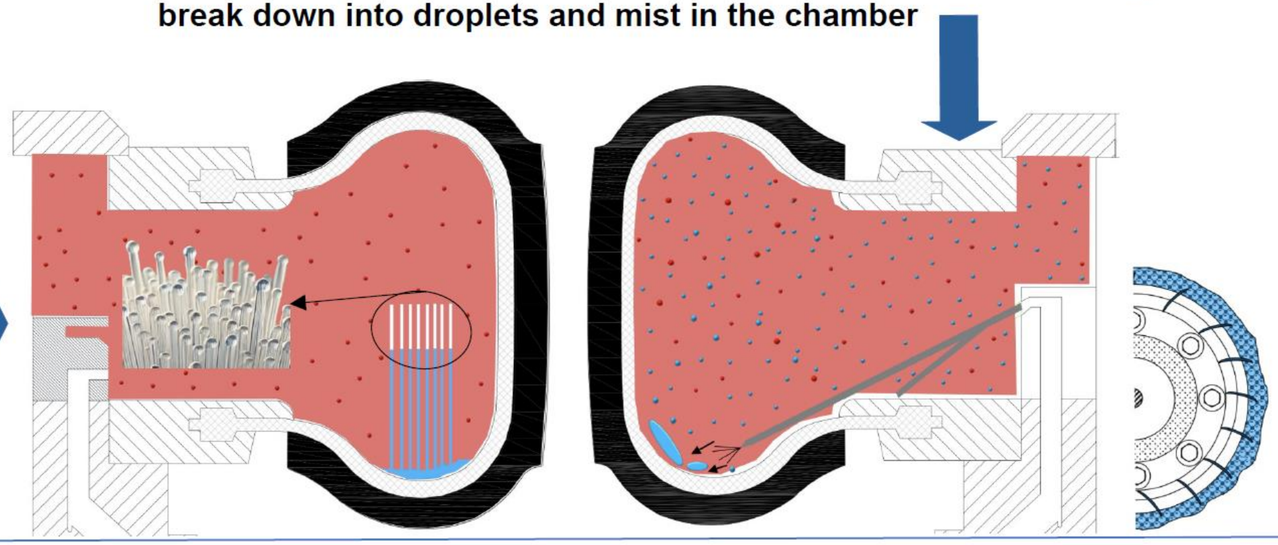
Nitrogen Condensate

Moving stagnant water to outlet port by existing resource - Nitrogen

Solutions

F1: Nitrogen pressure differential within bladder cavity to drive condensate-up

F2: Nitrogen directed on condensate during entry into bladder cavity to break down into droplets and mist in the chamber



Substance Field Analysis – by 76 Inventive standards

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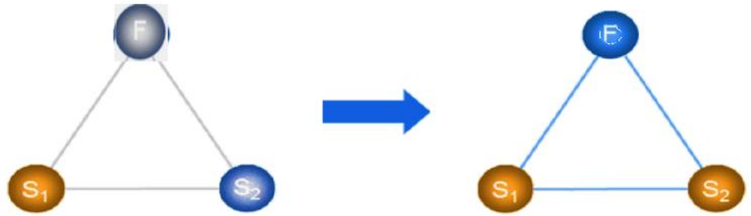
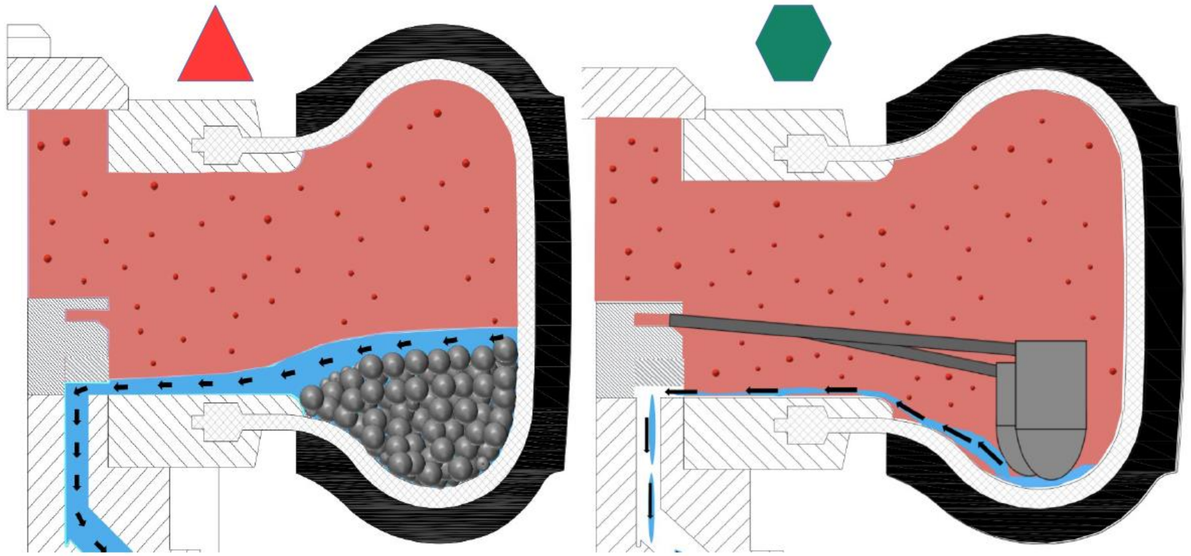
Problem solving approach : Standard 1.1.1 (1.1.1.3)

Create and improve interaction by synthesis of Su-Fields which produces the necessary change in the object.



Condensate Outlet Port

The object (stagnant water) is subjected to the action of a new substance and physical field. Field is missing to move water up against gravity



Solutions

Field	Substance
Mechanical (Pressure)	Flexible tube immersed in condensate water connected to outlet port
Thermal	Steam; thermal field would convert water S1 to steam S2
Mechanical (Physical movement)	Fins / vanes attached to centre post to drive the condensate water to the port
Mechanical (Physical displacement)	Thermally conductive beads having suitable shape and size to raise the water level to the port

Substance Field Analysis – by 76 Inventive standards

MATRIZ Official

Key Disadvantage 2

"Nitrogen used to pressurise bladder condenses Steam"

Identified Problem

How to reduce Steam condensation caused by Nitrogen contact during pressurisation ?

Problem solving approach : Standard 1.2.1

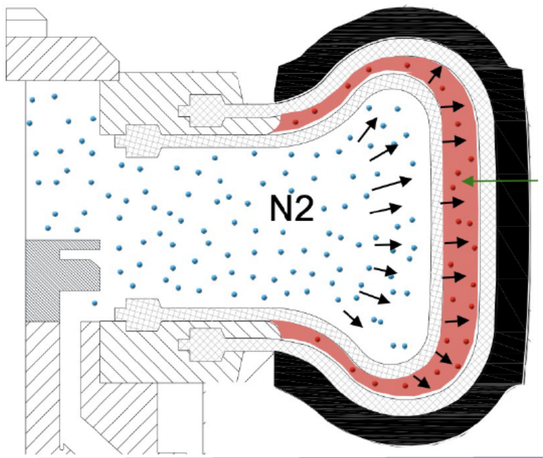
Introduce a third substance between two substances which breaks the harmful effect of interaction while preserving the useful effect of interactions.
Direct contact of two substances not necessary.

Nitrogen Steam

Thermal field (cooling of Steam) is to be destroyed.
Introduce a new substance between Nitrogen and Steam

Solutions

To avoid contact , provide a separate bladder for Nitrogen inside the bladder containing Steam



Problem solving approach : Standard 1.2.4

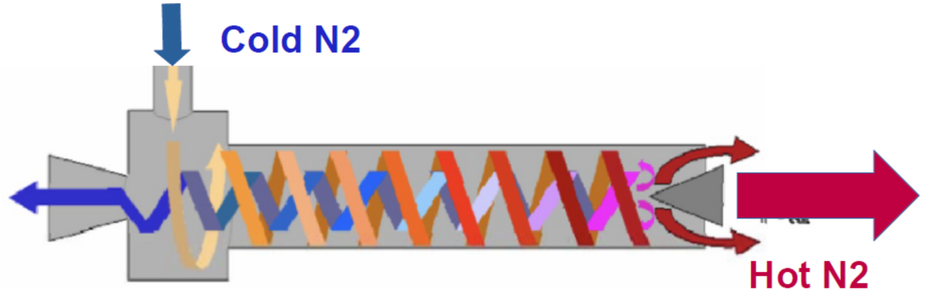
Introduce a new field to eliminate harmful interactions between two substances
Direct contact of two substances is necessary

Nitrogen Steam

Introduce a new field between Nitrogen and Steam. Transitioning to a 'dual Su-Fi' , in which the useful effect is provided by the existing field while a new field neutralizes the harmful effect of thermal field (cooling of steam)

Solutions

1. Use existing Steam to heat the Nitrogen while entering
2. Use pressure field of Nitrogen with "vortex" to create a thermal field heating the Nitrogen during entry



Overview of Industry practices and technologies

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Incremental Innovations

1. Intermittent condensate purging with Steam and Steam quality improvement
2. Inlet port designs to direct steam / N2 to push condensate to outlet / for improved Nitrogen-Steam mixture
3. Outlet port design, lowering and , increased area for improved condensate draining
4. Multiport design for inlet for improved Nitrogen – Steam mixing
5. Higher bottom mould temperature
6. Bladder clamping ring design for directing condensate towards outlet

Radical Innovations

1. Gas circulation pump * outside to circulate N2 – Steam mix
2. Flexible metal mould inside , induction – heated
3. Hot Nitrogen / N2 heated inside with internal fan circulation , without Steam

* Gas circulating unit , Rocky-Ichimaru Co. Ltd; Japan

Outcomes / learnings

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Corrected

1. Systematic analysis with tools like FA , CECA , TC & PC and identify key problems
2. Derived solution directions with different tools : Trimming , TC , PC & Su-Fi in a process system
3. Derived improvement concepts , and compared with industry practices , technologies / patents
4. Electrical heating system and hot Nitrogen system evolving
5. Improvement concepts for existing systems with Steam / Nitrogen , which is most prevalent
6. Tyre design also evolving with radical innovations
   - Cavity inside tyre for air is getting eliminated with Non- Pneumatic Tyre (Air-less)
   - Result: Entire manufacturing system will change from current

TRENDS

Conclusion

TRIZ tools can be effectively applied in the process industry :

- **Provides a comprehensive understanding of the underlying causes of a problem**
- **Gives innovative solution directions**

Q&A

Thank You

Research on PBL(Problem Based Learning) based on TRIZ

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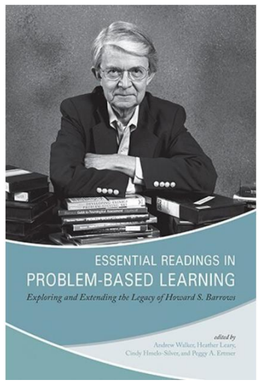
CONTENTS

What is PBL?

- **PBL (Project vs. Problem Based Learning)**

PBL

- Project Based Learning
- Problem Based Learning



Problem Situation → Problem Definition → Data Collection → Idea Generation → Outputs Presentation → Wrap-up

What is PBL?

PBL (Problem Centered vs. Based Learning)

Problem-Centered Learning	Problem-Based Learning
❖ Problems are given as a way to check whether learning has been carried out properly ❖ A simple problem applying one or two factual knowledge or principles ❖ The instructor informs the learner of the information needed to solve the problem through a lecture.	❖ Problems are presented as a way to begin learning ❖ A broad range of questions encompassing everything you need to learn ❖ A complex problem where multiple concepts and principles work together – multiple solutions, not just one ❖ Learners must find answers to problems by themselves – the instructor plays the role of facilitator

[Barrows & Mayers, 1993]

What is PBL?

- **Representative Model for PBL**

MINERVA

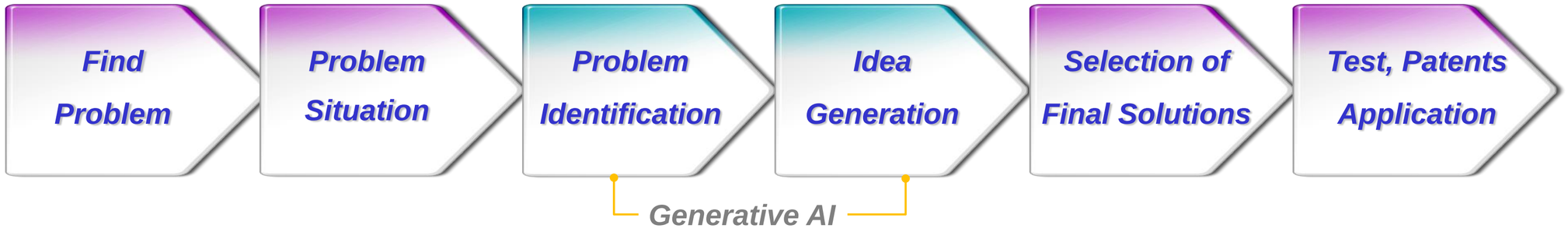
Olin College of Engineering

What is T-PBL+?

T-PBL+ (TRIZ Based PBL) in Our University

+ : advanced

Empathize **D**efine **A**nalyze **G**enerate **E**valuate **V**erify



kit 국립금오공과대학교 Kumoh National Institute of Technology

T-PBL+ 1st stage (1st Semester)

On/Offline Course	Implementation of Project
3 Problem Analysis	4 Idea Generation
2 Problem Definition	5 Evaluate Ideas
1 Problem Situation	6 Selection of Final Solutions

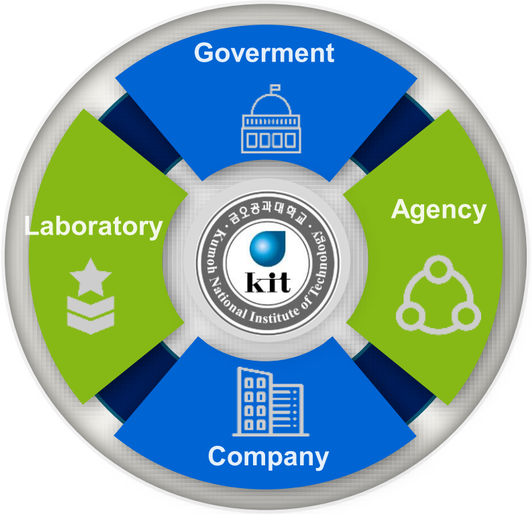
T-PBL+ 2nd stage (2nd Semester)

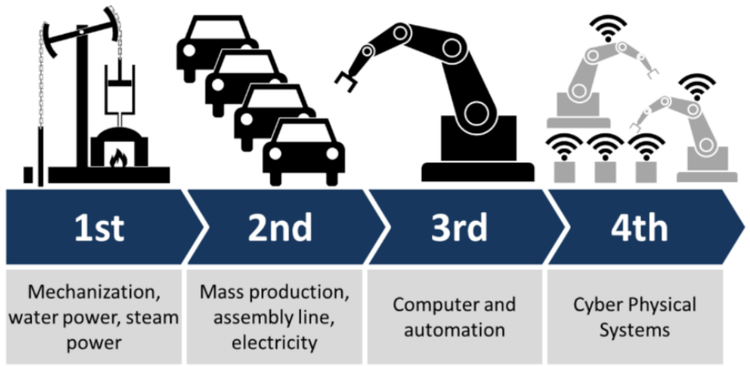
4 Performance Test	5 Performance Analysis
3 Prototype Implementation	6 Wrap up
2 Design and Simulation	Patents Application/Registration Writing Papers Technology Transfer Production/Process Application
1 Project Plan	

What is T-PBL+?

Project from T-PBL+ (TRIZ Based PBL)

- ❖ Mechanical industry field
- ❖ Smart factory/farm field
- ❖ National defense logistics field
- ❖ ICT field
- ❖ Etc.

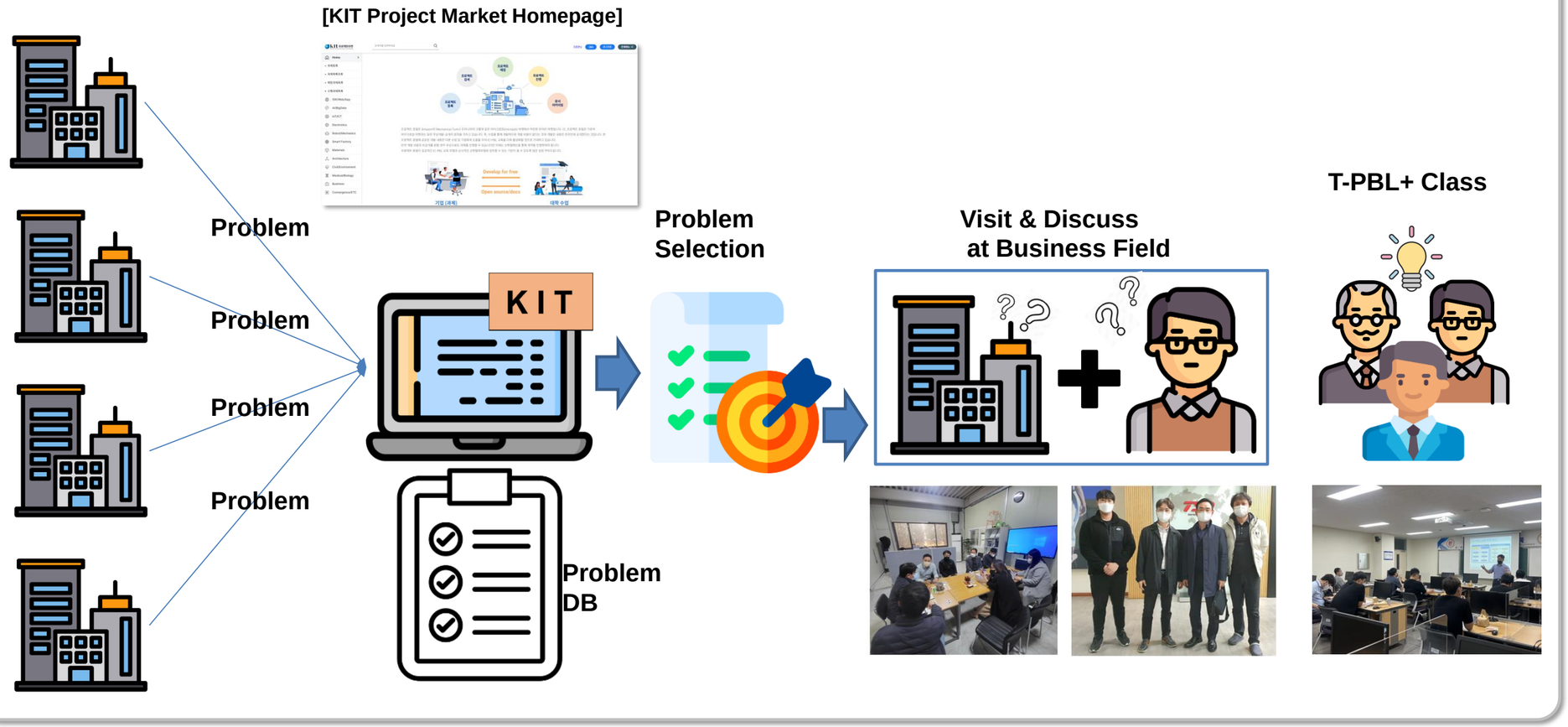




What is T-PBL+?

Project from T-PBL+ (TRIZ Based PBL)

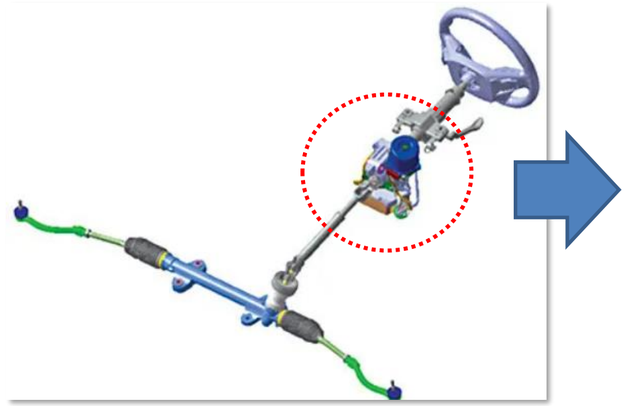
[Establishment of a system for collecting chronic problem from companies]



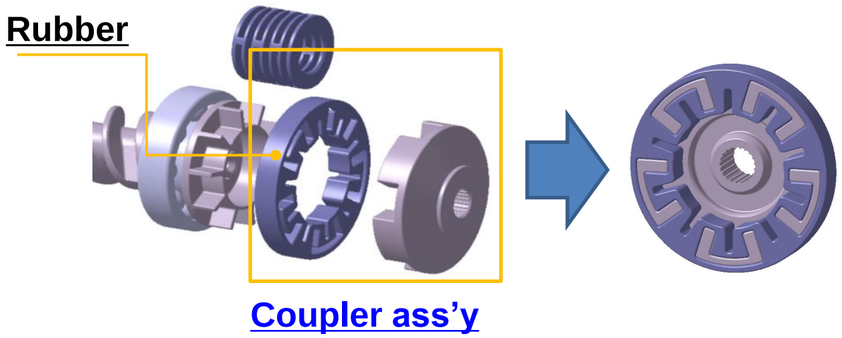
Case Study from T-PBL+

Effective Removal of Flash in Rubber Couplers

- ✓ Study on the complete removal of flash of the coupler assembled on the motor shaft of C-EPS
  - → A coupler is a part that is assembled on the motor shaft and transmits power
  - → Maintaining rigidity and adhesion of rubber are required in the process of transmitting repetitive torque
- ✓ The coupler is composed of rubber and auxiliary materials and is completed through a curing process using a mold



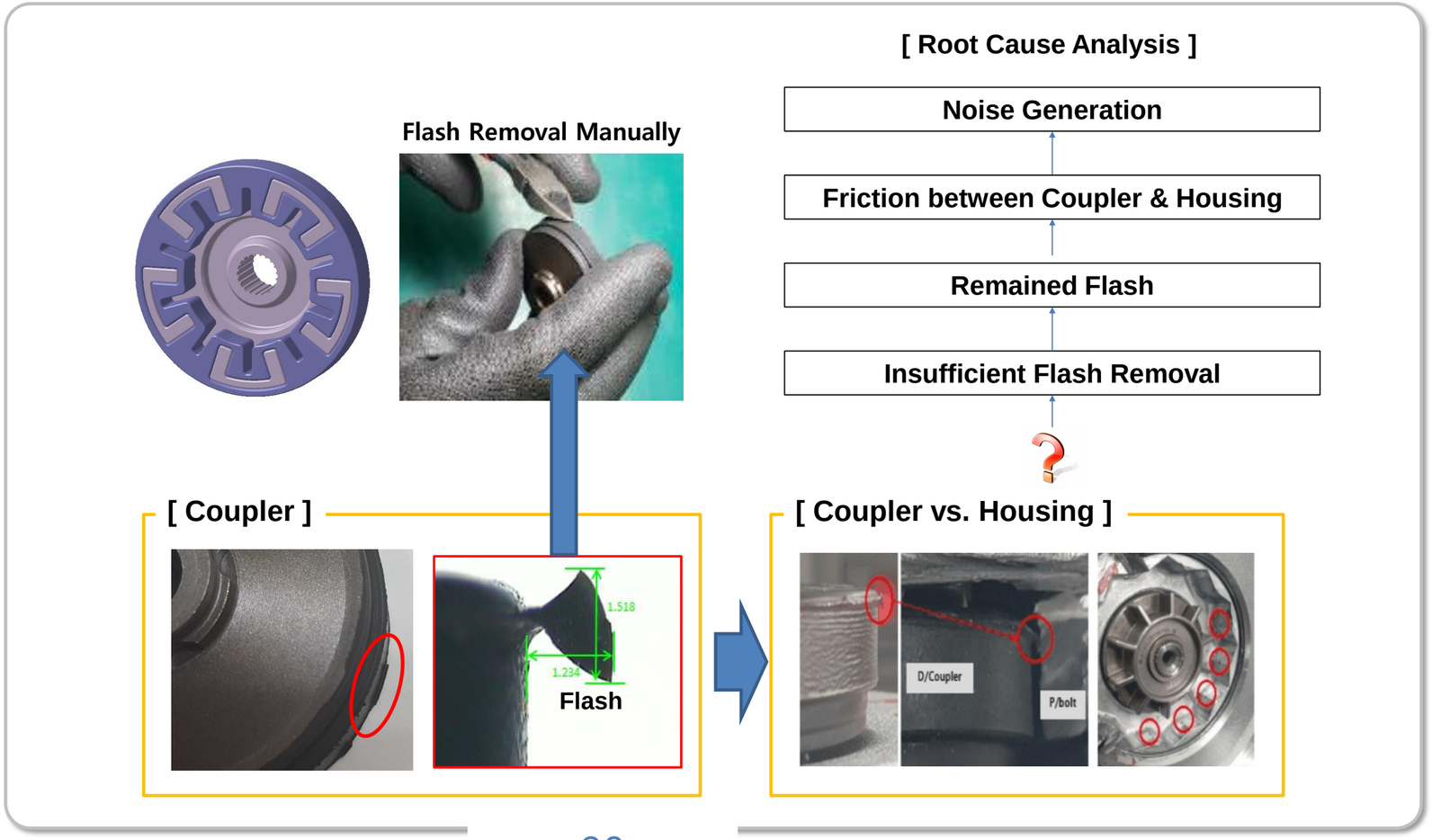
C-EPS (Column Type Electric Power Steering)



Case Study from T-PBL+

Effective Removal of Flash in Rubber Couplers

Problem	When the motor rotates, noise occurs due to friction between the flash and other parts



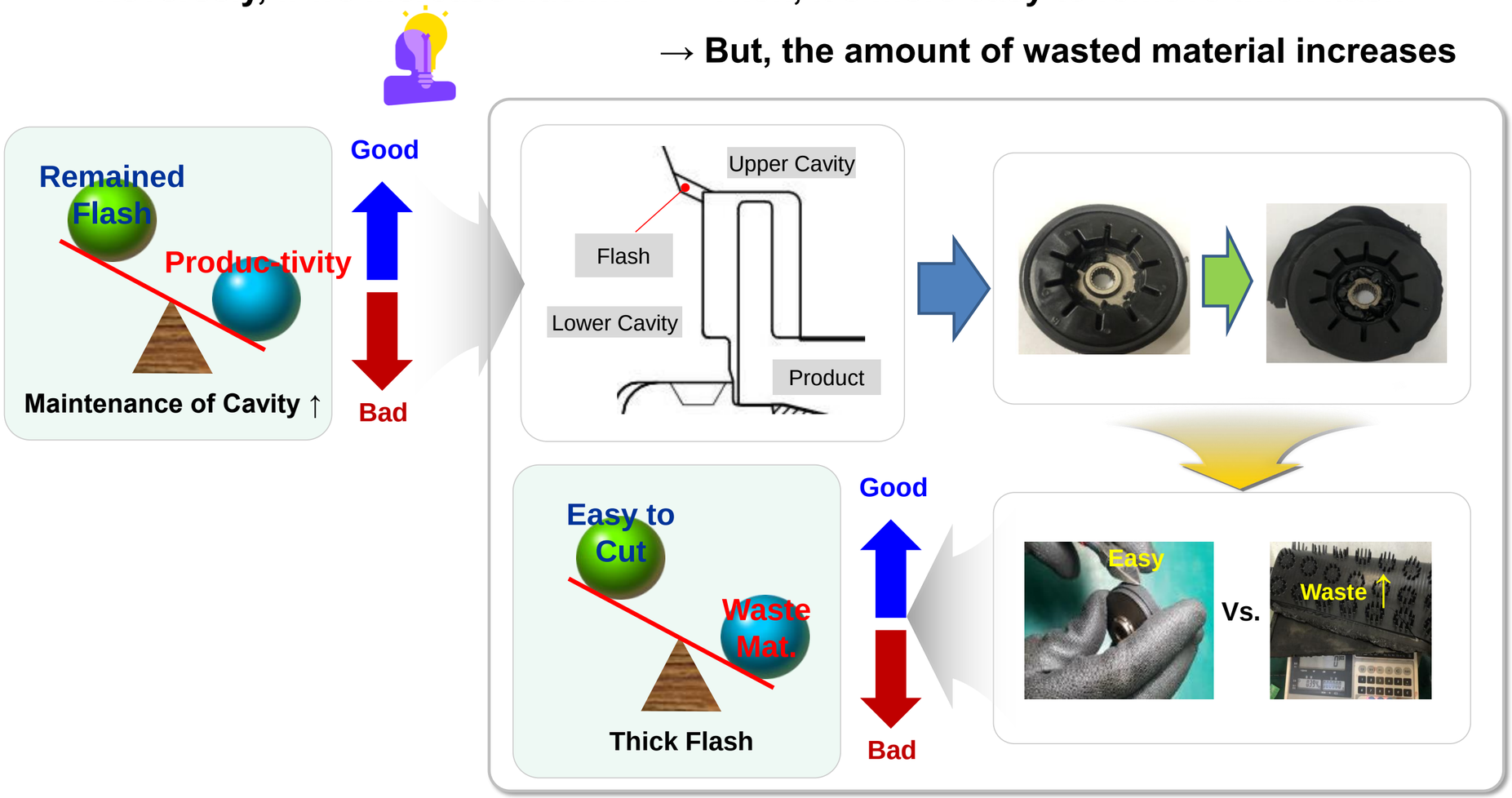
Case Study from T-PBL+

Effective Removal of Flash in Rubber Couplers

✓ **Key Problem : How to remove flash sufficiently? (maintenance of cavity ↑)**

→ Reversely, if we increase flash…? → Then, it's more easy to remove thick flash

→ But, the amount of wasted material increases

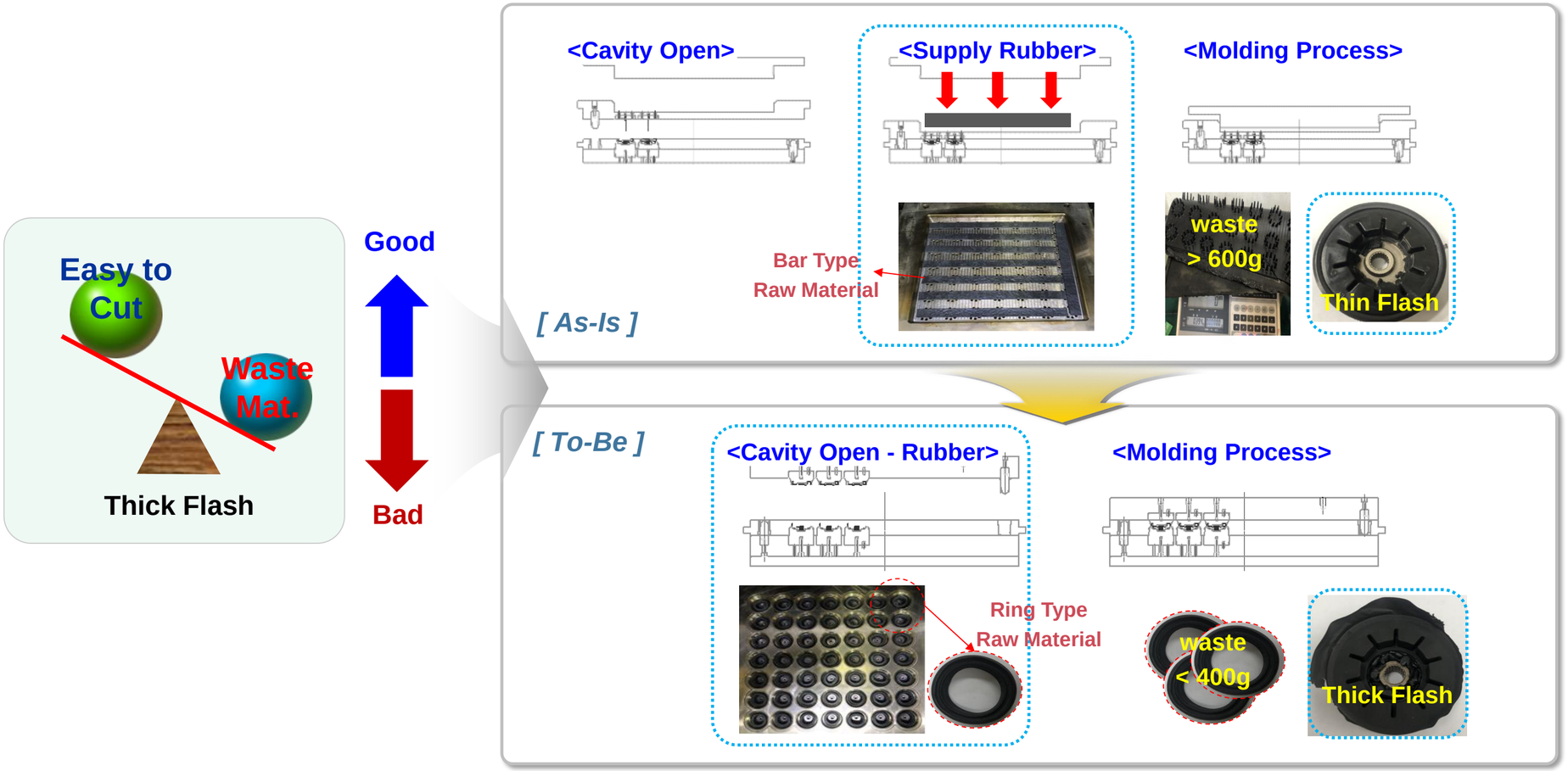


Case Study from T-PBL+

Effective Removal of Flash in Rubber Couplers

✓ **Key Problem : How to decrease wasted material?**

☞ **Precisely control the amount of material in advance and put it into the mold**



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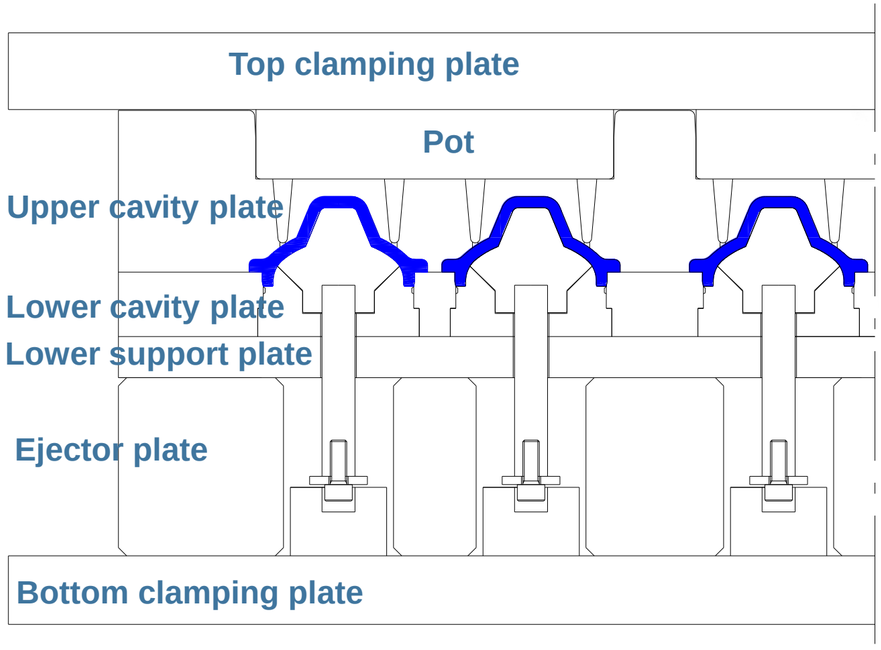
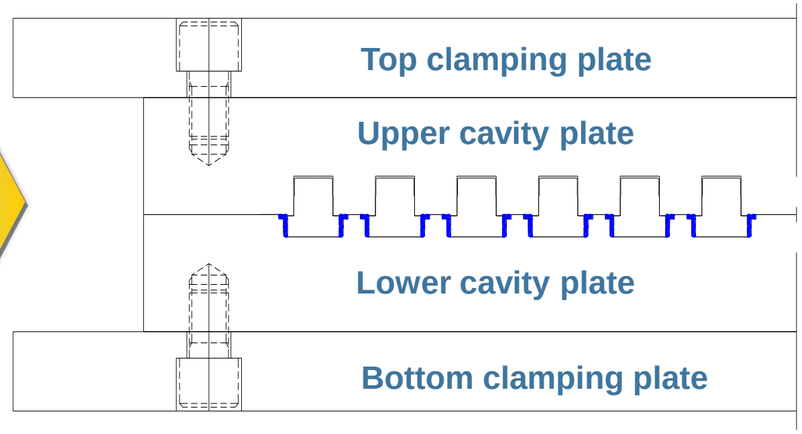
[As-Is (Mold type)]



[To-Be (Mold type)]



Case Study from T-PBL+

Effective Removal of Flash in Rubber Couplers

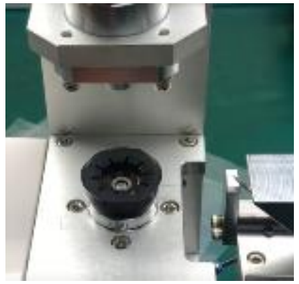
✓ **Key Problem : How to increase cutting productivity and quality?**

☞ **Semi-automatic blade device to removal flash → Cutting productivity & quality ↑**

[As-Is (Cutting flash)]

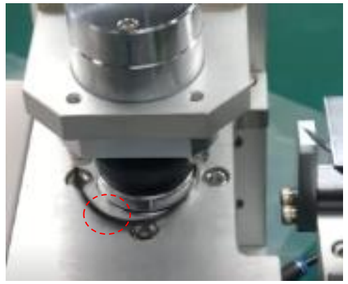
[Flash Removal Manually]

[To-Be (Cutting flash)]



[Product Input]

[Product Rotation ⇒ Blade Down]



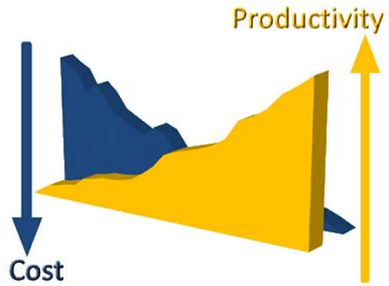
[Remove Flash]

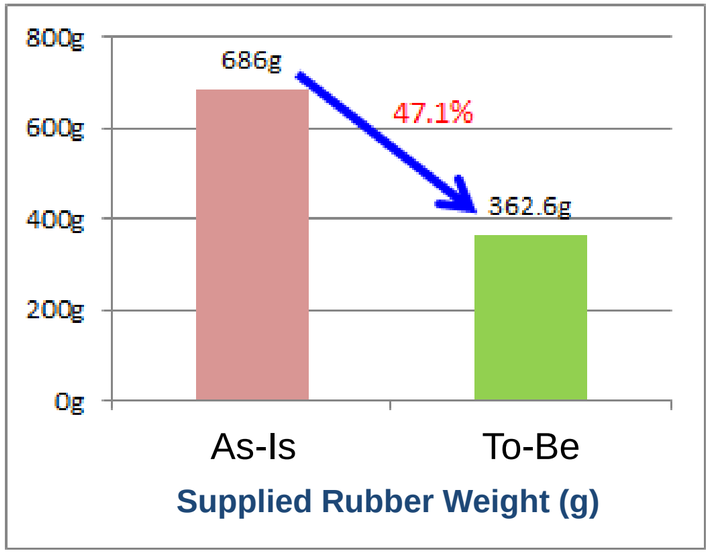
< Final Product >

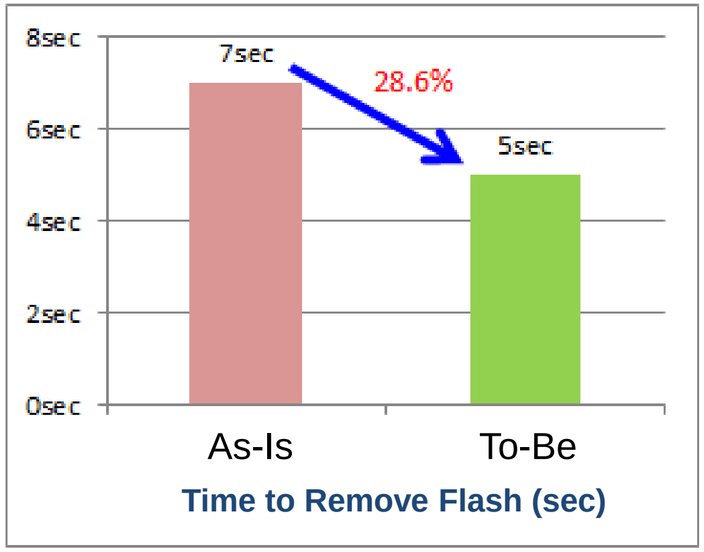
Case Study from T-PBL+

Effective Removal of Flash in Rubber Couplers

- ✓ Reduce manufacturing costs by improving quality and reducing wasted material
- ✓ Increase productivity by reducing time to remove flash
- ✓ Solve a problem by deriving a opposite concept







Conclusions

- **Our activities for T-PBL+ in our university**

  1) Education process in university has been tried to change toward PBL

  2) However, there was no proper method to lead/guide PBL process

  3) PBL based on TRIZ can be a best approach to solve complex real problem

- **TRIZ can be a key methodology for PBL in education field,**

  our efforts will continue to adopt TRIZ into PBL and to make best practices

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ACKNOWLEDGMENT

This work was supported by Innovative Human Resource Development for Local Intellectualization program through the Institute of Information & Communications Technology Planning & Evaluation(IITP) grant funded by the Korea government(MSIT) (IITP-2024-RS-2020-II201612)

Thank You

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MATRIZ Official

Presents

ITC 2024

INTERNATIONAL TRIZ CONFERENCE

14 -17 OCT'24 | DUBAI

Radisson Blu Hotel, Dubai Canal View

TRIZ PROJECT :
Ejective Pre-cleaner – Bearing Issue

Rakesh Kulkarni

Fleetguard Filters Pvt. Ltd. (FFPL)

Pune, India

Hosted by TRIZ Association of ASIA

Supported by TRIZ ASIA

Support Partner EUROGATE

Project Background

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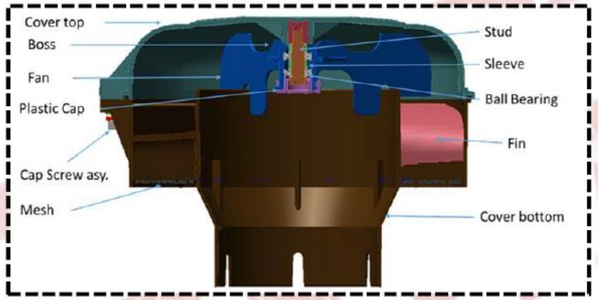
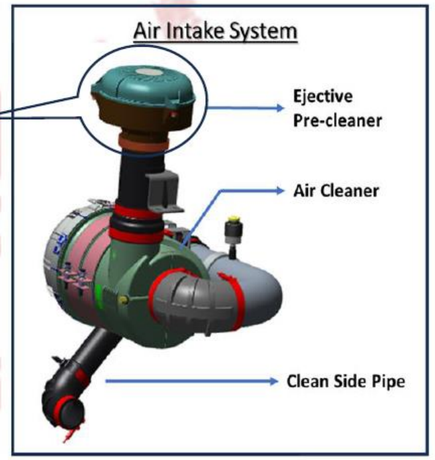
Background :- FFPL offers an air intake system with an eject pre-cleaner to satisfy customers' needs throughout its service life. However, we have received a customer complaint regarding the eject pre-cleaner, indicating that the fan failed after 1000–1200 hours of operation.

