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Solving an engineering problem in shipbuilding by Triz method

A. Nocerino [(a)], M. Pappalardo [(a)], A. Pellegrino [(a)], F. Villecco [(a)]

[(a)] University of Salerno, Department of Industrial Engineering

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Corresponding author:
Arcangelo Pellegrino
Tel.: 089-964308
Fax.: 089-964037
e-mail:apellegrino@unisa.it
Address: Via Ponte don Melillo, 84084, Fisciano (SA)

Abstract

This work follows from an application of Triz theory to an engineering problem. The mounting and positioning of a logo-structure on the ship funnel, which seems to be a simple technical problem, might lead instead to a significant number of aesthetic, structural and shipyard organization problems. After a careful examination of the various solutions proposed, it was decided to analyze it by means of Triz methodology.
The analysis of technical reports and thanks to some works related to this field, we have obtained the solution of the problem with the help of software specifically devoted to organizing and managing information. This obtained solution has been used and tested in an European shipyard for a concrete shipbuilding problem.

1 Introduction

In recent years, the shipbuilding industry has reached one of the highest quality standard comparing with other sectors, thanks to the evolution of design techniques and the introduction of design software.
However, still some unexpected cumbersome problems arise when dealing with challenging singular ship stuff constructions. In the realization of a large ton ships, especially in building some dockyard parts, there appear many solitary problems mostly solved thanks to the operators experience.
In this work, a real problem from the many dockyard constructions is selected and an optimal solution is given by using a modern design methodology based on Triz Theory[10,12].
By examining some anomalies arisen during the construction and assembly, we have focused on the problem of positioning and fixing the shipping company logo on the ship funnel. This apparently trivial operation, has been responsible for a significant delay in the realization of the ship, because the usual technical solution didn't consider some logo's structural problems.
In the following we will propose the solution of this problem by using Triz Method.

2 Triz theory

Triz theory uses a systematic approach to solve any problem from a common base. That method is eligible to transfer solutions from a field of science and technology to another one. The typical pattern is shown in Figure 1

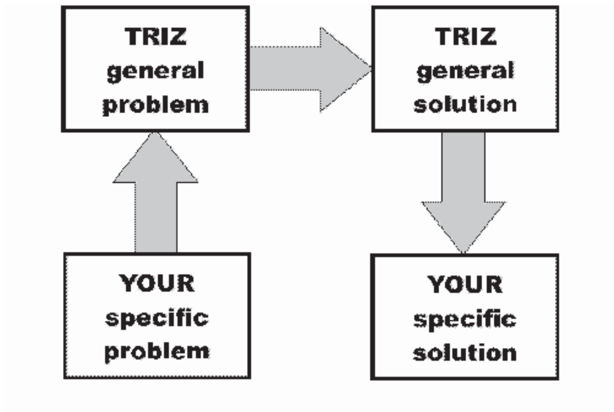

Fig. 1 TRIZ Method[7].

Sometimes the designer, for a "psychological inertia" or for an insufficient knowledge, doesn't find the right steps to find the solution to the problem. To overcome these difficulties, TRIZ methodology uses the abstraction of the problem, based on a model that provides a range of problem-solving principles from which comes out the better solution. The TRIZ methodology shows that the suitable solutions come out when the designer can overcome the compromises generally accepted as inevitable constraints. Instead it's right identification and the overcoming of the contradictions that lead to adopt compromises which give us innovative and effective solutions. The contradictions are the main points of the Triz theory. Expressing a good contradiction allow us to reach the focus of the problem and to find the best solution quickly. If there aren't any contradictions the inventive problem doesn't exist it isn't necessary to use the Triz method.
The theory is based on 39 engineering parameters to be considered in the design stage, thus carry out a matrix with 39 rows and 39 columns. In that matrix the intersection of a parameter with the remaining 38 gives

rise to inventive principles. These principles are 40 and usually overcome the contradiction and solve the problem. They are simple, obvious and not debatable.[8-12]

3 Analysis of shipbuilding solutions

In the search of methodologies, concerning the design, have been analyzed several publications in the naval field. By analyzing these papers it has been immediately carried out that every author has proposed a specific solution to a specific naval problem [1-6]. This statement is evident but we can note that we have the same kind of problems recurrently. In particular, this we have seen it, after a bibliographic research in the ship design where we have classified the various types of solved problems.

It's important to note that in a field where the designer works on a large ton ships there aren't any design methods that can automate or optimize the design. For example to realize a medium-sized ship it takes about 12 months, but part of this time is spent in the search for solution of tolerance problems, such as the non-synchronism of the worker teams. Infact, just a little mistake, during the design phase, implies a change in a specific area that can take up to 10 working days. The design error is solved closely thanks to the operators (carpenters and engineers) experience who are in the shipyard. Therefore it would be natural to think about the prevention of such mistakes, but this is not a simple task because many variables have to be consider. This is an example of the problems that usually happen during the construction and assembly.

