

# 'MODERNIZED ARISTOTLE'S CAUSATION VIEW' FOR CAUSE EFFECT ANALYSIS

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# Background

- Most of technical problems have undesired phenomena which must be prevented to solve the problems. The fact makes Cause Effect Analysis be one of the most important and popular tools in technical problem solving methodologies.

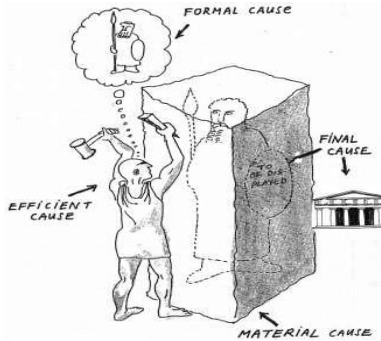


Typical cases of undesired phenomena of engineering systems

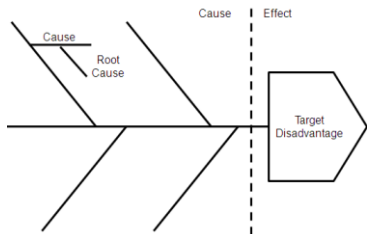
# Background

- From the ancient era up to today, people tried to suggest a guide of how to think effectively about the causes like 'Aristotle's Four Causes' and 'Fishbone Method' for more efficient Cause Effect Analysis.
- Likewise, in TRIZ field, we have many strong ways for Cause Effect Analysis
- Current guides don't provide the way to formulate the models based on 'Scientific and Engineering Principles', neither offer they generic categories.

An example of Aristotle's Four Causes

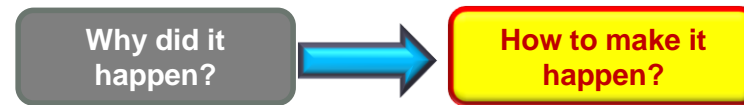


A schematic diagram of Fishbone method

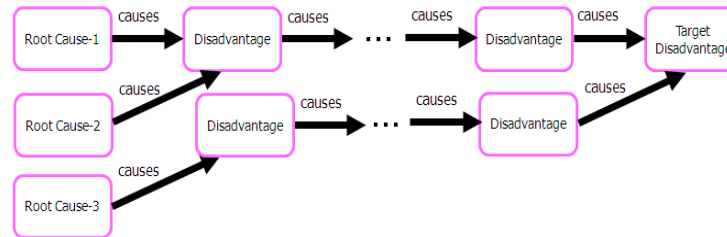


Subversion Analysis

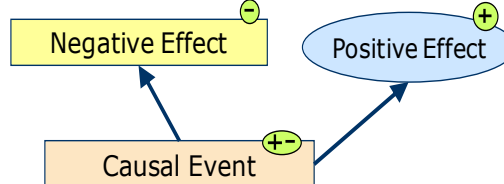
[ Anticipatory Failure Determination of B.Zlotin, etc.]



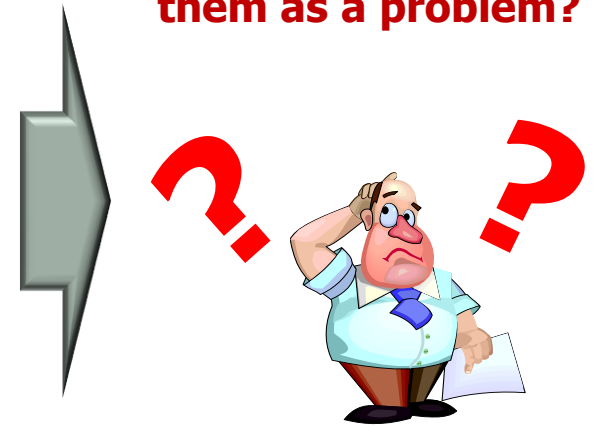
Cause Effect Chain Analysis [ GEN3:ID, etc. ]



Root Conflict Analysis [ V.Souchkov ]



**So how to formulate them as a problem?**




# Weakness of Current Ways in TRIZ Field

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## 1. Requirement for a generic categorical guide

Current guides don't provide the way to formulate the models pertinent to TRIZ-based tools, neither offer they how to manage all kinds of causes.

 **Generic categories pertinent to TRIZ-based tools are required to identify all kinds of causes more exactly and to mobilize most of all TRIZ-based tools to reformulate causes into models.**

## 2. Requirement to deal with contradictory events

Cause Effect Analysis must provide formulation of contradictions as 'core problems'. 'Root Conflict Analysis' of V.Souchkov deals with contradiction formulation but it doesn't cover a full range of positive effects