Application :- Wheel loader, Excavator, Backhoe loader

Working Environment :- Mining, Construction



PRE-CLEANER, CROSS-SECTION VIEW



Field Observations :-

1. Dust observed between bearing.

2. Rust found on a bearing.

3. Rubbing of fan with Housing.

4. Protecting plastic cap was missing.

Objective and Scope

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Objective	• Ejective pre cleaner is necessary to provide continuous clean air till the service life of air intake system.
Scope	• Ejective pre-cleaner must demonstrate uninterrupted rotation throughout its designated operational hours.
Constraints	• Pre-cleaner envelope size can not be change. • Pre-cleaner fan profile can not be change. • Ejective pre cleaner should rotate without making any noise at rated RPM.
Additional Desired Outcomes (ADO)	• Proposed solutions can be used with all sizes of Ejective pre cleaner.

Requirements and Success Criteria

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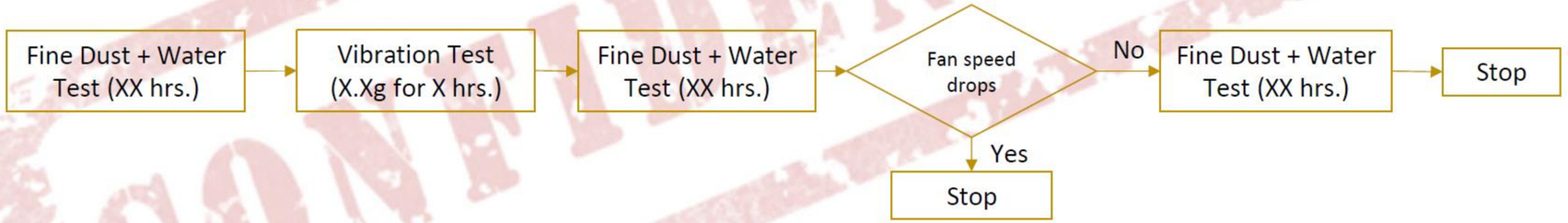
The requirements for a potential solution are:

- Ejective pre cleaner should provide more than XX% of pre-cleaning efficiency at rated RPM.
- Ensuring resilience in diverse operating conditions, the pre-cleaner must withstand vibration and maintain stability. (Vibration level : X.X g)
- It must endure various environmental stressors, including corrosion and exposure to UV light, to ensure longevity and sustained performance.
- Pre cleaner to be tested for following endurance test setup:



Project Success Criteria:

- **Success** : Ejective pre cleaner should pass XXX hours of endurance test (Dust + Fog) without damage (fan and bearing) and dropping of RPM.

Project Logic: Analysis and Problem Identification

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Target problems
It is necessary to rotate pre-cleaner fan throughout its designated operational hours.

Component analysis

Function analysis

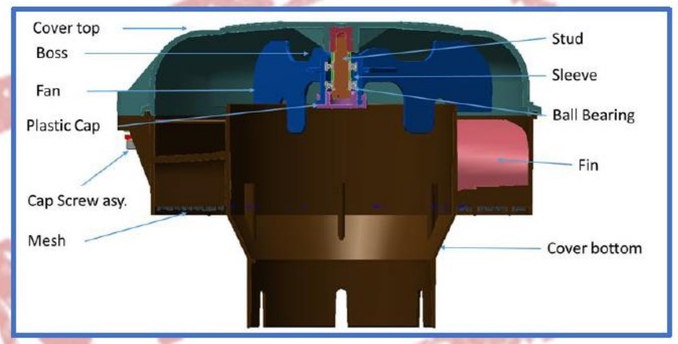
Cause and Effect Chains Analysis (CECA)
13 key disadvantages

Key problems in Conceptual directions
4 Key problems
9 Conceptual directions

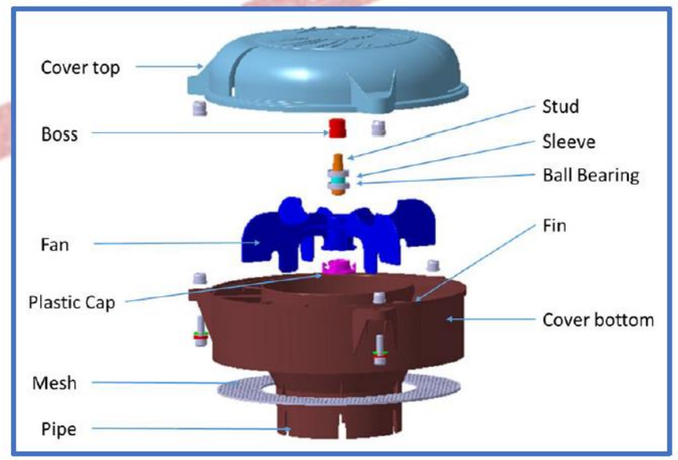
illustrative ideas generated
6 Possible direction solutions

Component Analysis

No	Engineering System Components	Supersystem Component
1	Cover top	Air
2	Boss	Dust particle
3	Plastic Cap	Soot
4	Fan	Water
5	Sleeve	Pipe Asy (pre cleaner mounting pipe)
6	Ball Bearing	Heat
7	Stud	Vibration
8	Cap screw asy	Gravity
9	Cover bottom	
10	Mesh	
11	Clamp	



CROSS-SECTION VIEW



COMPONENTS DETAILS

Interaction Matrix

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	Cover top	Boss	Plastic Cap	Fan	Sleeve	Ball Bearing	Grease (Ball Bearing)	Cap screw asy	Stud	Cover bottom	Mesh	Clamp	Air	Dust particle	Soot	Water	Pipe Asy	Heat	Vibration	Gravity
Cover top		+	-	-	-	-	-	+	-	+	-	-	+	+	+	+	-	+	+	+
Boss	+		-	-	+	-	-	-	+	-	-	-	+	+	+	+	-	+	+	+
Plastic Cap	-	-		+	-	-	-	-	-	-	-	-	+	+	+	+	-	+	+	+
Fan	-	-	+		-	+	-	-	-	-	-	-	+	+	+	+	-	+	+	+
Sleeve	-	+	-	-		+	-	-	+	-	-	-	+	+	+	+	-	+	+	+
Ball Bearing	-	-	-	+	+		+	-	+	-	-	-	+	+	+	+	-	+	+	+
Grease (Ball Bearing)	-	-	-	-	-	+		-	-	-	-	-	+	+	+	+	-	+	+	+
Cap screw asy	+	-	-	-	-	-	-		-	+	-	-	+	+	+	+	-	+	+	+
Stud	-	+	-	-	+	+	-	-		-	-	-	+	+	+	+	-	+	+	+
Cover bottom	+	-	-	-	-	-	-	+	-		+	+	+	+	+	+	+	+	+	+
Mesh	-	-	-	-	-	-	-	-	-	+		-	+	+	+	+	-	+	+	+
Clamp	-	-	-	-	-	-	-	-	-	+	-		+	+	+	+	-	+	+	+
Air	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+
Dust particle	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+
Soot	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+
Water	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+
Pipe Asy	-	-	-	-	-	-	-	-	-	+	-	-	+	+	+	+		+	+	+
Heat	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+
Vibration	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+
Gravity	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	

Functional Analysis

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Function carrier	Action	Object of the function	Parameter	Category	Rank	Performance	Comments
Cover top	holds	Boss	position	Useful	Auxiliary	Normal	
	directs	air	direction	Useful	Basic	Normal	
	stops	dust particle	position	Useful	Auxiliary	Insufficient	Coarse particle
	directs	dust particle	direction	Useful	Auxiliary	Excessive	Fine particle
	directs	soot	direction	Useful	Auxiliary	Excessive	towards gap between sleeve & fan
	stops	water	position	Useful	Auxiliary	Insufficient	large droplet
	directs	water	direction	Useful	Auxiliary	Insufficient	mist
Boss	stops	sleeve	position	Useful	Auxiliary	Insufficient	axial movement
	moves	stud	position	Useful	Auxiliary	Excessive	Fitment & Vibration
Plastic cap	stops	dust particle	position	Useful	Auxiliary	Insufficient	Inside ball bearing & sleeve asy
	holds	dust particle	position	harmfull			particle enters from other side of stud asy & rub with bearing
	stops	water	position	Useful	Auxiliary	insufficient	Inside ball bearing & sleeve asy
Fan	holds	Plastic cap	position	Useful	Additional	Insufficient	
	moves	Plastic cap	position	Useful	Additional	Excessive	Vibration
	rotates	Plastic cap	position	Useful	Additional	Normal	Rotary motion
	pushes	ball bearing	direction	Useful	Additional	Excessive	Radial force
	rotates	ball bearing	position	Useful	Additional	Normal	Rotary motion
	directs	air	direction	Useful	Basic	Normal	
	directs	dust particle	direction	Useful	Auxiliary	Insufficient	Fine particle : Inside ball bearing & sleeve asy
	directs	soot	direction	Useful	Auxiliary	Insufficient	Soot : Inside ball bearing & sleeve asy
	directs	water	direction	Useful	Auxiliary	Insufficient	mist : Inside ball bearing & sleeve asy
	directs	water	direction	Useful	Auxiliary	Insufficient	Water removal efficiency
Sleeve	stops	ball bearing	position	Useful	Auxiliary	Insufficient	axial movement
Ball bearing	holds	Fan	position	Useful	Auxiliary	Insufficient	
	holds	Grease	position	Useful	Auxiliary	Normal	Grease moves out from bearing recess
	holds	dust particle	position	harmfull			Fine particle : Inside ball bearing
	holds	soot	position	harmfull			Soot : Inside ball bearing
	holds	water	position	harmfull			mist : Inside ball bearing & sleeve asy
	moves	Fan	position	Useful	Auxiliary	Excessive	Axial motion
Grease	moves	ball bearing	position	Useful	Auxiliary	Insufficient	Rotary motion
	holds	dust particle	position	harmfull			
	holds	soot	position	harmfull			
	holds	water	position	harmfull			
Cap screw	holds	cover top	position	Useful	Auxiliary	Normal	
	moves	cover top	position	Useful	Auxiliary	insufficient	Vibration
	holds	cover bottom	position	Useful	Auxiliary	Normal	
Stud	holds	sleeve	position	Useful	Auxiliary	Insufficient	axial movement
	moves	sleeve	position	Useful	Auxiliary	Excessive	Vibration
	pushes	ball bearing	position	Useful	Auxiliary	Excessive	Inadequate fitment
	holds	ball bearing	position	Useful	Auxiliary	Insufficient	axial movement
	stops	ball bearing	position	Useful	Auxiliary	Insufficient	axial movement at bottom
	moves	ball bearing	position	Useful	Auxiliary	Excessive	Vibration
Cover bottom	moves	Rivet/Cap screw	position	Useful	Auxiliary	Excessive	Vibration
	stops	clamp	position	Useful	Auxiliary	Normal	clamping action
	directs	air	direction	Useful	Basic	Normal	Fin & outlet pipe
	directs	dust particle	direction	Useful	Auxiliary	Normal	Fin & outlet pipe
	directs	water	direction	Useful	Auxiliary	Normal	Fin & outlet pipe - Mist
	directs	soot	direction	Useful	Auxiliary	Normal	Fin & outlet pipe
	moves	cover bottom	position	Useful	Auxiliary	Excessive	Vibration
Mesh	stops	dust particle	position	Useful	Auxiliary	Normal	Large particle
	directs	air	direction	Useful	Basic	Normal	
Clamp	pushes	Cover bottom	direction	Useful	Auxiliary	Normal	Cover bottom - pipe
Air	moves	Fan	position	Useful	Auxiliary	Normal	Noise
	moves	dust particle	position	Useful	Auxiliary	Normal	
	moves	water	position	Useful	Auxiliary	Excessive	
	moves	soot	position	Useful	Auxiliary	Excessive	
Dust particle	stops	ball bearing	position	harmfull			Rotary motion
	pushes	ball bearing	position	Useful	Auxiliary	Excessive	pushes rubber seal
Soot	stops	ball bearing	position	harmfull			Rotary motion
	pushes	ball bearing	position	Useful	Auxiliary	Excessive	
Water	stops	ball bearing	position	harmfull			Rotary motion - Rust
Pipe Asy	directs	air	direction	Useful	Basic	Normal	
	directs	dust particle	direction	Useful	Auxiliary	Normal	
	directs	soot	direction	Useful	Auxiliary	Normal	
	directs	water	direction	Useful	Auxiliary	Normal	
	moves	cover bottom	direction	Useful	Auxiliary	Excessive	Vibration
Heat	expands	fan	temperature	harmfull			Exhaust
Vibration	moves	stud	position	Useful	Auxiliary	Excessive	
	moves	Plastic cap	position	Useful	Auxiliary	Excessive	
	moves	sleeve	position	Useful	Auxiliary	Excessive	
	moves	ball bearing	position	Useful	Auxiliary	Excessive	
	moves	cap screw asy	position	Useful	Auxiliary	Excessive	
Gravity	moves	dust particle	position	Useful	Auxiliary	Insufficient	
	moves	water	position	Useful	Auxiliary	Insufficient	
	moves	Soot	position	Useful	Auxiliary	Insufficient	

Cause Effect Chain Analysis (CECA)

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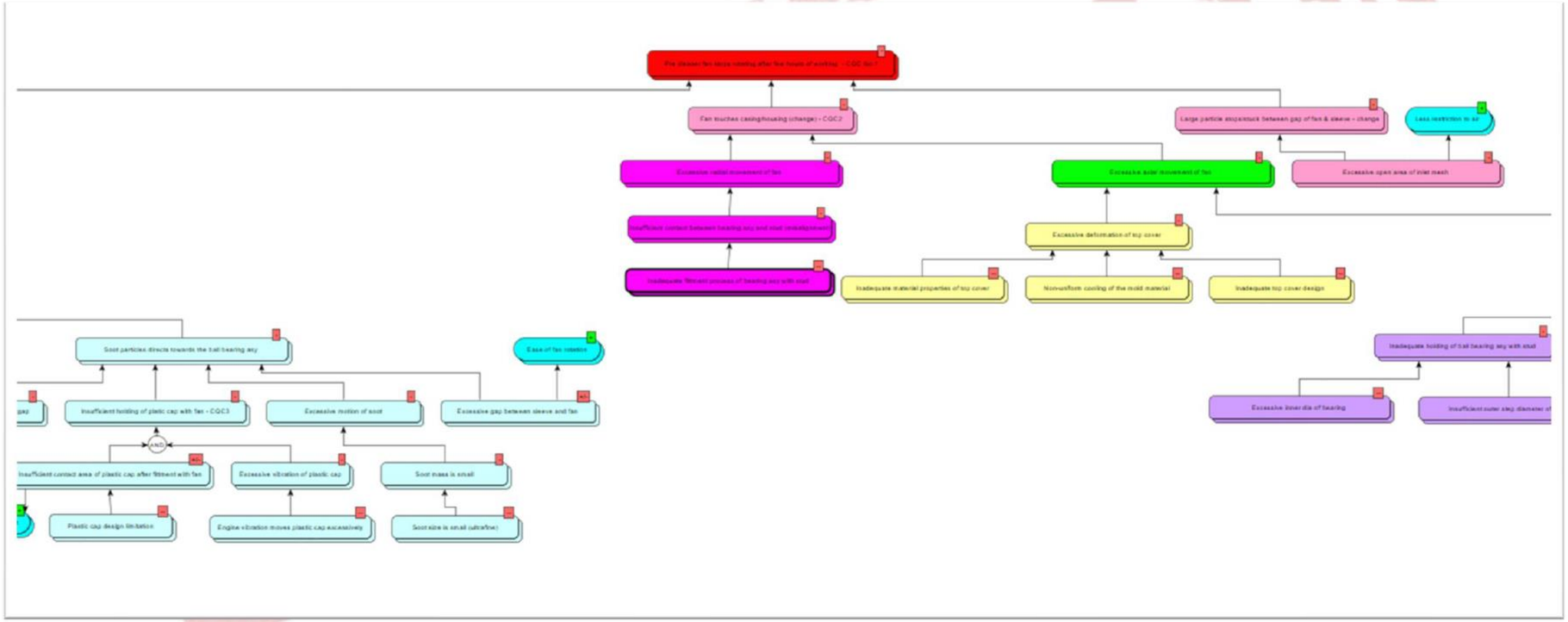
Adobe Acrobat Document



Key Disadvantage from CECA chart

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Component	Key Disadvantage
Fan	1. Excessive gap between stud assembly & fan
Top cover	2. Shape of top cover directs dust particle inside gap 3. Shape of top cover directs the soot inside gap 4. Shape of top cover directs the water particle inside gap 5. Excessive deformation of top cover 6. Boss fixed inside top cover moves stud excessively (fitment)
Air	7. Air moves dust and water particle excessively
Plastic cap	8. Insufficient contact area of plastic cap after fitment with fan 9. Excessive vibration
Bearing assembly	10. Inadequate material property of rubber seal 11. Inadequate fitment process of bearing assembly with stud 12. Dust particle pushes rubber seal excessively 13. Inadequate material properties of ball bearing against water resistance

Key Problem - Grouping

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Key Disadvantage to Solve	Key Problem	Key Problem (Grouping)
Shape of top cover directs dust particle through the gap	How to eliminate Key Disadvantage "Shape of top cover directs dust particle through the gap"?	How to eliminate top cover directs dust, soot & water particle towards the gap?
Shape of top cover directs the soot particle through the gap	How to eliminate Key Disadvantage "Shape of top cover directs the soot particle through the gap"?	
Shape of top cover directs the water through the gap	How to eliminate Key Disadvantage "Shape of top cover directs the water through the gap"?	
Excessive gap between stud assy. & fan	How to eliminate Key Disadvantage "Excessive gap between stud assy. & fan"?	How to eliminate excessive gap between stud assy. & fan?
Insufficient holding of plastic cap with fan	How to eliminate Key Disadvantage "Insufficient holding of plastic cap with fan"?	How to eliminate Key Disadvantage "Insufficient contact area of plastic cap after fitment with fan"?
Dust particle pushes rubber seal excessively	How to eliminate Key Disadvantage "Dust particle pushes rubber seal excessively "?	How to eliminate contact of bearing assembly against dust and water interaction?
Inadequate material properties of ball bearing against water resistance	How to eliminate Key Disadvantage "Inadequate material properties of ball bearing against water resistance "?	

Identified Key Problems and Conceptual Directions

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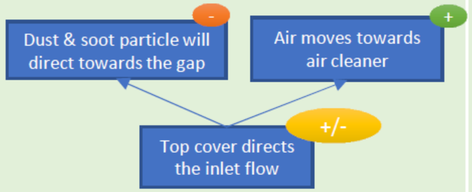
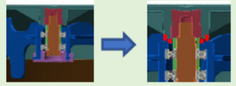
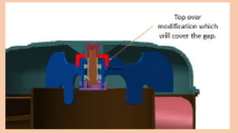
Key Problem No.1 How to eliminate top cover directs dust, soot & water particle towards the gap?

Contradiction	Recommended Inventive Principles	Chosen Inventive Principles	Solution - Conceptual Direction
Engineering Contradiction 	29 Pneumatics or hydraulics 30 Flexible films or membranes 7 Nesting dolls	**7 Nesting dolls :-** Make one part pass through a cavity in the other. Or Place one object inside another; place each object, in turn, inside the other.	**CD 1.1 – Flow barrier** : Use of flow barrier to avoid direct entry of dust and soot through the gap 
		30 Flexible films or membranes : Isolate the object from the external environment using flexible shells and thin films.	**CD 1.2 – Use of additional rubber seal** : Use of rubber seal between gap of sleeve and fan 
Physical Contradiction Top cover should direct air towards air cleaner. It should not direct the air to avoid dust & soot entry towards gap	Satisfying Separation in Space Demands The following principles should be used to Separation in Space : • 1 - Segmentation • 3 - Local quality • 7 - "Nested doll" • 4 - Symmetry change • 17 -Another dimension	**3 - Local quality :** Change an object's structure from uniform to non-uniform, change an external environment (or external influence) from uniform to non-uniform.	**CD 1.3 – Top cover with skirt to protect the gap :** Boss of top cover can be extended to cover the gap. 

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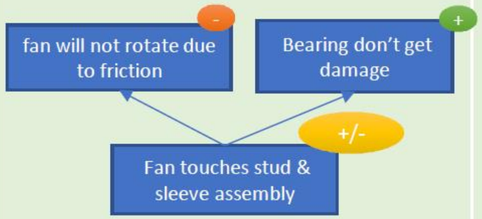
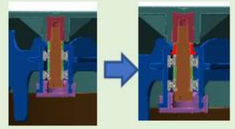
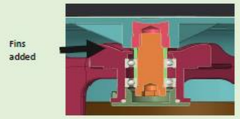
Key Problem No.2 How to eliminate excessive gap between stud assy. & fan?

Contradiction	Recommended Inventive Principles	Chosen Inventive Principles	Solution - Conceptual Direction
Engineering Contradiction 	3 Local quality 35 Physical/chemical properties 5 Merging or combining	**5 Merging or combining :** By combining components or parts, it is possible to create new solutions and improve the overall performance of a system.	**CD 2.1 – Replace cylindrical sleeve with L-shape to fill the gap** : Replace sleeve with shape of cavity which is metal part with coating against frictional force 
		3 Local quality : Change an object's structure from uniform to non-uniform, change an external environment (or external influence) from uniform to non-uniform.	**CD 2.2 – Extra fins on fan :** Extra fins with smaller diameter were added into existing design to change as external environment 

Continued..

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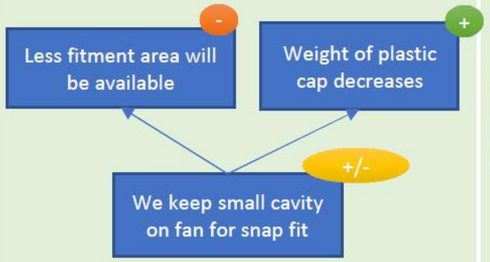
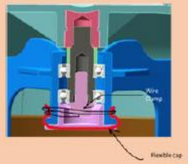
Key Problem No.3 How to eliminate Key Disadvantage "Insufficient contact area of plastic cap after fitment with fan"?

Contradiction	Recommended Inventive Principles	Chosen Inventive Principles	Solution - Conceptual Direction
Engineering Contradiction 	2 Taking out 17 Moving to another dimension 29 Pneumatics or hydraulics 4 Asymmetry	**2 Taking out :** Separate an interfering part or property from an object, or single out the only necessary part (or property) of an object.	**CD 3.1 – Eliminate / take out plastic cap :** Fan and plastic cap fitment with threating provision 
		17 Moving to another dimension - To move an object in two- or three-dimensional space.	**CD 3.2 – Fan and plastic cap fitment with O-ring provision :** Threading/rubber o ring can be provided to plastic cap to fit with fan. 
Physical Contradiction Cavity for snap fit should be large to attain max vibration load. It should be small to keep structure of fan strong	Satisfying Contradictory Demands The following principles should be used to satisfy contradictory demands: 13 — The other way around 24 — Intermediary 28 — Mechanics substitution 30 — Flexible shells and thin films 35 — Parameter changes 36 — Phase transition 37 — Thermal expansion 38 — Strong oxidation 39 — Inert atmosphere	**30 Flexible shells and thin films :** Use of rubber seal between cap and fan.	**CD 3.3 – Flexible cap instead of plastic cap :** Instead of plastic cap we can put elastic cap around fan to closing 

Continued..

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Key Problem No. 4 How to eliminate contact of bearing assembly against dust and water interaction?

Contradiction	Recommended Inventive Principles	Chosen Inventive Principles	Solution - Conceptual Direction
Physical Contradiction Fan and Stud should not have gap to block dust particle, There should be gap to have relative motion	Bypassing Contradictory Demands The following principles should be used to bypass contradictory demands: 6 — Multi-functionality 13 — The other way around 25 — Self-service	**13 The other way around** : Inverted the bearing & stud asy. use support of "yoke & stud" which fixed to the outlet pipe	**CD 4.1 – Inverted fan assembly** : Inverted the bearing & stud asy. use support of "yoke & stud" which fixed to the outlet pip 

List of Possible direction for solutions & Compatibility

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No.	Solution	1.1	1.2	1.3	2.1	2.2	3.1	3.2	3.3	4.1
1	CD 1.1 – Flow barrier		0	0	+	+	0	+	0	0
2	CD 1.2 – Use of additional rubber seal	0		+	0	0	0	+	0	0
3	CD 1.3 – Top cover with skirt to protect the gap	0	+		0	0	0	0	+	0
4	CD 2.1 – Replace cylindrical sleeve with L-shape to fill the gap	+	0	0		+	+	+	0	0
5	CD 2.2 – Extra fins on fan	+	0	0	+		0	0	+	0
6	CD 3.1 – Eliminate / take out plastic cap	0	0	0	+	0		0	0	+
7	CD 3.2 – Fan and plastic cap fitment with O-ring provision	+	+	0	+	0	0		0	+
8	CD 3.3 – Flexible cap instead of plastic cap	0	0	+	0	+	0	0		0
9	CD 4.1 – Inverted fan assembly	0	0	0	0	0	+	+	0	

Legend: + means that solutions can be combined

Overview of Generated Solutions(combined solutions)

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Solution	Key Problem 1	Key Problem 2	Key Problem 3	Key Problem 4	Needs to be combined with solution(s) #	Anticipated success level
CD 1.1 A : Flow barrier + L-shape + Fins	Yes	Yes	Yes	N/A	1.1 with 2.1 and 2.2	N/A
CD 1.2 A : Rubber Seal + Top cover with skirt	Yes	Yes	Yes	Yes	1.2 with 1.3	N/A
CD 1.3 A : Top cover with skirt + Rubber Seal	Yes	N/A	Yes	N/A	1.3 with 1.2	N/A
CD 2.1 A : L-shape sleeve + O ring	Yes	Yes	Yes	Yes	**2.1 with 3.2**	Success
CD 2.1 B : L-shape sleeve + O ring + Flow barrier	Yes	Yes	Yes	Yes	2.1 with 1.1 and 3.2	Success
CD 2.2 A : Extra fins on fan + O ring	Yes	Yes	Yes	Yes	2.2 with 3.2	Success
CD 3.1 A : Without plastic cap + Inverted fan assembly	Yes	Yes	Yes	N/A	3.1 with 4.1	N/A
CD 3.2 A : L-shape sleeve + O ring + Flow barrier + Extra fins on fan	Yes	Yes	Yes	Yes	3.2 with 1.1 and 2.1 and 2.2	Success
CD 3.2 B : Rubber Seal + O ring	Yes	Yes	Yes	Yes	3.2 with 1.2	Success
CD 3.1 A : L-shape sleeve + without plastic cap	Yes	Yes	Yes	Yes	3.1 with 2.1	Success

Option 1

Option 2

Option 3

Option 4

Option 5

Option 6

TRIZ : Possible direction solutions

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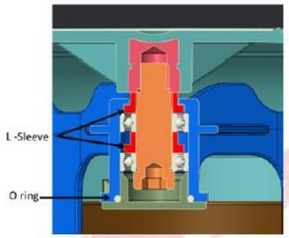
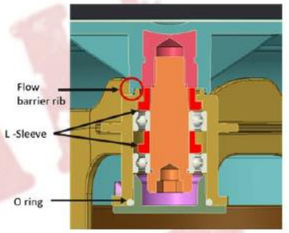
Option 1 : L-shape sleeve + O ring

Modifications Required:
1. Top cover inner profile
2. Groove for O ring on fan plastic



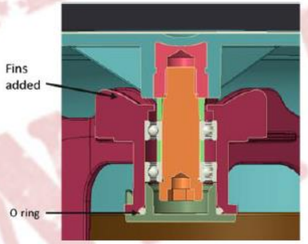
Option 2 : L-shape sleeve + O ring + Flow barrier

Modifications Required:
1. L sleeve added
2. Rib added for Flow barrier on fan plastic
3. Rib added for Flow barrier on top cover
4. Plastic Cap modified - fillet changed
5. O ring added
6. Groove for O ring on fan plastic



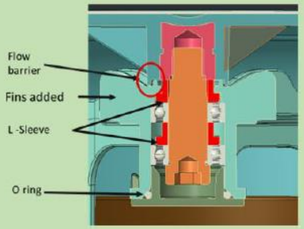
Option 3 : Extra fins on fan + O ring

Modifications Required:
1. Plastic Cap modified - fillet changed
2. Groove for O ring on fan plastic
3. Modification in fan bore area.
4. Metal sleeve modified for adjustment



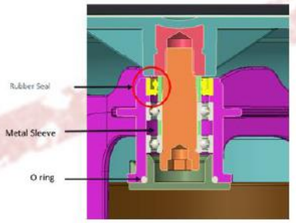
Option 4 : L-shape sleeve + O ring + Flow barrier + Extra fins on fan

Modifications Required:
1. L sleeve added
2. Rib added for Flow barrier on fan plastic
3. Rib added for Flow barrier on top cover
4. Small fin features added on fan
5. Plastic Cap modified - fillet changed
6. O ring added
7. Groove for O ring on fan plastic



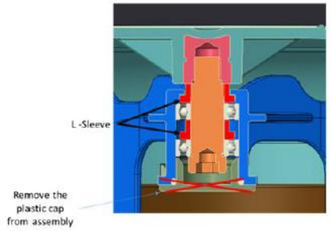
Option 5 : Additional Rubber Seal + O ring

Modifications Required:
1. Plastic Cap modified - fillet changed
2. Groove for O ring on fan plastic
3. Modification in fan bore area.
4. Metal sleeve modified for adjustment



Option 6 : L-shape sleeve + without plastic cap

Modifications Required:
1. Plastic Cap modified - fillet changed
2. Metal sleeve modified for adjustment
3. Remove plastic cap from assembly



Final solution after TRIZ method implementation

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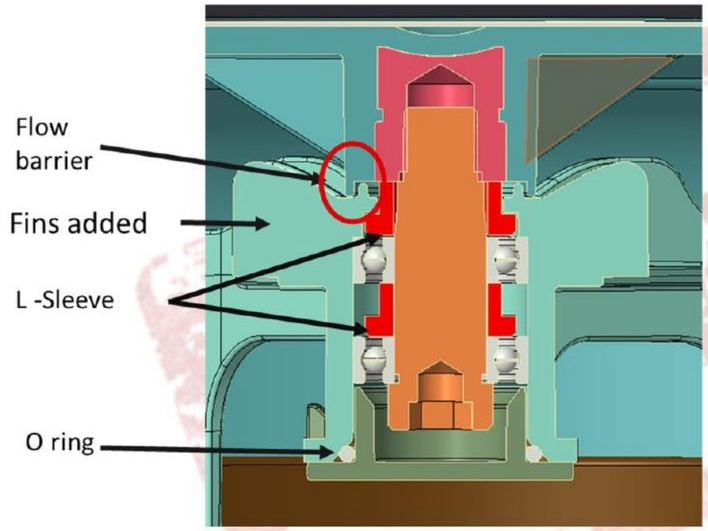
We have applied for a **patent** for our newly modified design.
Indian Patent Application No. - **202421048016**

Option -4



Modifications Required

1

L –Sleeve metal (New)

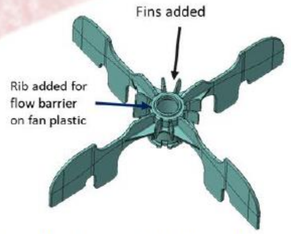
2

O – ring (New)

3

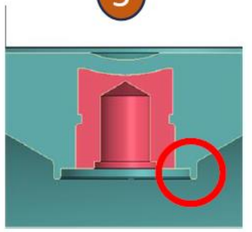
Cap, plastic (modified)

4



Fan design with flow barrier and fins (modified)

5



Top cover with additional ring (modified)

s required 0.5 mm approx.

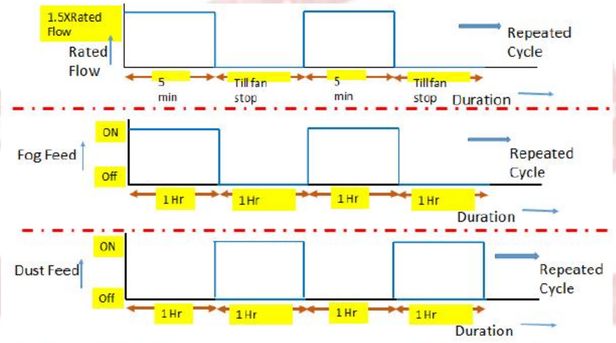
Design Validation

Endurance test

Testing Details :

- Rated Flow: 250 CFM
- Test Flow: 375 CFM (1.5X of rated flow)
- Fog feed rate: 35 ml/min
- Test Dust : ISO Fine test dust
- Dust concentration: 0.5 g/m3
- Dust feed rate: 5 g/min

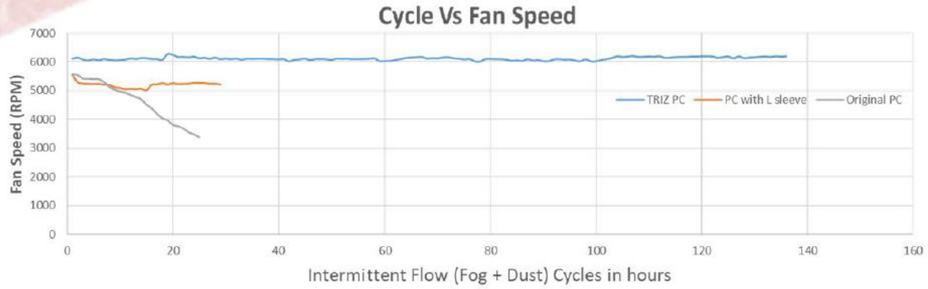
Testing Procedure :



Test Setup :

Test Results:

- Fan speed before test : 6106 RPM
- Fan speed before vibration (after 35 hours) : 6099 RPM
- Fan speed after vibration (8hrs at 4.5g) : 6108 RPM
- Fan speed after 100hours of cycle after vibration : 6188 RPM
- No change observed in RPM due to dust and water test.



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Thank You !!!

MATRIZ Official

Presents

ITC 2024

INTERNATIONAL TRIZ CONFERENCE

14 -17 OCT'24 | DUBAI

Radisson Blu Hotel, Dubai Canal View

Common PU Development for all PU Air Filter Variants

Rakesh Kulkarni

Fleetguard Filters Pvt. Ltd. (FFPL)

Pune, India

Hosted by

TRIZ Association of ASIA

Supported by

TRIZ ASIA

Support Partner

EG EUROGATE

Problem Definition

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1. The MOQ of PU laid down by the supplier is higher than the annual consumption of PU for panel filter application. This results in –
    - Excessive inventory
    - Shelf-life expiry leading to wastage of PU material.

2. The MOQ can be met by using a common PU. However, based on past experience and data, the PU used for Opti-air filters cannot be used for the panel filter applications as we have observed failure in terms of cracks on PU. So two different grades of PU are procured.

Primary Objective

MATRIZ Official

- To develop a common formulation of PU, which caters to both Panel & Opti-air filter requirements, meeting desired performance requirements.

Scope :

- Development of PU formulation till PPAP.

Boundary conditions :

- No changes allowed in existing manufacturing processes & set-up.

Primary Objective

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- To develop a common formulation of PU, which caters to both Panel & Opti-air filter requirements, meeting desired performance requirements.

Scope :

- Development of PU formulation till PPAP.

Boundary conditions :

- No changes allowed in existing manufacturing processes & set-up.

Goal

MATRIZ Official

To develop a common PU in order to –

1. Reduce the PU cost.
2. Reduce the material wastage.
3. Reduce supply lead time.

Project success criteria (%) :

a. Success = 10 – 12% Cost saving.
b. Great success = 20 – 25% Cost saving.
c. Home Run = 30 – 35% Cost saving.

