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Teoría de Resolución de Problemas de Inventiva para el Desarrollo de Patentes en el Centro Universitario UAEM Valle de Chalco

Theory of Inventive Problem Solving for Patent Development at the UAEM Valley of Chalco University Center

Teoria da Resolução de Problemas para o Desenvolvimento Inventivo Desenvolvimento de Patentes no Centro Universitário UAEM Valle de Chalco

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Resumen

La investigación se enfoca en la falta de sistematización en los procesos de creación empleados para el desarrollo y mejora de productos y servicios dentro de las instituciones de educación superior (IES), panorama que limita la generación de innovaciones susceptibles de protección intelectual. En México, los índices de registro de patentes no superan más del 7% (Diario Evolución, 2017). El objetivo del estudio es establecer criterios que faciliten la comprensión y aplicación de la Teoría de Resolución de Problemas de Inventiva (TRIZ) en las fases de innovación desarrolladas en la licenciatura en Diseño Industrial del Centro Universitario UAEM Valle de Chalco, mediante un enfoque descriptivo no experimental, se busca sistematizar los métodos de creatividad empleados por los estudiantes, con el fin de proponer un patrón metodológico estructurado que fortalezca la formación en innovación, incremente la calidad de las propuestas de diseño y favorezca su transición hacia procesos formales de patentamiento ante el IMPI.

Palabras clave: diseño industrial, patentes, TRIZ.

Abstract

The research focuses on the lack of systematization in creative processes used for the development and improvement of products and services within higher education institutions (HEIs), a condition that restricts the generation of innovations capable of intellectual protection. In Mexico, patent registration rates do not exceed 7% (Diario Evolución, 2017). The aim of this study is to establish criteria that facilitate the understanding and application of the Theory of Inventive Problem Solving (TRIZ) within the innovation stages developed in the Industrial Design undergraduate program at the UAEM Valle de Chalco University Center. Using a non-experimental descriptive approach, the study seeks to systematize the creativity methods employed by students in order to propose a structured methodological framework that strengthens innovation training, enhances the quality of design proposals, and supports their transition toward formal patenting processes before the Mexican Institute of Industrial Property (IMPI).

Keywords: industrial design, patents, TRIZ .

Resumo

Esta pesquisa concentra-se na falta de sistematização nos processos criativos utilizados para o desenvolvimento e aprimoramento de produtos e serviços em instituições de ensino superior (IES), situação que limita a geração de inovações elegíveis para proteção da propriedade intelectual. No México, as taxas de registro de patentes não ultrapassam 7% (Diario Evolución, 2017). O objetivo deste estudo é estabelecer critérios que facilitem a compreensão e a aplicação da Teoria da Resolução Inventiva de Problemas (TRIZ) nas fases de inovação desenvolvidas no curso de graduação em Design Industrial do Centro Universitário UAEM Valle de Chalco. Por meio de uma abordagem descritiva e não experimental, o estudo busca sistematizar os métodos criativos utilizados pelos alunos, a fim de propor um arcabouço metodológico estruturado que fortaleça a formação em inovação, aumente a qualidade das propostas de design e facilite sua transição para os processos formais de patenteamento perante o Instituto Mexicano da Propriedade Industrial (IMPI).

Palavras-chave: design industrial, patentes, TRIZ.

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Introduction

In recent years, various educational institutions and organizations have focused their efforts on technological and economic strengthening, creating a favorable environment for designing educational strategies related to the creation and protection of innovations. Within this framework, the TRIZ method, whose name comes from the Russian acronym for Theory of Inventive Problem Solving (Back, Ogliari , Dias , and Silva, 2008), has become established as a methodological strategy capable of fostering original solutions and addressing problems of varying complexity. This methodology offers precise procedures, applicable in short timeframes and across multiple disciplines (Teti and D'Addona, 2011). From this perspective, TRIZ is understood as an organized system that purposefully guides innovative processes and facilitates the creation of new ideas aimed at promoting technological advancement (Rantanen and Domb , 2002).

Altshuller's observations on TRIZ led to the definition of key conditions for its effective implementation: (a) providing the method with an explicit structure; (b) situating the “ideal solution” within a broad spectrum of alternatives; (c) reproducing reliable procedures without relying on psychological heuristics; (d) systematizing the capture of creative information; and (e) articulating creative knowledge in an integrated way (Ekmekci and Köksal, 2015). Within this framework, contradiction management is recognized as the operational core of the approach and is applied, in engineering and design, through the 40 inventive principles and the contradiction matrix, tools that allow for the identification of incompatibilities throughout a system until the "ideal design," TRIZ's central goal, is approached (Ruchti and Livotov, 2001). As Isoba (2006) argues, TRIZ functions as a systematic innovation procedure oriented toward the development of creative capabilities. The method was formulated in the mid-1940s by Genrich Altshuller, who analyzed a massive volume of patents to identify patterns of inventive problems and the recurring strategies used to solve them; by 1990, only about 40,000 patent applications were classified as genuinely inventive. This process made it possible to organize and categorize fundamental stages for generating new solutions, which have been adopted and adapted in contemporary invention processes (Rodríguez, Machado, and Robaina, 2015).