 **Desired events can be deployed to plural ones along 'Purpose Scale' for more effective formulation of contradictions**

# Main Notions of 'Modernized Aristotle's Causation View'

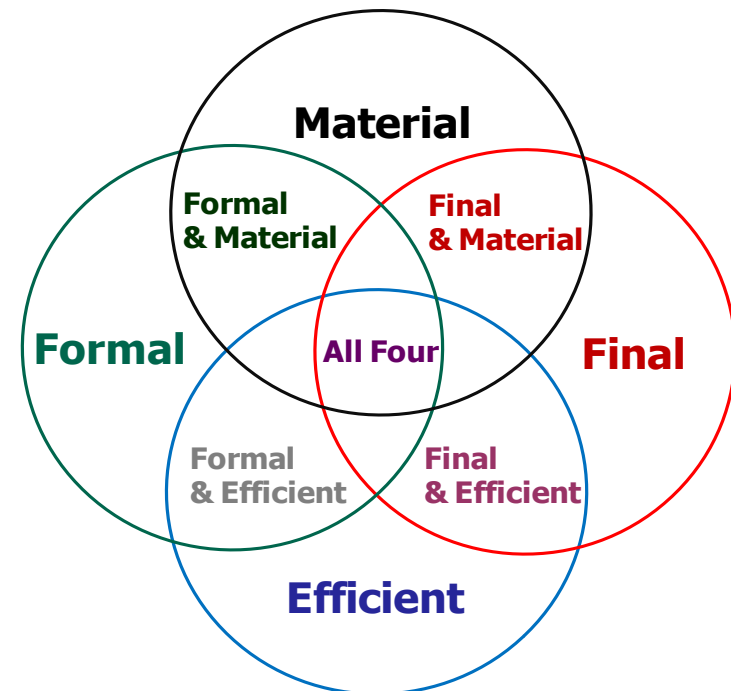
## 1. Requirement for a generic categorical guide

**Generic categories based on 'Scientific and Engineering Principles' are required**

- **5 Whys**
- **5Ms, 6 Ms, ...**
- **'What causes this?'**
- **'How to make it happen?'**
- **Resource Analysis**
- ...



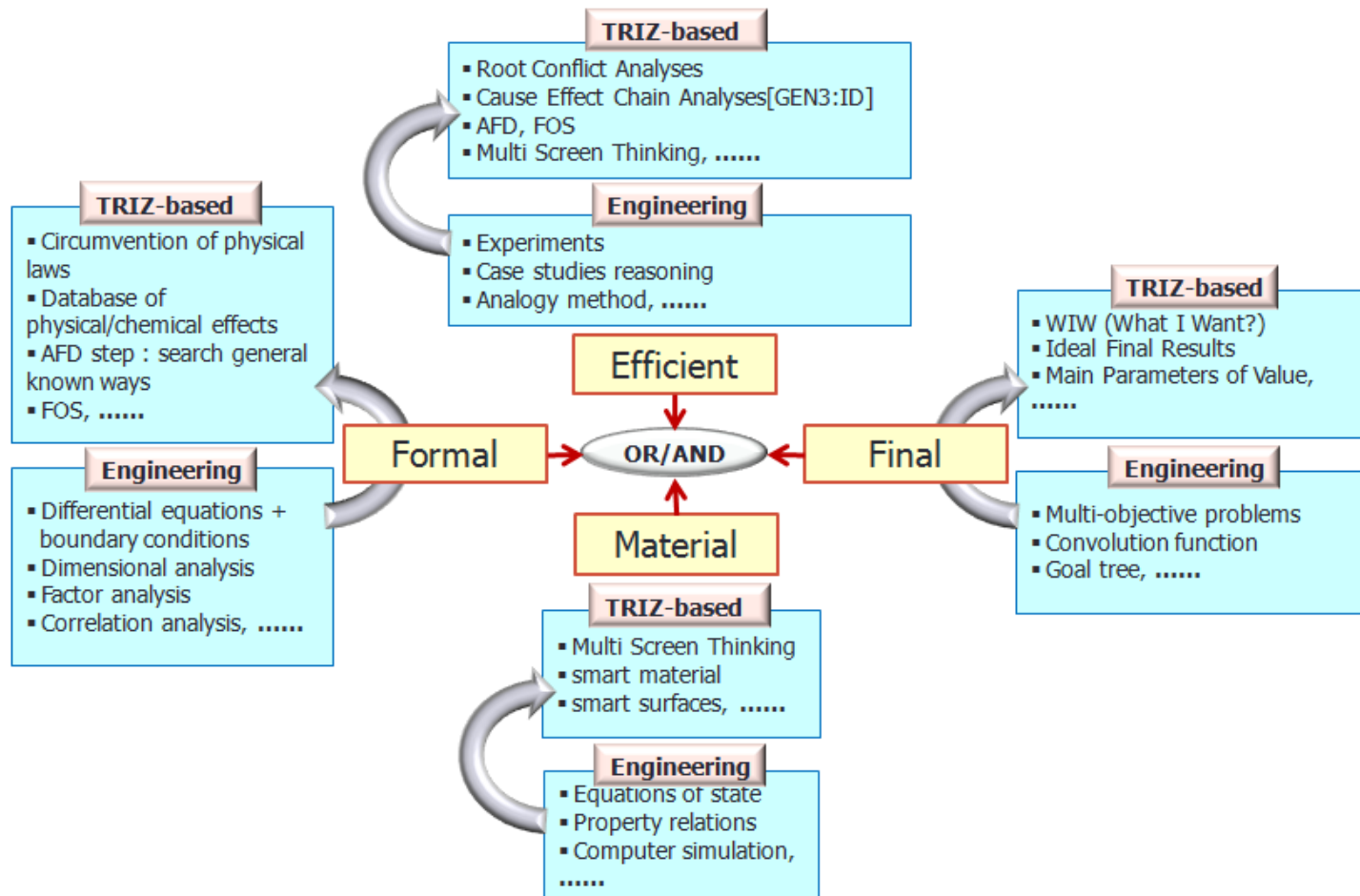
'Modernized Aristotle's Causation View'



# Main Notions of 'Modernized Aristotle's Causation View'

## 1. Requirement for a generic categorical guide

**'Modernized Aristotle's Causation View' integrates all of other tools**



# Main Notions of 'Modernized Aristotle's Causation View'

## 1. Requirement for a generic categorical guide

- **Generic categories based on 'Scientific and Engineering Principles' are suggested**

Cause Category	Checking Question
Final	Is/was the event done for any purpose or positive effect? If any, what is it? (if not, it is an unwanted event)
Efficient	What interactions cause the event ?
Material	What parametric prerequisites are needed for the event ?
Formal	By what physical laws/principles is the event governed ?