Project Logic : Road Map

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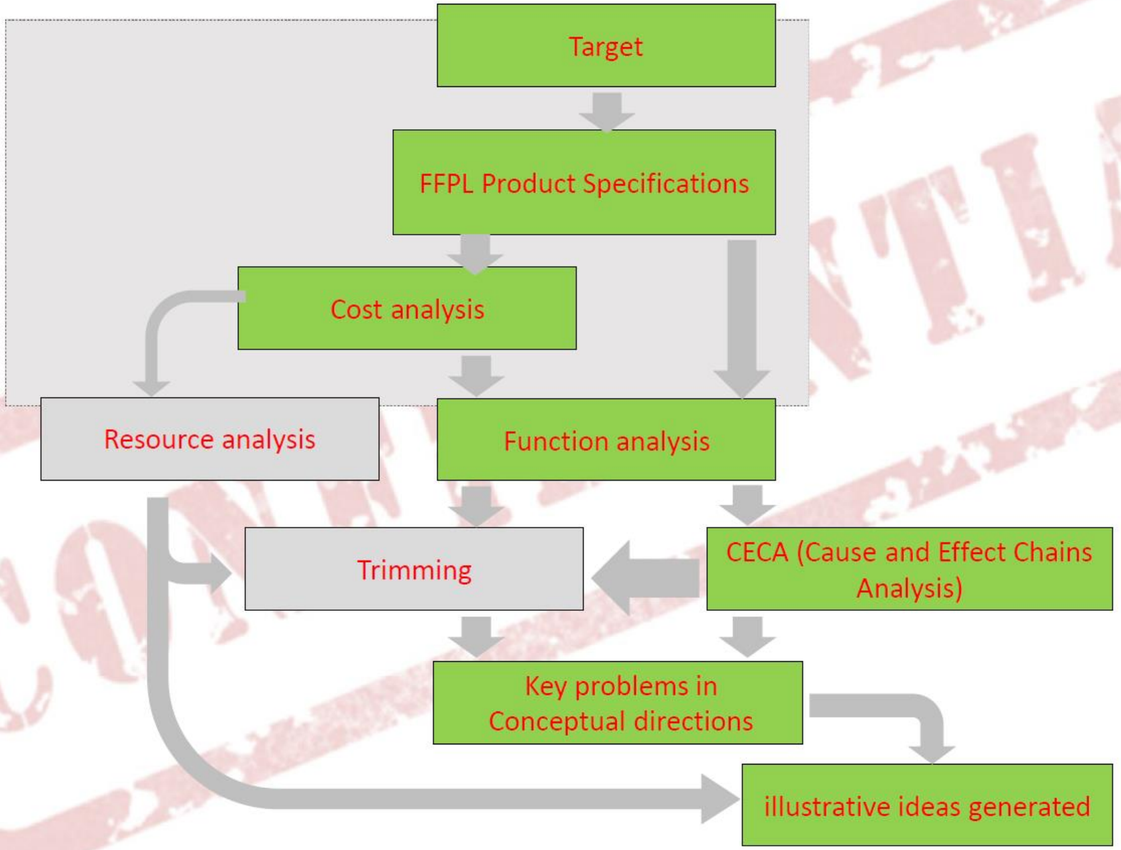
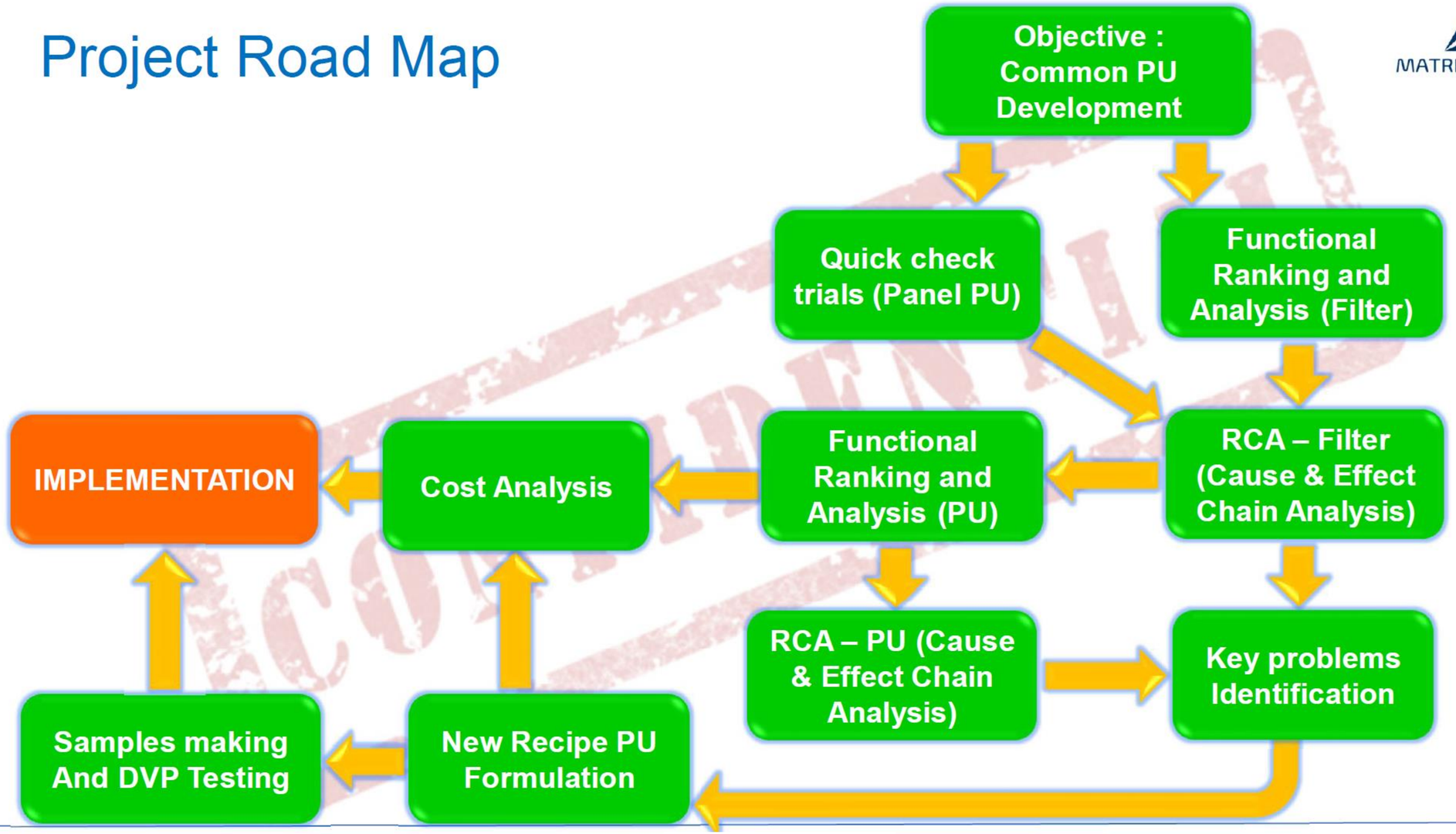


Project Road Map



Proposed Steps / Approach

MATRIZ Official

Project Structure and Schedule	Stage 1 Analysis and Problem Identification	Stage 2 Problem Solving and Idea Generation	Stage 3 Preliminary Substantiation
Recommended timeline for each stage	Completed	Go-no-go decision Completed	Go-no-go decision Completed
Goals	• To understand the problem and perform basic analysis of the components and establish their interaction with each other.	• To generate the base data and identify the key disadvantages. Based on design PU formulations.	• To evaluate the functional performance of the designed PU formulations.
Activities	• Perform comprehensive TRIZ analysis in order to identify key problems that have to be solved in order to achieve the project objectives. • Develop and prioritize conceptual directions to solve these problems. • Develop preliminary solutions to illustrate conceptual directions.	• Quick trials to generate base data. • Comprehensive TRIZ analysis of problem (Product Failure) & PU RCA. • Experimentation & trials for new formulation. • Manual samples making.	• Alpha stage samples production using production lines. • Estimate investments and potential cost savings • Develop recommendations for the implementation steps at industrial scale • Preliminary evaluate IP potential.
Deliverables	• Component Analysis. • Interaction matrix and functional ranking.	• Key disadvantages of existing PU filters and PU formulation. • DVP&R testing & results analysis. • Experimentation results & analysis. • Finalization of R&D PU formulation.	• "Reasons to believe" that proposed solutions are feasible (DVP&R testing & results analysis). • IP potential evaluation results. • Recommendations for the implementation steps. • ROI calculations.

Steps…

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Component Analysis

Interaction Matrix

Function analysis & Ranking

Function Performance

Initial Testing.

RCA

Opti-Air with Panel PU

VTS Failure RCA.graphml

Engineering system - Opti-air Air Filter		
Target - Contaminant		
Engineering System	**Components**	**Supersystem Components**
Opti-air Filter	Panel Filter PU - Bottom	Air cleaner Bottom Cover
	Panel Filter PU - Top	Air cleaner Top Cover
	Pleated Media Block	Heat

	Panel Filter PU Top	Panel Filter PU Bottom	Pleated media block	Inner Wrapper	Outer Wrapper	Air Cleaner Bottom cover	Air Cleaner Top cover	Clamp	Heat	Moisture	Gravity	Dirty Air	Contamination	Clean Air
Panel Filter PU Top		-	+	+	+	-	+	-	+	+	+	+	+	+
Panel Filter PU Bottom	-		+	+	+	+	-	-	+	+	+	+	+	+
Pleated media block	+	+		+	+	-	-	-	+	+	+	+	+	+
Inner Wrapper	+	+	+		-	-	-	-	+	+	+	-	-	+
Outer Wrapper	+	+	+	-		-	-	-	+	+	+	+	+	-
Air Cleaner Bottom cover	-	+	-	-										
Air Cleaner Top cover	+													
Clamp	-													
Heat	+													
Moisture	+													
Gravity	+													
Dirty Air	+													
Contamination	+													
Clean Air	+													

Functional Carrier	Action	Object of the Function	Parameter	Category	Rank	Performance
Panel Filter PU Top	Holds	Pleated media block	Position	Useful	Auxillary	Normal
	Holds	Inner Wrapper	Position	Useful	Auxillary	Normal
	Push	Inner Wrapper	Foce	Useful	Auxillary	Normal
	Holds	Outer Wrapper	Position	Useful	Auxillary	Normal
	Push	Outer Wrapper	Foce	Useful	Auxillary	Normal
	Push	Air Cleaner Top cover	Force	Useful	Additional	ormal / insufficient
	Stops	Air Cleaner Top cover	Position	Useful	Additional	ormal / ~~Excessive~~
	Resists	Air Cleaner Top cover	Force (Frictional)	Useful	Additional	ormal / ~~Excessive~~
	N.A.	Heat				
	N.A.	Moisture				
	N.A.	Gravity				
	Stops	Dirty Air	Flow	Useful	Additional	Normal

Initial Experimentation on Filters

MATRIZ Official

- Cylindrical Air Primary and Safety filters of large size, medium size and small size were produced manually using regular Panel PU in order to generate base data.

- Filters produced were subjected to various structural & functional performance tests and results were analyzed.

Test Results

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Sr. No.	Test Name	AIS – 1	AIS – 2
01.	Sealing Test.	Passed.	Passed.
02.	Clamp Force Measurement.	Passed.	Passed.
03.	Thermal Cycle Test.	Passed.	Passed.
04.	Blind Entry Fitment Test.	Passed.	Passed.
05.	Dust By-pass Test / Leakage Test.	Passed.	Passed.
06.	Vibration Test.	Failed. (A/C top cover & Filter PU Top observed worn out)	Failed. (A/C top cover & Filter PU Top observed worn out)

Vibration Failure RCA Analysis

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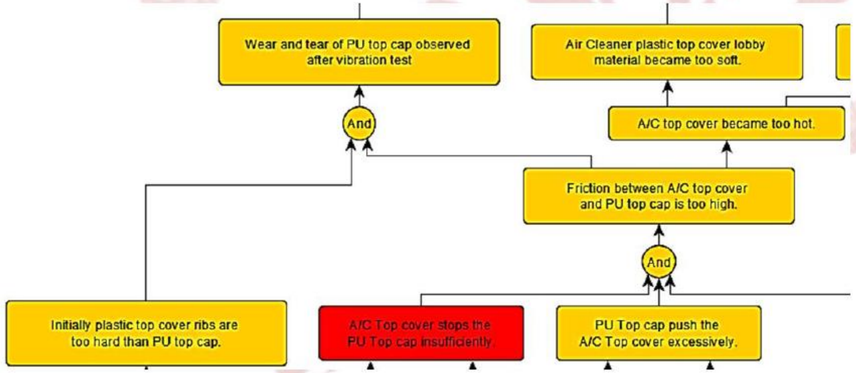
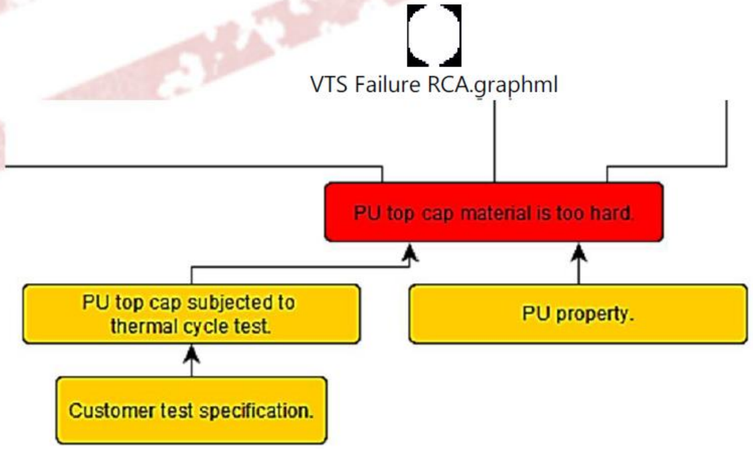
- During vibration testing, following observations were noted.
  - Filters are rotating in the air cleaner while testing resulting in heat generation due to friction between two components.
  - This heat is causing the wear and tear of both the components in contact with each other.

Disadvantages identified based on Functional ranking and RCA Analysis –

- Top cap of air cleaner stops / holds the PU top cap insufficiently (rotational movement).
- PU top cap material is too hard.





Further steps – PU Analysis (Chemical)

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Component Analysis

Engineering System		Components	Supersystem Components
PU (Resin + Hardener)	Resin	Base resin	Moisture
		Extender (Cross linker)	Heat
		Catalyst	Gravity
		Blowing agent	
		Surfactant	

Interaction Matrix

	Base Resin	Extender	Catalyst	Blowing agent	Surfactant	Pigment	Isocynate	Humidity	Temperature	Gravity
Base Resin		+	+	+	+	+	+	+	+	+
Extender	+		+	+	+	+	+	+	+	+
Catalyst	+	+		+	+	+	+	+	+	+
Blowing agent	+	+	+		+	+	+	+	+	+
Surfactant	+	+	+	+		+	+	+	+	+
Pigment	+	+	+	+	+		+	+	+	+
Isocynate	+	+	+	+	+	+		+	+	+
Humidity	+	+	+	+	+	+	+		+	+
Temperature	+	+	+	+						
Gravity	+	+								

Function analysis & Ranking

Functional Carrier	Action	Object of the Function	Parameter	Category	Ra	Performance
Base Resin	Hold	Extender	Volume	Useful	Auxilary	Normal
	Hold	Catalyst	Volume	Useful	Auxilary	Normal
	Hold	Blowing agent	Volume	Useful	Auxilary	Normal
	Hold	Surfactant	Volume	Useful	Auxilary	Normal
	Hold	Pigment	Volume	Useful	Auxilary	Normal
	Hold	Isocynate	Volume	Useful	Auxilary	Normal
	Join	Isocynate	Phase change (Solidifies)	Useful	Basic	Normal
	Hold	Heat	Temperature	Useful	Aux	Normal
	Hold	Moisture	Humidity	Harmful		
	Join	Base resin	Cross link density	Useful	Basic	Excessively
	NA	Catalyst				
	NA	Blowing agent				
	NA	Surfactant				
	NA	Pigment				
	Join	Isocynate	Phase change (Solidifies)	Useful	Basic	Normal
	Hold	Heat	Temperature	Useful	Auxilary	Normal
	Hold	Moisture	Humidity	Harmful		

PU Document

Function Performance

RCA

PU RCA 24-Feb-23.graphml

PU RCA Analysis

MATRIZ Official

Disadvantages identified from Functional ranking and RCA analysis –

- Quantity of extender is too high.
- Molecular weight of extender is too low.
- Molecular weight of polyol is too low.

Physical parameters involved in defining PU characteristics –

- Quantity of extender.
- Molecular weight of extender.
- Molecular weight of polyol.

Quick Dirty Experiments

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- During experimenting with the development of PU recipe, we produced about 10–15 variants in order to achieve the desired physical properties of PU.
- Couple of recipes happened to be close to the existing PU (Opti-Air PU) used for cylindrical filters.
- Thus, we decided to work in parallel on development of Opti-Air PU as well as common PU.
- The recipe consists of same raw material ingredients, except for some changes in the chemical formulation.
- We have further opportunity for cost reduction with the Opti-Air PU.

R&D PU Formulations

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Sr. No.	Properties	Specification	Benchmark	FFPL R&D Panel PU Formula 1 with Density 350 kg/m^3	FFPL R&D Panel PU Formula 1 with Density 300 kg/m^3	FFPL R&D Opti-air PU Formula 2 with Density 300 kg/m^3
Reaction characteristic @ 25°C, mixing RPM = 3500 – 4000						
1	Mixing ratio	N.A.	100(R) : 50(H)	100(R) : 41(H)	100(R) : 43(H)	100(R) : 43(H)
2	Cream time (Seconds)	25 ± 5	26	25	24	24
3	Gel time (Seconds)	50 ± 10	48	41	42	43
4	Rise time (Seconds)	Max. 80	76	80	79	74
5	Tack free time (Seconds)	Max. 120	96	118	118	119
6	Demold time (Minutes)	5.0	5.0	5.0	5.0	5.0

- The above table indicates no major change, in processing time.
- PU slabs were produced and tested for basic physical parameters which passed all the basic requirements.

Remarks

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Test results indicate –

- R&D Panel PU (PA-1) could successfully be implemented for all variants of filters, i.e., panel filters as well as cylindrical filters. **This meets our goal of developing a common PU for all variants.**
- Filters with both R&D developed PU grades successfully passed the respective test requirements.
- Both R&D developed PU grades (Panel PU as well as Opti-Air PU) can be used for filters manufacturing on respective production lines without any major process parameter changes.
- The shelf-life issue due to excessive MOQ by supplier is resolved.
- All the three variants have different cost saving percentiles.

MATRIZ Official

Thank you…

Protecting the heat elements of electric horizontal storage water heater

Haijun Li (Allan)

Content

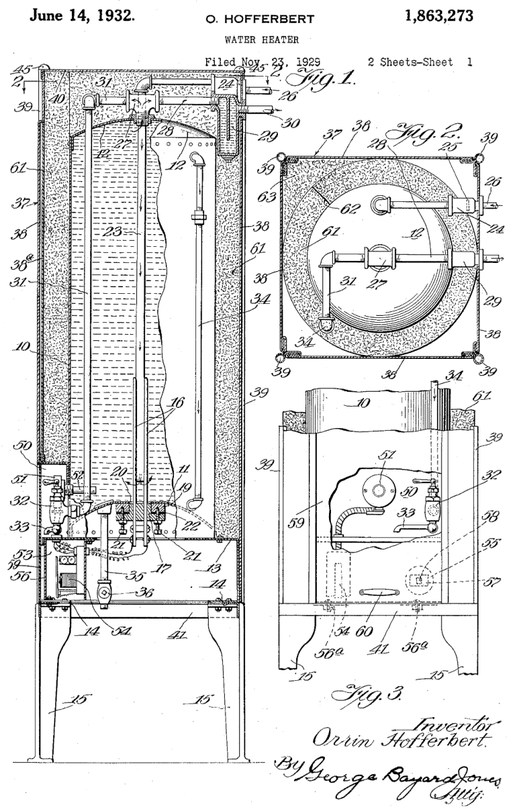
1. **Background**
2. Function Analysis
3. Trimming
4. Problem Solving
5. Conclusions
6. Q&A

Background

In 1889

Edwin Ruud

（First household storage gas water heater）



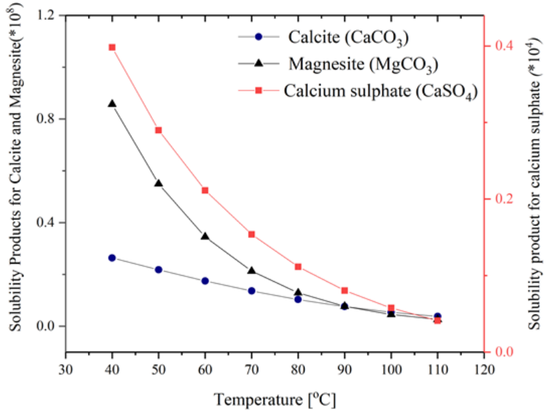
In 1929

Hofferbert Orrin

（First household storage electric water heater）

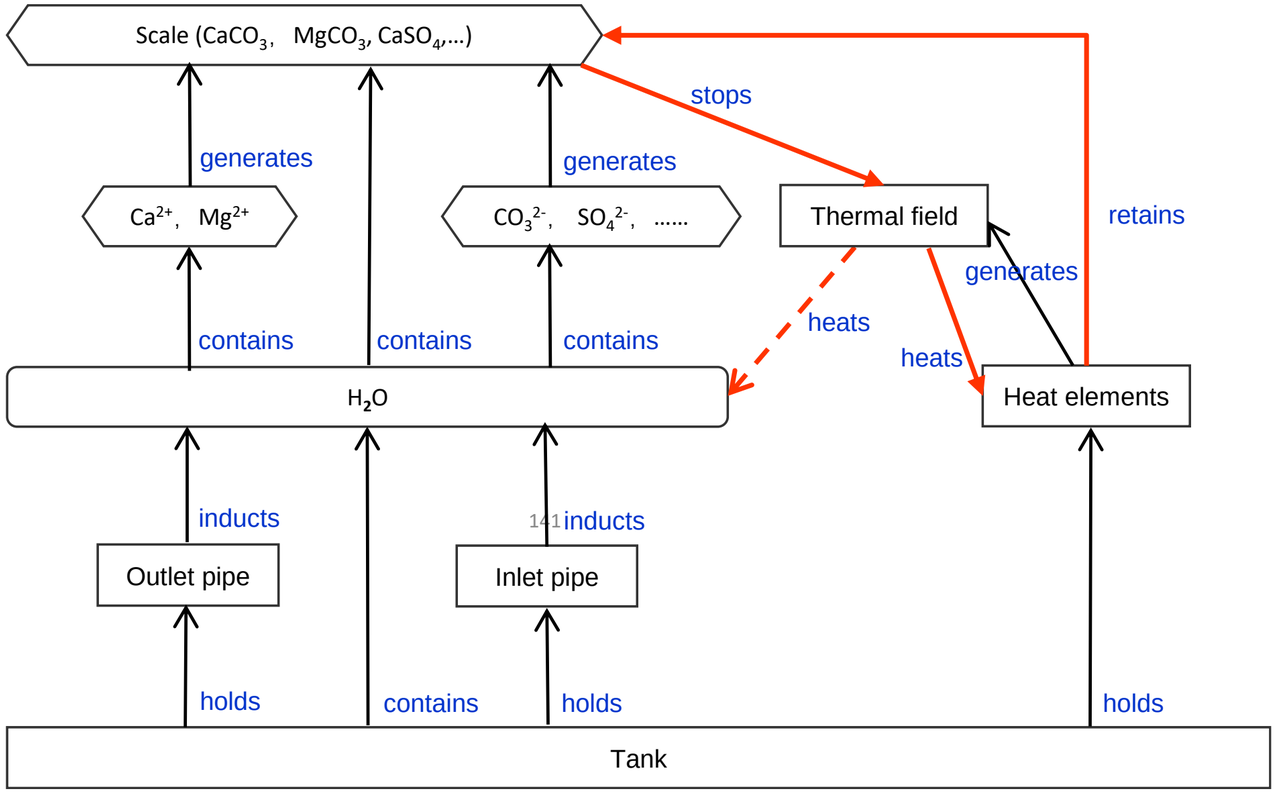
Background

- Tap water contains a large number of metal cations (eg, Ca^{2+}， Mg^{2+}, etc.) and anion groups (eg, CO_3^{2-}， $SO4^{2-}$, etc.). During the working process, electric horizontal storage water heater will heat the tap water in its inner cylinder. Metal cations will combine with anion groups, and crystallize $CaCO_3$， $MgCO_3$, $CaSO_4$ solid particles on the surface of the heat elements. These small solid particles will adhere to the surface of the heat elements and form scale.
- Dangers of scale:
  a. After the scale is attached to the surface of the heat elements, the heat exchange efficiency between the heat elements and the water will be reduced, which not only increases the power consumption, but also greatly increases the time required for heating;
  b. Thick scale will seriously hinder the heat exchange between the heat elements and the water, causing local overheating of the metal tube wall of the heat elements, causing electric leakage, and endangering the lives of users.



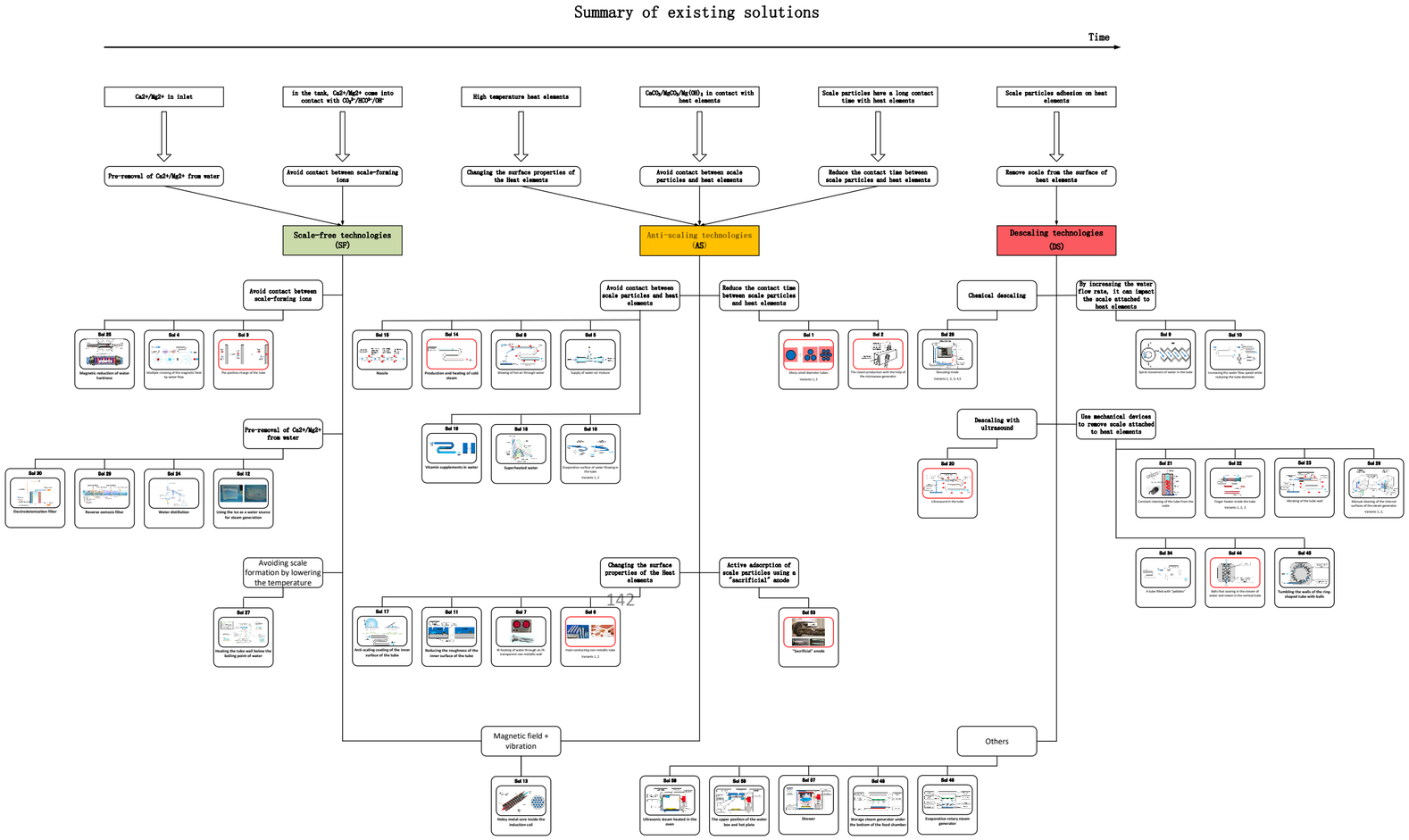
140

Background



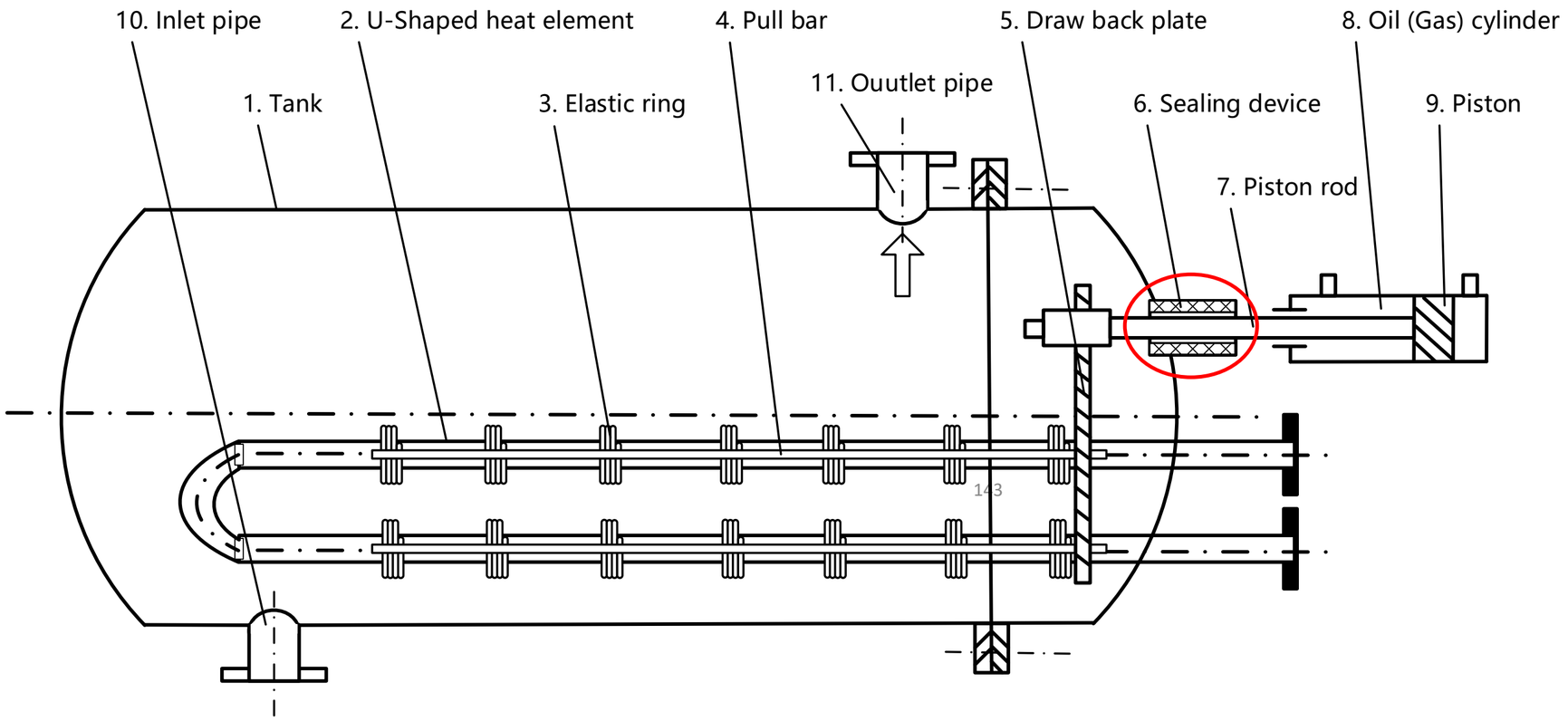
- Fig. 4. Function Model of electric storage water heater

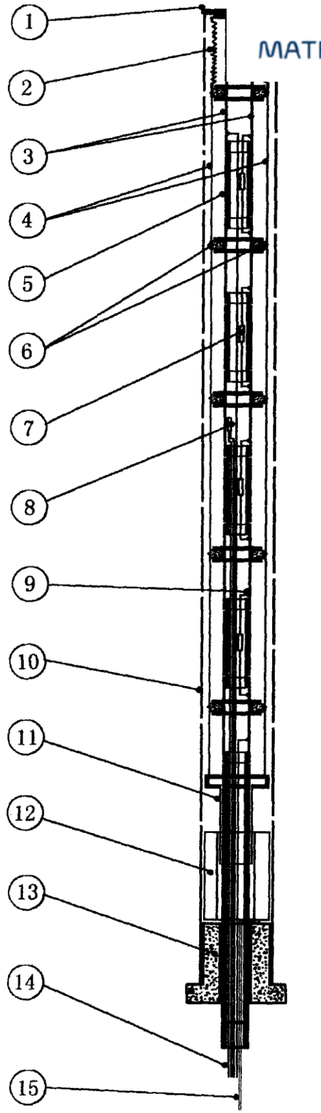
Background



- Fig. 5. Summary of existing solutions

Prototype: CN2187278Y & CN103575359A



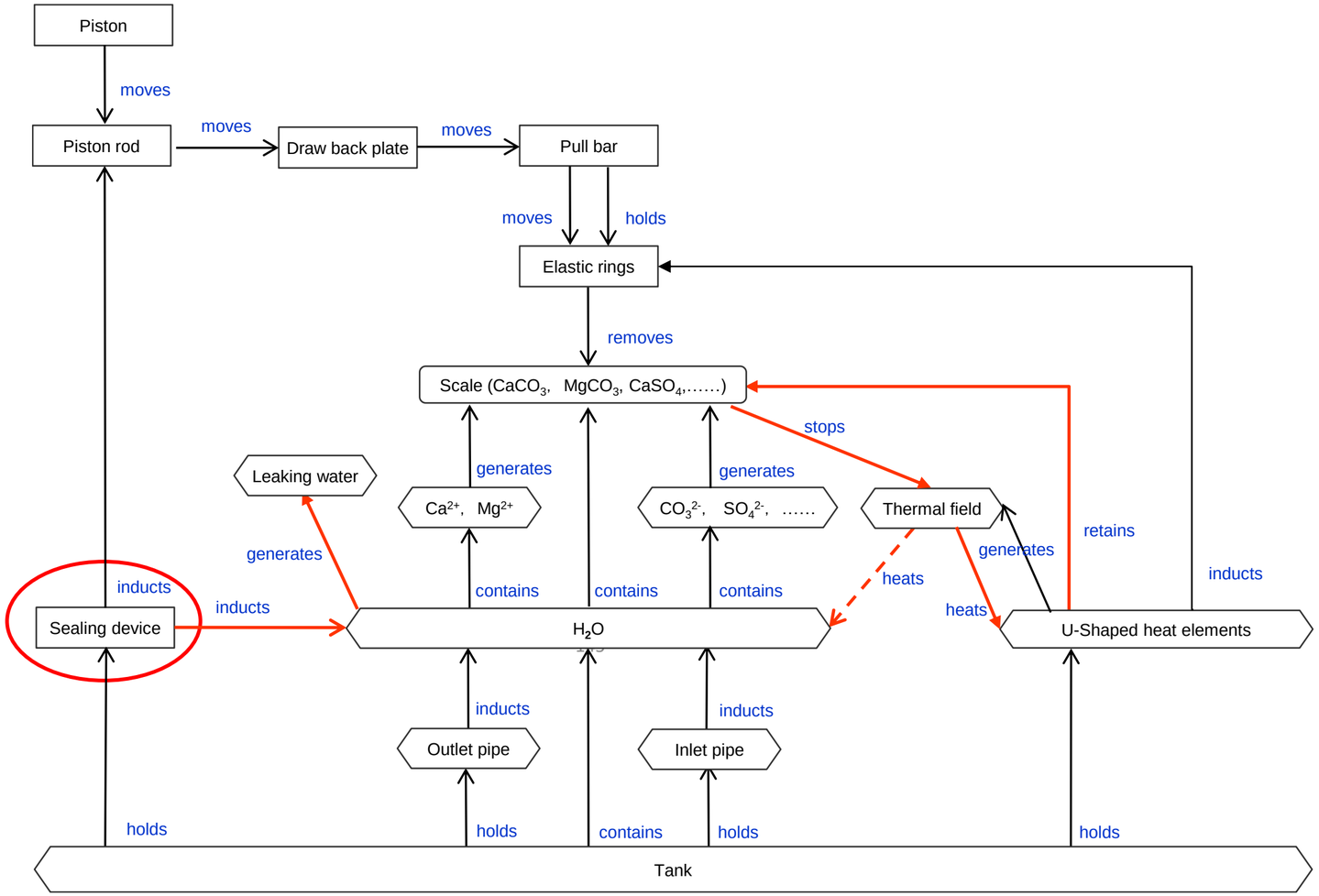


- CN2187278Y

CN103575359A

Content

Functional Analysis

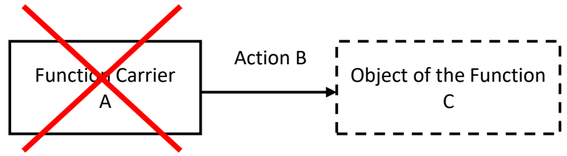


- Fig. 7. Function Model of CN2187278Y

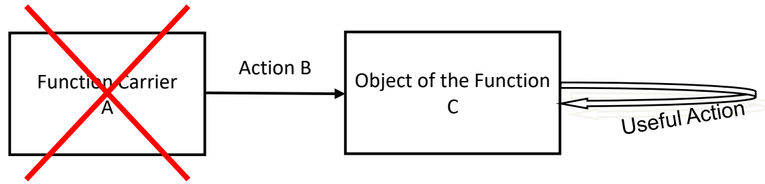
Content

Summary of Trimming Rules

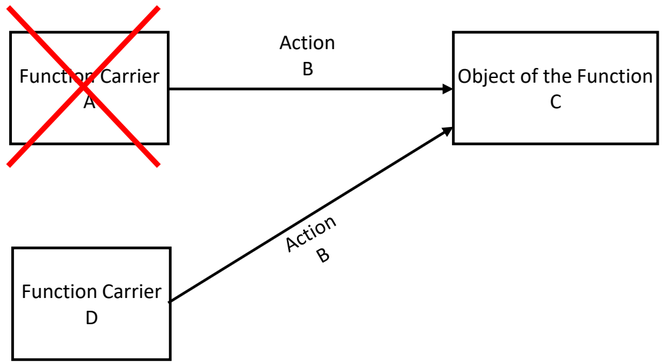
- Rule A: Function Carrier can be trimmed if the Object of the Function does not exist (the most radical trimming)



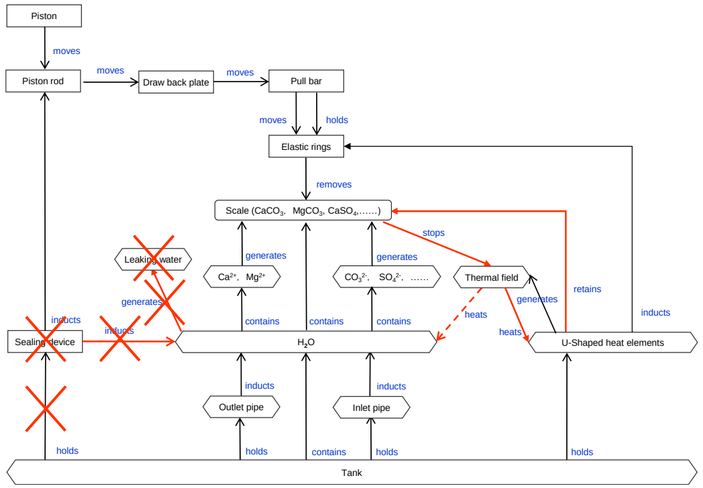
- Rule B: Function Carrier can be trimmed if the Object of the Function performs the function itself

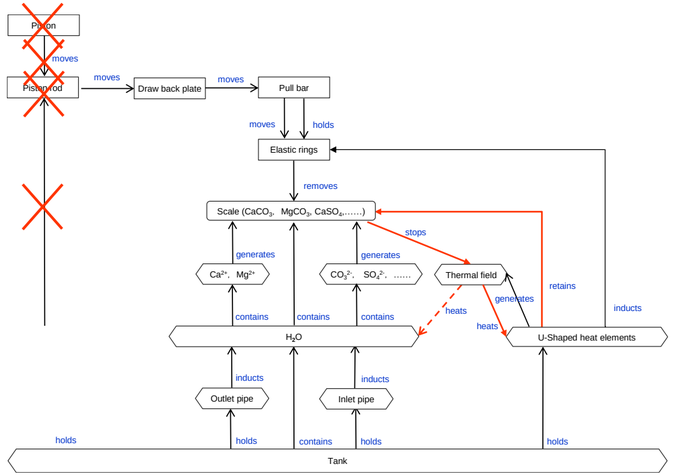


- Rule C: Function Carrier can be trimmed if the Another Component of the Engineering System or Supersystem performs the useful function of the Function Carrier



