

Coupling Contradictions

Jérôme Laforcade

Résumé

L'article propose le concept de contradiction de couplage comme un développement de la Théorie de la Résolution Inventive de Problèmes (TRIZ), en élargissant le modèle classique de la contradiction technique. Alors que la contradiction technique décrit une situation dans laquelle l'amélioration d'un paramètre du système entraîne la dégradation d'un autre, la contradiction de couplage met en évidence des limites qui ne relèvent pas uniquement du système technique, mais de l'environnement associé dans lequel ce système opère. À partir de la notion de Résultat Final Idéal (RFI) formulée par Genrich Altshuller, l'auteur montre que, dans les cycles d'innovation incrémentale, le développement technologique tend à respecter l'adaptation progressive du système à son environnement. Toutefois, dans les contextes d'innovation de rupture, cette logique est rompue : la limitation centrale devient une crise de ressources environnementales (temps, espace, niveau systémique ou séparation sous conditions spécifiques), rendant insuffisante la simple optimisation interne du système. En s'appuyant sur les lois d'évolution des systèmes techniques et les courbes en S, l'article démontre que certaines innovations exigent la transformation simultanée de la technologie et de son super-système. Des exemples tels que le transport routier illustrent comment la rareté de l'espace urbain, et non la performance des véhicules, bloque des avancées supplémentaires. Le texte propose enfin une méthodologie étendue, fondée sur l'algorithme des 9 questions et sur des outils classiques de la TRIZ (standards d'invention, algorithme de Smirnov et matrice d'Altshuller), afin d'identifier les crises de ressources environnementales et de formuler des contradictions de couplage.

Mots-clés : Contradiction de couplage; TRIZ (Théorie de la résolution inventive de problèmes); Résultat Final Idéal (RFI); Innovation de rupture; Crise de ressources environnementales.

CONTACT: Jérôme Laforcade, Founder and Principal Consultant, TRIZ Conseil, France,
ORCID: 0009-0009-6186-8798



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Abstract

The article proposes the concept of coupling contradiction as a development of the Theory of Inventive Problem Solving (TRIZ), extending the classical model of the technical contradiction. While a technical contradiction describes a situation in which the improvement of one system parameter leads to the degradation of another, a coupling contradiction highlights limits that do not pertain solely to the technical system itself, but to the associated environment in which the system operates. Drawing on the notion of the Ideal Final Result (IFR) formulated by Genrich Altshuller, the author shows that, in cycles of incremental innovation, technological development tends to respect the system's progressive adaptation to its environment. However, in contexts of disruptive innovation, this logic is broken: the central limitation becomes a crisis of environmental resources (time, space, systemic level, or separation under specific conditions), making mere internal optimization of the system insufficient. Relying on the laws of evolution of technical systems and Scurves, the article demonstrates that certain innovations require the simultaneous transformation of the technology and its supersystem. Examples such as road transportation illustrate how the scarcity of urban space, rather than vehicle performance, blocks further progress. Finally, the text proposes an extended methodology, based on the 9question algorithm and on classical TRIZ tools (invention standards, the Smirnov algorithm, and Altshuller's matrix), in order to identify environmental resource crises and to formulate coupling contradictions.

Keywords: Coupling contradiction; TRIZ (Theory of Inventive Problem Solving); Ideal Final Result (IFR); Disruptive innovation; Environmental resource crisis.

TRIZ relies heavily on the concept of technical contradiction. This model associates every technical problem observed in a system with an opposition between two parameters of that system.