The idea to solve these problems is to apply the Triz method in that field analyzing the contradictions and finding the right inventive principles suitable for our case

4 Case study

Let us consider the positioning and fixing the shipping company logo on the ship funnel (see Fig. 2).

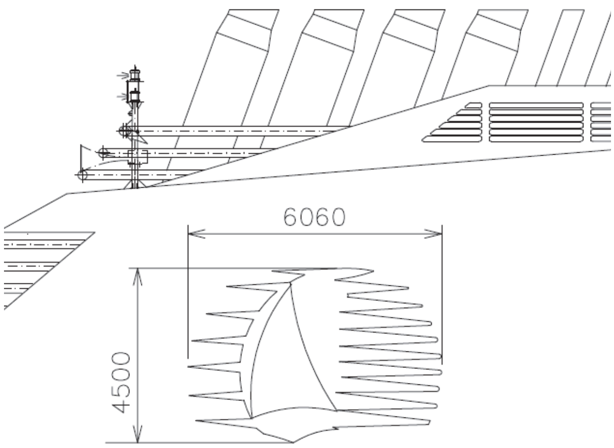

Fig. 2 Ship funnel.

As we can see from the dimensions shown in Figure 2 the most evident engineering problem is the lifting up the object. The logo is made by aluminum and it has a very high arrow (Fig 3). Even if the only problem would be represented by the weight load, it is very hard to lift the object directly along with the vertical also because it has been assembled horizontally. Therefore, we have tried to solve this problem by using the Triz method.

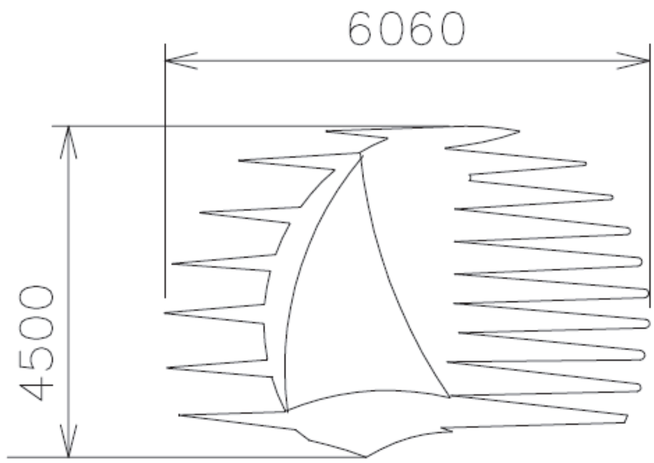

Fig. 3 Logo.

During the preliminary design step, it has been estimated that the aluminum rods to be used have dimensions 80 mm wide by 6 mm thickness, these bars were cut to be placed along the contour of the figure; In order to fix the bars over the logo there were necessary some weld beads of 5-6 cm length every 30 cm on both sides (Fig 4).

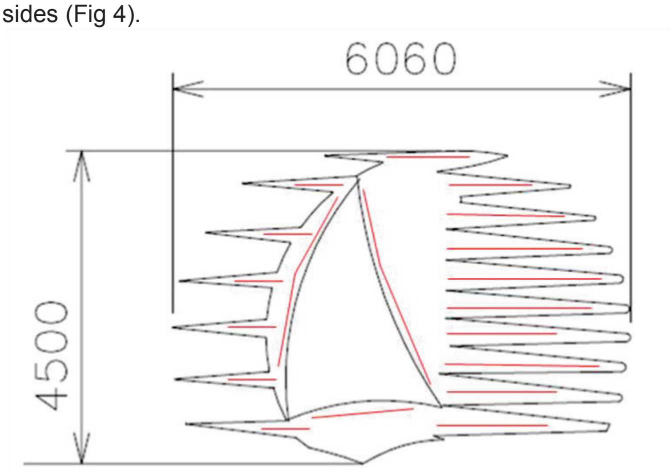

Fig. 4 Weld beads positions.

However, the design was wrong, because the wings of the structure were too long to be held in the right position by the bars because only the force of gravity was flexing the frame. Furthermore, the welding spots were too close each other, so there was an increasing of the costs for the welder and a significant deformation of the logo due to the high temperatures generated in the material (Fig. 5).