Checking questions based on 'Modernized Aristotle's Causation View'

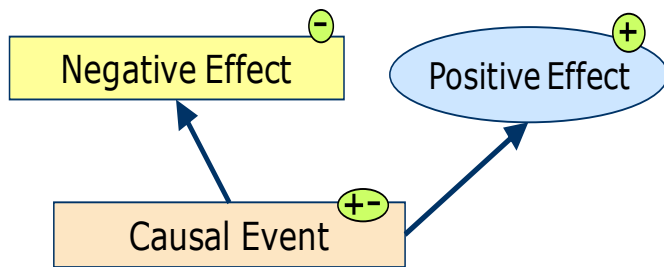
# Main Notions of 'Modernized Aristotle's Causation View'

## 2. Complete dealing with contradictory events

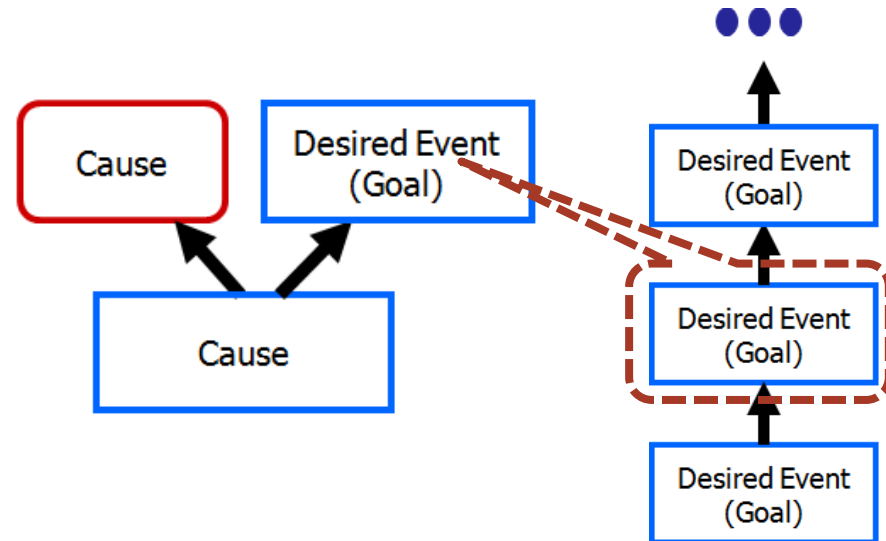
Cause Effect Analysis must provide formulation of contradictions as 'core problems'

Desired events must be considered and **identified as NOT a single event BUT plural along 'Purpose Scale'**

Root Conflict Analysis of V.Souchkov



Examination of Desired events along 'Purpose Scale'