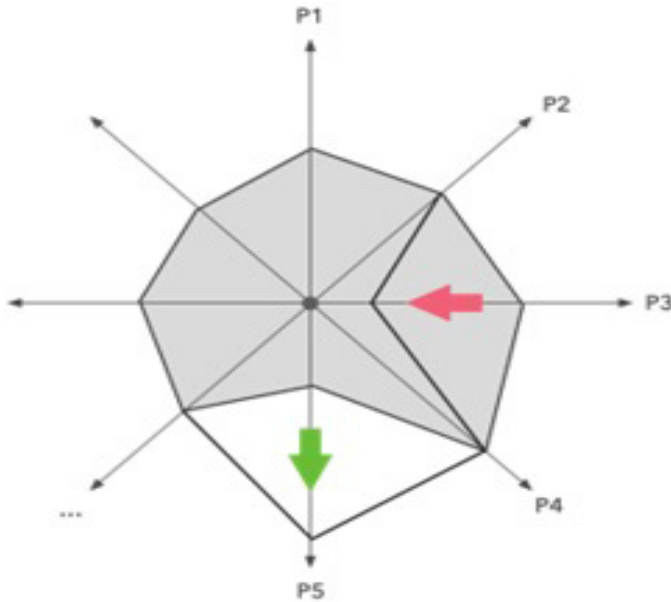


Figure 1. Technical contradiction: The positive evolution of one characteristic of the system leads to the deterioration of another characteristic of the system. P5 better → P3 worse.

For example, improving the driving range of a battery-powered electric vehicle entails a deterioration in the volume and mass of the battery, thereby increasing the vehicle's weight.

Identifying the technical contradiction makes it possible to use TRIZ methods to propose concepts that circumvent the problem at hand. The objective of this approach is to move toward an ideal solution known as the IFR (Ideal Final Result)—a solution that would resolve the problem without modifying the initial system. Obviously, this IFR is rarely achievable, but the TRIZ approach always aims to approximate it as closely as possible.

In the 1960s and 1970s, Genrich Altshuller, the founder of TRIZ, realized that the IFR is sometimes violated by technologically disruptive solutions that emerge during shifts in innovation cycles. For example, it is not possible to derive the concept of a calculator from the abacus if one strictly follows the foundational TRIZ principle based on the IFR.

As a result, a new branch of TRIZ emerged, leading to the formulation of the laws of evolution of technical systems. This branch makes it possible to explain and anticipate minor changes within a technology, as well as to identify the causes and early signs of deeper transformations associated with disruptive innovations.

In the case of disruptive innovations, A. Lyubomirsky identifies a fundamental cause of such cycle changes, referred to as an aggravated contradiction. The aim of this publication is to describe these aggravated contradictions in a way that makes them predictive and operational, while also providing them with a more precise and concrete definition.

Evolution of Technical Systems

The systematic study of millions of systems makes it possible to observe their transformations and to identify regularities—that is, trends that recur frequently as these systems evolve over time. These trends are referred to as the laws of evolution of technical systems, even though they are more accurately described as systematic patterns observed across the millions of systems analyzed by TRIZ.

Among these trends, Scurves indicate the main principles that must be respected when developing a technology according to its level of maturity; a technology must therefore follow these principles in order to increase its chances of success. From this perspective, the description of technologies provided by the laws of technical system evolution is highly Darwinian, emphasizing the adaptation a technology must achieve with respect to its associated environment.

For example, the development of a new automotive technology necessarily depends on the vehicle's ability to use roads, parking facilities, and other systems with which it interacts. If several technologies were proposed to replace current vehicles, a significant advantage would be given to the solution that disrupts its environment as little as possible, especially in the early stages of its development.