Trimming


Piston
moves
Piston rod
moves
Draw back plate
moves
Pull bar
moves
holds
Elastic rings
removes
Scale ($CaCO_3$, $MgCO_3$, $CaSO_4$,……)
stops
generates
generates
Leaking water
generates
Ca^{2+}, Mg^{2+}
CO_3^{2-}, SO_4^{2-}, ……
Thermal field
retains
inducts
inducts
inducts
Sealing device
contains
contains
contains
H_2O
heats
heats
U-Shaped heat elements
inducts
inducts
Outlet pipe
Inlet pipe
holds
holds
contains
holds
holds
Tank


Piston
moves
Piston rod
moves
Draw back plate
moves
Pull bar
moves
holds
Elastic rings
removes
Scale ($CaCO_3$, $MgCO_3$, $CaSO_4$,……)
stops
generates
generates
Ca^{2+}, Mg^{2+}
CO_3^{2-}, SO_4^{2-}, ……
Thermal field
retains
generates
inducts
contains
contains
contains
heats
heats
H_2O
U-Shaped heat elements
inducts
inducts
Outlet pipe
Inlet pipe
holds
holds
contains
holds
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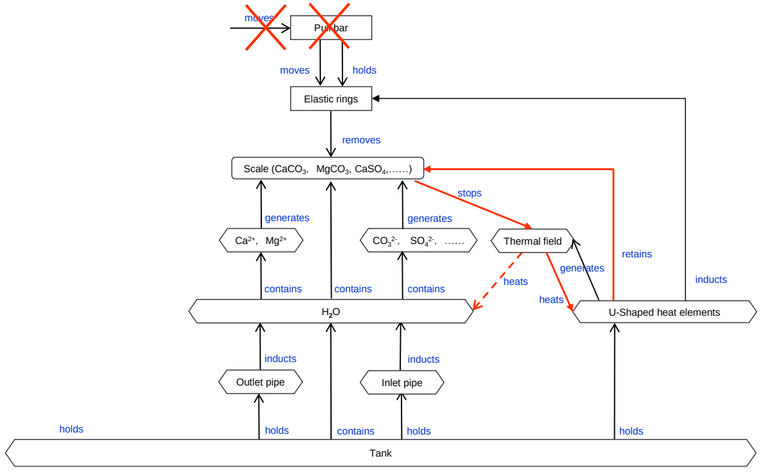
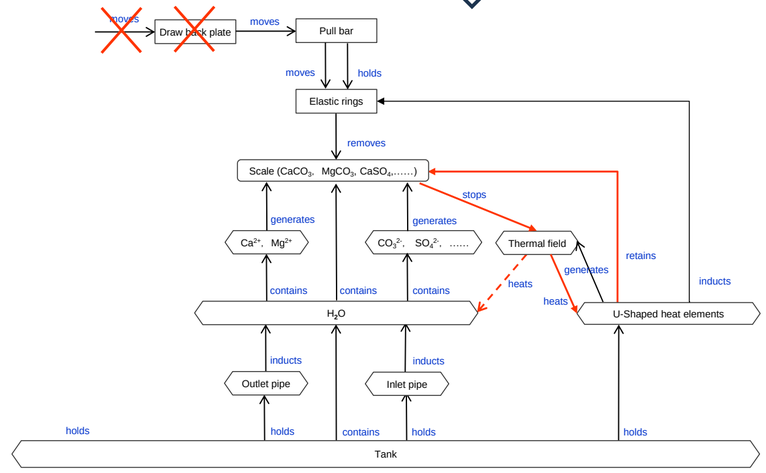
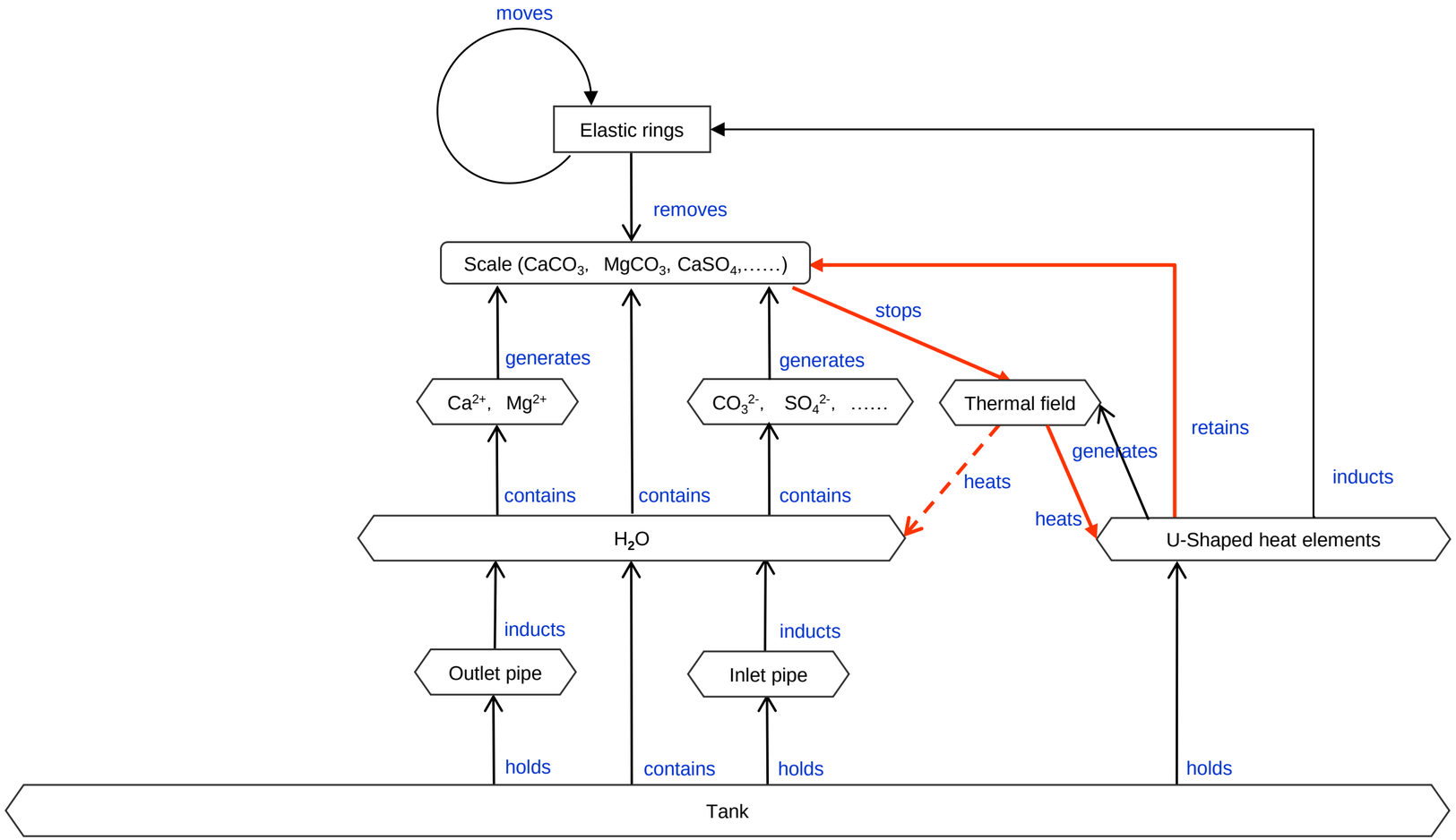
Tank


moves
Pull bar
moves
holds
Elastic rings
removes
Scale ($CaCO_3$, $MgCO_3$, $CaSO_4$,……)
stops
generates
generates
Ca^{2+}, Mg^{2+}
CO_3^{2-}, SO_4^{2-}, ……
Thermal field
retains
generates
inducts
contains
contains
contains
heats
heats
H_2O
U-Shaped heat elements
inducts
inducts
Outlet pipe
Inlet pipe
holds
holds
contains
holds
holds
Tank


moves
Draw back plate
moves
Pull bar
moves
holds
Elastic rings
removes
Scale ($CaCO_3$, $MgCO_3$, $CaSO_4$,……)
stops
generates
generates
Ca^{2+}, Mg^{2+}
CO_3^{2-}, SO_4^{2-}, ……
Thermal field
retains
generates
inducts
contains
contains
contains
heats
heats
H_2O
U-Shaped heat elements
inducts
inducts
Outlet pipe
Inlet pipe
holds
holds
contains
holds
holds
Tank

Trimming


moves
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Scale ($CaCO_3$, $MgCO_3$, $CaSO_4$,……)
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generates
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CO_3^{2-}, SO_4^{2-}, ……
Thermal field
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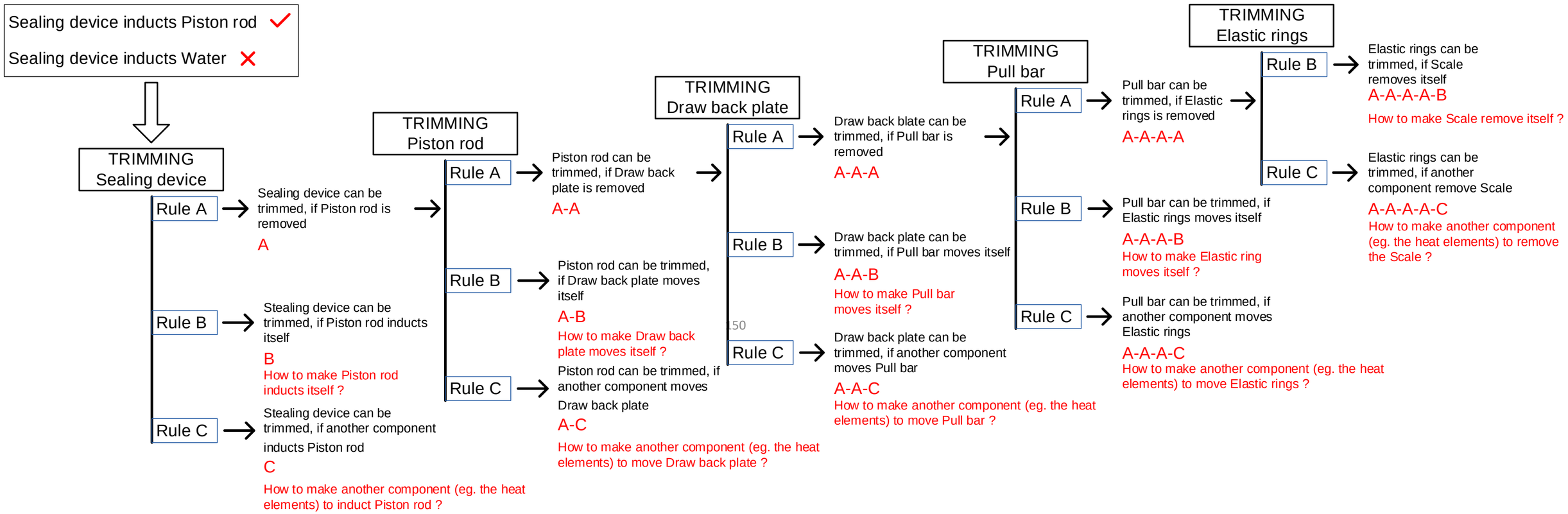
heats
contains
contains
contains
H_2O
U-Shaped heat elements
inducts
inducts
Outlet pipe
Inlet pipe
holds
contains
holds
holds
Tank

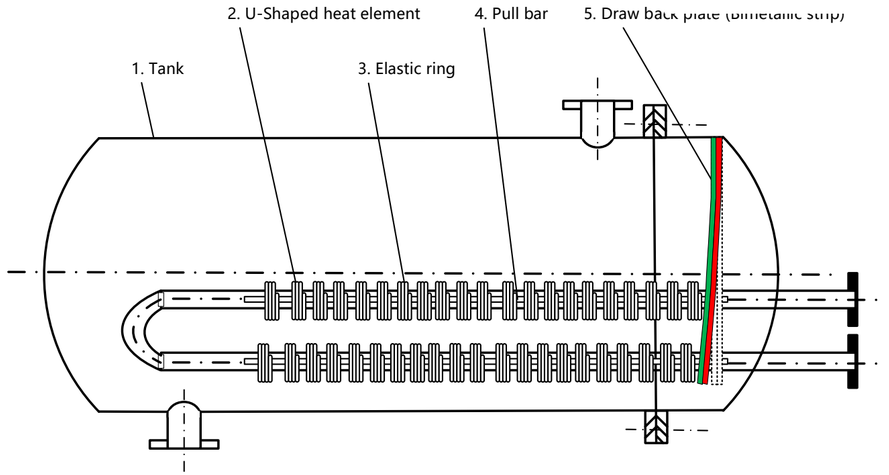
Trimming roadmap



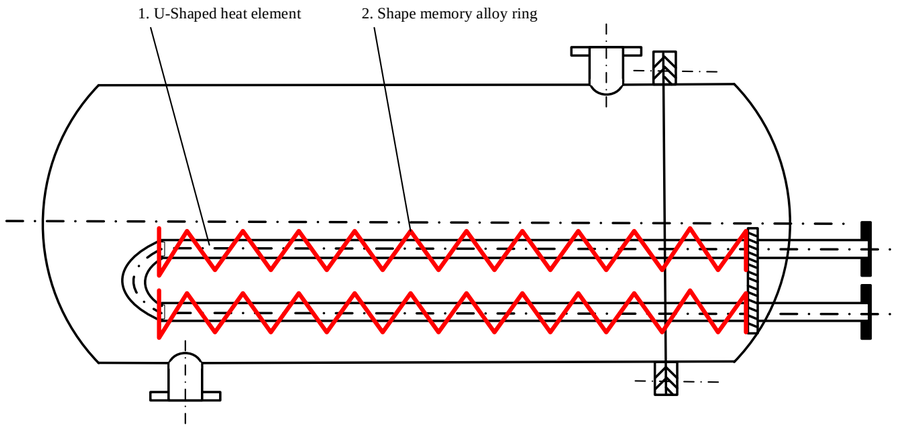
Content

Trimming Problem List

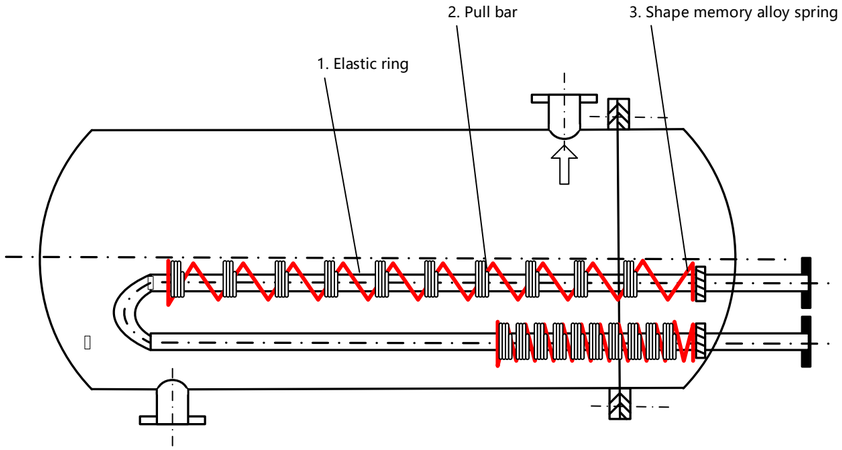
1. How to make Piston rod inducts itself ?
2. How to make another component (eg. the heat elements) to induct Piston rod ?
3. **How to make Draw back plate moves itself ?**
4. How to make another component (eg. The heat elements) to move Draw back plate ?
5. **How to make Pull bar moves itself ?**
6. How to make another component (eg. the heat elements) to move Pull bar ?
7. **How to make Elastic ring moves itself ?**
8. How to make another component (eg. the heat elements) to move Elastic rings ?
9. How to make Scale remove itself ?
10. How to make another component (eg. the heat elements) to remove the Scale ?



- 3. How to make Draw back plate moves itself ?



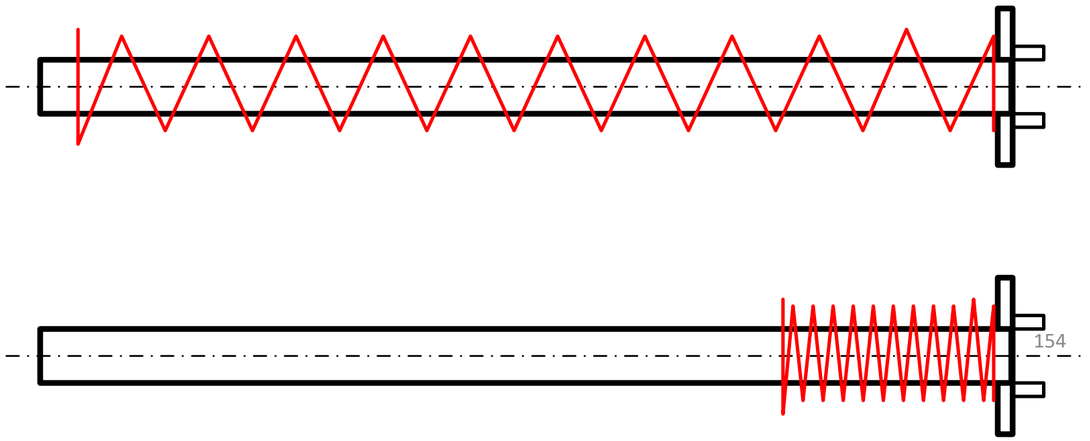
7. How to make Elastic ring moves itself ?



5. How to make Pull bar moves itself ?

Content

My patent: CN204934141U



(19)中华人民共和国国家知识产权局

(12)实用新型专利

(10)授权公告号 CN 204934141 U
(45)授权公告日 2016.01.06

(21)申请号 201520581357.3

(22)申请日 2015.08.05

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代理人 王艳珍

(51)Int.Cl.
B08B 9/023(2006.01)
F24H 9/18(2006.01)

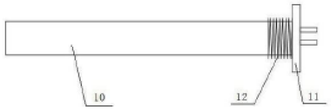
权利要求书1页 说明书3页 附图1页

(54)实用新型名称

热水器加热管除垢装置及热水器

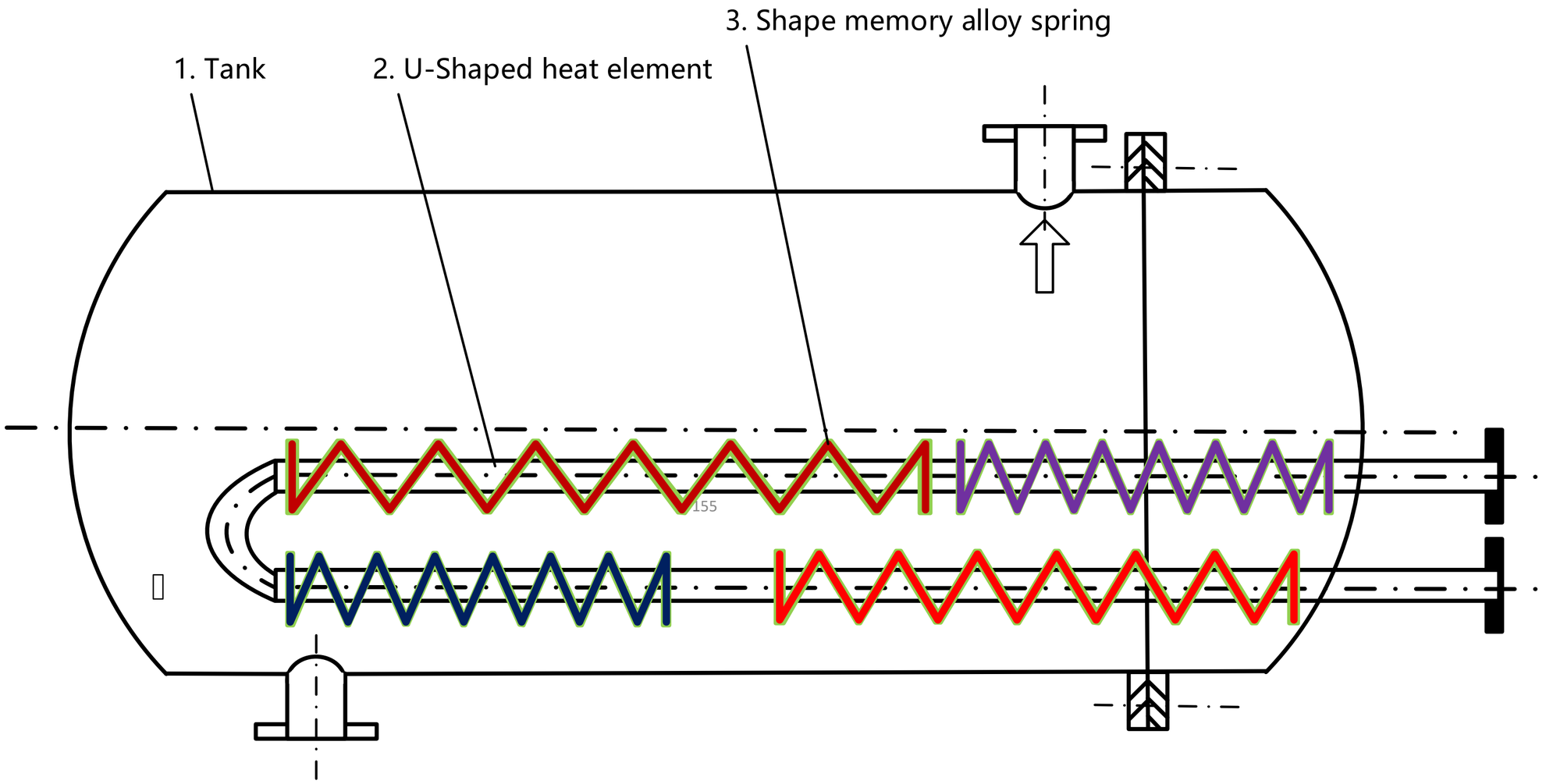
(57)摘要

本实用新型公开了一种热水器加热管除垢装置及热水器，包括环绕电加热管设置的感温记忆可伸缩结构，所述感温记忆可伸缩结构一端固定在电加热管座上。本实用新型的热水器加热管除垢装置，通过环绕电加热管设的感温记忆可伸缩结构，实现以温度变化为触发条件的形状变化，在水垢形成初期，还未达到致密状态时，感温记忆可伸缩结构在不同温度条件下产生形变，沿电加热管轴向做往复运动，可以直接摩擦电加热管表面，或者在运动时电加热管表面层带动水流流动形成紊流，使得水垢不能够结附在电加热管表面，以提高电加热管的传热系数和热交换率。



CN 204934141 U

Conclusions



Content

6.Q&A

Thank you for your attention!

Haijun Li (Allan)

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Tel: +86 13621311579
Skype: li.haijun.allan

MATRIZ Official

Presents

ITC 2024

INTERNATIONAL TRIZ CONFERENCE

14 -17 OCT'24 | DUBAI

Radisson Blu Hotel, Dubai Canal View

TRIZ Problem Solving - Case Study of Attic Stairs in the US Market

Jerzy Obojski

Consulting Jerzy Obojski

Hosted by

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EUROGATE

Intro

- Globalization

How do Global companies work?
A simplified model of Global Companies.

Intro

1. RnD & Design:

- Global company specializes in creating innovative products that are designed to delight and inspire people around the world.
- Their design teams work on the functionality, design, and ergonomics of the products to meet customer expectations.

Own R&D

Intro

2. Production:

- Global company has an integrated business model that includes the production of its own products.
- They work with suppliers around the world to ensure the quality and availability of their products.

Suppliers network

Intro

3. Distribution and Logistics:

- Global company has a presence in many countries, with a lot of stores worldwide.
- They focus on effective distribution to make products available to customers in different regions.

Reliable distribution system

Intro

4. Complaints and Servicing:

- Global company focuses on the quality of customer service.
- In case of complaints or problems with the product, they offer support and solutions to satisfy the customers.

Cost pay supplier

Intro

Intro

Year	Country	Supplier
2012	China	A
2013	Denmark	B
2014	Denmark	B
2015	China	C
2016	China	D
2017	China	E
2018	China	F
2019	Denmark	B
2020	Denmark	B
2021	Poland	G
2022	Poland	G

Product: Attic Stairs

Various suppliers from different countries provided the identical product to the US market across different years.

Intro

"Common look and feel" in designing everyday things means making them look and work similarly. This helps people use them easily and recognize the brand. Here are the main ideas:

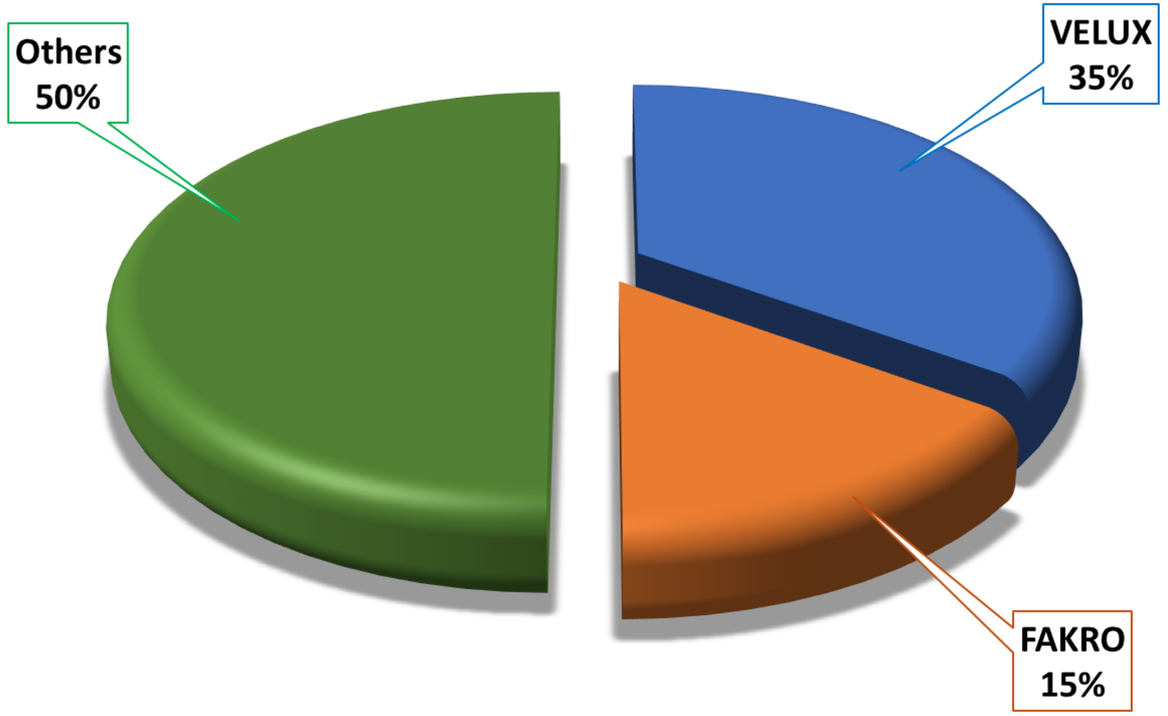
1. Brand Image: The design should match what the company stands for.
2. User Feelings: Good design makes people feel happy about using the product.
3. Easy to Use: The design should help the product work well, not just look nice.
4. Sameness: When all products from one brand look alike, it helps people remember the brand better.

These ideas help make products that people enjoy using and can easily spot as belonging to a certain brand.

Issue

- In 2020, the Polish company FAKRO won a contract for the production and delivery of attic stairs for one of the large chains on the American market.

- The initial euphoria of winning the contract and outcompeting the global leader in the American market quickly turned into a nightmare.

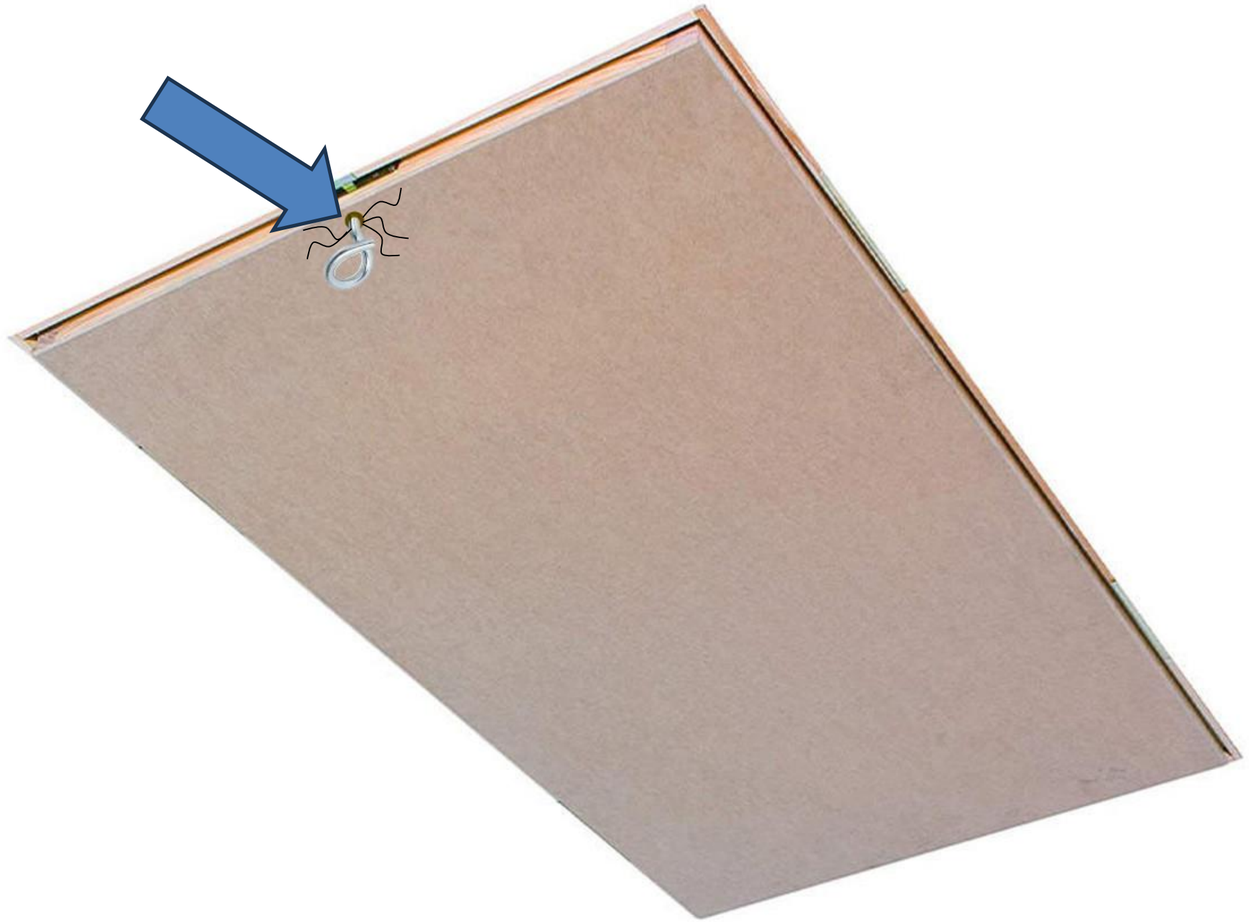


Global producers of Attic Stairs

Issue

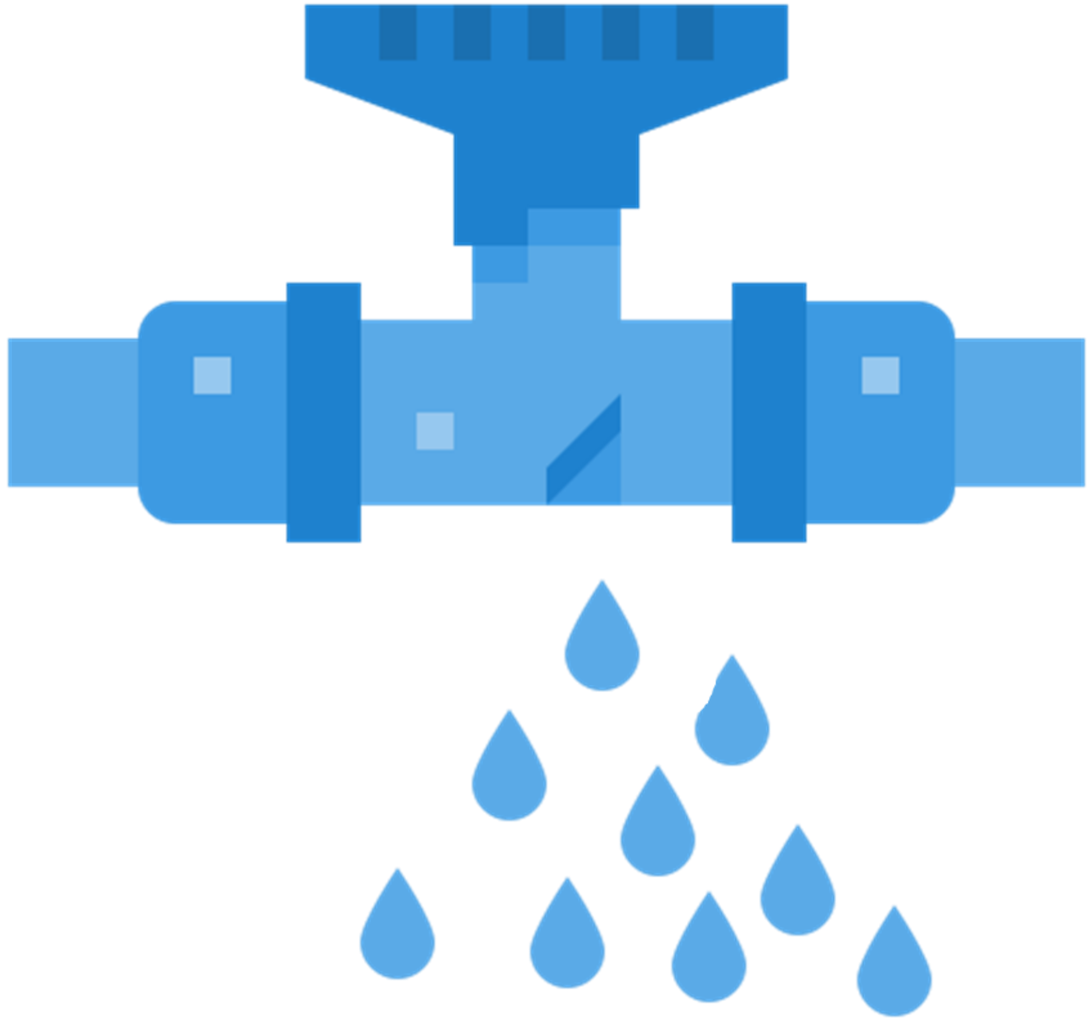
Production and sales according to the customer's design were not a problem. Operating profit also looked great at the beginning. Problems arose when user complaints from the market began to flood in rapidly.

Issue



Issue

The costs of repairs and handling complaints practically ate up the entire profit. The key here was to understand the causes of the problem and remove them quickly.



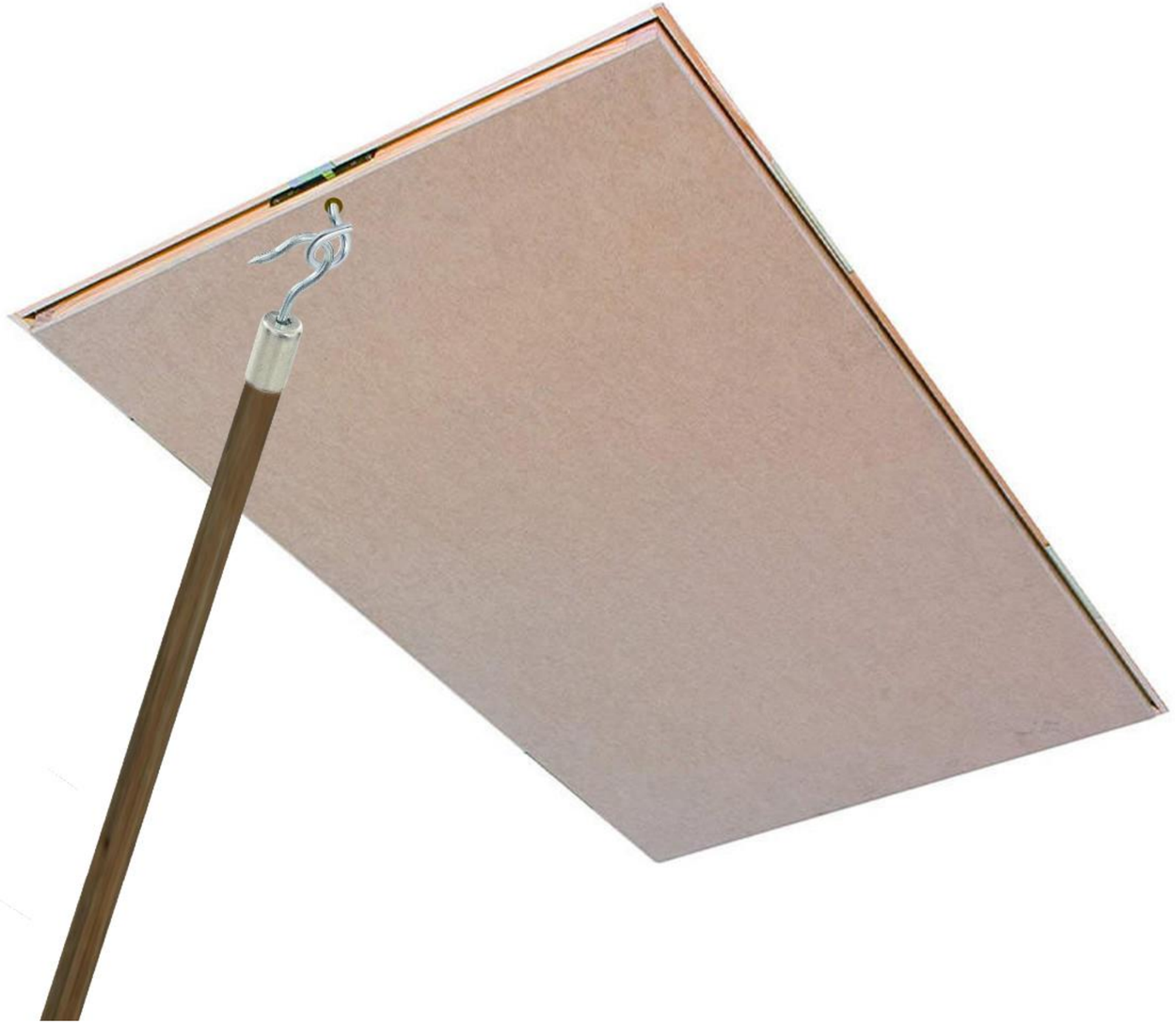
TRIZ

MATRIZ Official

For TRIZ consulting projects, ideal clients are distinguished by three key characteristics: they have a **complex problem** to solve, they value **time as a crucial resource**, and **they are ready** for profound changes. My experience shows that such clients not only achieve spectacular results but also become leaders in their industries, inspiring others to take action. This was exactly the case with FAKRO.