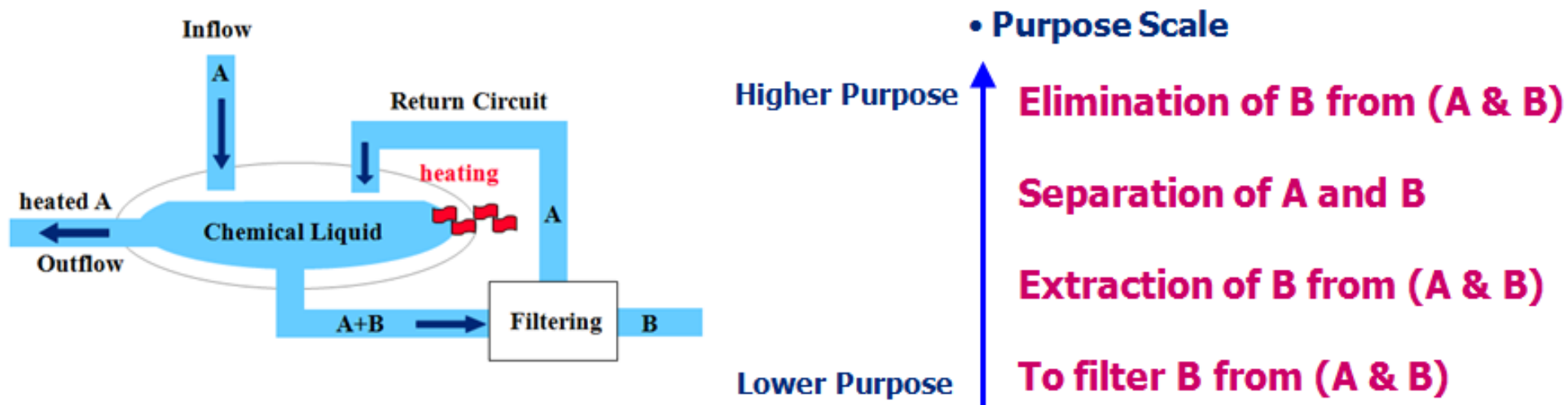


# Main Notions of 'Modernized Aristotle's Causation View'

## 2. Complete dealing with contradictory events

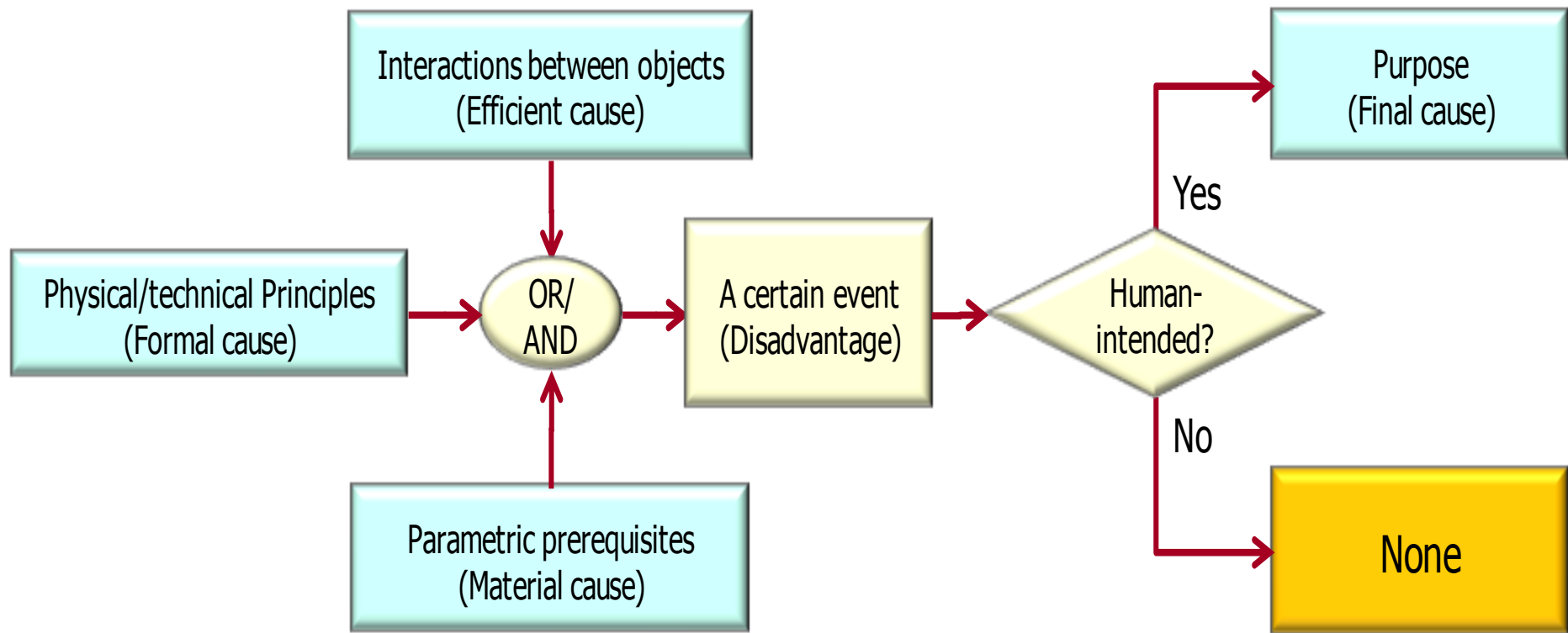
Desired events must be considered and **identified as NOT a single event BUT plural along 'Purpose Scale'**

An example of deployment of desired events along 'Purpose Scale'



# Application of 'Modernized Aristotle's Causation View'

## 'Modernized Aristotle's Causation View' Procedure



# Application of 'Modernized Aristotle's Causation View'

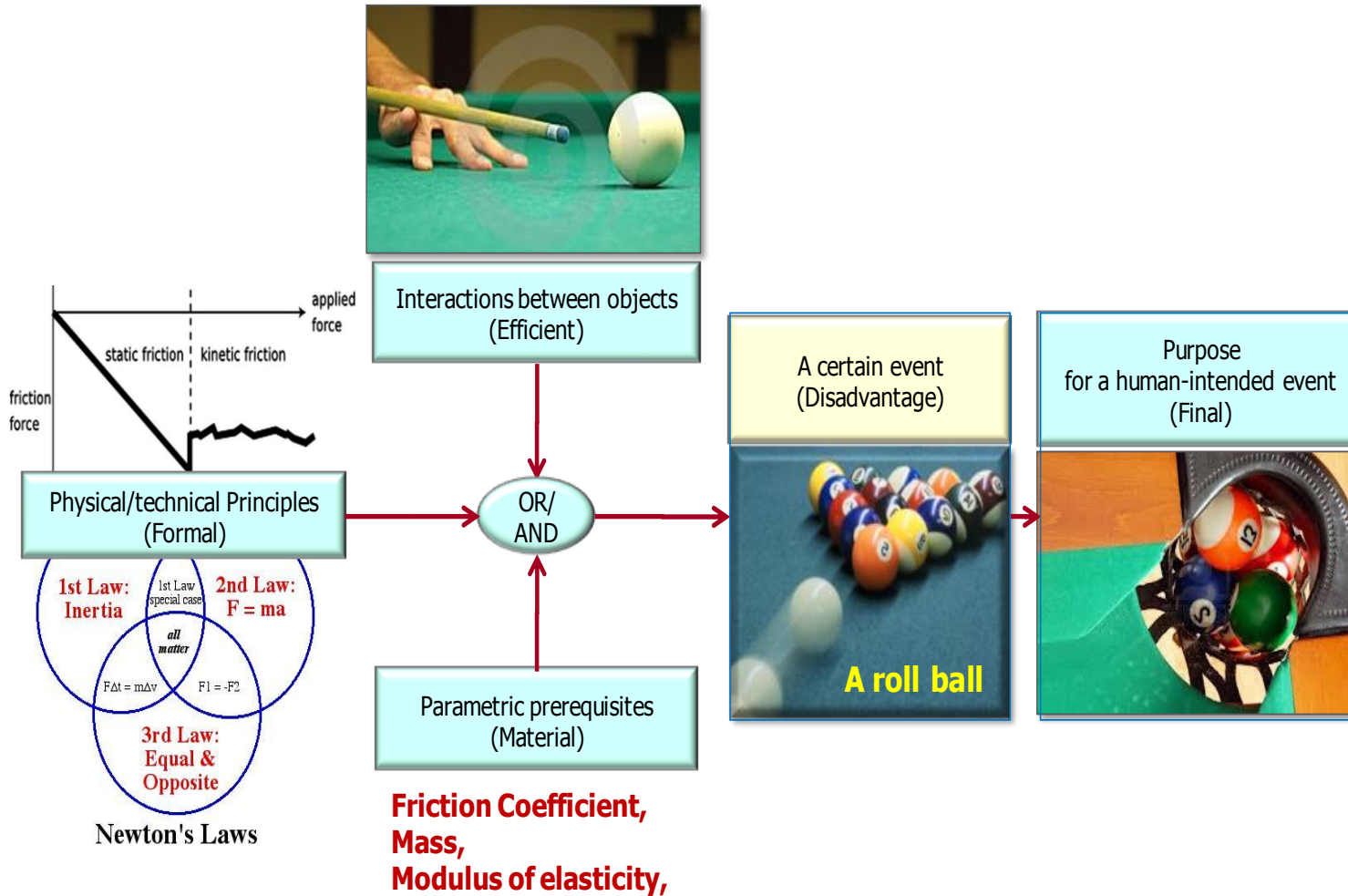
Example-1 of checking questions based on 'Modernized Aristotle's Causation View'