Within this framework, higher education institutions (HEIs) have focused their efforts on establishing systematic procedures that promote innovation and, consequently, increase patent generation. A review of international studies shows that, in different academic contexts, particularly in Europe and the United States, factors such as national conditions, prevailing theoretical approaches, and institutional configuration significantly influence the acquisition of industrial property registrations. Despite these advances, since the 1980s, a partial understanding persists regarding the meaning, conceptual structure, and theoretical scope of patenting, a phenomenon that is frequently and ambiguously linked to technological innovation, product creation, or the formulation of new industrial processes (Aboites and Díaz, 2013). Likewise, the commercialization of knowledge generated in public universities began to strengthen towards the end of the seventies (Calderón, 2013), which encouraged an increase in scientific activity, both basic and applied, with the expectation that its results would have a more defined impact on the productive sector (de Gortari, 1997).

Higher education institutions (HEIs) have also focused their efforts on establishing systematic procedures that foster innovation and, consequently, increase patent generation. However, it is considered a priority to direct some of these efforts toward the productive sector and, in parallel, consolidate a business logic linked to basic research (Jaffe et al., 2007). In countries like Mexico, patents, the commercialization of university knowledge, and technological innovation demand increasing attention given the conditions of the global economy, as they represent opportunities to trigger new value chains. According to the Mexican Institute of Industrial Property (IMPI), the agency responsible for coordinating the industrial property system for the past two decades, its central function is to safeguard and incentivize intellectual property rights and promote fair competition through mechanisms such as patents, utility models, industrial designs, trademarks, trade names, commercial notices, and designations of origin. According to a statement from IMPI (2025), in 2024 10,203 patents were granted to foreign applicants and 694 to Mexican applicants; these figures demonstrate the need to evaluate and compare innovation methods that raise this indicator, in whose strengthening universities play a decisive role.

In parallel, higher education institutions (HEIs) have established links with the industrial sector to promote economic strategies, foster knowledge exchange, and strengthen both patent development and technological innovation. However, these efforts have not resulted in stable programs with clearly articulated objectives and guidelines across different areas, partly due to the prevalence of short-term interests in the business world. Furthermore, basic research focused on explaining phenomena and causal relationships often takes a back seat for those involved in the production of goods and services, who prioritize projects geared toward specific requirements. Adding to this situation are persistent tensions between universities and the productive sector: while academia prioritizes the public dissemination of results, companies tend to protect information as a strategic asset and trade secret. In this context, universities have designed their own models to promote patenting and strengthen knowledge transfer to the productive sector.

The Autonomous University of the State of Mexico (UAEMéx) reports 10 patents and 68 industrial designs, mostly developed in faculties such as architecture and design, where the industrial design degree program at the UAEM Valle de Chalco University Center is located. In 2022, UAEMéx filed 111 industrial property applications with the Mexican Institute of Industrial Property (IMPI); of these, 14 were patents, 12 were industrial designs, and 1 was a utility model (El Valle, 2022). Furthermore, through its Center for the Protection of Innovation, Inventions, and Trademarks, the institution promotes initiatives aimed at increasing the volume of applications and registrations processed by this agency.

The application of the TRIZ methodology in various areas of technological development and innovation within the UAEM Valle de Chalco University Center presents an opportunity to promote new educational strategies and their eventual incorporation into the 2025 curriculum for the Bachelor's degree in Industrial Design. This academic program is structured in nine semesters and organized into two core areas: basic and comprehensive, which, in turn, are articulated within three fundamental areas: a) design, b) sociotechnics and management, and c) sociocultural. Within this framework, UAEMéx allocates institutional resources to strengthen research and the protection of intellectual property through the work of the Center for Innovation and Technology Development (CIDT) and the Science and Technology Park (PCT). Furthermore, the research professors affiliated with the Academic Groups (CA) develop their projects under a Line of Knowledge Generation and Application (LGAC), which systematically guides their work. However, as Impi Marca (2024) points out, filing applications with the IMPI continues to pose a significant challenge for universities, since the patent process is lengthy and complex, compounded by the need to address the legal aspects related to ownership between the institution and the inventors. These circumstances frequently generate tensions related to authorship, project development, and economic interests stemming from potential commercialization.

The research employed a non-experimental, descriptive design using a mixed-methods approach to analyze the factors involved in proposing, developing, and registering patents within the Industrial Design undergraduate program at the UAEM Valle de Chalco University Center. The central purpose was to formulate principles and strategies based on TRIZ theory to support the projects of students in the upper semesters of their academic program and facilitate their successful completion with patent applications before the relevant authority.

Preliminary analysis

The incorporation of diverse theoretical tools can significantly enhance the application of the TRIZ method; for example, systems theory, which can be applied to solve problems by articulating concepts that allow us to approach, understand, or transform reality. In contrast, traditional approaches that seek to solve problems from fragmented analytical perspectives have, over time, shown limitations and errors in their results; moreover, they have promoted excessive specialization within different areas of knowledge.