Principle of operation

Principle of operation

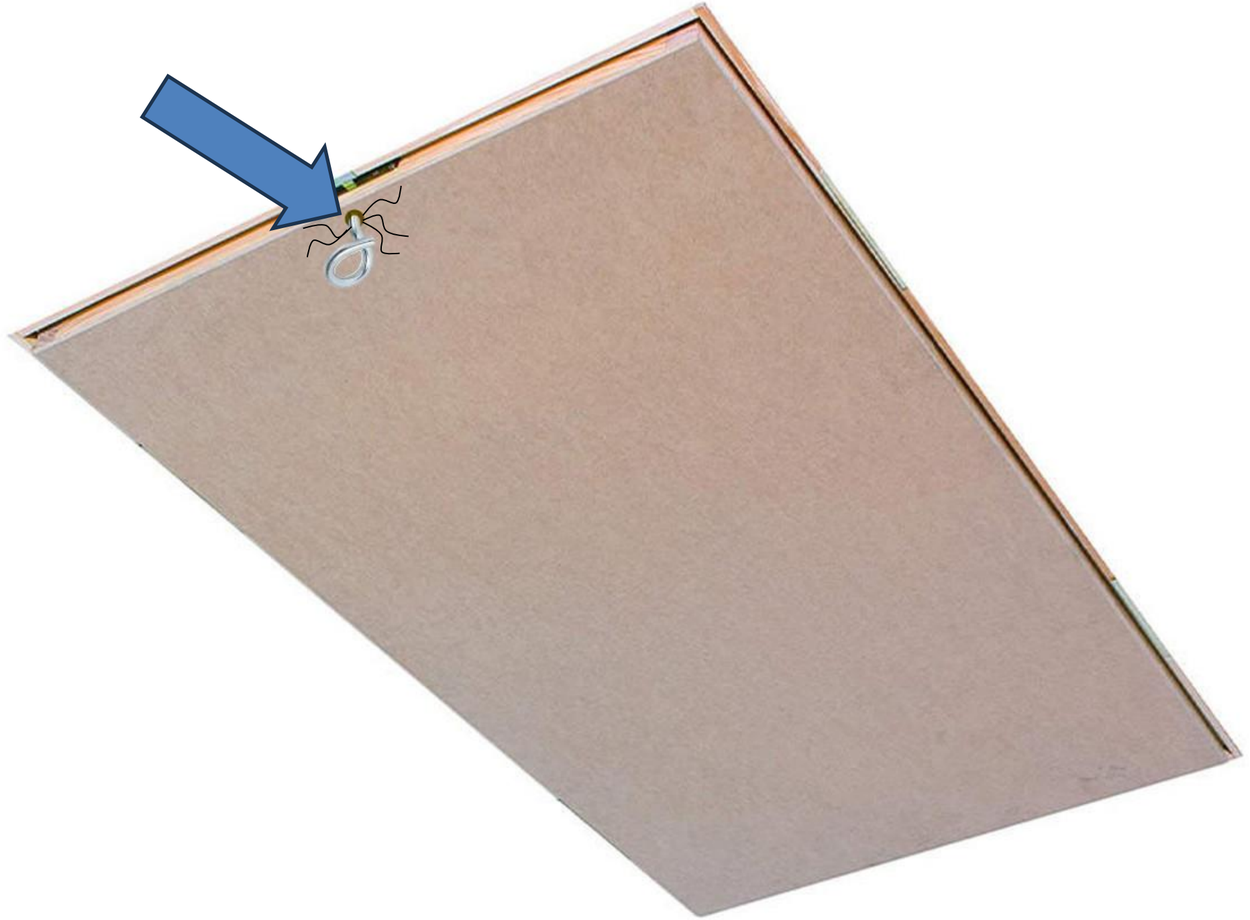


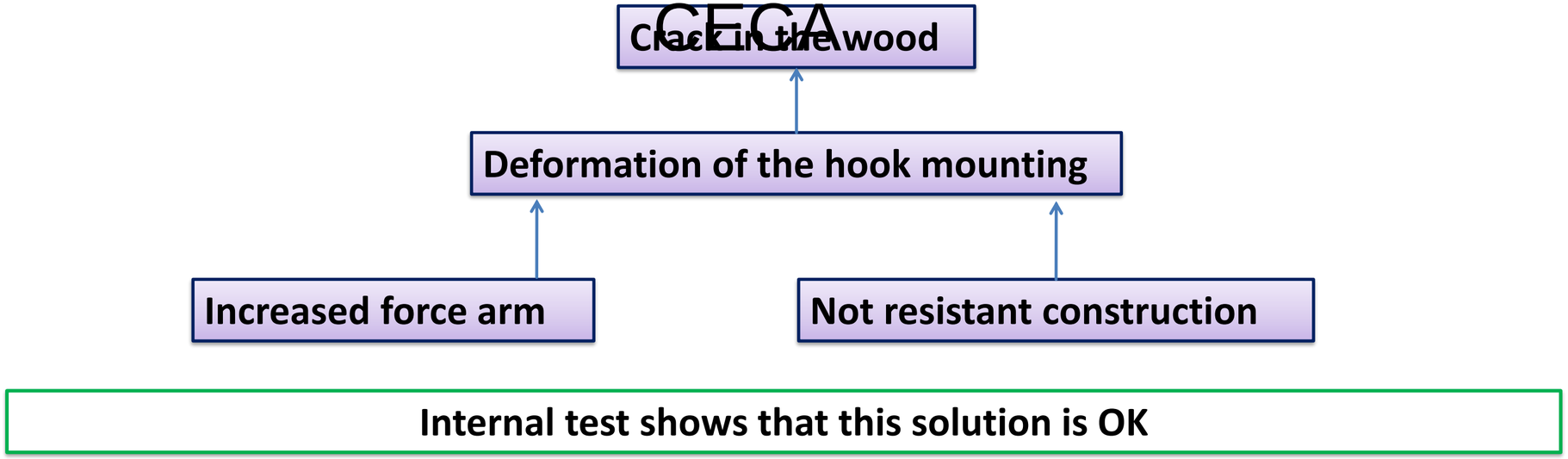
Principle of operation

Principle of operation

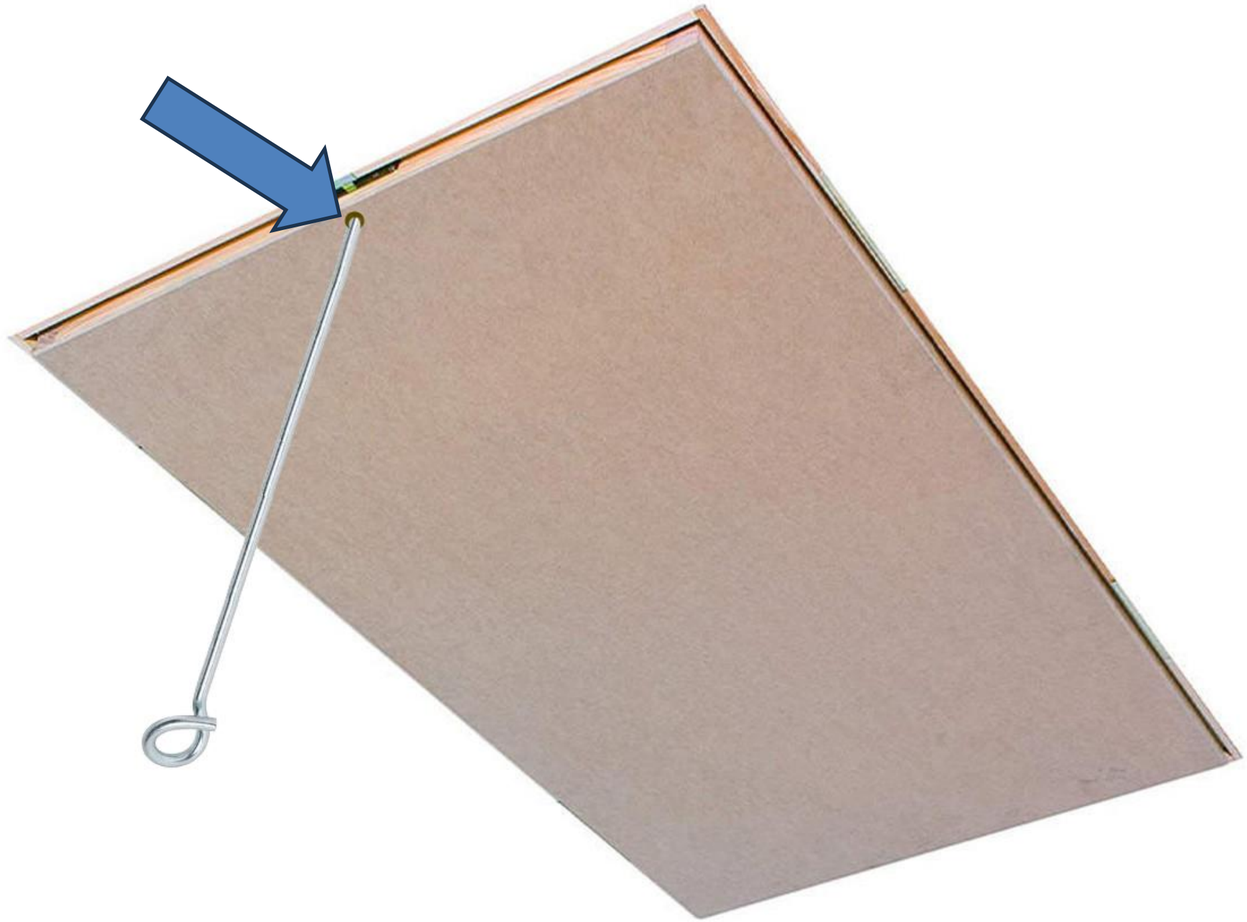
Principle of operation

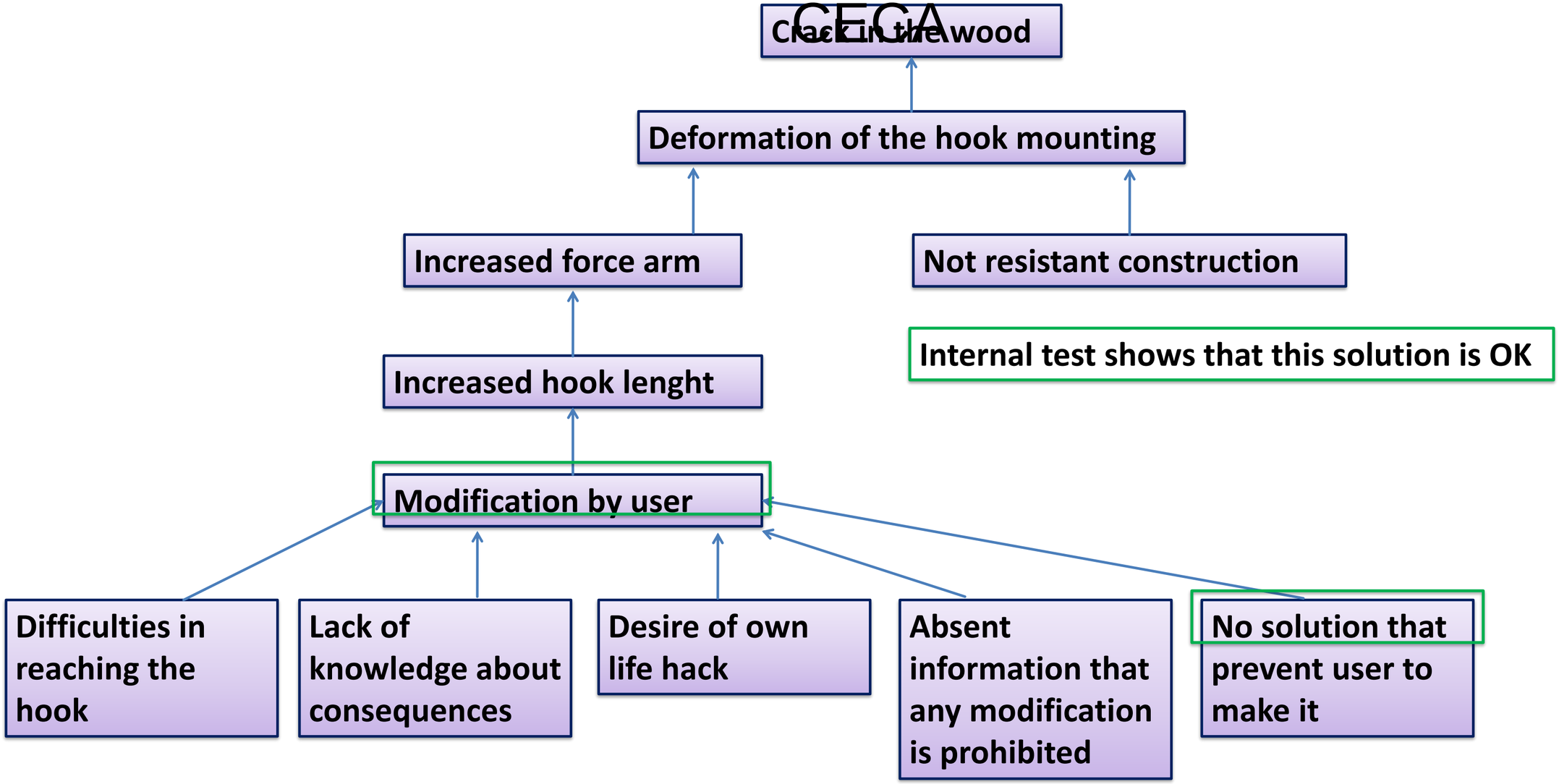
Issue



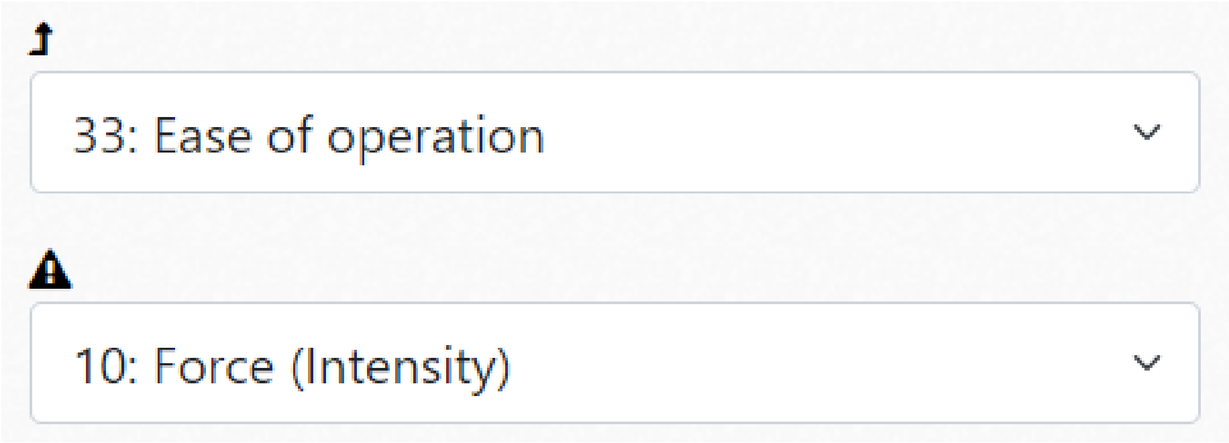

Crack in the wood
Deformation of the hook mounting
Increased force arm
Not resistant construction
Internal test shows that this solution is OK

Root cause




Crack in the wood
Deformation of the hook mounting
Increased force arm
Not resistant construction
Increased hook lenght
Internal test shows that this solution is OK
Modification by user
Difficulties in reaching the hook
Lack of knowledge about consequences
Desire of own life hack
Absent information that any modification is prohibited
No solution that prevent user to make it

Technical contradiction



13. The other way round

- Invert the action(s) used to solve the problem (e.g. instead o
  cooling an object, heat it
- Make movable parts (or the external environment) fixed, and
  fixed parts movable
- Turn the object (or process) 'upside down

28. Mechanics substitution

- Replace a mechanical means with a sensory (optical, acoustic, taste or smell)means.
- Use electric, magnetic and electromagnetic fields to interact with the object
- Change from static to movable fields, from unstructured fields to those with structure
- Use fields in conjunction with field-activated (e.g. ferromagnetic) particles

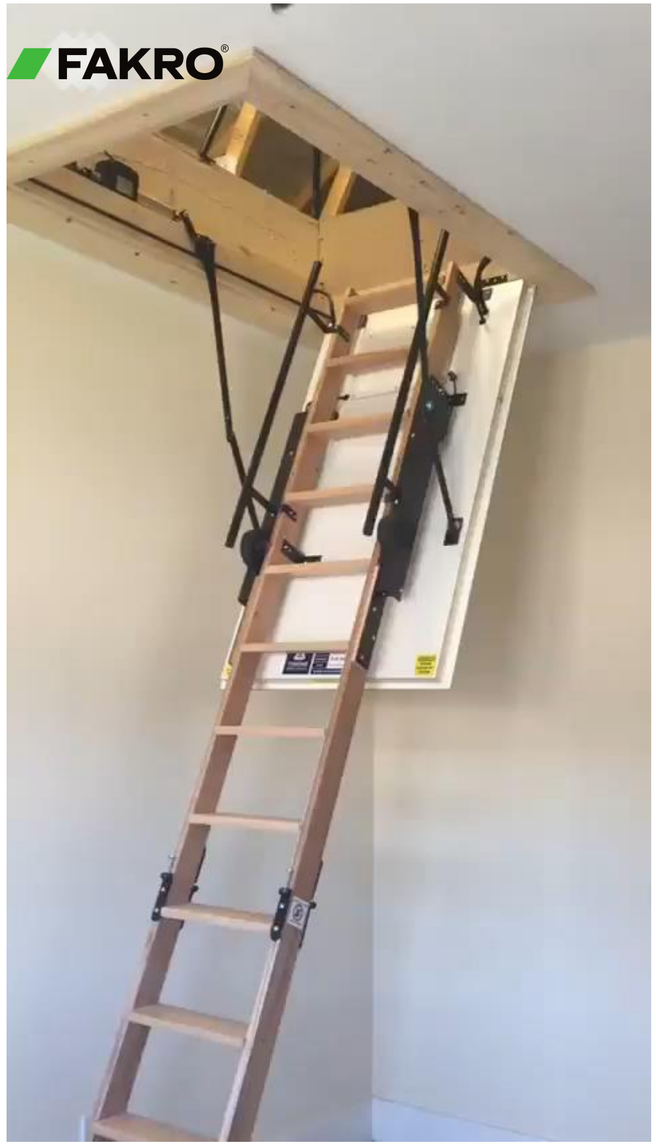
35 Parameter changes

- Change an object's physical state (e.g. to a gas, liquid, or solid.). Change the concentration or consistency.
- Change the degree of flexibility
- Change the temperature.

Ideas

28. Mechanics substitution

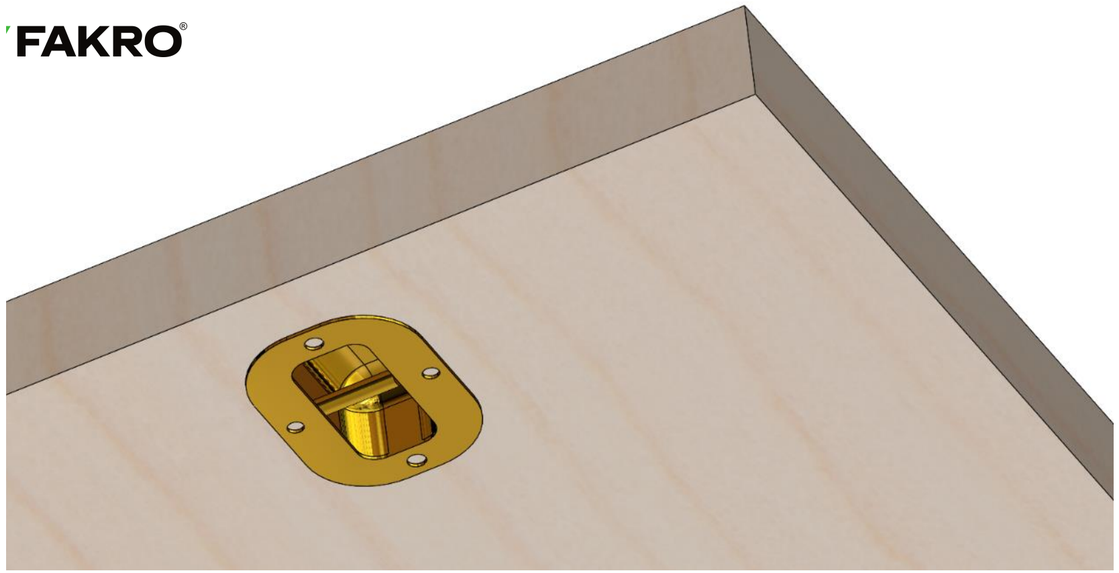
Manual operation will be changed to electrical drive operation.



Operator should only push the button.

Ideas

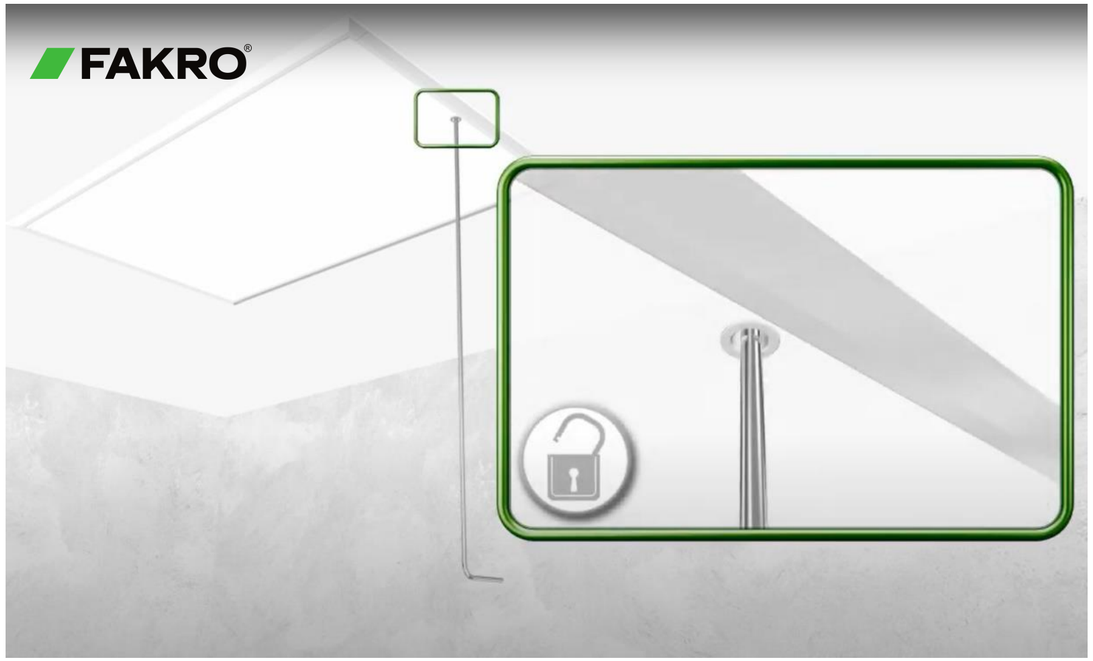
13. The other way round

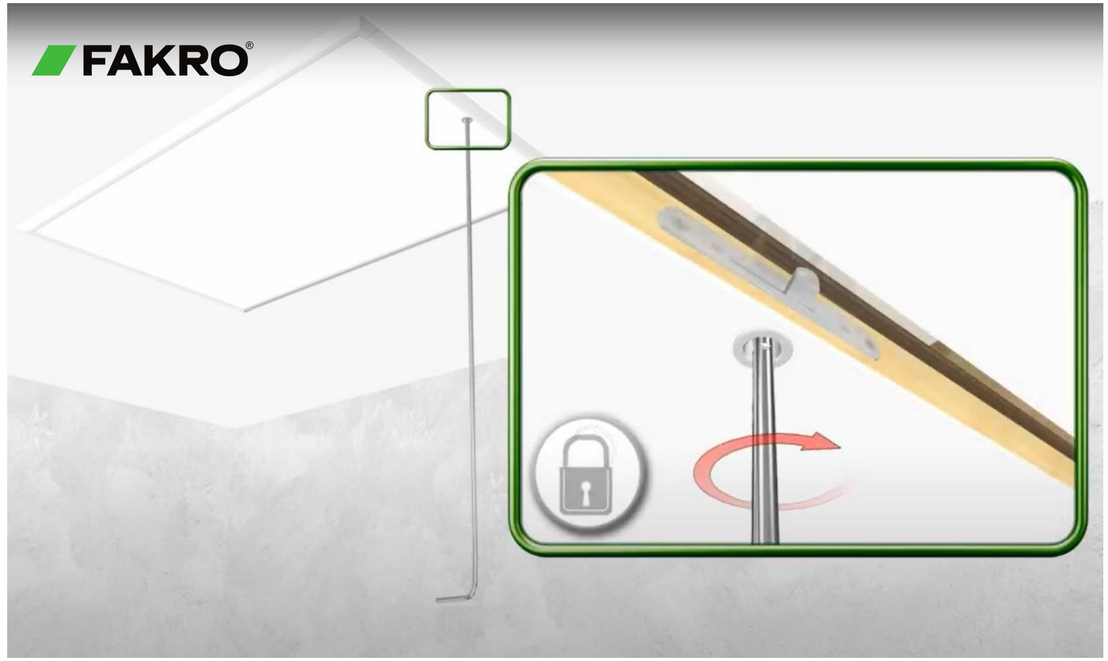


External docking hook will be changed to internal one.

Ideas

35 Parameter changes





Changes from push – pull solution to rotate solution.

Response

Due to the **'Common look and feel'** policy, all proposals for changes in the present attic stairs design were **refused**.

So, the new challenge was reformulated in this way: **we need to change the design to avoid customer complaints, and we cannot change the design in order to keep the same product appearance.**

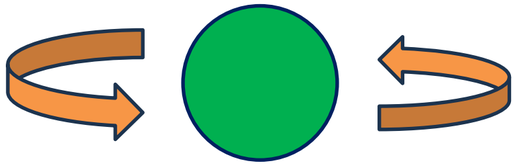
Physical contradiction

1	Can a Physical Contradiction be resolved by separation in space? (where?)	YES	inventive principles:	1,2,3,7,4,17
		NO	If not, justify and go to point 2:	
2	Can a Physical Contradiction be resolved by separation in time? (When?)	YES	inventive principles:	9,10,11,15, 34
		NO	If not, justify and go to point 3:	
3	Can Physical Contradiction be resolved by separation in relation? (for whom?)	YES	inventive principles:	3,17,19, 31, 32, 40
		NO	If not, justify and go to point 4:	
4	Can Physical Contradiction be resolved by separation at the systemic level?	YES	inventive principles:	1, 5,13, 33
		NO	If not, justify and go to point 5:	
5	Can a Physical Contradiction be resolved by separating in a direction? (in which direction?)	YES	inventive principles:	4, 40, 35,14,17, 32
		NO	If not, justify and go to point 6:	
6	Can a Physical Contradiction be resolved by satisfying contradictory requirements?	YES	inventive principles:	13, 28, 35, 36, 37, 38, 39
		NO	If not, justify and go to point 7:	
7	Can a Physical Contradiction be resolved by bypassing the contradictory requirements?	YES	inventive principles:	25, 6,13
		NO	The wording of the Physical Contradiction needs to be changed.	

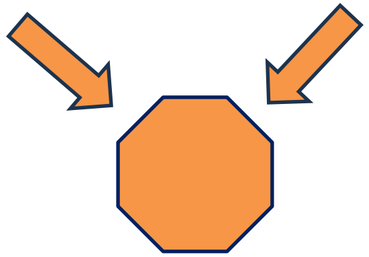
Physical contradiction

17. Transition to another dimension
Move the object in two- or three-dimensional space.
Use a multistory arrangement for the objects instead of a single-story arrangement.
Tilt or re-orient the object, put it on its side.
Use a different side of the given area.

14. Spheroidality – Curvature
Instead of using rectilinear parts, surfaces, or forms, use curvilinear ones; change from flat surfaces to spherical ones; from cube-shaped (parallelepiped) parts to ball-shaped structures.
Use rollers, balls, spirals, domes.
Go from linear to rotary motion; use centrifugal forces.

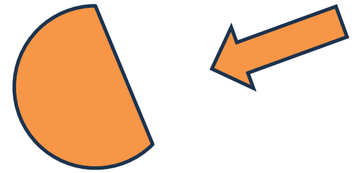


35. Parameter changes
Change the object's physical state (e.g. to a gas, liquid, or solid).
Change the concentration or consistency.
Change the degree of flexibility.
Change the temperature.



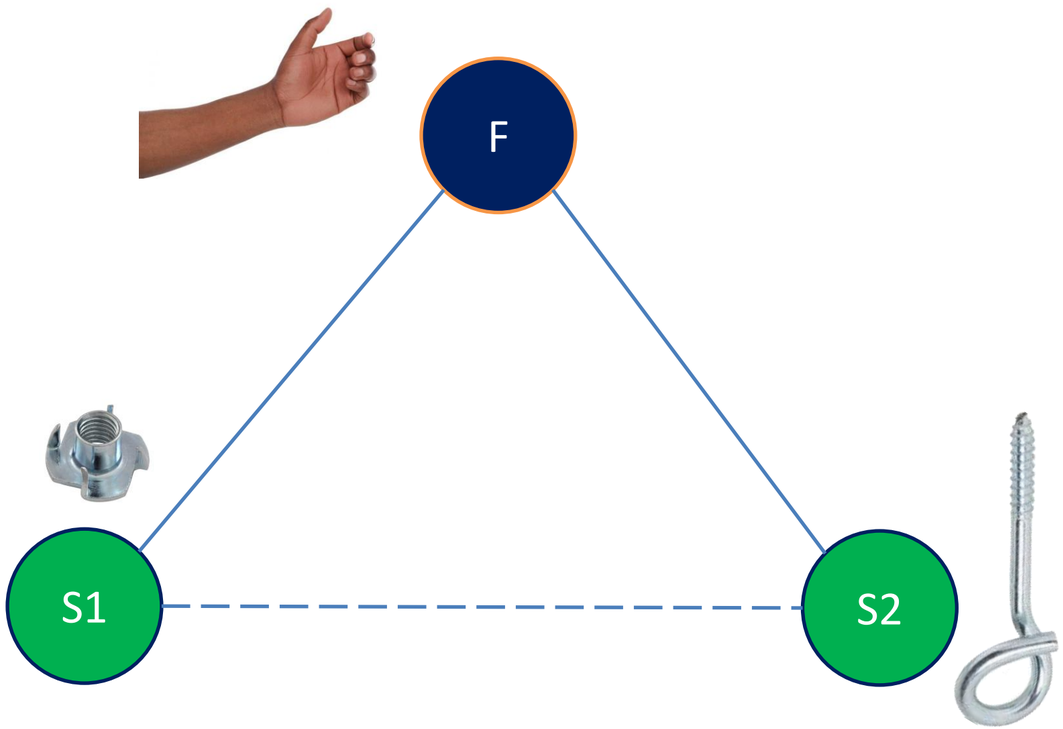
Physical contradiction

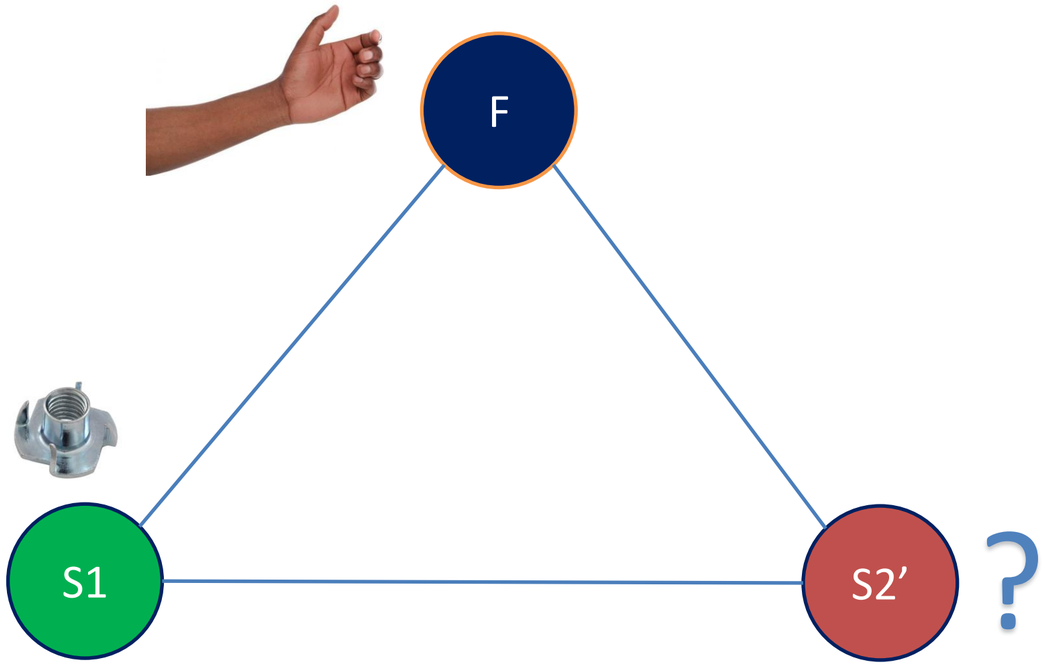
4. Asymmetry
Change the shape of the object from symmetrical to asymmetrical.
If the object is asymmetrical, increase its degree of asymmetry.



13. The other way around
Invert the action(s) taken to solve the problem (e.g. instead of cooling the object, heat it).
Make movable parts (or the external environment) stationary, and stationary parts movable.
Turn the object (or process) “upside down”.

Su-Field model

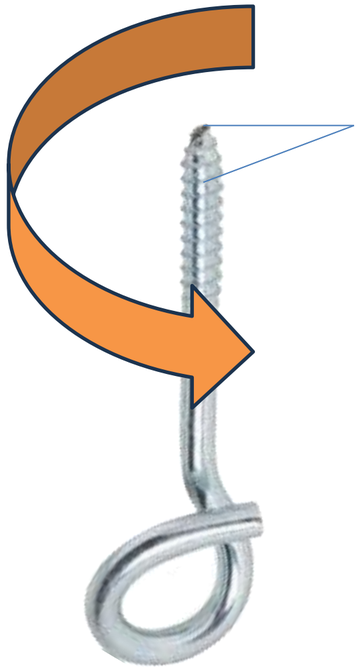




A given Su-field model cannot be adequately performed. Design changes are not allowed.

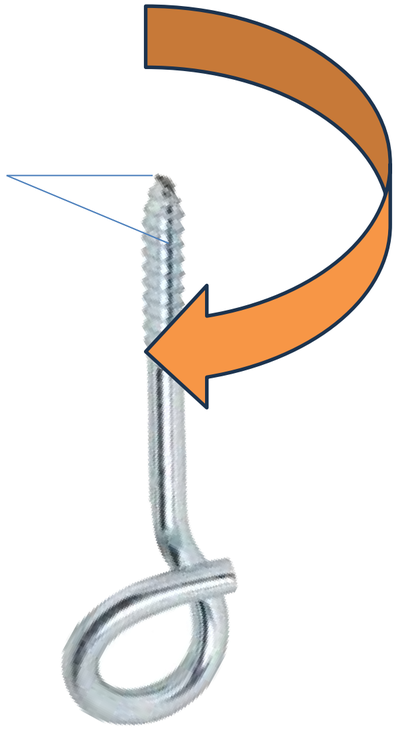
Modify existing substance S2 into S2' to give the Su-field model the desired properties.

Solution



Right-handed thread

Extended version is available on the market.



Left-handed thread

No easy to get on the market.

Solution

- The final solution involved modifying the internal mechanism of the stairs without altering its external appearance. Specifically, the team changed the thread direction on the hook mechanism:

- • Original right-handed thread was changed to left-handed thread

- This clever modification prevented users from easily extending the hook length, thus addressing the root cause of the failures without changing the product's outward appearance.

Key Takeaways

1. TRIZ provides powerful tools for solving complex technical contradictions, especially when conventional solutions are constrained.

2. Understanding the root cause of problems is crucial. In this case, user behavior (modifying the hook) was the primary issue, not the original design.

3. Creative solutions can often be found by looking at the problem from different perspectives and applying systematic innovation techniques.

Key Takeaways

4. Constraints (like the "Common look and feel" policy) can drive more innovative solutions by forcing teams to think beyond obvious changes.

5. The importance of considering user behavior and potential misuse in product design and improvement processes.

6. Global companies must balance standardization with local market needs and user behaviors, which can vary significantly across regions.

Key Takeaways

7. Effective problem-solving in manufacturing often requires a multidisciplinary approach, combining engineering, user experience, and business considerations.

- This case study illustrates how TRIZ methodology can be applied to solve real-world engineering problems, even under strict constraints. It highlights the power of systematic innovation in overcoming seemingly impossible contradictions and finding elegant solutions that satisfy all stakeholders.

- Some of the proposals for resolving this specific problem were used as new product offerings by FAKRO in the market.

Thank you

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Ensuring Sterile Transfers

Aditya Nangia
(IIIT-Delhi, India)

Saksham Bhupal
(IIIT-Delhi, India)

Dr. Anuj Grover
(IIIT-Delhi, India)

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Context

Industry

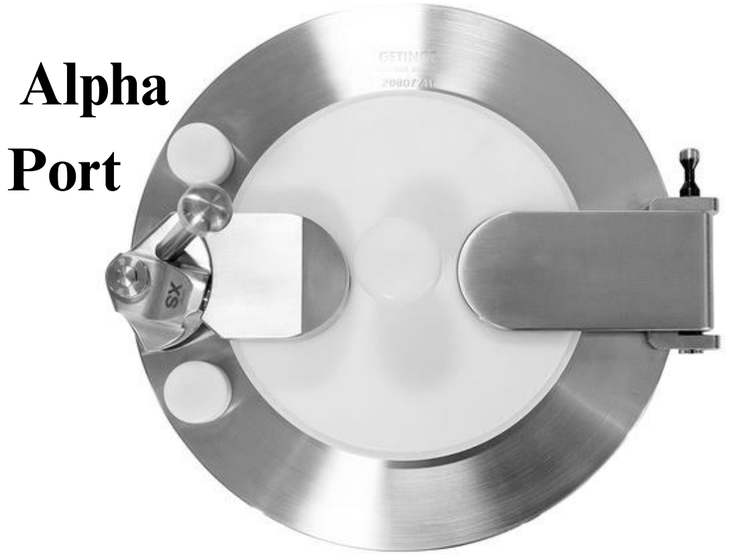
The Pharmaceutical Industry is a cornerstone of modern global healthcare, saving lives through the discovery, development, and manufacturing of life-saving medications.

Production

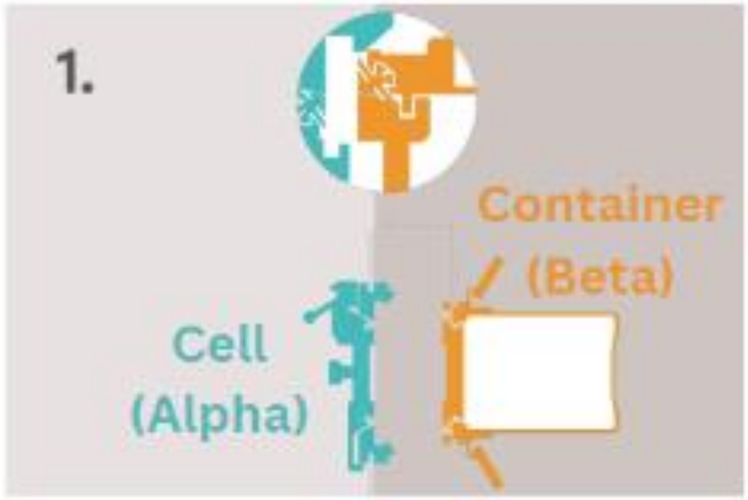
Pharmaceutical Production is the most critical aspect of the industry requiring a sterile and aseptic environment throughout in order to prevent contamination.