Event	Cause Category	Checking Questions
A rolling billiard ball on the billiard table	Final	Is/was the event done for any purpose or positive effect? Ans : to impact other balls for gathering them in one pocket
	Efficient	What interactions cause the event? Ans : the billiard stick impacts the billiard ball the billiard table retards the ball by friction air around the ball retards the ball
	Material	What parametric prerequisites are needed for the event? Ans : value of mass, elasticity of the billiard ball, friction coefficient, ...
	Formal	By what physical laws/principles is the event governed ? Ans : Newton's motion laws, friction law

# Application of 'Modernized Aristotle's Causation View'

Example-1 of checking questions based on 'Modernized Aristotle's Causation View'



# Application of 'Modernized Aristotle's Causation View'

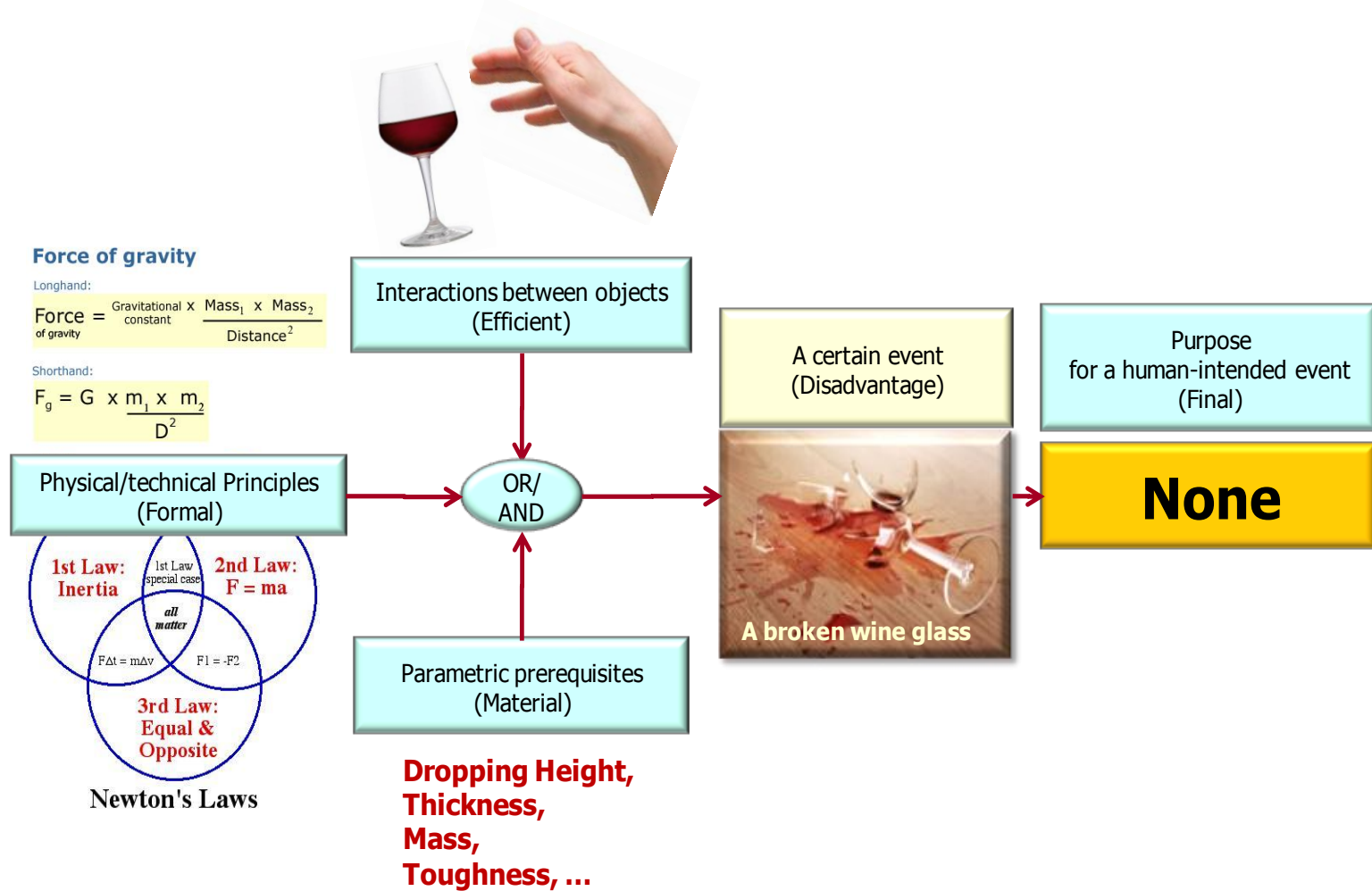
Example-2 of checking questions based on 'Modernized Aristotle's Causation View'