In this sense, Faludi (2013) argues that a problem arises when there is tension between a person's goals and their environment. Similarly, Matus (1987) states that the notion of a problem involves formalizing, for an individual, an incompatibility between observed or simulated reality and a norm that is created or accepted as a reference. In both cases, the problem is directly related to the person. For his part, Ackoff (1981) posits that every problem is composed of different elements that must be identified and analyzed to formulate consistent and relevant solutions.

Among the components identified by Ackoff (1981) are:

1. The actors responsible for solving the problem, those who have the ability to make decisions.
1. Controllable variables, susceptible to being modified by those facing the problematic situation.
2. Uncontrollable variables, which cannot be altered and which influence the results of any solution alternative.
3. Internal and external constraints, which limit the values or behaviors of both controllable and uncontrollable variables.
4. The possible results, derived from the joint interaction between the controllable and uncontrollable variables.

Defining a problem is a fundamental step in clearly establishing the direction of the analysis and outlining the actions necessary to achieve the established objectives. This identification requires recognizing the interaction of multiple causes that give rise to the problematic situation, as well as its direct and indirect effects, which allows for understanding its complexity and characterizing it appropriately (Estrada, 1996). Table 1 shows the interaction between three actions that facilitate problem-solving.

Table 1Three ways to solve problems

Optimization	Satisfaction	Dissolution
Selection of the values of the controllable variables that offer the best value of the result.	When at least one selection of the controllable variables allows for obtaining an acceptable solution.	When values or reference points are changed

Note. Ackoff, RL (1981). The art of solving problems . *El Nacional.*

Root cause analysis

Root cause analysis is an important problem-solving tool that focuses on improving systems and processes. It emphasizes analysis rather than assigning blame to individuals, aiming to pinpoint the root cause of the problem to resolve it and prevent future issues. This process consists of the following:

1. Define the problem to understand exactly what is wrong, where and when it occurs, and to what extent it deviates from the desired standard.

2. Identify the causes to gather different perspectives using tools such as observation that allows you to directly follow the process or brainstorming.
3. Analyze the process and determine which factors contribute to the problem to understand its causes using basic tools, such as direct observation, diagram mapping, or the five whys method (Acosta et al., 2017).

Problem-solving is an ongoing activity in all areas of professional and academic practice. From this perspective, a patent can be understood as the result of a process of identifying and addressing specific needs within a field of knowledge. Consequently, the development of patents derived from industrial design proposals in higher education institutions requires both interdisciplinary and multidisciplinary work among the stakeholders involved. It also requires coherent and aligned administrative procedures, as well as the application of methods that conceptually facilitate the generation, structuring, and implementation of these innovations.

Design process

In the Industrial Design Bachelor's program at the UAEM Valle de Chalco University Center, design courses are structured around the identification of problems and needs present in diverse productive, social, and technological contexts. Within this process, design methodology serves as a tool for acquiring knowledge through theoretical and practical activities, facilitating the conceptualization, planning, and development of products. The central objective of these learning units is to address and resolve issues related to sustainability, functionality, ergonomics, aesthetics, production, distribution, and marketing, among other aspects inherent to design. From this perspective, university projects are developed using various design methodologies, recognized as essential parts of the creative process and as mechanisms that allow for the systematic approach to addressing and solving problems.

The methods frequently used for innovation and creative activity in industrial design provide support in the planning, development, and registration of patents. Institutions such as the Autonomous University of the State of Mexico and the Autonomous Metropolitan University, among others, have worked on different styles, concepts, and strategies, including:

1. The design method is based on a logical sequence that begins with identifying the problem, followed by gathering and analyzing information, creatively generating ideas, experimenting, and verifying the results. Its purpose is to offer functional and efficient design alternatives; however, it has been noted that in certain contexts it can limit the creative process (Munari , 2016).
2. The General Design Process Model (GDPM) of UAM Azcapotzalco emerged as a unique methodological approach to design from an integrative perspective. This model proposes a work plan that articulates interdisciplinary approaches and departs from the linear or strictly sequential schemes that have traditionally relied on other disciplines. Its structure includes stages such as case analysis, problem definition, the development of a working hypothesis, the development of the design solution, and its implementation. The entire process is based on a critical, contextual, and transversal stance, aimed at directly impacting the transformation of reality through design. Despite its historical relevance, the GDPM has been questioned due to its limited updating in the face of the technological, conceptual, and epistemological changes characteristic of the 21st century (General Design Process Model [GDPM], n.d.).

3. The design process proposed by Bernd Löbach is structured around a sequence that includes problem analysis, the generation of alternatives, the evaluation of proposals, and their implementation. This approach is characterized as creative, iterative, and user-oriented, as it conceives of design as a form of applied research with a project-oriented purpose. From this perspective, the process involves deeply understanding the situation to be resolved, exploring diverse possibilities, and validating the developed solutions. However, the model has been criticized because it relies heavily on the designer's prior experience, which can restrict or bias some components of the learning process and limit the methodological development of those in the initial stages of learning design (Löbach , 1981).