Existing Pipeline

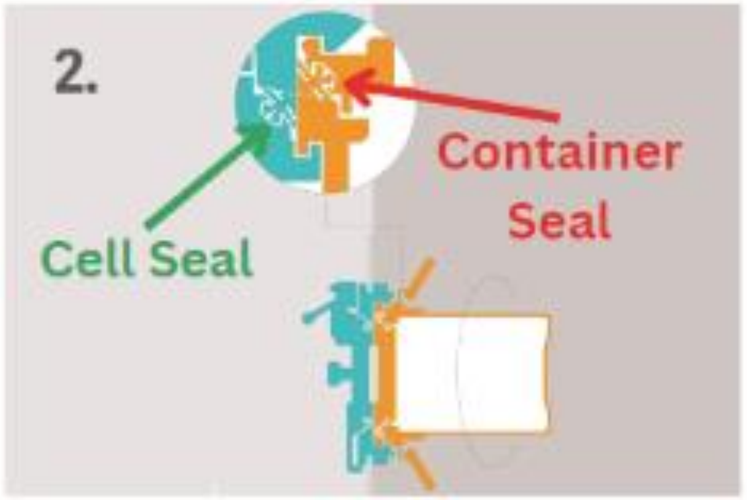
[Video]



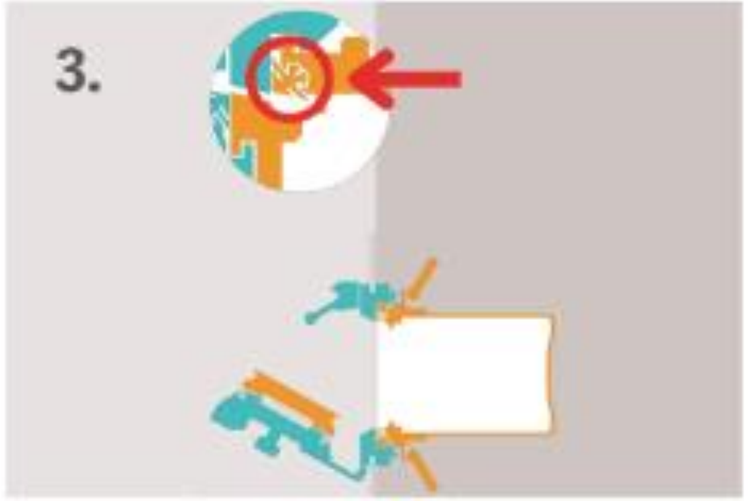
System Working



Line up the Alpha and Beta ports



Rotate the Beta part 60° to ensure tighten seal and open the door.



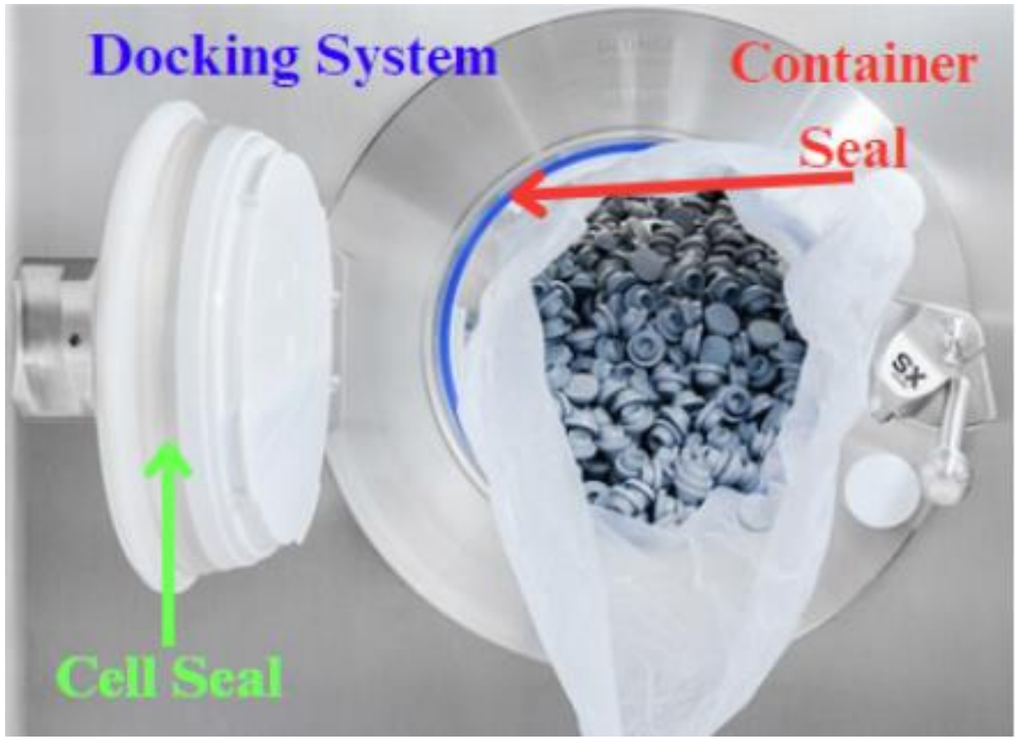
The red circle denotes where the misalignment jeopardizes sterility

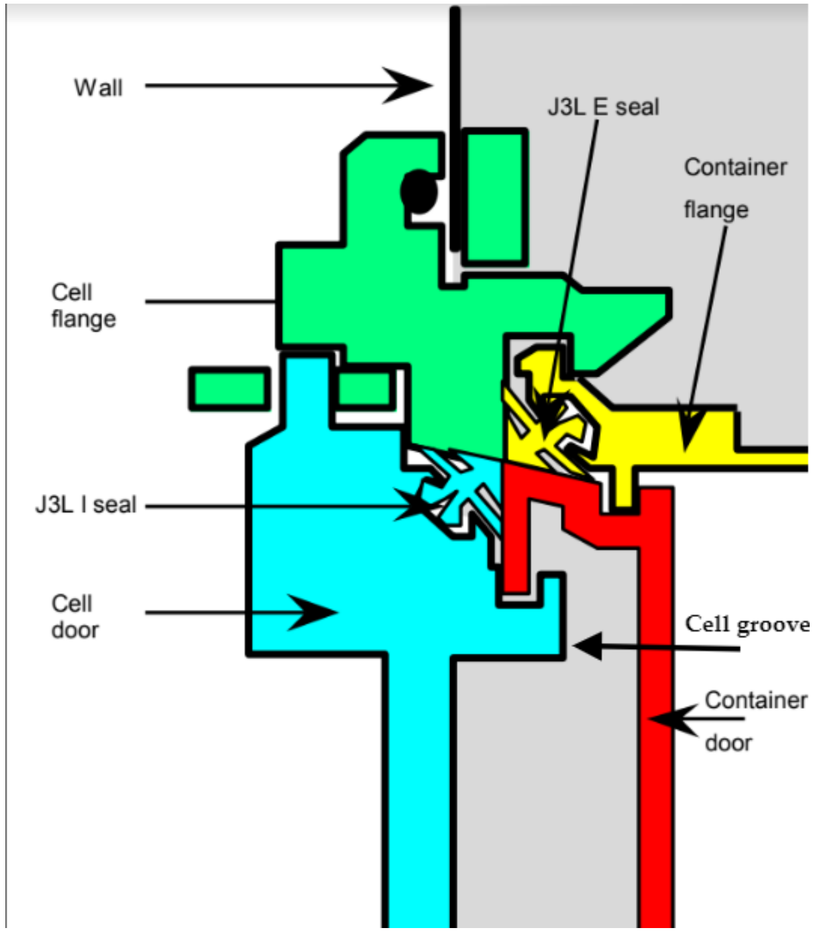
Problem

The problem is simple:

HUMAN GREED

Component Diagram





Ideal Final Solution

Main Function of Engineering System

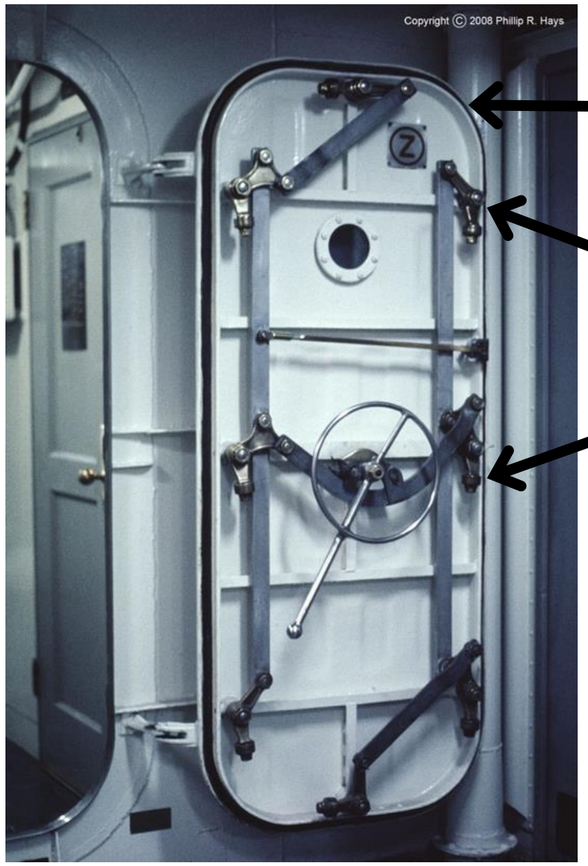
Block Atmosphere to maintain an Aseptic and Sterile Environment

Ideal Final Solution

- **Zero Contamination Risk:** Maintaining a sterile and aseptic environment is paramount.
- **Cheap Containers (Beta Ports):** Cheaper Beta Ports will encourage manufacturers to use original containers instead of low-quality cheap alternatives.
- **No Cell (Alpha Port) Changes:** To minimize production line disruption, the new design should require no modifications to existing alpha ports.

Function Oriented Search

Industry Leader



Industry Follower

Pharma production is itself an industry leader due to the high cost of failure involved

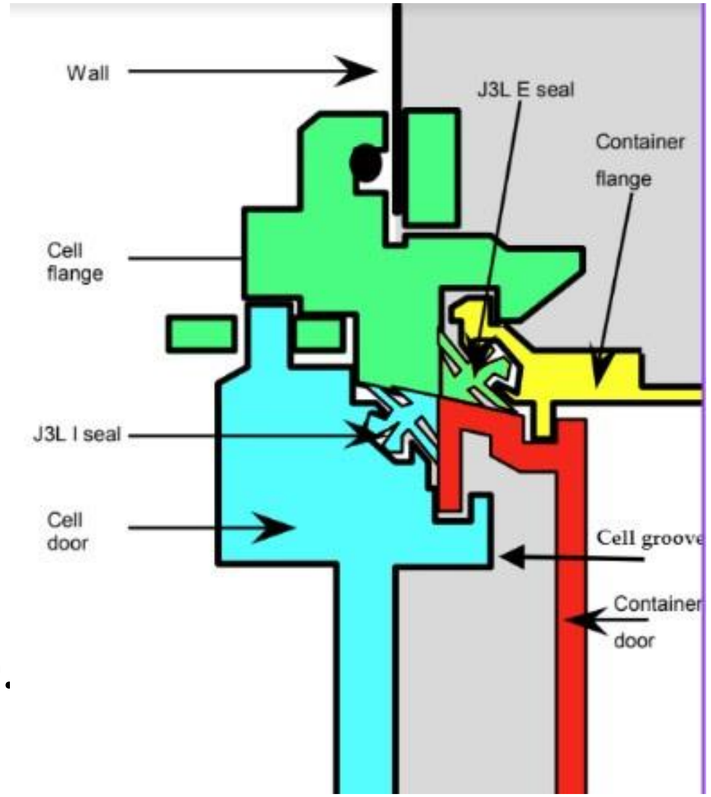
Proposed Solution

Physical Contradiction:

The container-sealing gasket must be

- **large** when a large beta port is connected to it, and
- **small** when a small beta port is connected to it.

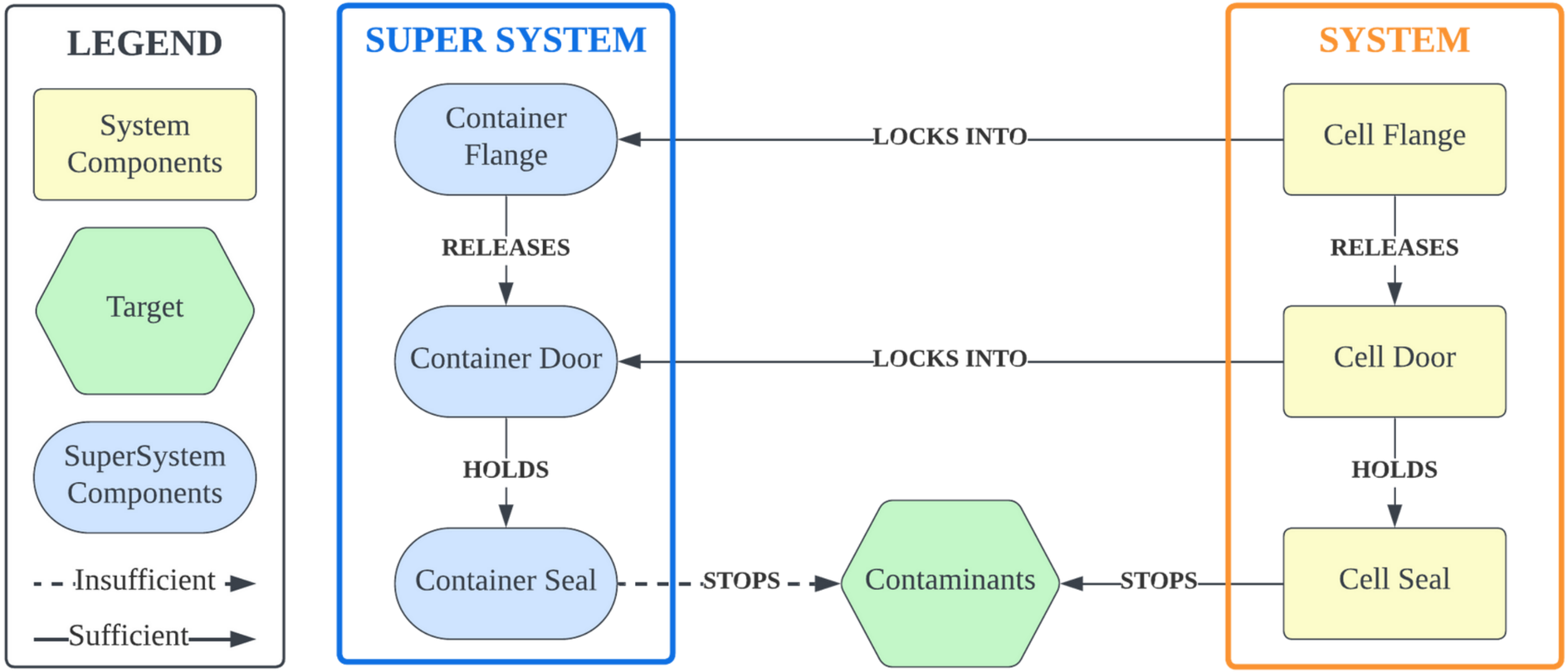
These contradictory demands can be satisfied through a **Separation in Time.**



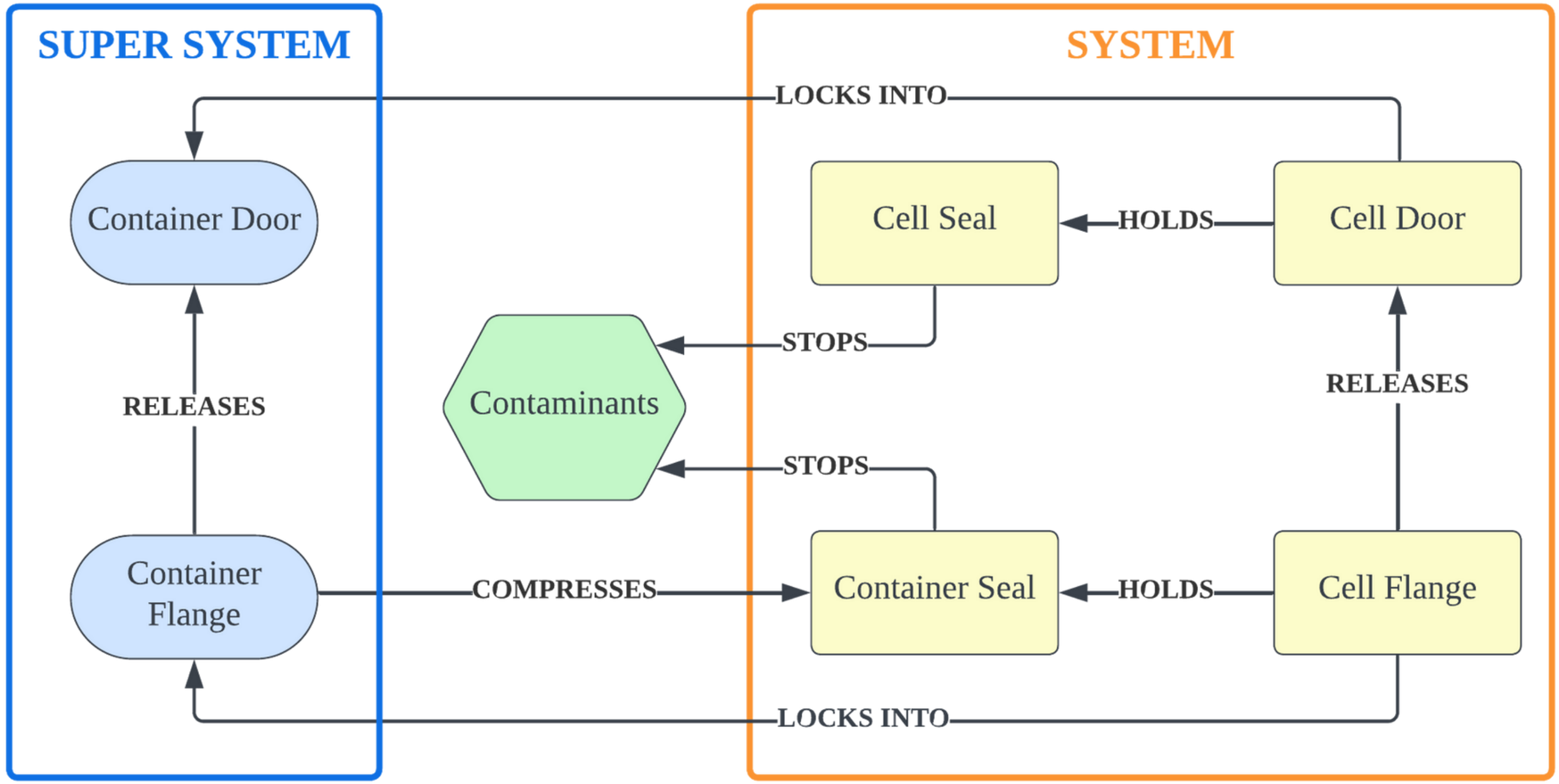
The Other Way Around:

- Everyone places the gasket on the Container Flange.
- We propose to invert and place the gasket on the Cell Flange, such that it is already aligned with the Cell Seal.

Function Analysis



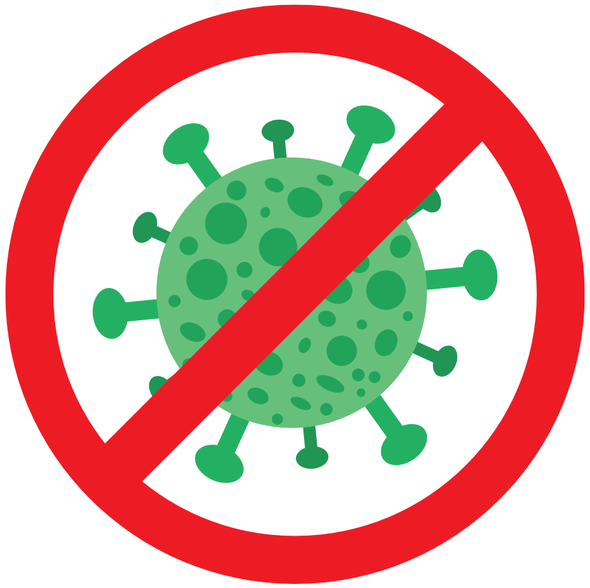
Updated Functional Analysis

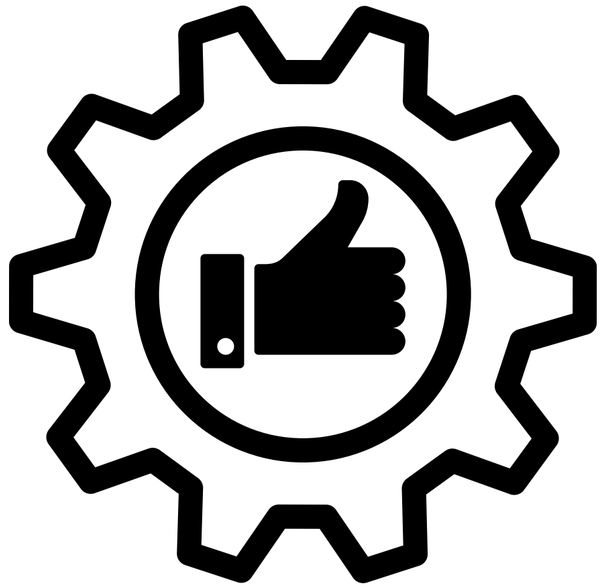


Positive Impact

Our solution prioritizes patient safety by eliminating contamination risks during pharmaceutical production. This safeguards product quality and builds trust and strengthens the company's reputation for delivering reliable medication.

Our solution also enhances the overall efficiency of the pharma production flow.





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Application of TRIZ –TOC Synergy.

Sadashiv Pandit
Founder
Unigo Fashionwear LLP, Pune, India

Mukta Pandit
Co-Founder
Unigo Fashionwear LLP, Pune, India

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Business Challenge of Retail Channels…

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- Unigo Fashion ware is in the business of selling Men's footwear products thru Digital marketing channels.
- ‘Digital marketing’ as an innovation is in stage II of TESE and will be providing big growth opportunity to retail industry in coming years.
- Key issues associated with Digital marketing are…Consumers ‘commoditise’ the products by comparing with other products. , thus driving the prices down. Lower margins and high competition does not generate break even volumes for sustaining and growing of the business. In addition to this problem, the current established social media platforms charge very high premium for displaying the products/services.
- Unigo finds it difficult to survive and grow profitably.

Business Challenge of Retail Channels…

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- Goal…To grow profitably by synergizing TOC [theory of Constraint] and TRIZ management tools.

- Approach…Develop synergy by using TOC and TRIZ tools of problem identification and problem solving. [1+1=11]. This approach aims at sustaining and raising the price levels and penetrating the current market.

- Mini Goal- To make the current product/service immune to ‘commoditization’

Two Genius of our Century….

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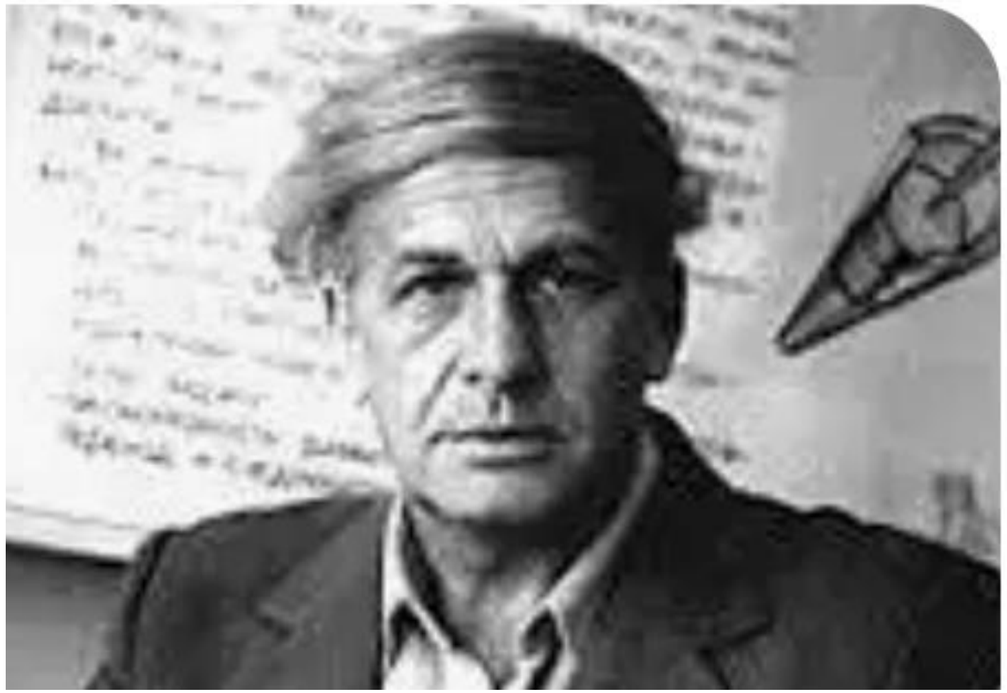
Dr Eli Goldratt ,Inventor TOC [Theory of constraint]

Dr Althshuller ,Inventor TRIZ

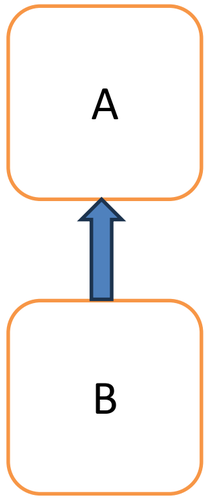


Synergy…[1+1=11]

- Identify systemic leverage points using TOC tool necessary thinking/CRT.
- Provide TOC standard solutions to make system optimum/productive.
- Improve current products using benchmarking by using TRIZ tools.
- Design new offer using TOC ‘sufficiency thinking ‘ for the equation V=F/C
- Use TRIZ tools in developing the new offer.
- Measure impact on sales and profits and learning notes.

Identify systemic leverage points using TOC tool necessary thinking/CRT.

- Unigo footwear operates with supersystem components as consumers , environment, Government and subsystem of its vendors.
- TOC tool CRT identifies three generic leverage points.. Finish good store ,New Product Development delivery SOP and Sales offer. They control the throughput [margins], fixed costs and investment like inventory.
- Necessary thinking Logic…



For A to happen ,B must be present.
Example…To pass an exam, we must attend it

Provide TOC standard solutions to make system optimum/productive.

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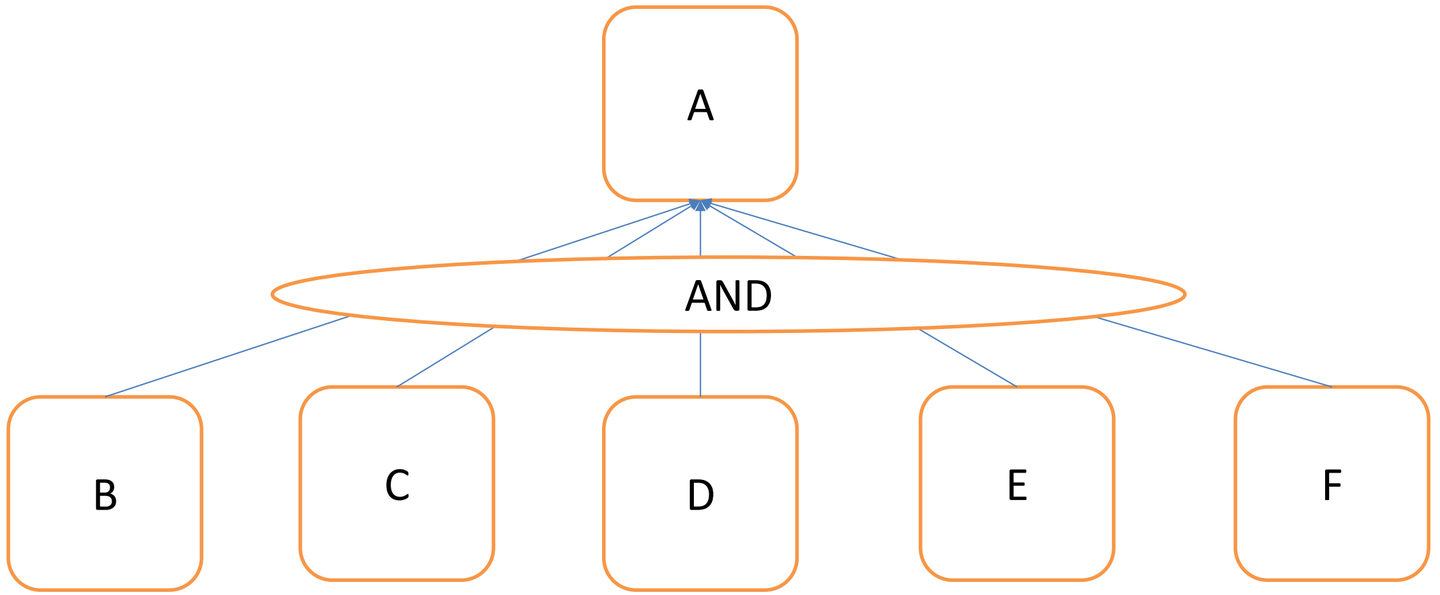
- TOC standard solutions..
- DBR [Dynamic buffer management]
- CCPM [NPD delivery system]
- MTS [made to stock as sales offer]
- The above solutions brought ‘flow’ in the system and ‘improved cost structure’ **but it did not stop commoditization.**

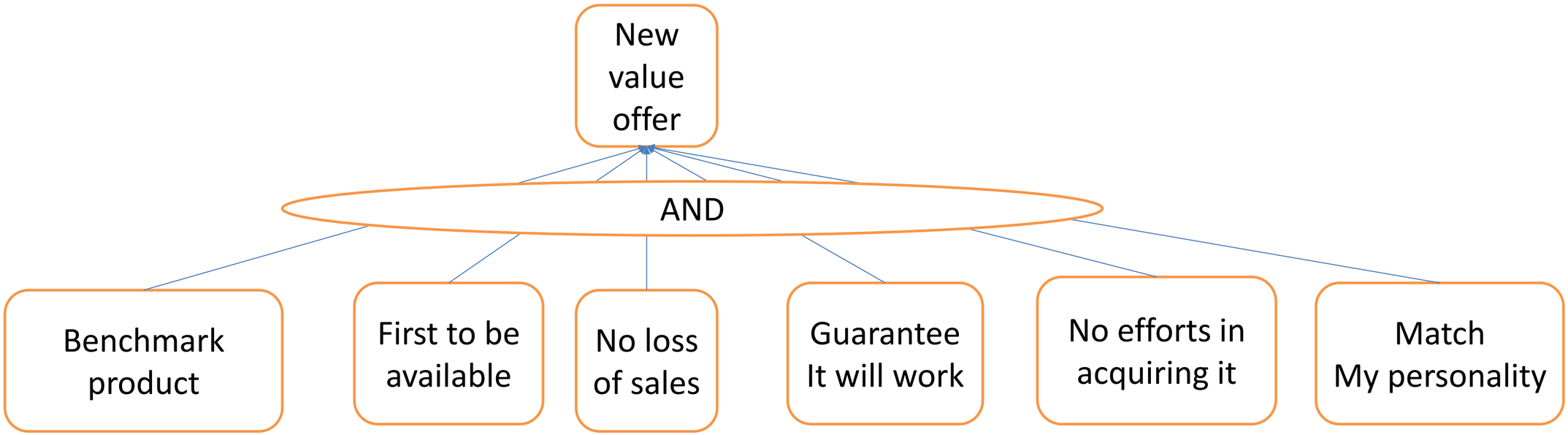
Design new offer using TOC ‘sufficiency thinking ‘ for the equation V=F/C

- Sufficiency Thinking…



FOR A TO BE PRESENT, B AND C AND D AND E AND F.. MUST BE PRESENT.

Design new offer using TOC ‘sufficiency thinking ‘ for the equation V=F/C



Design new offer using TOC ‘sufficiency thinking ‘ for the equation V=F/C Benchmark Product

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- Final Product…At higher Price

For enhanced foot support , feature ‘wedge action’
Is selected from material handling industry. The upper
Is modified to provide 7 degree of wedge action.
For cushioning and long life ,feature ‘automobile scrap tyre’
Is selected and outsole is made from that material.

Design new offer using TOC ‘sufficiency thinking ‘ for the equation V=F/C
First to be available and No loss of sales

- First to Be available…USED TOC Tool CCPM [critical chain management]
- Conflict resolved is ..if we want to meet original commitments then we must do everything to meet the endangered original ‘D’ date
- BUT
- We may have to jeopardize the scope of the project.
- No loss of sales…USED TOC tool Dynamic Buffer Management.
- Conflict resolved is.. If we want to avoid delivery failures, then we must constantly fight to reduce waste
- BUT
- We may have to compromise flow disruptions.

- Both above tools can be further sharpened by using TRIZ tools like trimming, feature transfer for on ongoing improvements.
-

Design new offer using TOC ‘sufficiency thinking ‘ for the equation V=F/C Guarantee that Offer will deliver, No efforts in acquiring the product and it will match my personality..

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- Use TRIZ principle ‘Mental inertia’ for identifying obstacles in the offer.
- Digital Marketing is ‘different ‘ than ‘offline or in store’ marketing. In case of Digital marketing , before buying the product ‘only’ information will be available to the consumer.
- Conflict is.. If we use Digital marketing, then we cost-effectively ‘inform’ product/service features to many consumers [high reach]
- BUT
- Consumers may not believe in our information.
- TRIZ tools used…1.eliminate information flow disturbances.2. Add additional field to pull consumer on decision making cycle.[SU-FIELD]

Improving Flow to reduce ‘Mental inertia’

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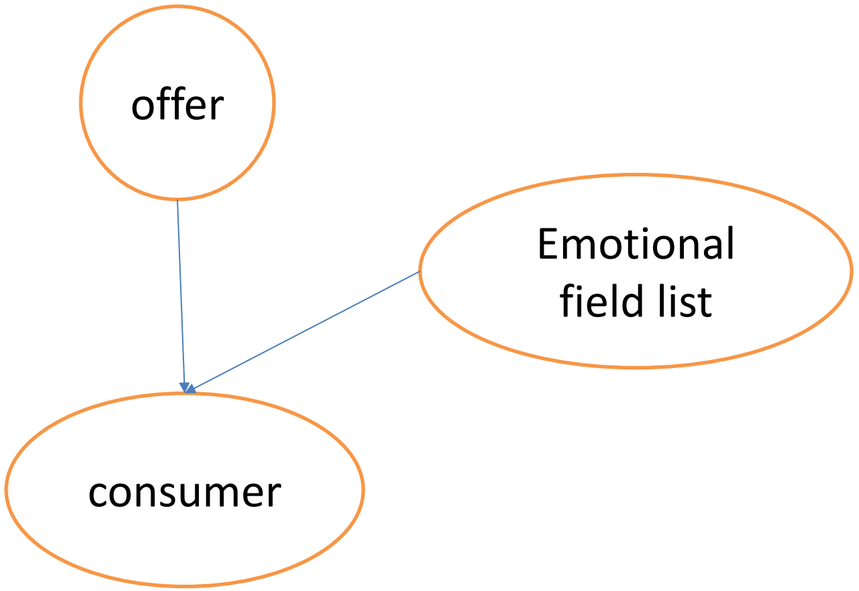
problem	Root cause	solution	benefits
Less people log on to web site	bottlenecks	Key words innovated to target nearest competition.	Cost of marketing is reduced.
Huge transport cost for distant locations	Length of flow	Local warehouse n salesperson set up done.	Cost of transport is saved
MPV comfort communicated insufficiently	Grey zone	emotion targeted in photoshoots.	Conversion rate is improved
Time to browse more than competition	Length of flow	Redesigned website	Conversion rate is improved
Product rejected on receipt	Value underestimated	Physical salesperson delivered n gave trial/alternate solutions	Cost of rejection is reduced.

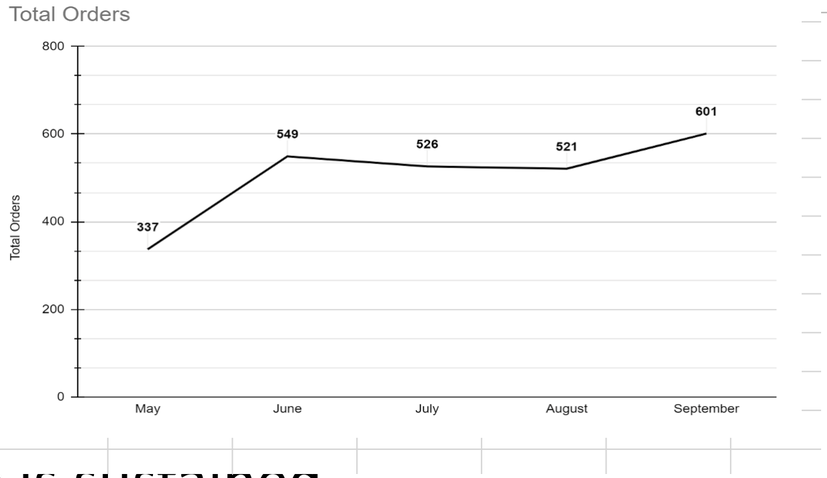
Adding ‘Emotional field’ to help consumer in decision making..

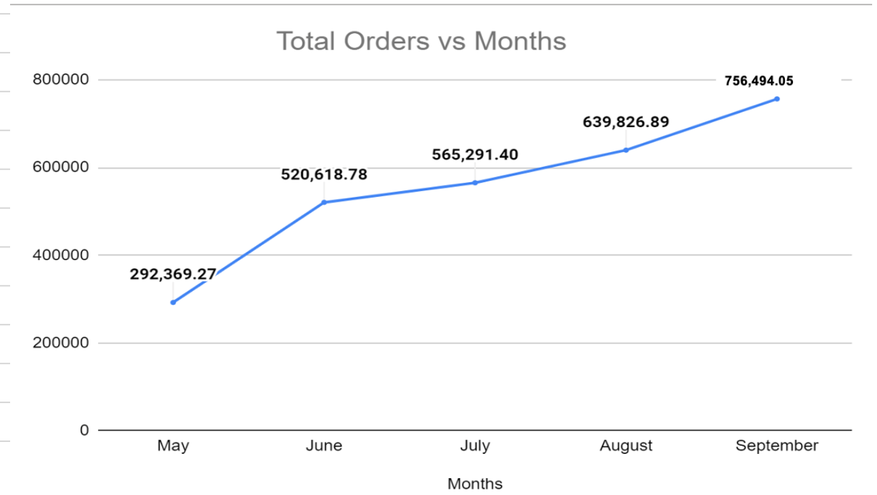
- Following key elements added to solution..
- Footwear models were compared to typical dress codes.
- Footwear models were compared to ‘special occasions’
- Footwear models were compared to ‘ladies footwear colors’ for matching.
- List of ‘satisfied and unsatisfied consumers’ is shared.



Results and Learnings….

- Business sales growt





- 30% increase in price is sustained.
- Leverage point audit managed the health of the company.
- Compounded profit benefits were 25%+.
- A systemic view is a must for identifying the leverage points
- MPV along with Sufficiency thinking a must for modifying the offer for better penetration
- TOC-TRIZ offer fantastic synergy.