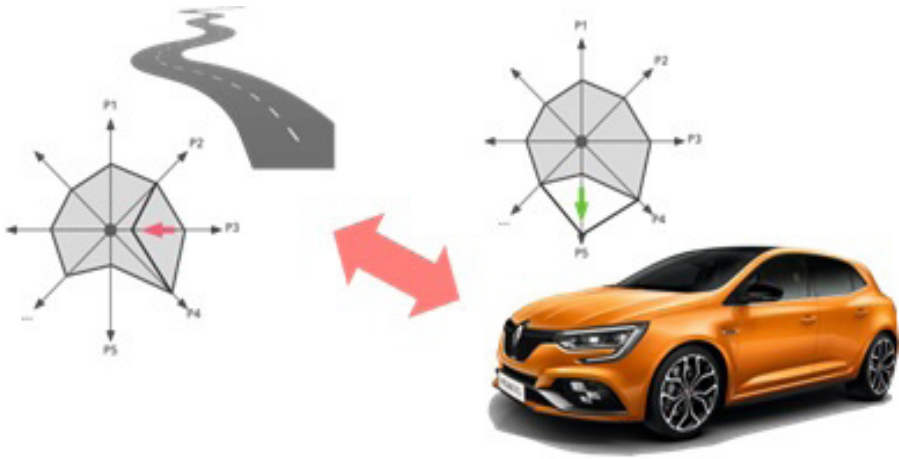
Coupling Contradiction

The notion of a coupling contradiction can be understood within this framework. Sometimes, a minimal change to the associated environment is not sufficient for a new technology to emerge. In such cases, the environment itself must be radically modified to enable the appearance of the new technology.

Thus, the limitation does not lie in the system itself but in the deterioration of a parameter of the associated environment, which forces a simultaneous transformation of both the technology and its environment.

Examples:

- Increasing crude oil transport capacity is not limited by ship parameters, but by the inability of ports to accommodate larger vessels.



- Reducing automobile travel time is not limited by vehicle speed, but by the inability of infrastructure to handle increasing traffic volumes (number of lanes, parking spaces, etc.).

Consequences of Coupling Contradictions

To solve the technological problem, it is not enough to adapt the technology; the environment (supersystem) in which it operates must also be modified. Changes to the environment will affect other interacting systems. Although it is difficult to evaluate the scope and quality of these consequences during the early stages of a disruptive technology, several phases can be anticipated:

1. Resistance phase: Many associated environments resist adopting the new technology, through regulatory restrictions and outright bans. Only a few pioneers—the *early adopters*—embrace it. Dominant companies attempt to suppress the new technology through lobbying or acquisition.
2. Acceleration phase: Suppression efforts fail. New firms enter the market, investments increase, applications multiply, and performance improves rapidly.
3. Adaptation phase: Interacting environments progressively adapt, leading to the decline of older technologies. This triggers widespread changes in technologies, practices, companies, and regulations.
4. Stabilization (saturation) phase: Market consolidation occurs through mergers and acquisitions. Technologies stabilize around shared principles, interoperability improves, prices decrease, and the environment completes its adaptation.

Coupling Contradictions and Resource Crises

A problem formulated as a coupling contradiction reveals a resource crisis, reducible to four cases:

- T: Time
- S: Space

Systemic level requiring transition to the subsystem or supersystem. Conditional separation, resulting in incompatible categories (e.g., ship, airplane, train, car).

The problem is formulated at the system level and simultaneously reveals a resource crisis in the associated environment, in the form of a parameter belonging to that environment.

Methodology

Identifying a coupling contradiction requires identifying a resource crisis in the associated environment that prevents solving the problem at the system level alone.

In the case of a conventional problem leading to a technical contradiction, the 9-question algorithm (© Jérôme Laforcade, 2008) can be used. This algorithm makes it possible to identify the main contradiction step by step, first by identifying the operational zone and time, and then by conducting a physical analysis of the identified elements, allowing both the identification of malfunctioning physical functions and the physical parameters associated with those malfunctioning functions.

Obviously, this algorithmic approach makes it possible to identify only endogenous causes, and not causes arising from coupling problems with the associated environment.

It is therefore necessary to modify this algorithm in order to integrate a phase dedicated to identifying the resource crisis that generates the coupling contradiction. What follows is a proposed version of this new algorithm (in italics).

1. *Describe the system to be evolved. Analyze this system using Scurves, the law of ideality, and the law of system completeness. If there is an opportunity to change the physical principle (system in phase 3++ and the existence of physical limits), then proceed with the questionnaire.*

2. Where exactly does the problem occur?

3. At what precise moment does the problem occur?

4. Which components *AND* associated environments interact with the identified components?

5. *Formalize the physical analysis graph between the system components involved and the associated environment on which the resource crisis depends*

6. Identify the physical function (vepole) that is the most harmful or the least well performed

7. Identify the component or resource belonging to the associated environment that produces the function identified in question

8. Which parameter would need to be changed in order to resolve the identified vepole on the component or resource identified in question 8? What would its ideal value be?