4. The generalist design approach developed by Victor Papanek is based on the integrated evaluation of six fundamental dimensions: need, method, use, telesis, association, and aesthetics. This approach proposes a systemic vision in which design must respond to real-world problems while simultaneously considering social, cultural, and environmental factors. Its central aim is to generate relevant solutions that minimize ecological impact and promote responsible practices. Despite its

theoretical relevance, the model has received criticism because its strong ethical and social orientation is often perceived as difficult to implement in traditional commercial contexts, where economic interests prevail and limit its full adoption (Papanek, 1973).

5. The target method, developed by Oscar Olea and Carlos González Lobo, is structured around an analysis of a project's location, purpose, and economic conditions, integrating these elements with the evaluation of five components: functionality, environmental impact, expressiveness, structural integrity, and constructability. This methodological approach is based on a dialectical, logical, and deeply contextual framework, aiming to articulate the technical aspects of design with its symbolic and emotional dimensions. However, the model has been criticized due to the wide variety of factors it considers, which hinders its application in projects operating under time constraints or limited resources (Olea & González, 1977).

Framing a problem from the root cause, analyzing in detail the methodology to be used in the creative process and combining the general scheme that organizes the inventive process into systematic stages (Altshuller, 1984) to solve a particular problem, strengthens the possibilities of generating new patents.

The general framework proposed by Altshuller for addressing technological invention problems can be integrated with various design methodologies; however, this approach implies modifying how the designer conceives and approaches the project from its initial stages. Multiple methodologies exist for project development, and those previously reviewed facilitate the generation of alternatives and the articulation of traditionally employed methodological processes. In this sense, the first step in solving an inventive problem using TRIZ consists of precisely defining the specific need or challenge. Similarly, a comparable starting point is often observed in design methodologies:

1. In the design method proposed by Bruno Munari , the initial phase consists of the clear and precise definition of the problem, which guides the entire subsequent creative process.
2. In the general model of the design process developed at UAM Azcapotzalco , the case and the problem constitute the first stage and serve as a basis for structuring the design proposal.
3. In Victor Papanek's general design , the first stages focus on identifying and understanding the need.

4. In contemporary methodologies such as design thinking , the first step is to gain a deep understanding of the needs, followed by a second phase aimed at clearly articulating the problem through different strategies (Interaction Design Foundation, 2025; Creately, 2025).

In summary, all these methodologies agree in placing problem analysis and needs identification as the initial axis of the design process. Consequently, the designer must develop solid skills in these tasks in order to later interpret, adapt, and appropriately apply the TRIZ contradiction matrix.

An introduction to the TRIZ method

The correct solution to a problem depends largely on the approach taken at the beginning of the project. In the case of the Industrial Design degree program at the UAEM Valle de Chalco University Center, this process has not yet been systematized; furthermore, it has not been possible to begin by analyzing the different contradictions presented by TRIZ. These contradictions are classified into four main types:

1. Administrative contradiction: This occurs when the problem is formulated in terms of practical impossibility. For example, increasing output without increasing costs. This type of contradiction is often refined into technical and physical contradictions (Altshuller, 1999; Terninko, Zusman, and Zlotin, 1998).
2. Technical contradiction: This occurs when improving one component of a system worsens another. For example, reducing the weight of a metal component decreases its load-bearing capacity. This type of contradiction is considered key in the application of the TRIZ method (Altshuller, 1999; Mann, 2002).
3. Physical contradiction: This occurs when a single component of the system must have opposing properties to achieve the objective. For example, a material that must be flexible to avoid breaking and, at the same time, rigid to adapt to another component (Altshuller, 1999; Savransky, 2000).
4. Human contradiction : arises when a person experiences a block or resistance to change. There is a desire to improve an aspect, but at the same time there is fear of the change necessary to achieve it (Rantanen and Domb , 2010) .

In addition to the above, it is necessary to define the underlying problems stemming from the root cause. In this sense, the specific problems arising from the design of products and services do not fall under a structured methodology for technological innovation and the definition of contradictions according to TRIZ.

The TRIZ methodology can be understood as a systematic innovation system, as it allows for the analysis of the evolutionary trajectory of different technical systems and the identification of patterns that facilitate anticipation and promote significant advances in their development. It also provides guidelines for directing these systems toward more ideal states. In TRIZ, ideality is conceived as an inherent tendency of technical systems to evolve toward more efficient configurations; it is represented as the sum of all the useful functions of a system divided by the sum of all its harmful or detrimental effects (Altshuller, 1996). Its formulation is expressed as follows:

$$I = \frac{\Sigma FU}{(\Sigma EN + \Sigma C)}$$

Where (I) ideality: describes how perfect a system is, how many useful functions it presents, considering the costs and negative effects it generates.

Numerator ΣFU = sum of all useful functions that the system fulfills (desired results, advantages, benefits).

Denominator ΣEN = sum of all harmful effects (EN) and costs (C), which include money, time, risks, resources, energy, among others.

ΣC = Sum of the costs of the technological system.

The TRIZ methodology is a resource that allows designers, researchers, and institutions to systematically analyze innovative solutions developed by inventors internationally. From this perspective, TRIZ contributes to:

1. Recognize alternative solutions derived from a limited set of inventive principles and strategies;
2. Identify patterns and trends associated with the evolution of technologies;
3. Establish viable routes for solving a problem;
4. To transform undesirable or harmful elements present in a system into potentially useful resources; and
5. Detect contradictions or conflicts in design processes considered essential.