Event	Cause Category	Checking Questions
A broken wine glass and spilt wine on the floor	Final	Is/was the event done for any purpose or positive effect? Ans : no
	Efficient	What interactions cause the event? Ans : the earth pulls the glass and wine the hand missed grasping force on the glass the glass crushed into the floor
	Material	What parametric prerequisites are needed for the event? Ans : value of dropping height, mass, shape, toughness of the wine glass, hardness of the floor, ...
	Formal	By what physical laws/principles are the event governed ? Ans : Newton's motion laws, Principle of gravity

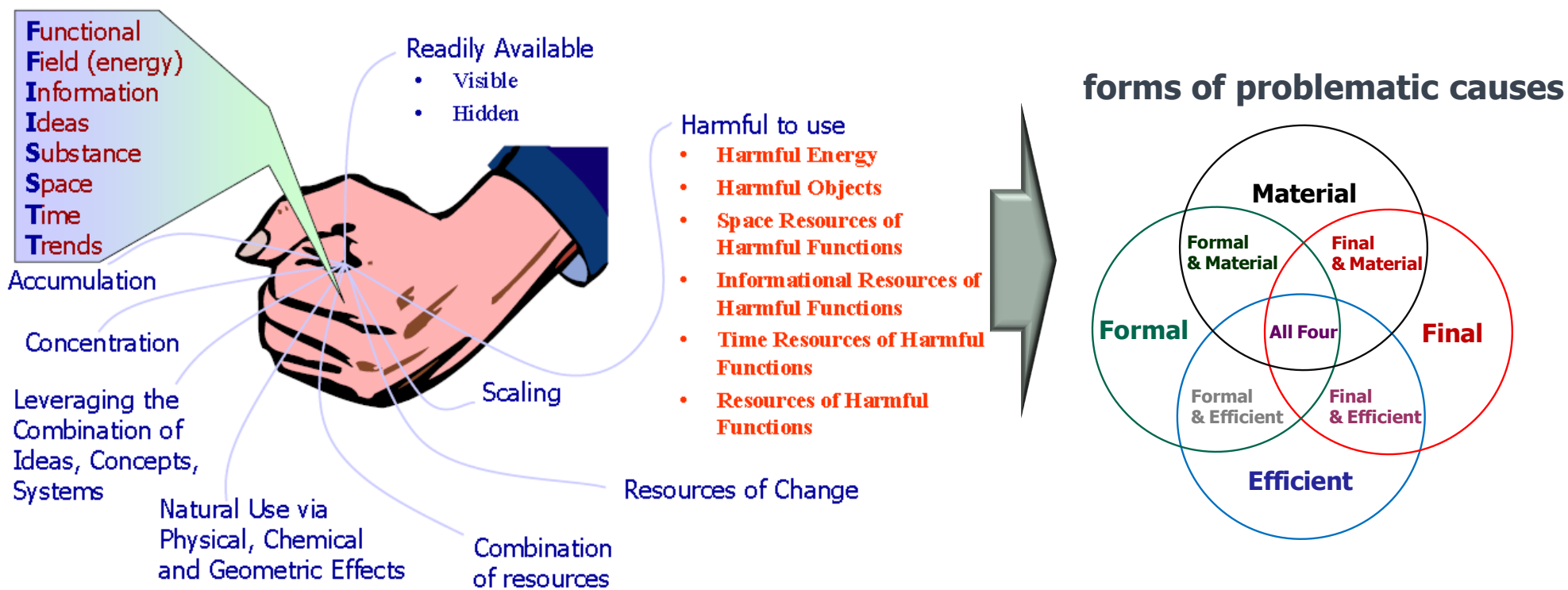
# Application of 'Modernized Aristotle's Causation View'

Example-2 of checking questions based on 'Modernized Aristotle's Causation View'