9. Identify the physical function or functions that are then degraded by the

change introduced in question. *Use the Smirnov algorithm to identify the structural modifications of the identified vepole and to propose concepts that address these modifications.*

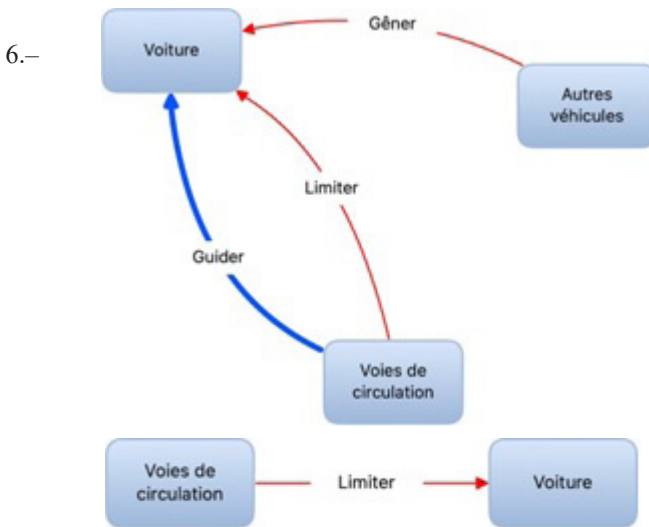
10. Which parameters would then be degraded? *Here, we must note a difference from the classical approach by allowing the identification of several possible parameters.*

Formulate the coupling contradiction or contradictions (9 vs. 11)

Example: Longterm evolution of the automobile

1. Personal car. How can travel time be reduced in periurban environments?
(Phase 3; no physical limitation identified at this stage)

2. – In traffic congestion
3. – During travel, at peak hours
4. – Car, other vehicles, road infrastructure
5. – Physical function graph:



7 – Road infrastructure

8 – It is necessary to increase the number of vehicles on the road network

9 – The resource crisis is therefore associated here with the space required to increase road infrastructure.

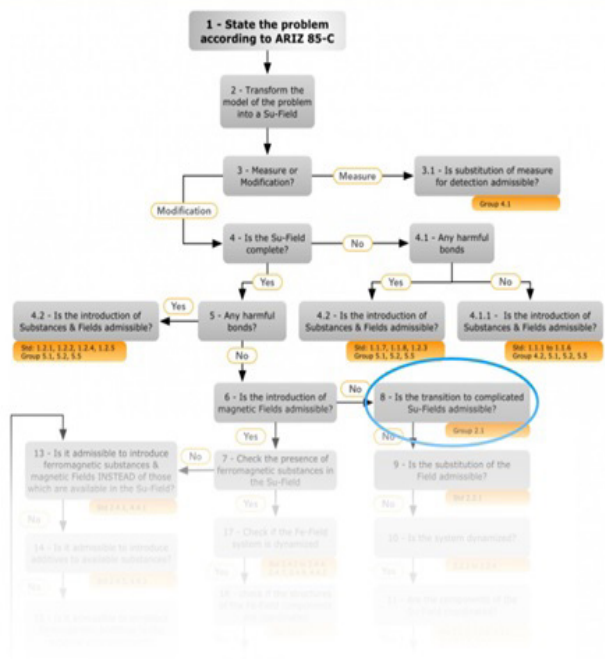
10 – Increasing the number of lanes requires taking surface area that is currently allocated to other uses: housing, infrastructure, etc.

11 – Coupling contradiction: Increasing the *number of vehicles* on the road network vs. *surface area allocated to road infrastructure*

The resource crisis is therefore linked here to the available surface area for building new road infrastructure.

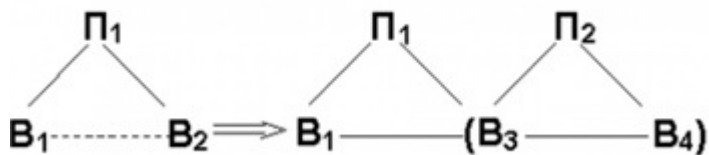
Resolving this coupling contradiction will require rethinking the coupling between the car and road infrastructure. Revising this coupling will have considerable consequences both for vehicle design and for the design of road infrastructure.