Problem-solving through inventive practices unfolds within a general methodological framework. In TRIZ, the process begins with identifying a need or challenge that currently lacks an adequate solution. Within this framework, technical and physical contradictions constitute the core of the problem, as they emerge when two design requirements, whether for a product or a process, are related in such a way that one negatively impacts the fulfillment of the other (López, 1999). Most technical difficulties incorporate multiple contradictions stemming from conceptual, production, ergonomic, or operational issues. These contradictions can be analyzed and resolved by applying the 40 principles of invention proposed by Altshuller. Table 2 presents a summary of the concepts associated with each of these principles.

Table 2. Altshuller's 40 principles of inventiveness

1 Segment	2 Extraction	3 Local quality	4 Asymmetry
5 Combination	6 Universality	7 Nesting	8 Counterweight
9 Anticipated counter-action	10. Anticipatory Action	11. Anticipatory precaution	12 Potential
13 Investment	14 Sphericity	15 Dynamism	16 Partial or excessive actions
17. Moving to another dimension	18 Mechanical vibration	19 Periodic action	20 Continuity of useful action
21. Pass quickly	22 Turn harmful damage into benefit	23 Feedback	24 Intermediary
25 Self-service	26 Copy	27 Use of cheap replacement items	28 Replacing a mechanical system
29 Use of pneumatic and hydraulic systems	30 Flexible membranes, thin films	31 Use of porous materials	32 Color Changes
33 Homogeneity	34 Rejection and regeneration of parts	35 Transformation of chemical and physical states	36 Phase Transitions
37 Thermal expansion	38 Rapid oxidation	39 Inert environment	40 Composite Materials

Note. Altshuller, G. S. (1996). And suddenly the inventor appeared: TRIZ, the theory of inventive problem solving. Worcester, MA: Technical Innovation Center.

Table 3 shows the technological parameters that clarify the path towards solving inventive problems.

Table 3. Technological parameters proposed by Altshuller

1 Weight of a moving object	11 Tension or pressure	21 Power	31 Damage caused by the object itself
2 Weight of a stationary object	12 Form	22 Energy loss	32 Manufacturability or ease of manufacture
3 Length of a moving object	13. Object stability	23 Loss of material	33 Ease of use
4 Length of a stationary object	14 Resistance	24 Loss of information	34 Ease of repair
5 Area of a moving object	15 Durability of a moving object	25 Waste of time	35 Adaptability or flexibility
6 Area of a stationary object	16 Durability of a stationary object	26 Amount of substance and matter	36 Object complexity
7 Volume of a moving object	17 Temperature	27 Reliability	37 Control complexity
8 Volume of a stationary object	18 Brightness	28 Measurement accuracy	38 Level of automation
9 Speed	19 Energy expended by a moving object	29 Precision in manufacturing	39 Productivity
10 Strength	20 Energy expended by a stationary object	30 External damage that affects an object	

Note. Altshuller, G. S. (1973). Algorithm of Inventive problem solving (ARIZ)

The general scheme for solving a problem addressed by technological inventiveness, according to Altshuller (1986), is structured in four phases:

1. Identification of the specific problem.
2. Definition of the contradiction to be eliminated.
3. Obtaining a generic solution using the 40 principles of invention.
4. Development of the specific solution applicable to the case.

In accordance with the above, a conceptual link is proposed between the professional practice of industrial design and the theoretical foundations of TRIZ. This relationship allows us to understand how the principles of the methodology can be integrated into the design process of the discipline. Figure 1 presents the sequence of actions that structure the procedure for solving inventive problems.