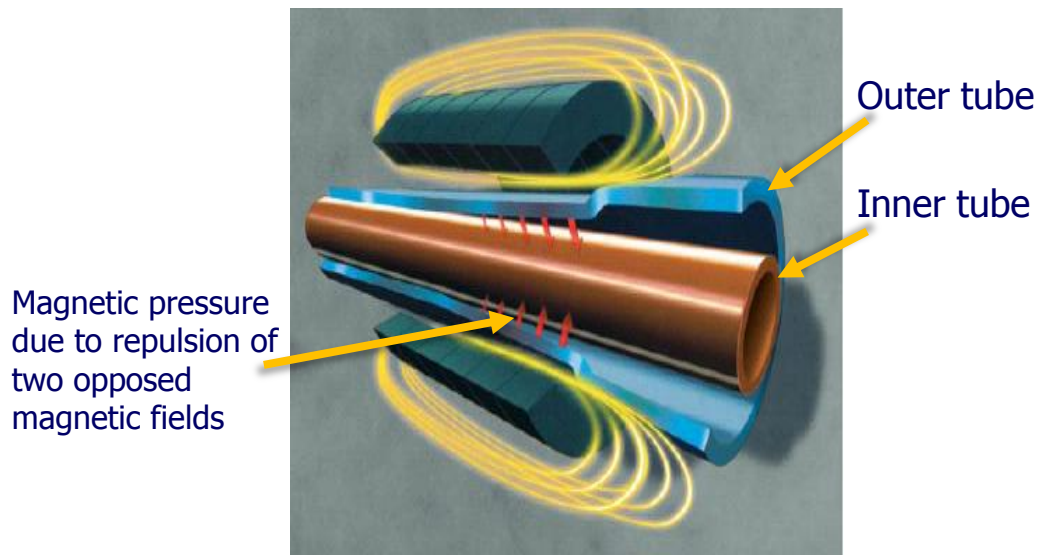
# Discussion on Results of 'Modernized Aristotle's Causation View'

- **Compared with 'Subversion Analysis' [AFD], generic categories are suggested as 'forms of problematic causes'**

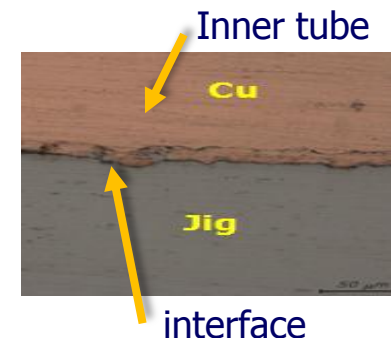
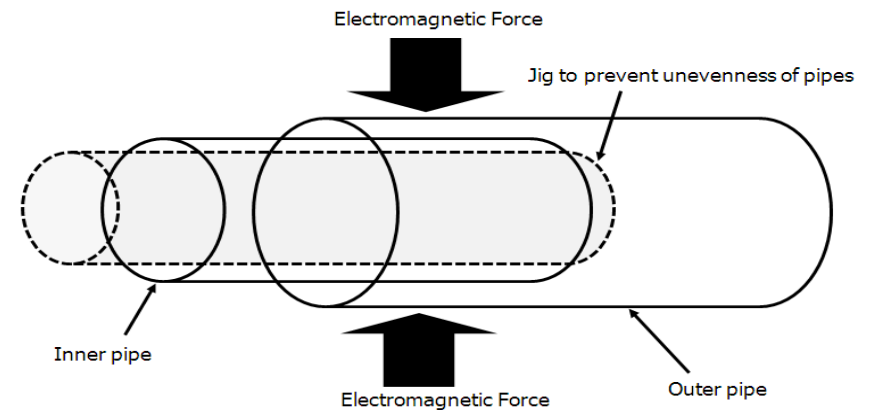


# A Practical Case

This case is a real project done in 2009 and the result was patented in Korea. It is about how to get a pipe comprised of an Al tube and a Cu tube which are welded by Magnetic Pulse Welding. A jig was introduced to prevent the inner pipe from deformation due to the impact of the outer pipe during the welding. The jig seemed to block the inner pipe expectedly but it was not extracted because the inner pipe (made of Copper, Cu) combined with the jig after welding. Therefore, even though the welded parts of the workpiece pipes were in a good shape, we could not use the welded pipes because the jig blocked the inside of the inner pipe.



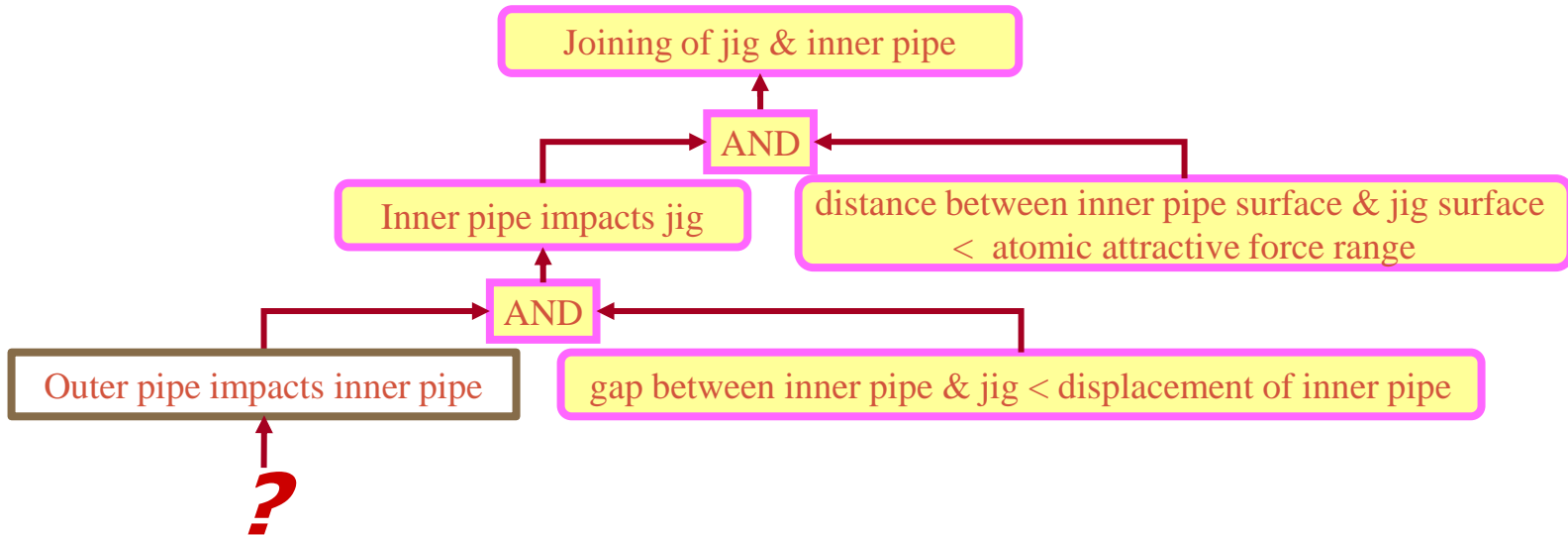
An image of a conventional Magnetic Pulse Welding System