The approach based on invention standards and the Smirnov algorithm proposes, for example:

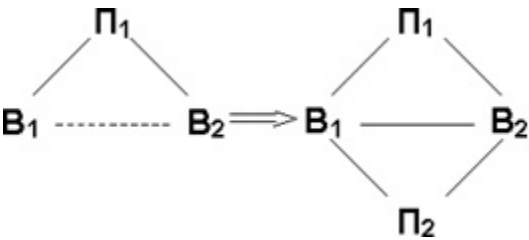


GROUP 2-1: TRANSITION TO COMPLEX VEPOLES

Standard 2-1-1: Transition to a chain vepole.



Standard 212: Transition to a double vepole



And the changes can then be extended to other types of standards by applying the Smirnov algorithm

The use of Altshuller’s matrix proposes, for example:

Contradictions analysis

Parameters

Contradictions

Separation principles

Choose the parameters from the following lists

Upgraded parameters

Durability of moving object

Energy spent by moving object

Waste of time

Harmful factors acting on object

Productivity

+

VS

Downgraded parameters

Area of stationary object

Shape

Amount of substance

Harmful side effects

+

Continue

Contradictions analysis



Parameters	Contradictions	Separation principles
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The following contradiction principles result from applying Altshuler’s matrix to the previously selected parameters, ordered by number of occurrences

14 occurrences
35 - Parameter changes
8 occurrences
10 - Preliminary action
7 occurrences
18 - Mechanical vibration
22 - Blessing in disguise
39 - Inert atmosphere
6 occurrences
2 - Separation
16 - Partial or excessive actions
17 - Dimensionality change
34 - Discarding and recovering
5 occurrences

17 - Dimensionality change



Move the object in 3 dimensions



Use multistories and back-sides

- Move an object in two- or three-dimensional space
- Use a multi-story arrangement of 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

Contradictions analysis



Parameters	Contradictions	Separation principles
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The following contradiction principles result from applying Altshuler’s matrix to the previously selected parameters, ordered by number of occurrences

4 occurrences
33 - Homogeneity
3 occurrences
5 - Merging
8 - Weight compensation
9 - Preliminary counteraction
11 - Beforehand compensation
13 - The other way around
15 - Dynamic parts
19 - Periodic action
20 - Continuity of useful action
24 - Intermediary
30 - Flexible shells and thin films

5 - Merging



Merge the objects



Merge the Actions

- Bring closer together (or merge) identical or similar objects, assemble identical or similar parts to perform parallel operations
- Make operations contiguous or parallel, bring them together in time

In this example, the classical TRIZ tools are used, but it is important to keep in mind that a coupling contradiction involves a resource shortage in the environment—in this case, the surface area allocated to transportation—which limits the development of the technical solution. Most of the time, this resource shortage leads to disturbances in the associated environments, resulting in attempts to maintain a fragile equilibrium, a status quo, which postpones the arrival of innovation until the situation becomes intolerable. In the example presented, such a solution could involve, for instance, restricting the use of road infrastructure to certain times based on license plate numbers, or requiring the use of alternative modes of transport when travel distances are below a certain threshold, and so on. One can imagine that these measures would only be implemented once periurban transportation has deteriorated sufficiently to make such concepts acceptable. It is also necessary to take into account the changes that these concepts would bring about if they were adopted. What would their longterm effects be?

Conclusion

Coupling contradictions are a powerful tool for identifying situations where resource scarcity necessitates radical innovation. In many cases, adapting the technology alone is insufficient; the associated environment must also be transformed. These transformations generate cascading effects across interacting systems.

Formulated as coupling contradictions, such problems reveal resource crises related to time, space, systemic level, or conditional separation. Resolving them requires rethinking the coupling between technology and environment.

In conclusion, coupling contradictions provide an effective means of detecting situations in which resource scarcity demands radical innovation—and of identifying ideas capable of overcoming these constraints through major disruptive innovations.

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