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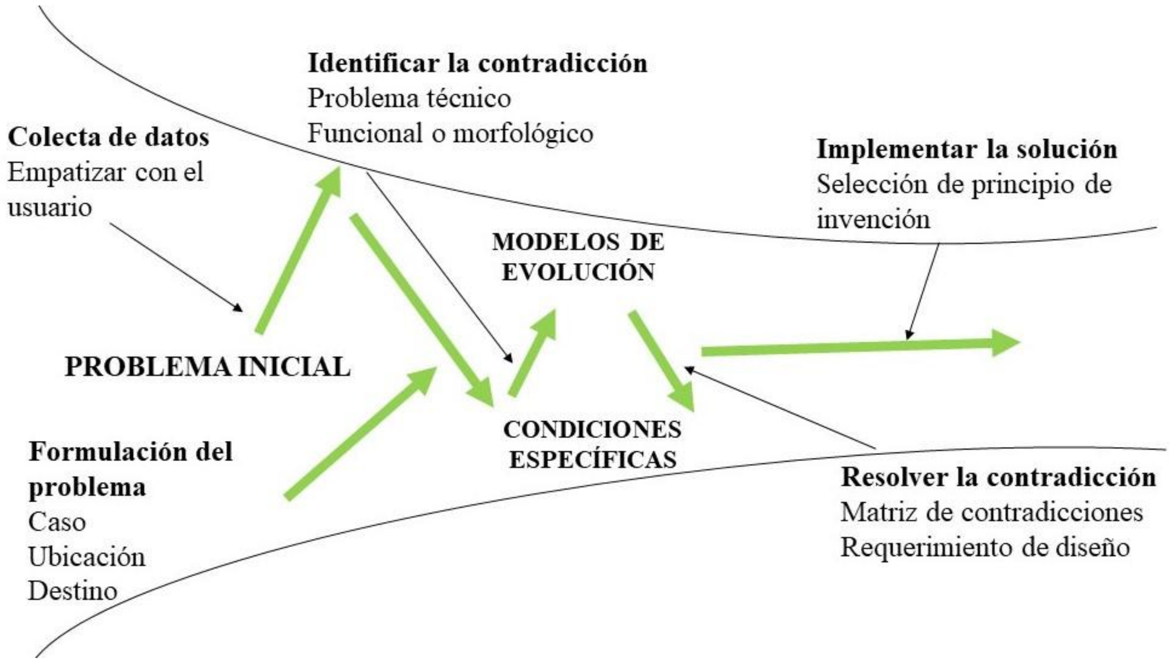
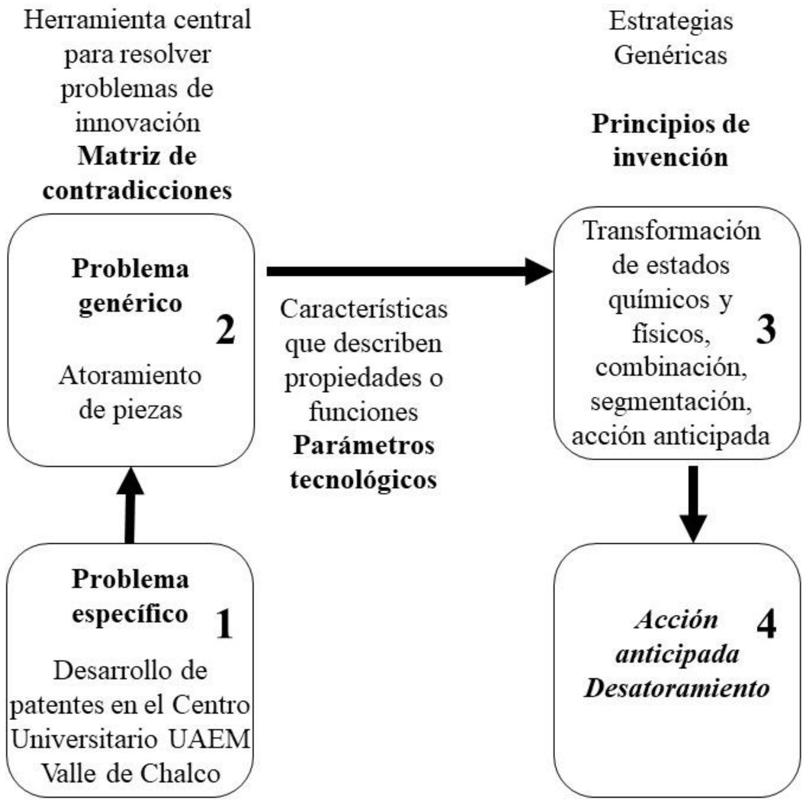
Figure 1. Conceptual parameters between TRIZ and Industrial Design



Note. Prepared by the author based on Rantanen and Domb (2010).

This process is linked to the practice of industrial design, which, from its initial phase, addresses important criteria such as ergonomics, aesthetics, production, sustainability, and distribution. This technique is similar in TRIZ because it works with important criteria related to the user and the object. However, the inventive or conceptualization process is the problem to be solved. Figure 2 shows the problem-solving stages according to TRIZ and the example of automotive parts transportation presented later.

Figure 2. TRIZ Phases



Note. Problem-solving stages using TRIZ based on Ames (2008)

Following each phase guides the designer in initiating a project. This process unfolds in a methodological sequence that allows for the creation of a practical solution to a technological challenge. The stages that comprise this sequence are described below:

1. Identifying the specific problem: This is exemplified in the patent development at the UAEM Valle de Chalco University Center. In this phase, the root cause of the conflict is located within the 39 technological parameters of TRIZ, which allows the problem to be reformulated and facilitates its addressing within a general framework.
2. Definition of the generic problem *:* in the case of jamming of parts, the matrix of contradictions is used to generalize the conflict, identify the main contradiction and enable the application of the principles of inventiveness.
3. Obtaining the general solution: This is achieved through the application of principles such as the transformation of physical and chemical states, combination, segmentation, and anticipatory action. These principles, when interwoven within a coordinated framework, offer systematic solution alternatives that can be adapted to the identified problem.

4. Development of the specific solution: This involves proposing a proactive unblocking mechanism. This phase entails defining an innovative solution through a structured creative process, aimed at addressing the original problem with a practical and applicable approach.