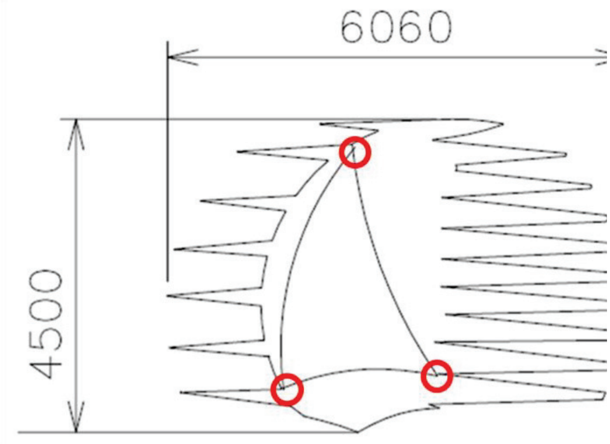

Fig. 5 Deformation points

To find a better solution we have applied the Triz theory. After the examination of the complete list of contradictions (totally 39), we have chosen the following ones:

- Weight of the moving object;
- Length of the moving object;
- Area of the moving object;
- Shape;
- Strength.

From the examination of the contradictions matrix we have a number of general solutions which are called “inventive principles”. We usually have three or four principles every intersection. In figure 6 it’s shown an intersection of the contradictions, “weight of the moving object’ and ‘area of the moving object’ that give us four inventive principles.

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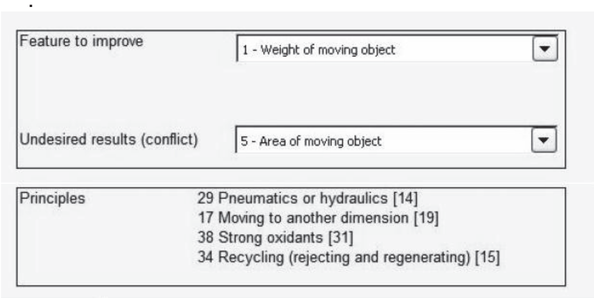

Fig.6 Table of contradictions (Tennant 2003).

Analyzing these inventive principles, that are carried out from the matrix, after the intersection of all contradictions chosen, it has been made a selection, because some of them didn’t fit well to the dynamic design of the problem.

The selected principles are reported as follow:

- Local quality: when a system is uniform and homogeneous to make it uneven; change things around from non-uniform to uniform system; allowing each party system works best locally; allowing each part of the system to perform various useful functions.

- Asymmetry: where a system is symmetrical and contains lines of symmetry change into an asymmetric system; change the shape of an object to suit external asymmetries; if an object is asymmetrical increase the degree of asymmetry.

- Merging: bring closer together (or merge) identical or similar objects, assemble identical or similar parts to perform parallel operations.

- Anti-weight: when the weight of an object causes problems, combine it with something to counterbalance.

- Preliminary action: Perform, before it is needed, the required change of an object; Pre-arrange objects such that they can come into action from the most convenient place and time.

- Another dimension: To 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, lay it on its side.

- Parameter changes: change an object's physical state; change the concentration or consistency, change the degree of flexibility; change the temperature; change the pressure. [10]

By merging all the information, it has been developed a solution which uses a temporary support structure; Observing the different possibilities of logo positioning, it has been seen that was possible to fix the logo to the funnel by some “C”-shape iron brackets. These brackets were bolted to the logo and were welded to the funnel. The temporary support structure was made up of three bulbs of iron spot-welded on the brackets that would later be easily removed with the aid of a flap disc.

After a careful analysis of all features, which characterize this logo, we agree to use some structures set diagonally behind the object. See detail in the following figure (fig.7).

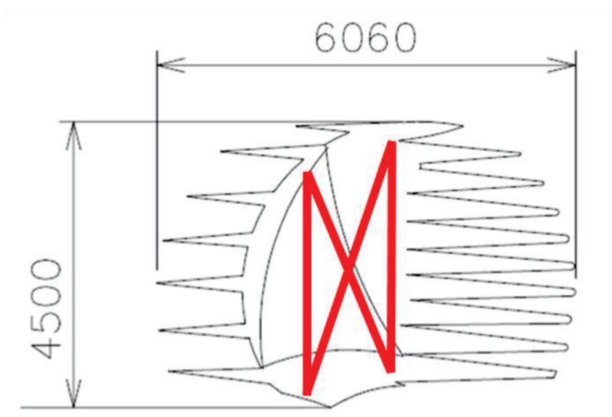

Fig.7 Final solution.

5 Conclusion

The Triz method has been chosen to solve an old problem with a different and innovative approach. By using Triz method it has been shown that heuristic methods are the natural evolution of a theory into systematic problem solving design and construction. The case study is certainly an example where the lacking of experience on the problem solutions has suggested a new approach, although the system was highly complex. We believe that this method is applicable to various technical fields of design and construction, which up to now were ruled by more classical methods

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