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Thank You

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Design of Low Voltage 6T SRAM

Shweta Pandey
(IIITD, Delhi,INDIA)

Dr. Anuj Grover
(IIITD, Delhi, INDIA)

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Outline

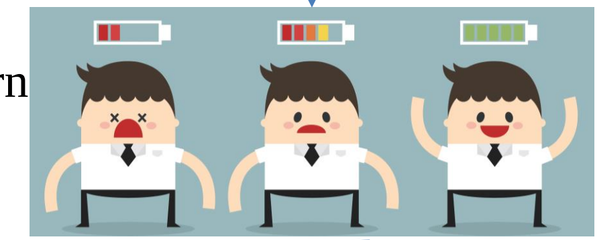
- Problem statement
- 6T SRAM
- Function model
- Function oriented search
- Physical contradiction
- Su-Field
- Conclusions

Problem Statement

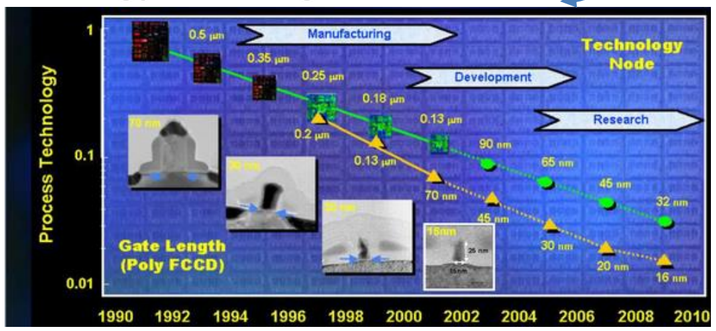
Sustainable World

IOT Products

Concern



Technology Scaling

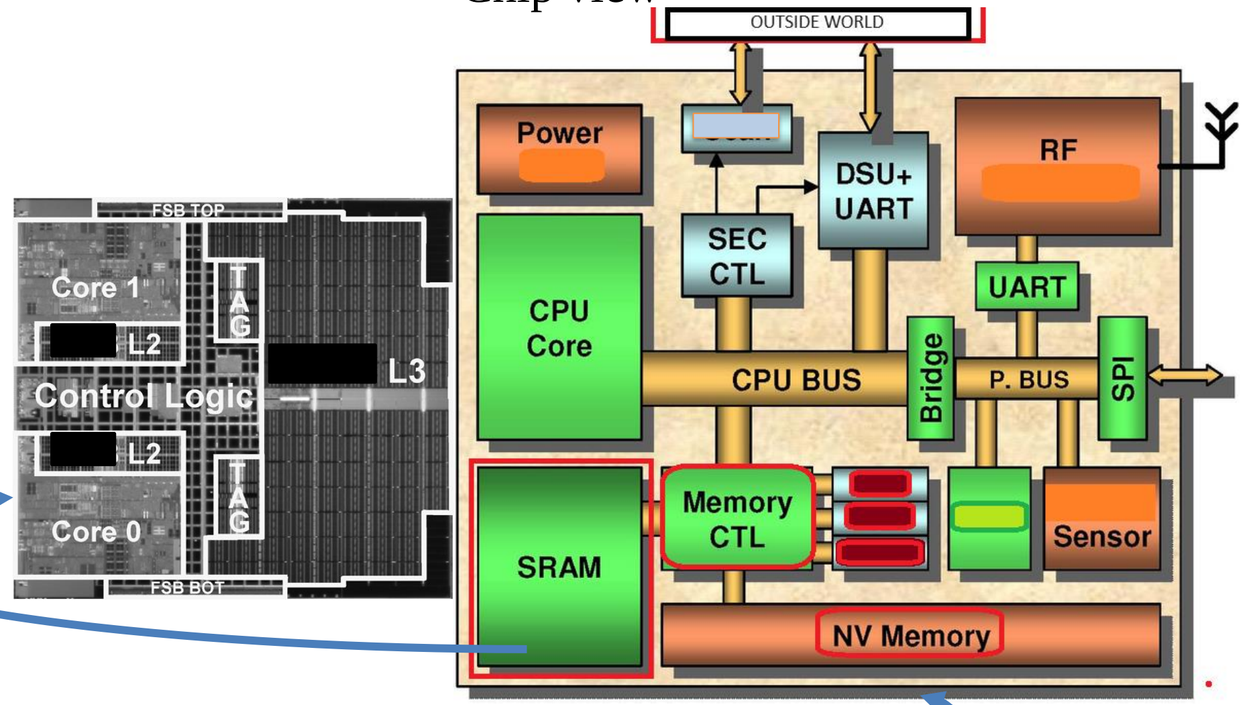


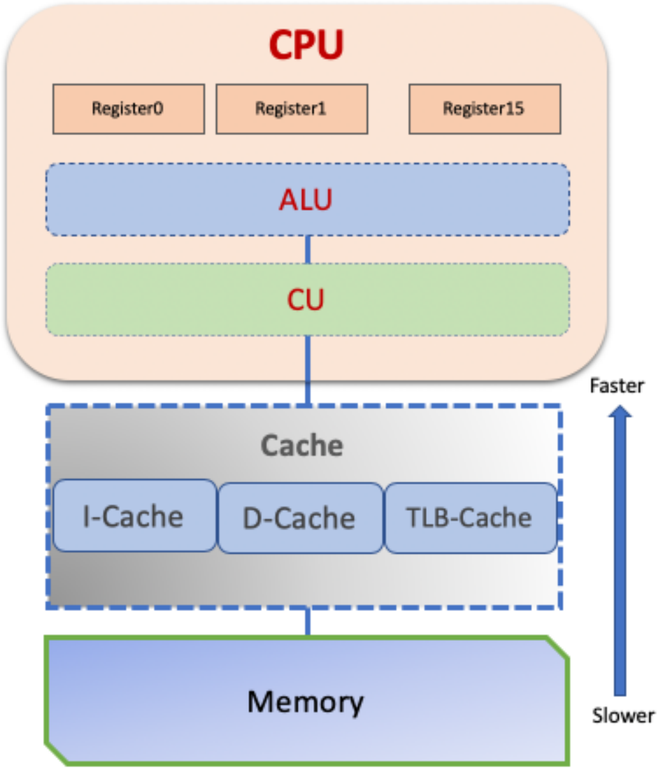
Leakage/Power Consumption

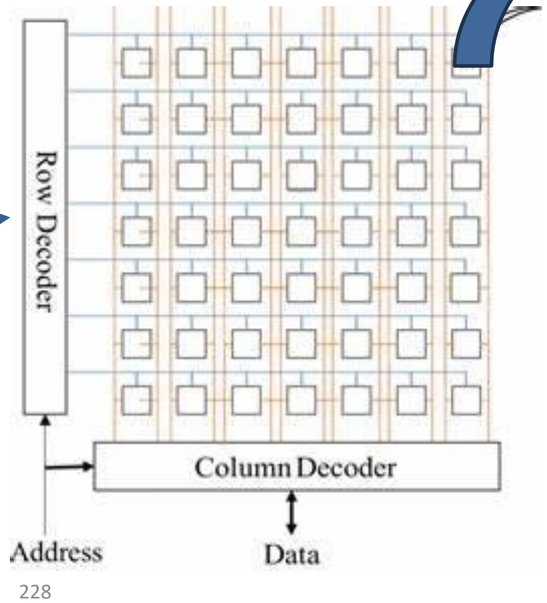
Area

Tradeoff

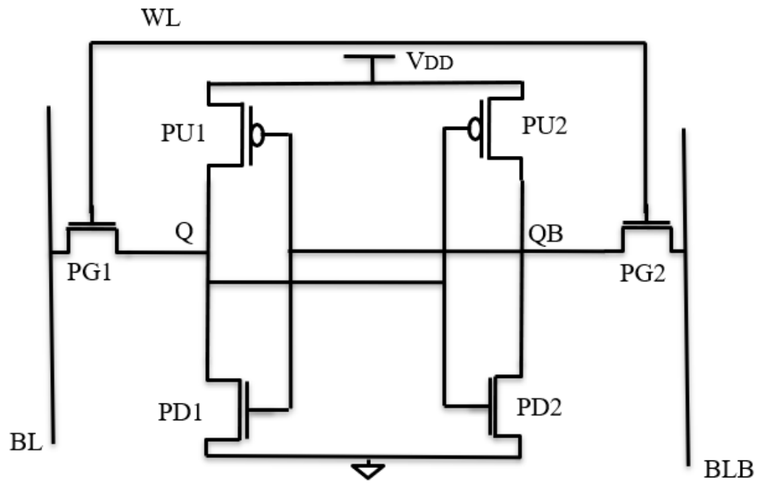
Chip view







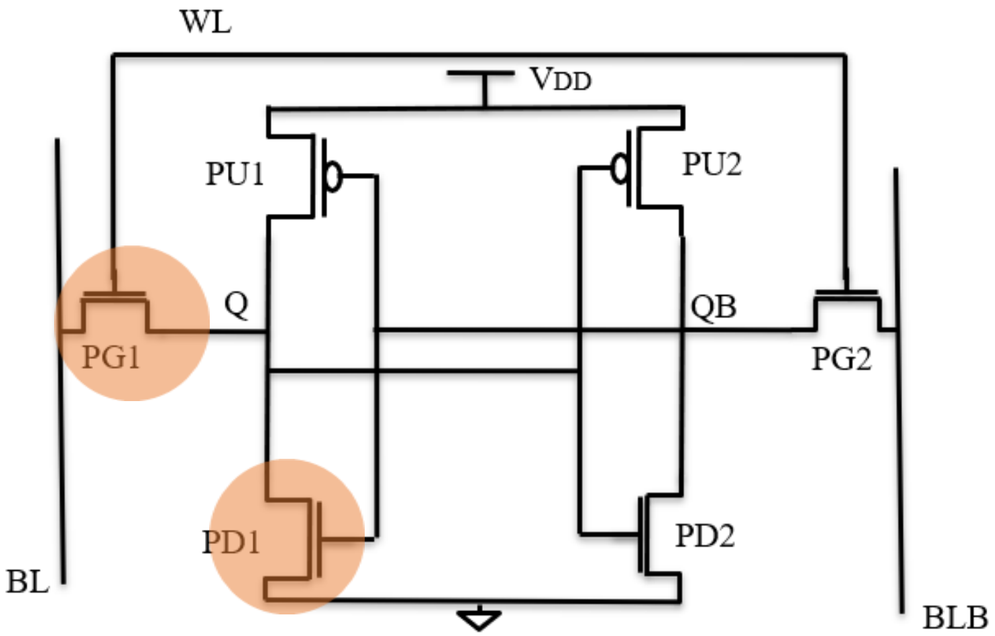
SRAM Array



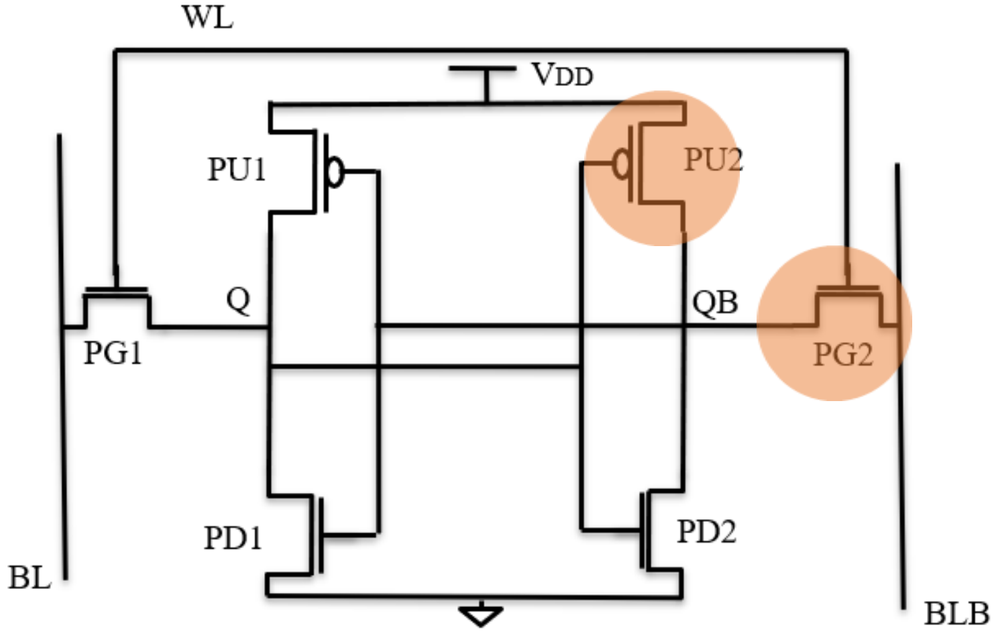
6T SRAM cell

6T SRAM

Read Operation



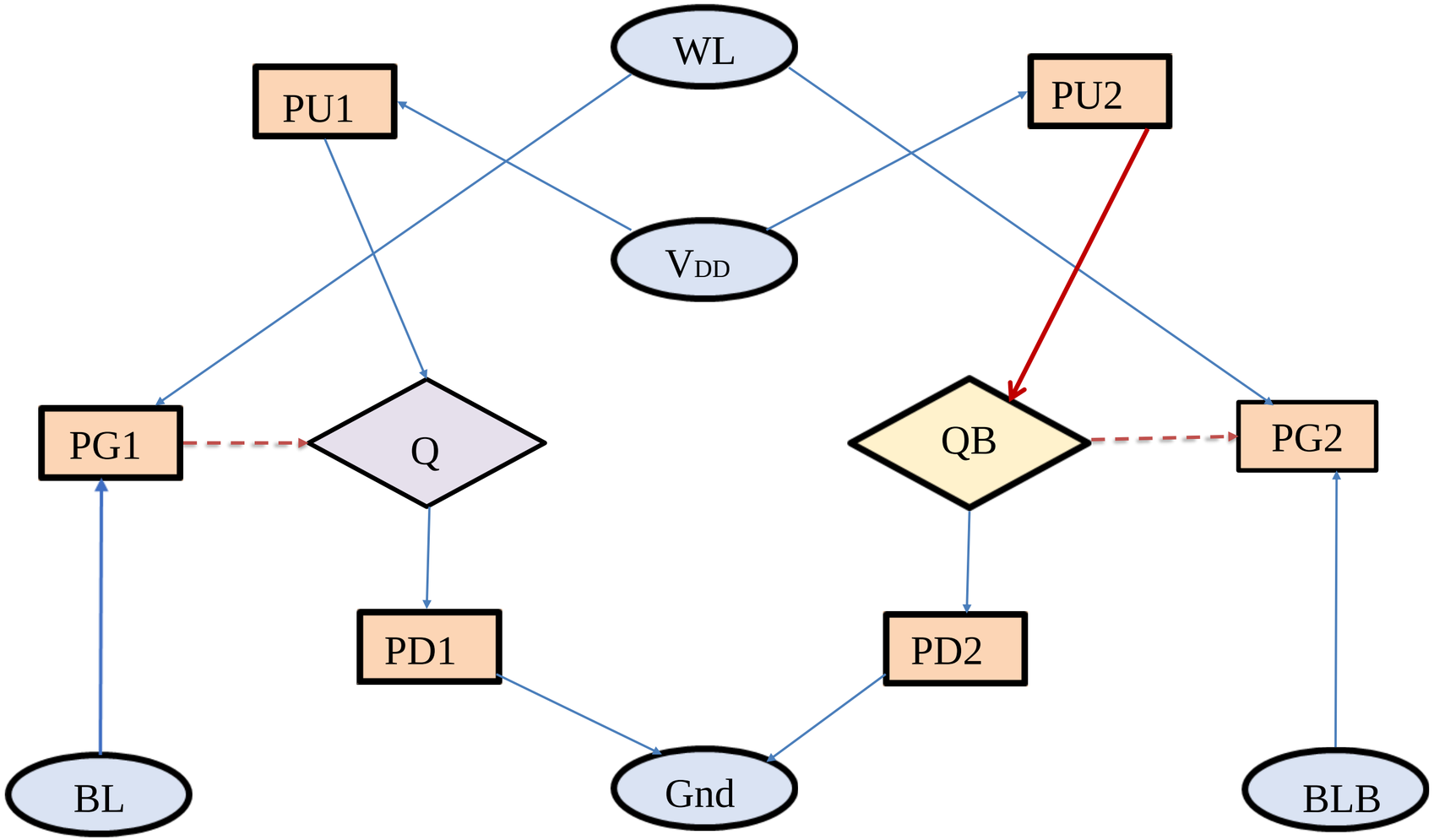
Write Operation

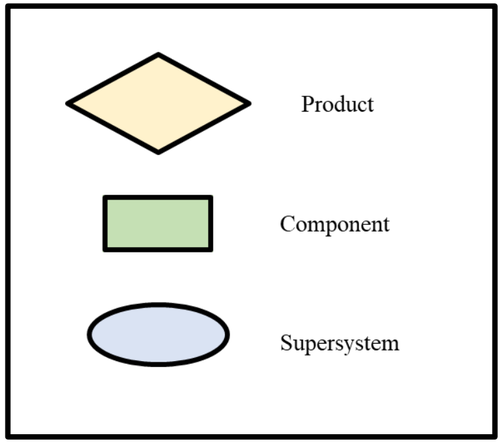


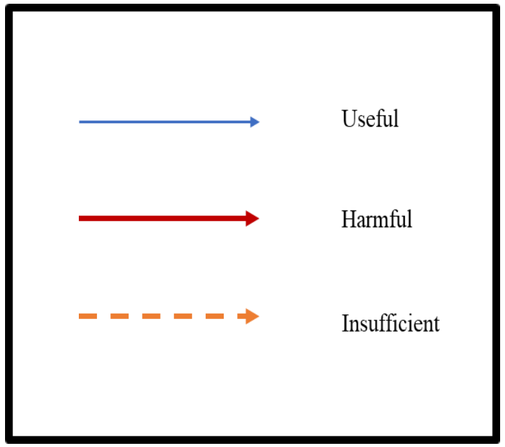
WL : Wordline
BL: Bitline
BLB: Bitline Bar
VDD: Supply Voltage

PU: Pull Up Transistor
PD: Pull Down Transistor
PG: Pass Gate Transistor

Function Model



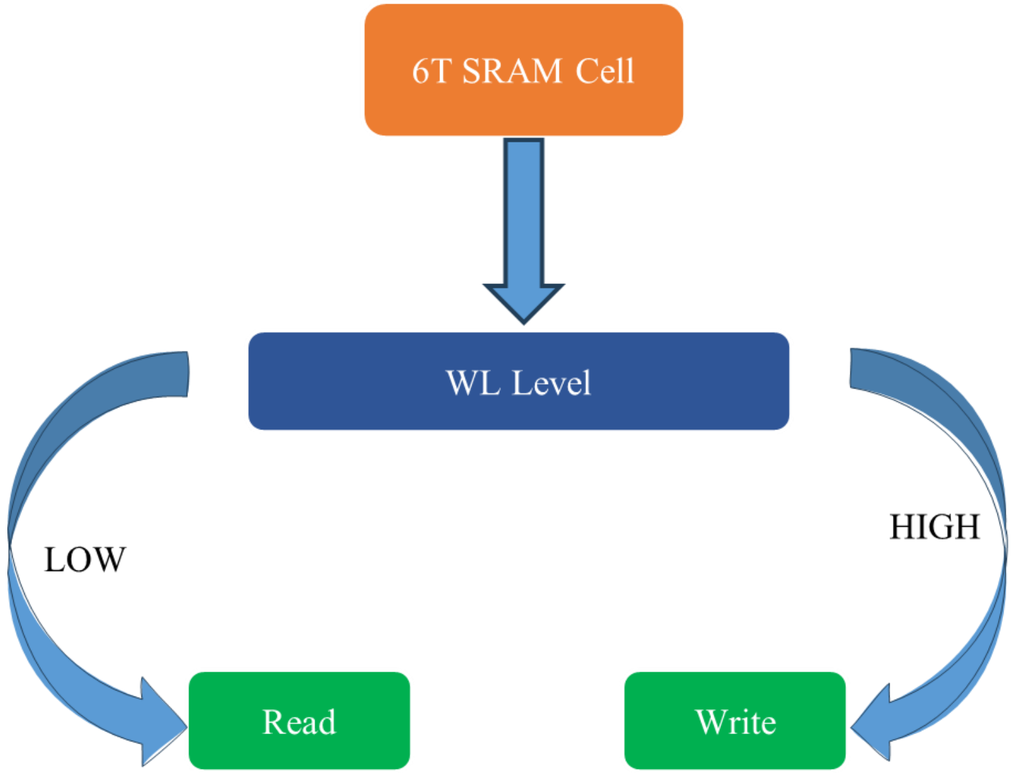




Solution Identification

❑ Physical Contradiction

- Two opposite requirement needed on a single object.
- Object is WL Level.
- Requirements are Read and Write operations.
- We need WL to be HIGH without any violation in write operation.



Solution Identification

❑ Physical Contradiction

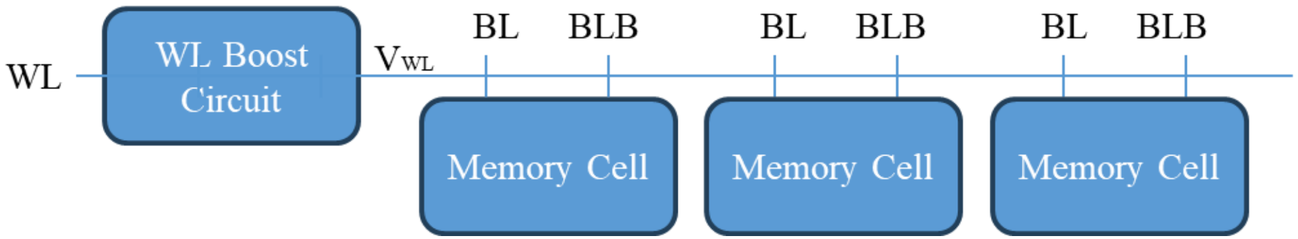
•1. Separation in space

- Separate WL for Read and Write operation.

•2. Separation in time

•Principle: Taking Out

- Incompatible with bit interleaving.
- To recover bit interleaving, a read-modify-write scheme can be employed, in which every column has a sense network so that a read operation can precede every write operation.
- Unselected columns are written back with the original data, while selected columns are written with new data.
- Degrades performance, area efficiency and power.

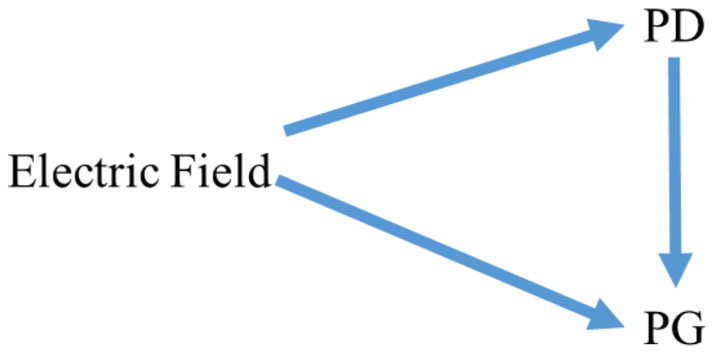


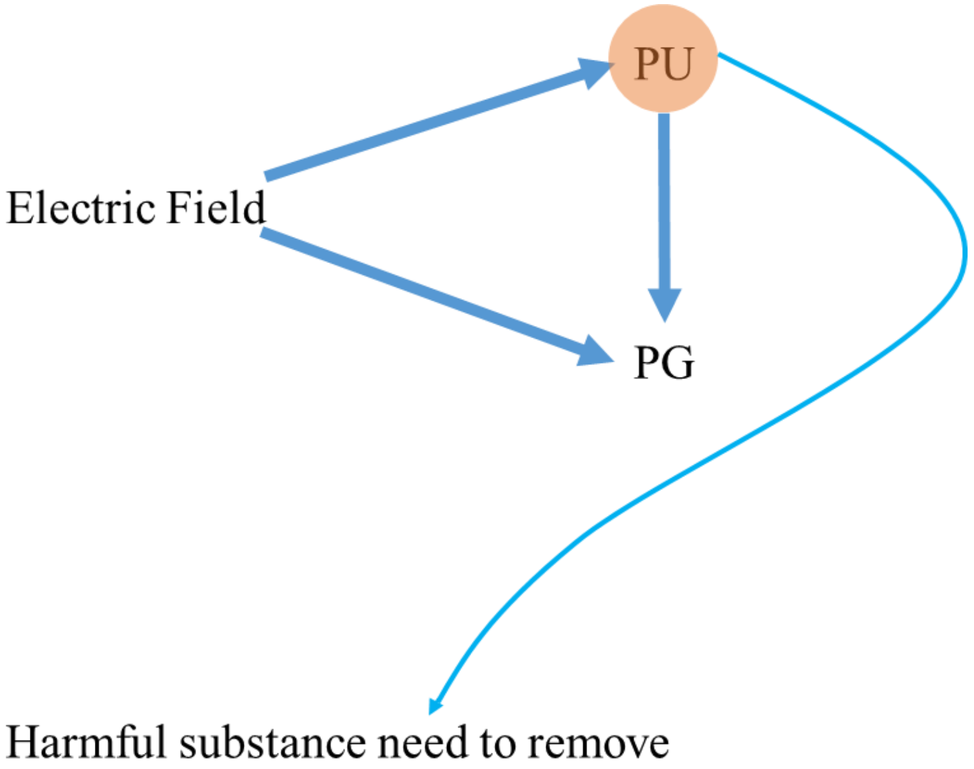
Solution Identification

- Substance-Field (Su-Field)

- **For Read**

For Write

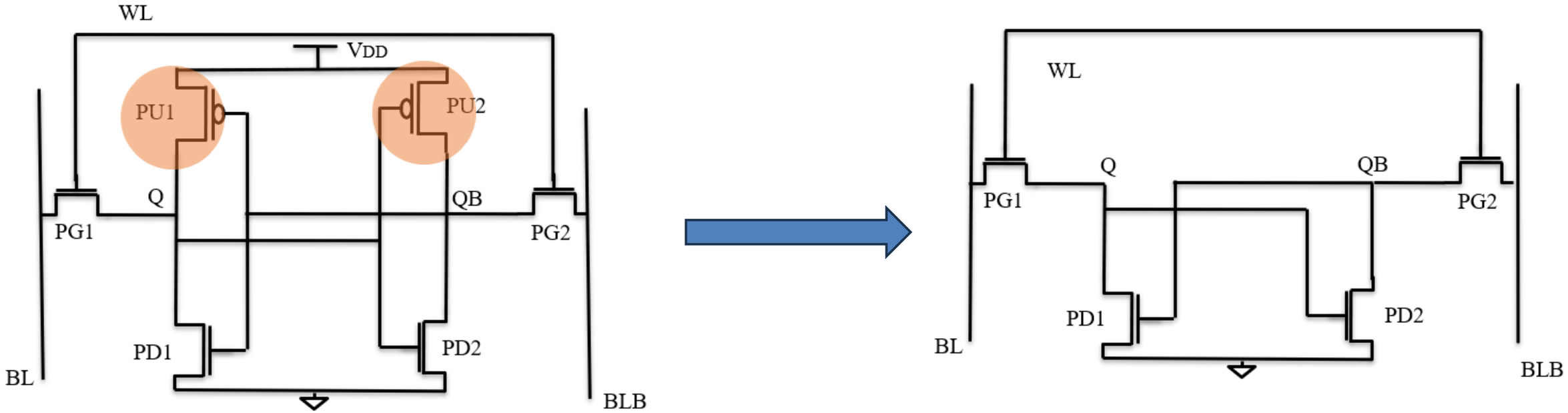




Solution Identification

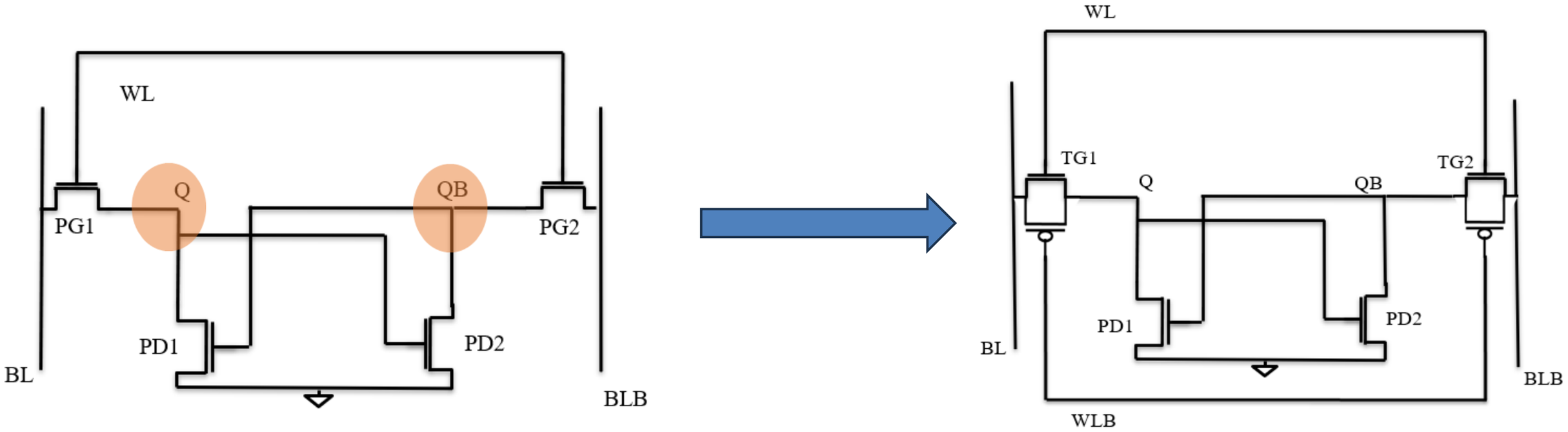
❑ Building and Destruction of Su-Field

- Try to remove harmful function.
- Harmful function PU1 and PU2 removed.
- This result difficult to write on Q node.
-



Solution Identification

- Building and Destruction of Su-Field
  - Introducing modification within boundaries of system.
  -



TG: Transmission Gate

Conclusion

- Modified 6T SRAM give better performance at low voltage.
- Modified 6T SRAM gives better FOM(Figure of merit) as compare to 6T SRAM cell.
- Resolve the issue of unable to writing full 0/1 at node Q and QB by using TG(Transmission Gate).

THANK YOU!

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ITC 2024

INTERNATIONAL TRIZ CONFERENCE

14 -17 OCT'24 | DUBAI

Radisson Blu Hotel, Dubai Canal View

Up to 45% faster Boosted Latch-type Voltage Sense Amplifier (B-LVSA) for Low-voltage and High-speed SRAMs

Rachit Sharma

(Indian Institute of Technology, Delhi, India)

Dr. Anuj Grover, and Ajay Shroti

(Indraprastha Institute of Information Technology, Delhi, India)

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EUROGATE

Outline

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- Motivation
- Cause Effect Chain Analysis
- Processor-Memory Interaction
- SRAM Architectural Outline
- SRAM Read Operation
- Sense Amplifier
- Function Model of Sense Amplifier
- ARIZ: SFR and IFR
- Proposed B-LVSA: Applying TRIZ Principles and Outcome

Motivation

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Cause Effect Chain Analysis (1/2)

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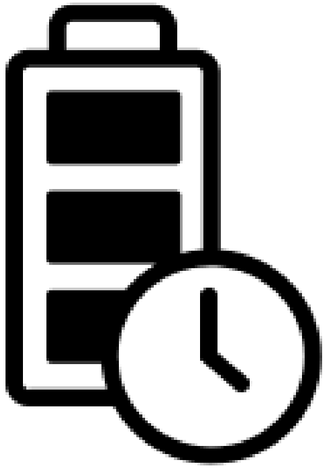
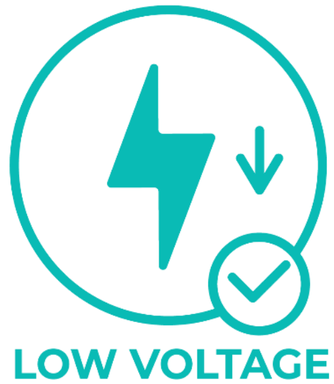
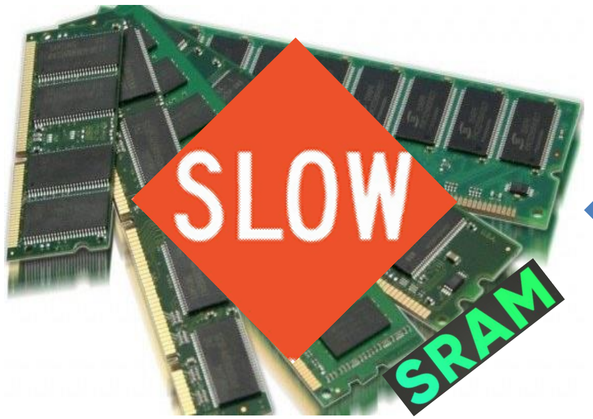


$P = \alpha.f.C.V^2$





Making devices power-efficient slows them down!

Cause Effect Chain Analysis (2/2)

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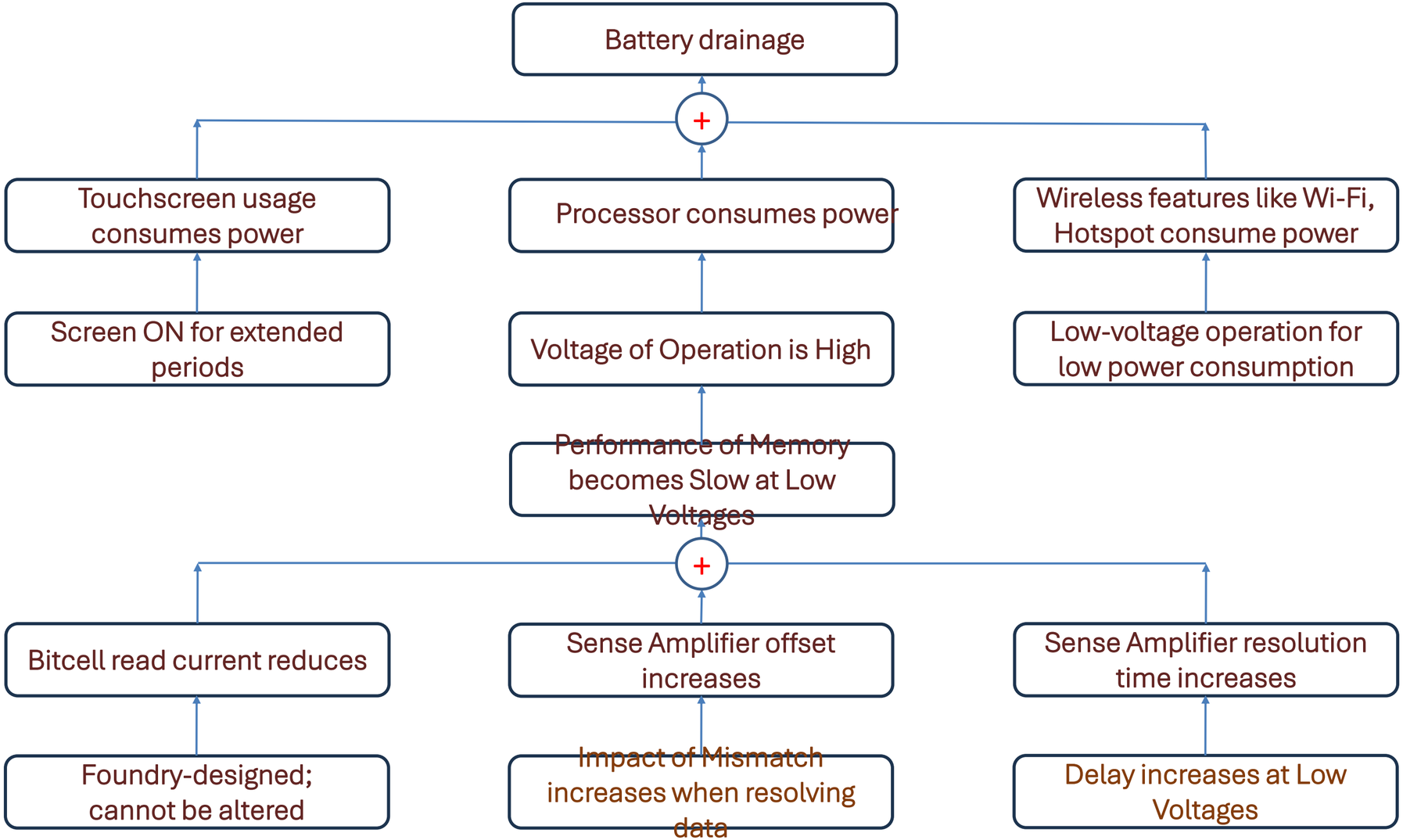

Processor-Memory Interaction

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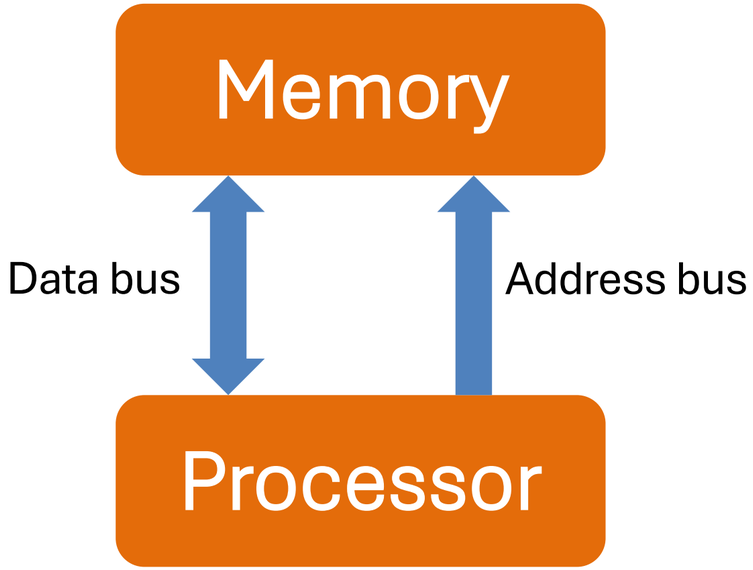
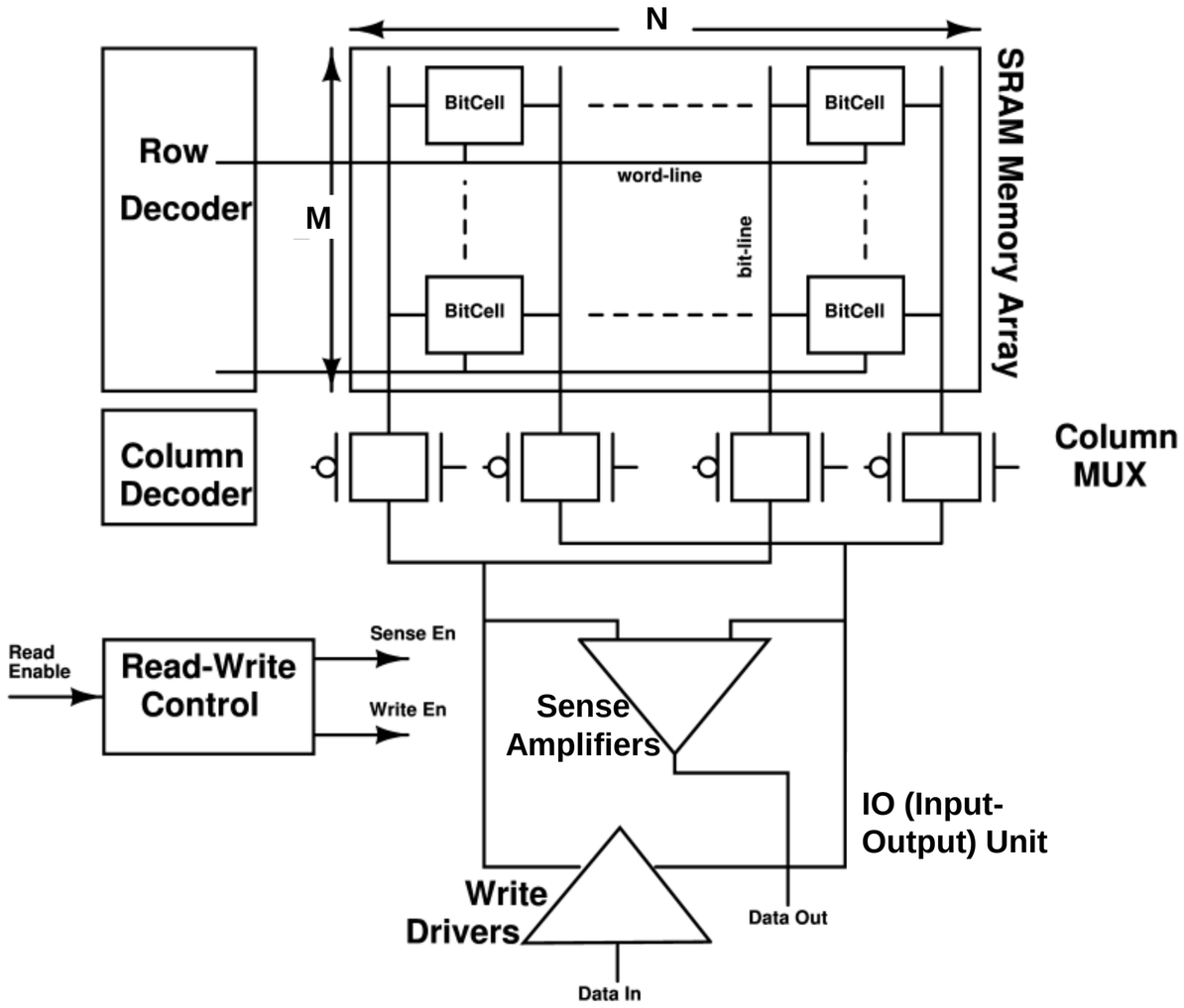