The contradiction matrix proposed by Altshuller was defined as a resource applicable to any type of contradiction, since it represents the problem as a conflict between two analogous parameters, regardless of the problem and its nature. The matrix is structured on two axes: a vertical axis (rows) and a horizontal axis (columns). The vertical axis shows the parameters that are to be improved (for example, the weight of a material), while the horizontal axis describes those that are negatively affected by said improvement. The point of intersection between both parameters indicates which of the 40 inventive principles of TRIZ can be selected to achieve the ideal state. Consequently, the matrix is based on these inventive principles, which integrate various alternatives for solving a given problem.

Phases for the application of TRIZ in Industrial Design

1. Solving a problem in industrial design begins with identifying its component elements. The discipline delves into, at a minimum, topics such as sustainability, function, ergonomics, aesthetics, production, distribution, and marketing; these are comprised of multiple variables. For example, ergonomics can refer to the sequence of use, comfort, and safety as relevant factors. In this process, it is pertinent to focus on one of the 39 technological parameters and relate it to the variable that arises from addressing the design requirements. According to Rodríguez (2011), these criteria allow for addressing quantitative or qualitative problems defined by the designer, according to the conditions that must be met to address the specific issue. The author also states that a problem is a point of view, the way in which it is conceived. However, the classification of requirements is comprised of the following categories: a) use; b) function; c) structural aspects; d) technical-production criteria; e) market conditions; f) formal factors; yg) identification elements, contributes to defining the problem more precisely.
2. Identify the interconnection between rows and columns of the contradiction matrix to define the inventive principle that makes it possible to give the general solution.

3. Analyzing in detail the inventive principles identified in the previously established interconnection allows for proposing alternative solutions that respond appropriately to the design problem.

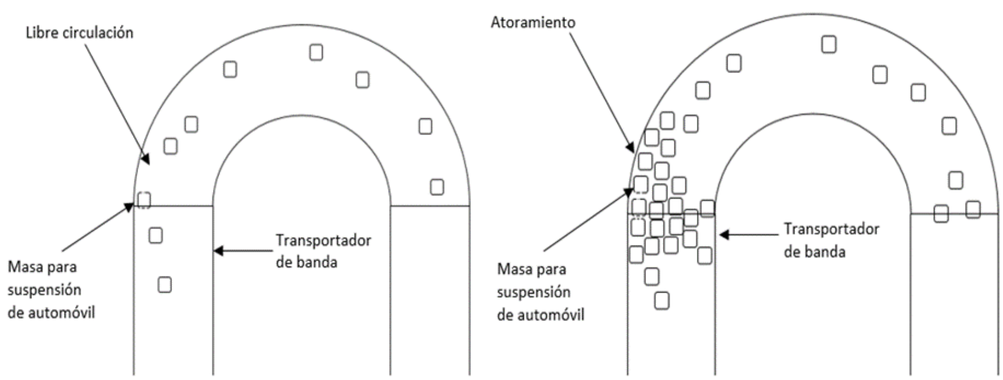
Therefore, applying the TRIZ method and integrating it with other disciplines not only facilitates the generation of more robust and well-founded proposals, but also broadens the analytical perspective to address problems from complementary viewpoints. Below is an example of how to interpret the method from a didactic approach.

Application:

1. Situation: In a factory, an automated belt conveyor is used to carry metal automotive parts (suspension mass) from one workstation to another, where they are assembled with brake discs.
2. Problem: They are propelled by an automated motor belt whose trajectory must change the angle of the conveyor curve, given that the parts get stuck.
3. The goal is to move more pieces in less time along the conveyor belt.

Figure 3 shows the metal parts getting stuck due to the curve of the belt conveyor.

Figure 3. Specific problem for the TRIZ application



Note: Original work

Table 4 shows the analysis of contradictions and the principles of inventiveness identified for application in solving the problem posed.

Table 4. Contradiction Analysis

Technical contradiction	Physical contradiction	Altshuller technological parameters	Altshuller's Principles of Inventiveness
Variable that improves *Measurement accuracy*	Physical variable that improves *Shape*	Identified parameter *28 - Measurement accuracy*	Identified inventive principles (35) Transformation of chemical and physical states; (5) Combination; (1) Segmentation; (10) Anticipatory action
Unclogging Benefit			
Variable that is affected *Control complexity*	Physical variable that is affected *Area of a moving object*	Identified parameter *35 - Adaptability*	

Note: Original work

Table 5 shows the inventive principle selected for solving the problem.