# A Practical Case

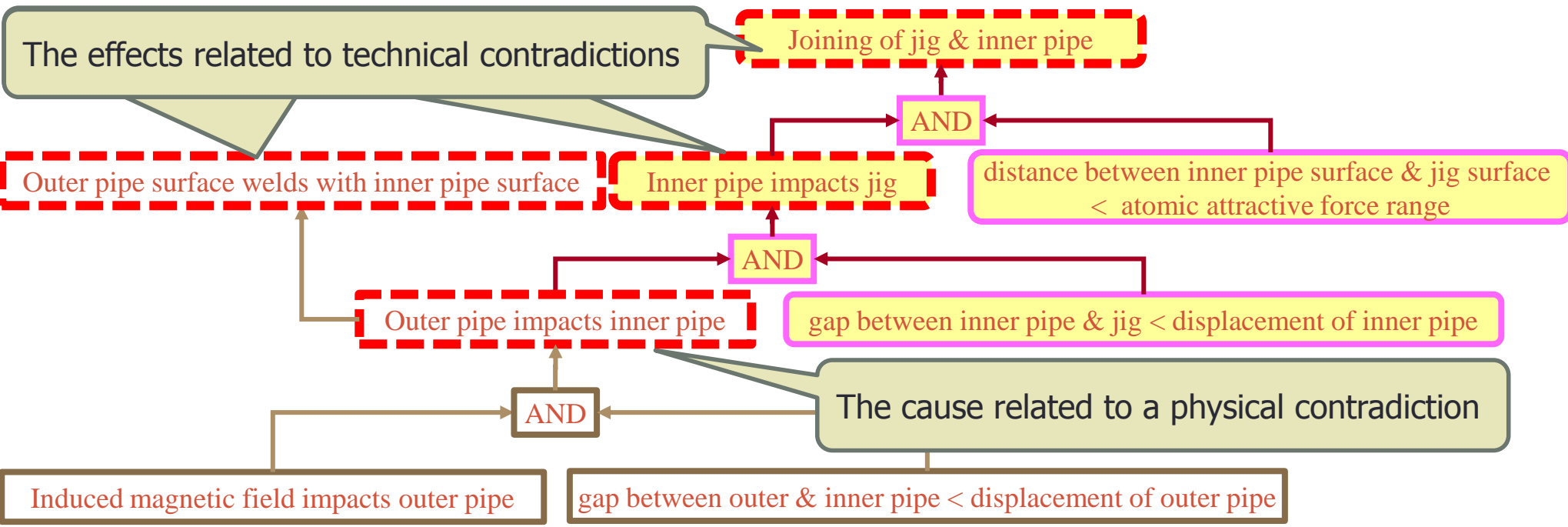
Next, the plausible causes of 'outer pipe impacts', were examined.



Event	Cause Category	Checking Questions
Outer pipe impacts inner pipe	Final	Is/was the event done for any purpose or positive effect? Ans : Outer pipe surface welds with inner pipe surface
	Efficient	What interactions cause the event? Ans : induced magnetic field impacts outer pipe
	Material	What parametric prerequisites are needed for the event? Ans : gap between outer & inner pipe < displacement of outer pipe
	Formal	By what physical laws/principles are the event governed ? Ans : Maxwell's equations, Newton's laws, Hooke's law

# A Practical Case

At this step, we can find the contradiction as one of 'core problems'. If we overcome this contradiction, the target disadvantage will be prevented. The solution idea to this point was patented (KR1012642620000).



# Summary

## Differences of 'Modernized Aristotle's Causation View' from Other Approaches

Comparison Point	Already-known Approaches	Modernized Aristotle's Causation View
<p><b>Cause Classification as a generic guide to formulate problem models</b></p>	<p><b>No any classification after resource analysis (Subversion Analysis, AFD, GEN3ID)</b></p>	<p><b>Four groups of cause models through generic categories</b></p>
<p><b>Positive Effect Examination for contradiction formulation</b></p>	<p><b>Checking 'A' Positive Effect for An Event (RCA of V.Souchkov)</b></p>	<p><b>Changing Purpose Scale to Provide Easier and Systematic Contradiction Formulation</b>                      → Changing the level of Purpose of 'Final Cause'</p>

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