SRAM Architectural Outline



SRAM Read Operation

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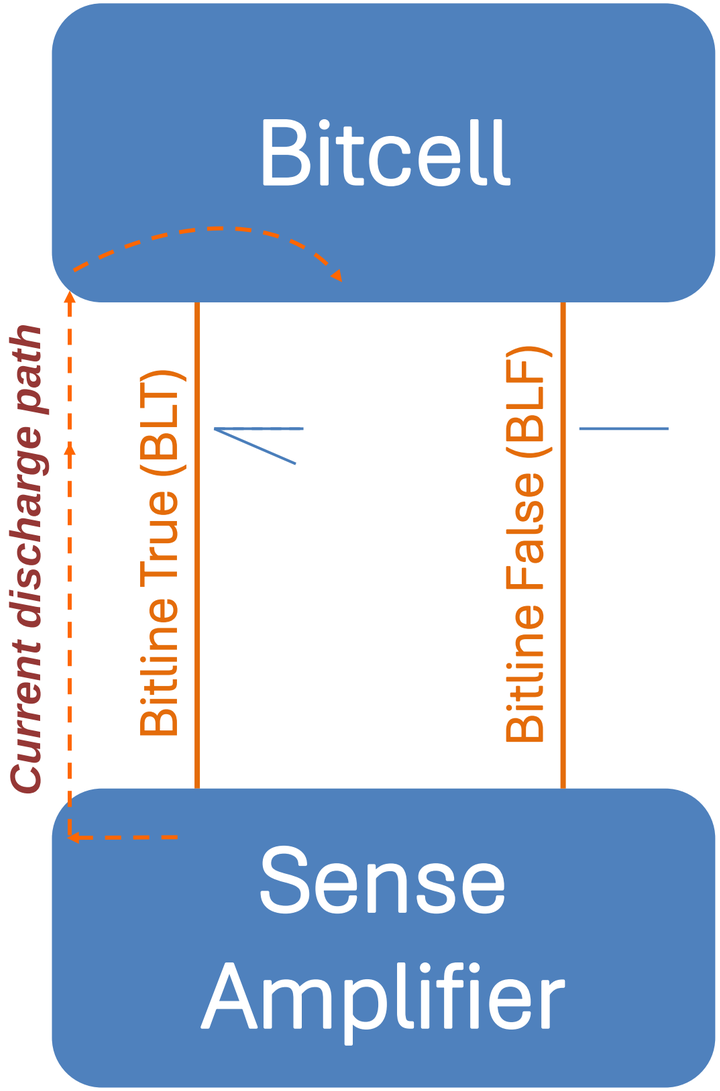
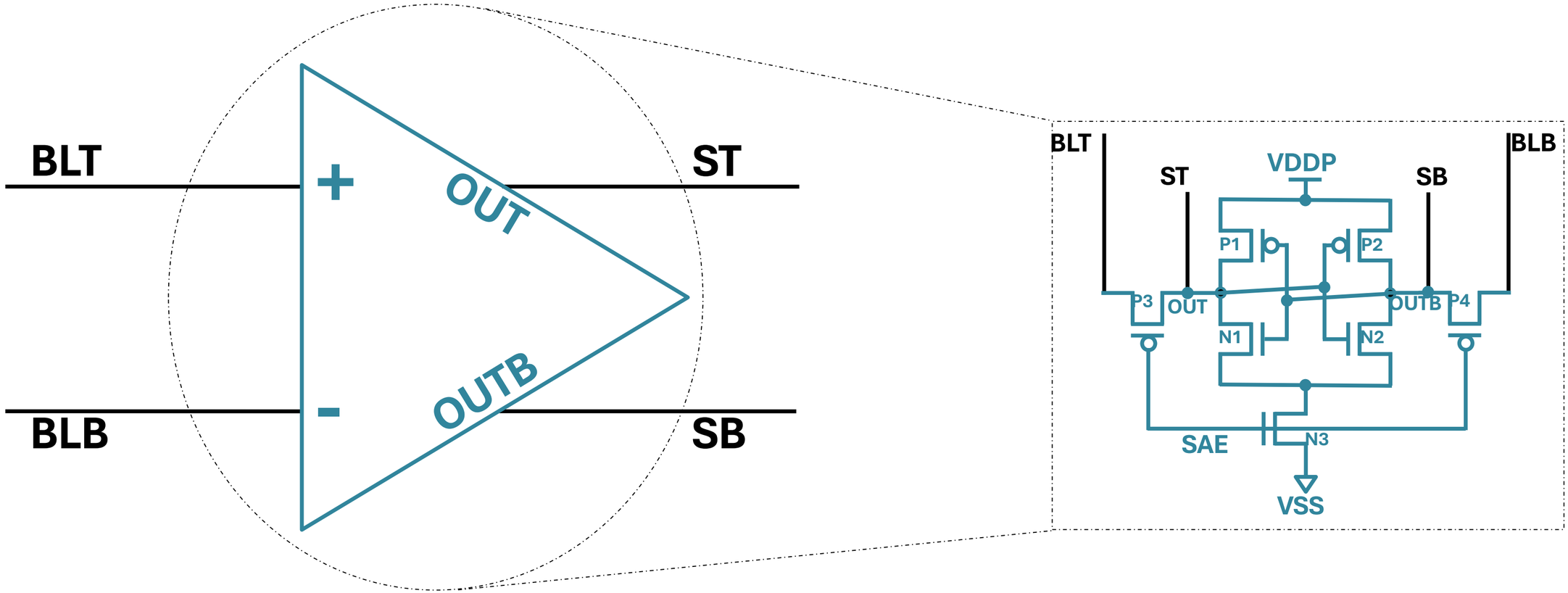


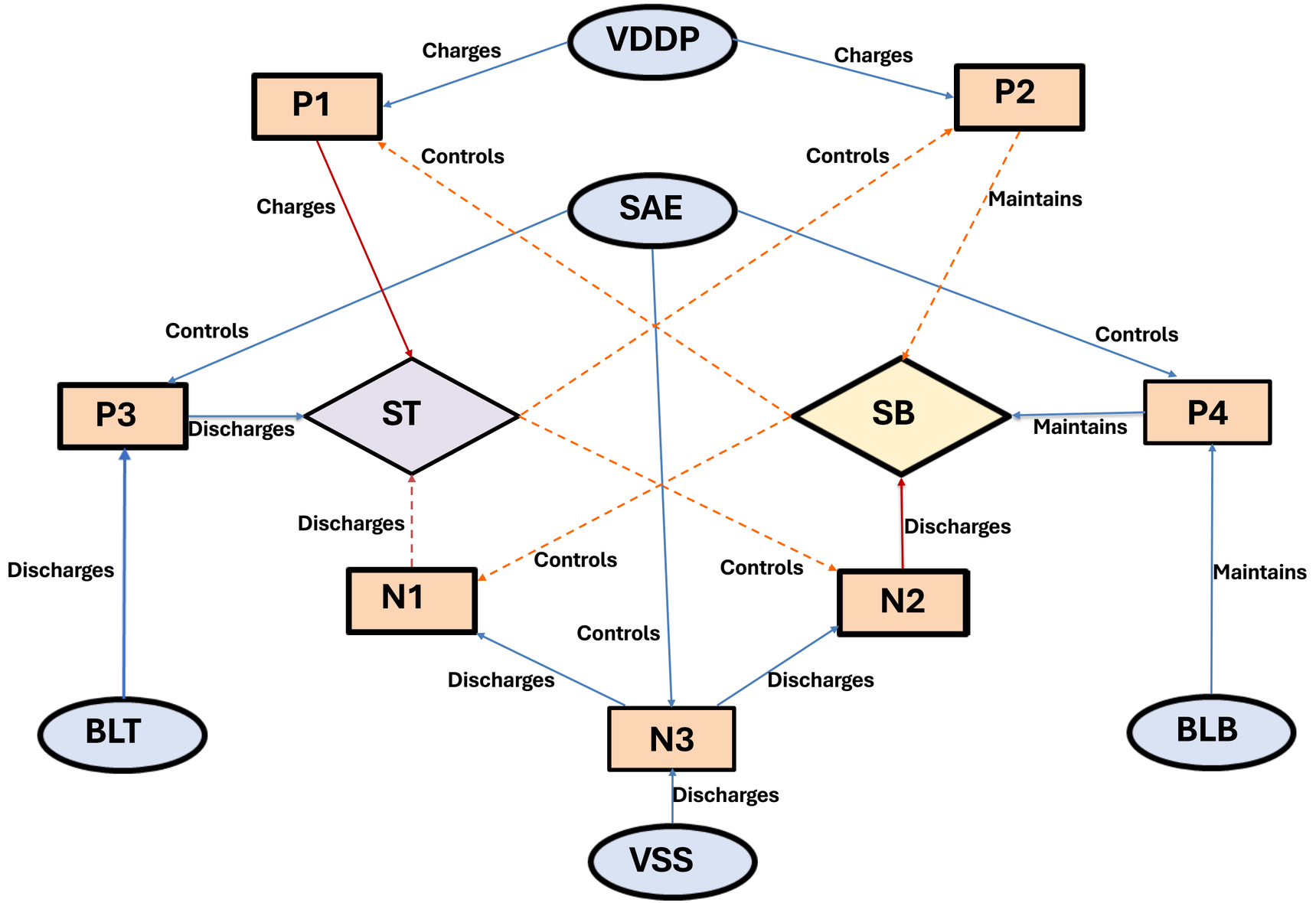
- Bitline discharges through bitcell which is sensed by the Sense Amplifier

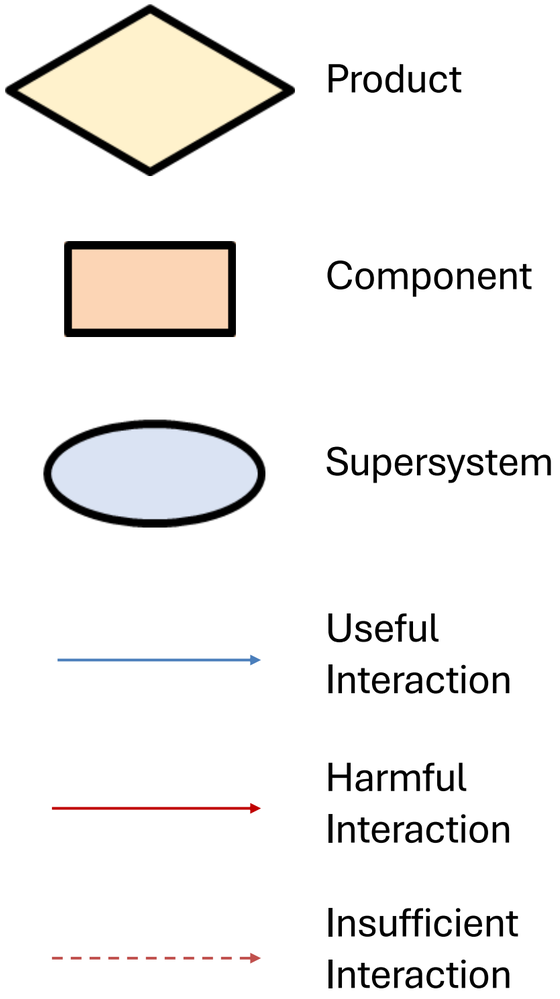
Sense Amplifier (SA)



- Sense Amplifier is a comparator that
- compares voltage levels of input signals BLT and BLB, and
- generates outputs ST and SB accordingly.

Function Model of SA





ARIZ of SA: Substance-Field Resources (SFR)

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System	Environment	Supersystem	Inexpensive Resource
Size of N1/ N2	VDDP	BLT/ BLB	Adjacent SA
Threshold voltage of N1/ N2	VSS	SAE	Write Driver
ON Current of N1/ N2			Pre-charge
Size of P1/ P2			
Threshold voltage of P1/ P2			
ON Current of P1/ P2			

ARIZ: Ideal Final Result (IFR) [1/3]

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1. Size of N1/ N2 should be large to rapidly discharge ST/ SB but small to not discharge SB/ ST and to not capacitively load ST/ SB.
   - Contradiction beyond a certain increase in size due to loaded ST/ SB.
2. Threshold voltage of N1/ N2 should be low to rapidly discharge ST/ SB but high to not discharge SB/ ST.
   - Possible solution but lowest threshold voltage may already be in use or lower threshold voltages may not be available.
   - Increases fabrication cost.
3. On Current of N1/ N2 should be large to rapidly discharge ST/ SB but small to not discharge SB/ ST.
   - Possible solution if there is a way to control N1/N2 better.

ARIZ: Ideal Final Result (IFR) [2/3]

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4. Size of P2/ P1 should be large to properly maintain SB/ ST but small to not charge ST/ SB and to not capacitively load ST/ SB.
   - Contradiction due to loaded ST/ SB.
5. Threshold voltage of P2/ P1 should be low to properly maintain SB/ ST but high to not charge ST/ SB.
   - Possible solution but lowest threshold voltage may already be in use or lower threshold voltages may not be available.
   - Increases fabrication cost.
6. ON Current of P2/ P1 should be large to properly maintain SB/ ST but small to not charge ST/ SB.
   - Possible solution and achievable by boosting VDDP which charges P2/ P1.

ARIZ: Ideal Final Result (IFR) [3/3]

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7. VDDP should be high to drive P2/ P1 more strongly and properly maintain SB/ ST. → *Same as 6*
   - Possible solution by boosting VDDP which charges P2/ P1.
8. VSS should be low to drive N1/ N2 more strongly and quickly discharge ST/ SB.
   - Possible solution by bucking VSS which discharges P2/ P1.
   - But longer path from ST/ SB to VSS may make it slower than VDDP boost.
9. BLT/ BLB should discharge P3/ P4 more to quickly discharge ST/ SB.
   - Not possible because BLT/ BLB discharge is dependent on bitcell which is foundry-supplied and cannot be altered.
10. SAE should arrive early to speed-up the read path before SA but late to allow BLT/ BLB to discharge more and speed-up the read path after SA.
    - Contradiction.

Proposed B-LVSA: Applying TRIZ Principles

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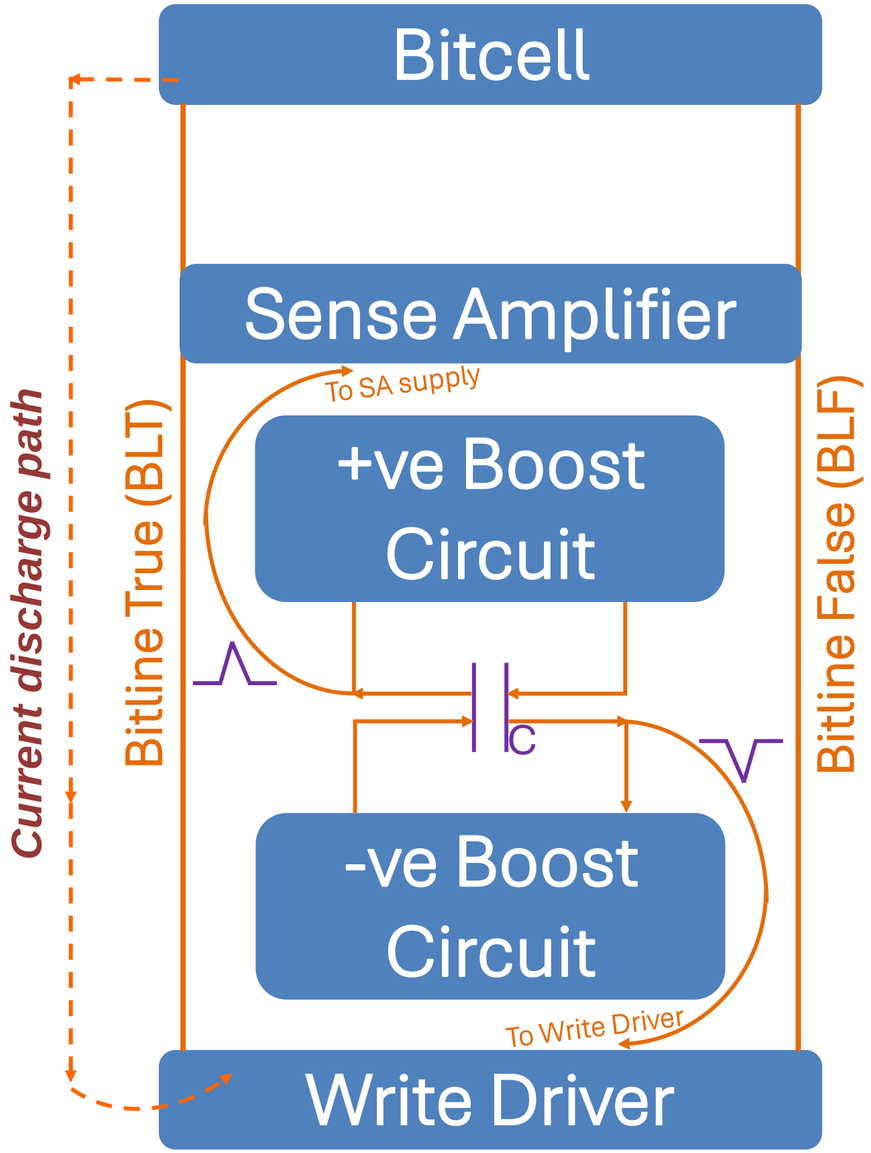
- Strong oxidants (Boosted interactions)
  - Boost sense amplifier supply VDDP
  - How? → Negative Bitline Write Assist
- SRAM Write Operation
- Negative Bitline Write Assist
  - Used to aid the Write operation
  - Uses large capacitance C to generate –ve boost
- Universality
  - Resue the large capacitance C to generate +ve boost
  - Make this +ve boost the supply of SA



Proposed B-LVSA: Outcome

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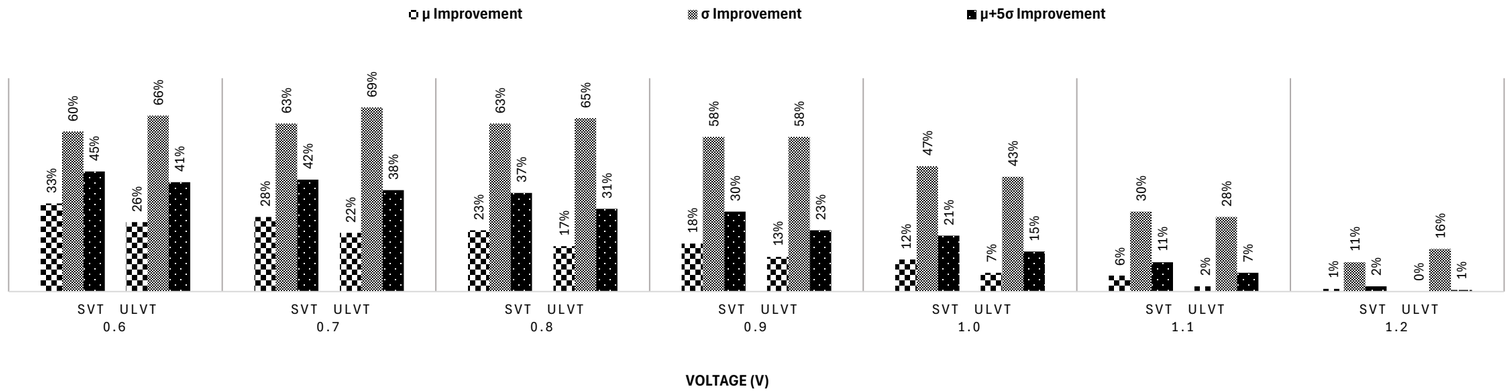
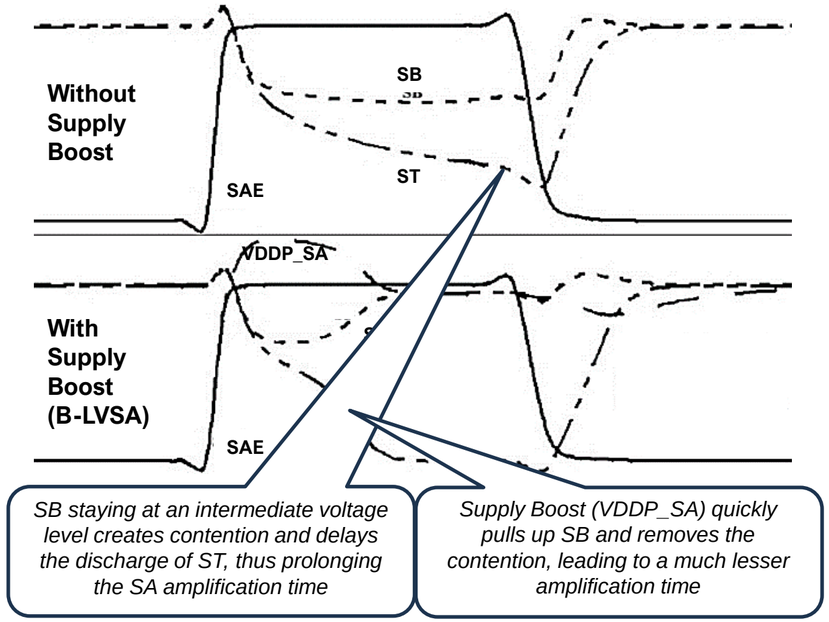
Percentage improvement in amplification time with the proposed B-LVSA in 22nm CMOS

1,000 Monte Carlo simulations at SSG, -40°C with MOSCAP width 'W'µm
(SVT = Standard VT, ULVT = Ultralow VT, µ = Mean, σ = Standard Deviation)





Area Overhead: Less than 1%

Improvement in SRAM TCQ with B-LVSA
(SS, Worst Extraction, Low Voltage, -40°C, 22nm CMOS)

Instance configuration	Improvement in TCQ
Small	9%
Wide	7%
Tall	7%
Big	6%

Overall Gain

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- ~8% improvement in Memory Speed enables lowering supply level by 50mV
- Chip operating at 0.75V can be operated at 0.7V
- Power consumption reduces by 15%
- Battery Life increases by 20%

THANKS!

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Using TRIZ to solve adhesion problem in the manufacturing process of mobile phone screens

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Using TRIZ to solve adhesion problem in the manufacturing process of mobile phone screens

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- **1. Introduction**
- - This work presents a problem-solving experience in engineering (attaching OCA panels to phone screens during manufacturing) using TRIZ's systematic thinking process.
- - Firstly, we present the solution process based on a streamlined ARIZ program in section 2.
- - Section 3 outlines the encountered problem, steps applying the streamlined ARIZ program, and the obtained solution.
- - Finally, results are discussed in section 4 along with some insights.

Using TRIZ to solve adhesion problem in the manufacturing process of mobile phone screens

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- **2. The streamlined ARIZ Program**
- - Altshuller's comprehensive ARIZ program, notably ARIZ 85C consisting of 36 steps, is widely known.
- - However, for moderately complex problems, the full ARIZ can be overkill.
- - Thus, a streamlined version proposed by Phan Dung in 2010 offers 6 steps that provides a structured approach to problem-solving, suitable for moderately complex problems without the overhead of the full ARIZ program.

Using TRIZ to solve adhesion problem in the manufacturing process of mobile phone screens

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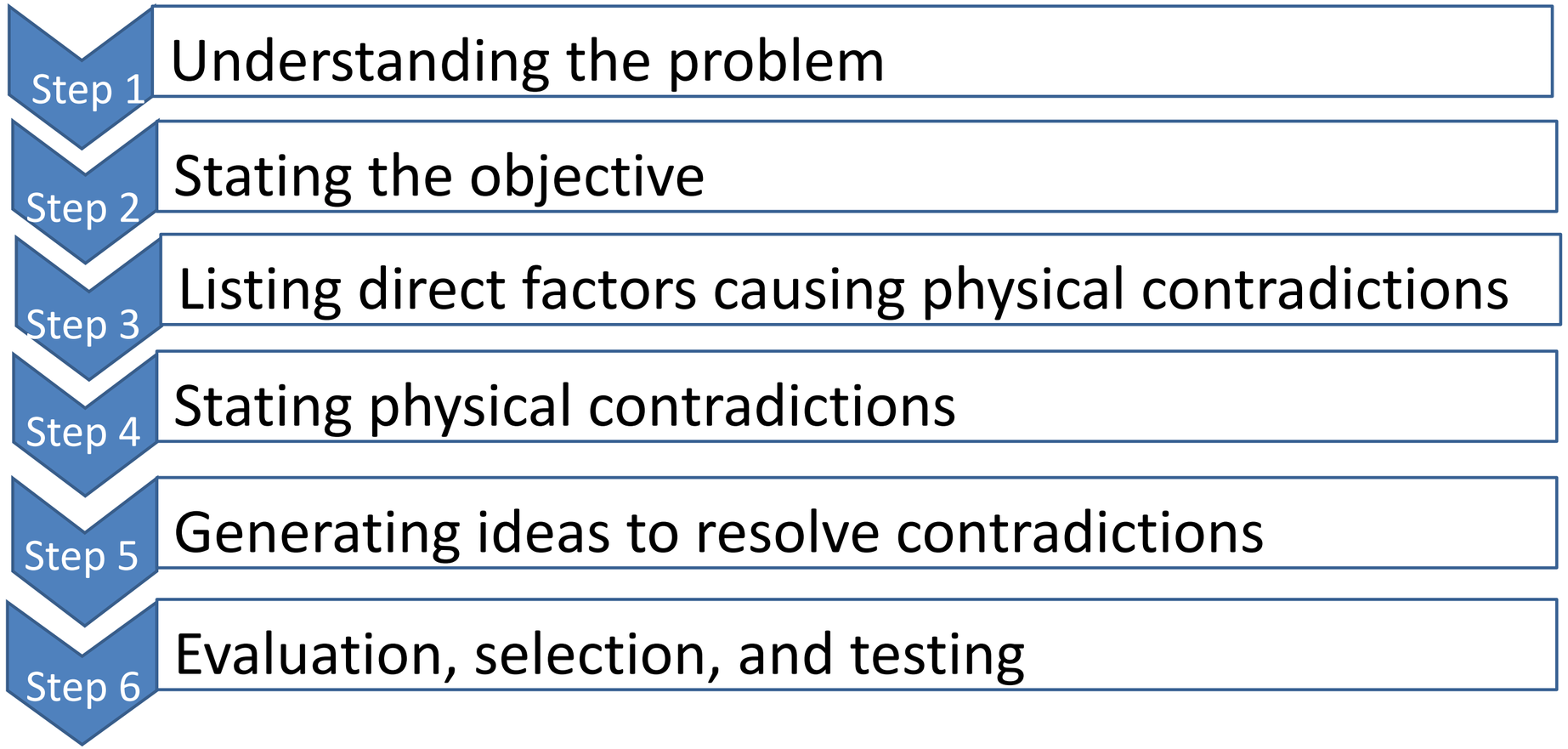
- **2. The streamlined ARIZ Program**



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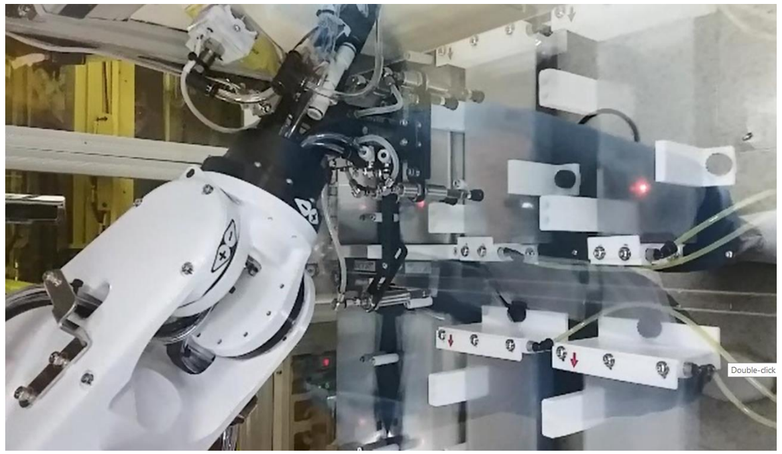
- **3. Problem and solution**
- Problem:
- The High Tech Company in Vietnam faces an issue during the production process where robot arms gripping OCA panels for phone screen attachment often end up sticking two OCA panels together. This causes production halts for troubleshooting, prompting the need to minimize such occurrences.



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- **3. Problem and solution**
- Solution:
- Step 1: Understanding the problem: The process of gripping OCA panels involves several steps, with the issue arising during loading due to additional OCA panels sticking together.
- Step 2: Stating the objective: Minimize the occurrence of OCA panel sticking errors.
- Step 3: Listing direct factors causing physical contradictions: Identified factors include the OCA panels and the air between them.

Using TRIZ to solve adhesion problem in the manufacturing process of mobile phone screens

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- **3. Problem and solution**
- Solution:
- Step 4: Stating physical contradictions: Three physical contradictions are identified regarding OCA panel adhesion and the air between them.
- Step 5: Generating ideas to resolve contradictions: The engineers proposed installing an Ion air blower system to eliminate static electricity and neutralize the vacuum force between the OCA panels.
- Step 6: Evaluation, selection, and testing: The proposed solution was implemented on 15 production lines for evaluation of effectiveness.

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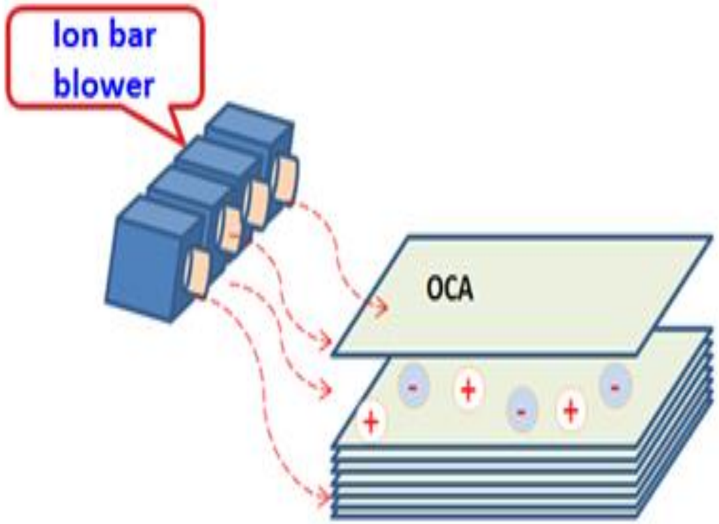
- **3. Problem and solution**
- Solution:



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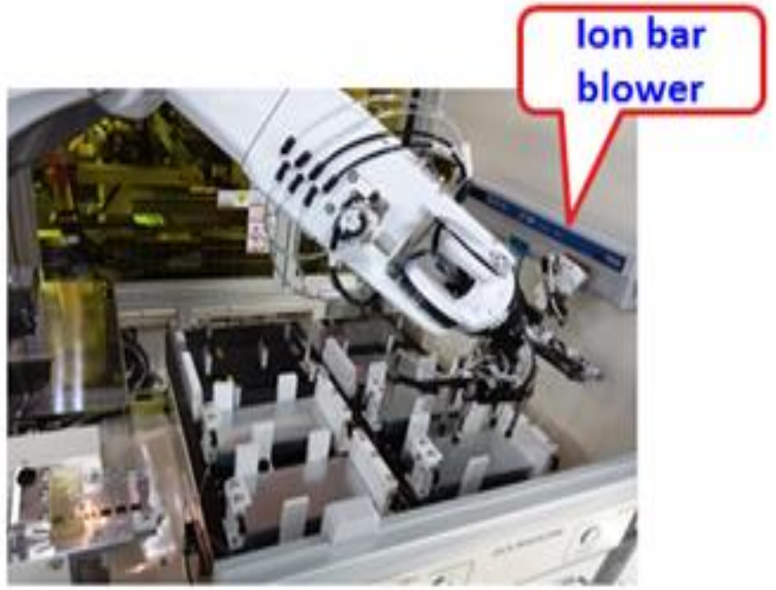

Using TRIZ to solve adhesion problem in the manufacturing process of mobile phone screens

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- **4. Results**
- - After implementing the proposed idea on 15 production lines and evaluating its effectiveness after one month of testing, the results were very positive.
- - Specifically, the number of errors decreased from 4,605 occurrences to 685 occurrences, representing an 85.12% reduction.
- - Additionally, machine downtime decreased from 3,686.8 minutes to 858 minutes, indicating a 76.73% reduction.

Using TRIZ to solve adhesion problem in the manufacturing process of mobile phone screens

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- **4. Results**

SEPTEMBER					
Line Name	Mã số sai sót	Giải thích Error	Thời gian(Min)	Tỷ lệ chiếm thời gian (%)	Số lần xảy ra lỗi
B1LAM46N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	379.1	5.9	325
B1LAM47N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	355.1	5.5	270
B1LAM48N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	116.3	1.8	421
B1LAM49N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	211.5	3.3	365
B1LAM50N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	154.3	2.4	262
B1LAM31N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	211.0	4.5	317
B1LAM32N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	328.1	5.3	226
B1LAM33N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	187.2	1.9	195
B1LAM34N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	256.0	4.6	337
B1LAM35N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	187.5	1.9	285
B1LAM36N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	352.1	5.5	266
B1LAM37N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	194.5	2.0	382
B1LAM38N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	337.0	5.4	412
B1LAM39N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	165.8	1.7	317
B1LAM40N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	251.3	4.7	225
		Total	3,686.8	56.4	4,605.0

Statistics on the number of errors and machine downtime before applying TRIZ

OCTOBER					
Line Name	Mã số sai sót	Giải thích Error	thời gian(Min)	tỷ lệ chiếm thời gian (%)	số lần xảy ra lỗi
B1LAM46N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	90.8	0.6	75
B1LAM47N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	81.6	1.2	68
B1LAM48N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	60.0	0.3	50
B1LAM49N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	45.3	0.1	35
B1LAM50N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	84.2	0.2	73
B1LAM31N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	58.6	0.3	32
B1LAM32N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	62.2	0.2	49
B1LAM33N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	55.4	2.1	41
B1LAM34N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	36.6	0.3	35
B1LAM35N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	42.1	0.5	35
B1LAM36N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	68.2	0.2	32
B1LAM37N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	54.8	0.2	49
B1LAM38N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	44.3	0.4	41
B1LAM39N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	38.7	0.1	35
B1LAM40N	E02670	SUB_ROBOT_1_PANEL_OCA_VAC_ON_ERR	35.2	0.1	35
		Total	858.0	6.8	685.0

Statistics on the number of errors and machine downtime after applying TRIZ

Using TRIZ to solve adhesion problem in the manufacturing process of mobile phone screens

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- **4. Results**

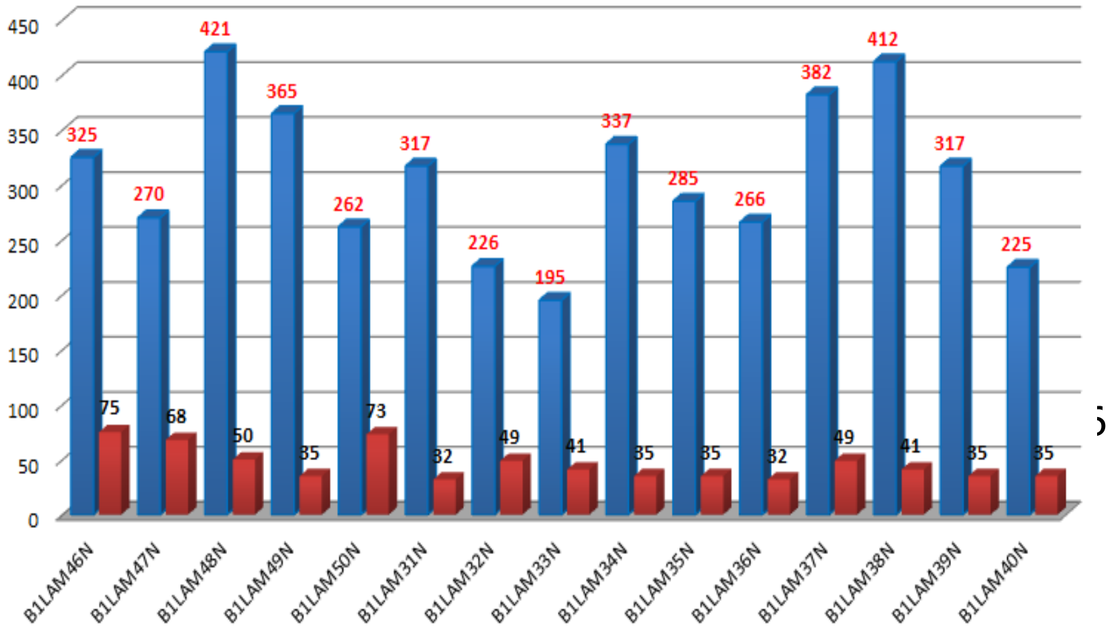

Chart comparing the number of errors before and after improvement.

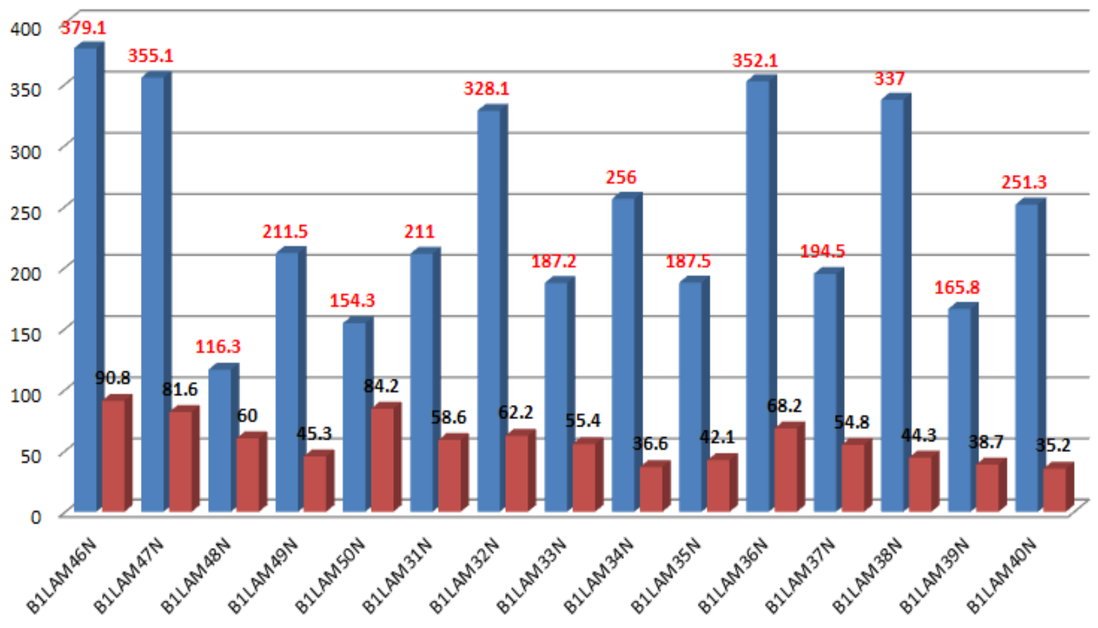

Chart comparing machine downtime before and after improvement.

Using TRIZ to solve adhesion problem in the manufacturing process of mobile phone screens

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- **4. Results**

Machine downtime reduced: 3,686.8 – 858 = 2828.8 minutes

Damage 1 minute downtime: 225 $

Amount saved: 2,828.8 minutes x 225 $ = 636,480 $

Productivity improvement efficiency: 4,600 EA/ 1 month

Product value of Lami process: 80 $/ 1 EA

267

The amount of money saved: 4,600 EA x 80 $ = 368,000 $

Total amount saved (1 month):

636,480 $ + 368,000 $ = 1,004,480 $

Using TRIZ to solve adhesion problem in the manufacturing process of mobile phone screens

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- **THANK YOU!**

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Proceedings of the 2nd MATRIZ Official International TRIZ Conference ITC 2024

October 14-17, 2024, Dubai, OAE

Organized by the International TRIZ Official Association – MATRIZ Official

Editor: Valeri Souchkov

The collection of presentations «**MATRIZ Official International TRIZ Conference ITC 2024**» is intended for TRIZ specialists and users: academics, engineers, inventors, innovation professionals, consultants, trainers, teachers.

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All presented presentations had bed being peer-reviewed before presenting at the conference and further publication.

ISSN: 2950-5224

ISBN: 978909039756

Published by the International TRIZ Official Association – MATRIZ Official

www.matriz-official.net