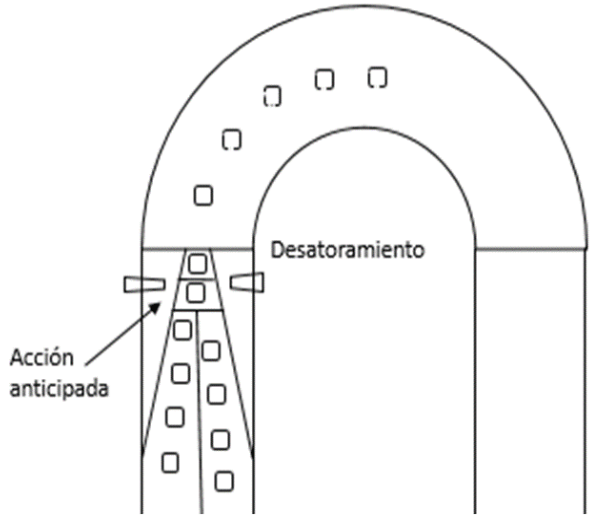
Table 5. Contradiction Analysis

Parameter that worsens / → Parameter that improves ↓	1 Weight of a moving object Reference to the matrix of contradictions	2, 3, 4 ….	28. Measurement accuracy
1 Weight of a moving object	Reference to the matrix of contradictions		
2, 3, 4…			
35 Adaptability or versatility			35 5 1 10

Note: Original work

The proposed invention focuses on Altshuller's principle (10), anticipatory action, which will allow for pre-adjustment of the direction of the automotive part (mass) and prevent jamming. Figure 4 shows the selected inventive principle.

Figure 4. Principle of inventiveness (10)



Note: Original work

The result promotes the state of ideality according to the method.

I = ΣFU/ (ΣEN + ΣC)

ΣFU = sum of all useful functions that the system fulfills (desired results, advantages, benefits).

1. It is desired that the conveyor belt (adjust the direction of the mechanical parts).
2. The mechanical part is intended to follow its path from station to station.

ΣC = Sum of the costs of the technological system (conveyor belt).

The total manufacturing costs are similar; the cost of the pusher, designed to operate in a demanding production process, and the belt replacement with guides are no more expensive than replacing the conveyor in its original structure. Therefore, it is proposed to install the pusher on the existing equipment using standardized tooling.

ΣEN = Sum of the harmful effects

3. Wear of the plastic band due to the coefficient of friction with the mechanical part.
4. Directional misalignment of the belt due to material deformation.

Discussion

Industrial design as a profession involves actions at multiple levels and stages of product development. The conceptualization of an object or system of objects adapts according to the needs and historical context of material culture. That is, in certain periods , the focus was on satisfying fundamental needs without regard for aesthetics. Over the years, some movements have centered aesthetics and form over functionality. The conception and production of objects were separated with the arrival of the Industrial Revolution; this led to unfinished, misaligned, and incongruous forms, substantially affecting the aesthetics of objects. This aesthetic was revisited by movements such as Arts & Crafts and the Bauhaus, which reconfigured mass production through functional aesthetics. All of this strengthened mass production, making the resolution of needs more practical. Currently, the symbolic intersects with technology, giving rise to discourses and initiatives focused on the anthropic, sustainable, inclusive, and identity-related (Crawford, 1997; Eisele, 2025).

Therefore, this area has great potential to strengthen patenting rates in Mexico; however, it has not been possible to develop and consolidate methods-based creativity models in the educational, business, and government sectors. Lack of awareness, insufficient intersectoral connections, and skepticism about the potential are some of the factors hindering the development of systematic innovation and, consequently, the technological development of the country. It is worth noting that in Mexico, systematic creation is not yet established in industry in general or in the educational sector, despite research that attempts to promote applied innovation through techniques such as forced relationships and combinations. Thus, the various sectors need a shift based on the development of new strategies for structured creative thinking (Rojas Morales, 2004).

Finally, disorganization and isolated efforts among academia, government, and the productive sector perpetuate shortcomings and a lack of proposals for growth in innovation and development. At the same time, insufficient funding for research and infrastructure projects focused on emerging technologies impacts the dissemination, outreach, and transfer of knowledge between sectors. In contrast, countries like China and South Korea have substantially increased their patents through diverse models of creation, evaluation, and improvement, interconnecting industrial design, intellectual property, and technological development (World Intellectual Property Organization [WIPO], 2025). Therefore, there is an opportunity for universities, government, and industry in Mexico to plan, develop, and consolidate programs that promote increased patenting rates.

Conclusions

Industrial design, as a creative project-based activity, must implement methods that facilitate the development and registration of new patents. Each project could undergo a detailed analysis of mandatory factors and requirements, which focus on prefiguring the concept based on the discipline's five pillars: a) ergonomics; b) aesthetics; c) sustainability; d) production; and e) distribution and sales. This analysis, through their interconnection, determines the conceptualization process that will give form and function to the new product or service. The TRIZ method, as a conceptualization tool, not only expands the possibilities for solving the problem but also increases the likelihood of generating knowledge transferable to strategic sectors with technological lags.

Future lines of research

Therefore, working towards structured creative thinking, national and international competitiveness, industrial design, and technological innovation is an opportunity to develop innovative programs in:

1. *Industrial design and sustainability*

   To delve deeper into projects through disassembly, circular economy, ecodesign and smart materials, considering the economically viable extraction of raw materials, economic viability and social equity.
2. *Models of systematized creativity applied to industrial design*

   Develop and validate creativity methods such as TRIZ, hypothetical distance thinking, design thinking, forced relationships and combinations in educational and business environments, by comparing the scopes for obtaining patents and industrial designs.
3. *Links between Academia, Industry and State*

   Determine criteria and strategies, taking as a reference documented international models to generate consensus through integrative public policies, tax incentives and technology transfer offices.

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