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THE HISTORICAL HERITAGE: A TOOL IN THE ABSTRACTION PROCESS IN THE MODERN DESIGN

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1. Introduction

The abstraction process is very important in modern and innovative design, since it is a possible means to overcome the designer tendency (that Altshuller called "psychological inertia") to follow well know procedures and solutions, instead of inventing new solutions.
A lot of other means have been proposed to solve this problem:

- Morphological matrix
- Brainstorming
- Design for functions instead than for objects
- TRIZ

In this paper, the authors will develop some considerations and make some proposals about the role of the historical evolution study of constructive solutions in overcoming designer psychological inertia.

2. Technical requirements

A logical schema of the conceptual procedure to embed the historical heritage in the design process can be derived from the TRIZ general schema (Figure 1) [Altshuller].

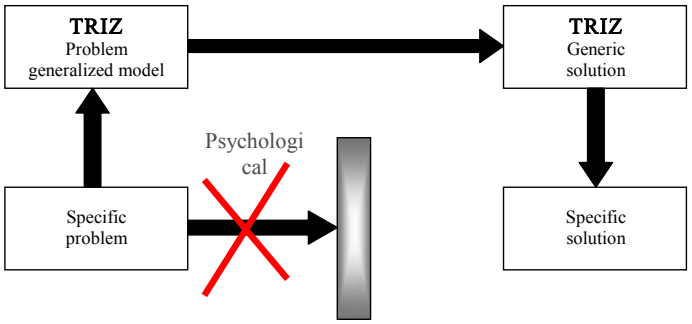


Figure 1. TRIZ Scheme

The first and fundamental point of the TRIZ method is to generalize the given problem, instead of searching for a specific solution. The second step consists in finding a general solution to the generalized problem. This solution should then be particularized in the specific given field [Michalewicz 2004] [Orloff 2002].
Figure 2 shows the design process schema conceived starting from these concepts.
The specific problem could also be solved by direct personal experience of the designer: this way is often followed, but it probably leads to the "ancient way", without innovation.

The proposed way to help the designer to formalize and generalize a specific problem relies on an archive of historical solutions. A search based on appropriate keywords in the archive of historical constructive solutions will lead the designer to the individuation of the historical evolution of the specific problem solutions.
Studying this evolution, the designer can reach two important goals:

- single out the typical problems that could arise solving the specific problem;
- derive the general principle, following an abstraction process.

After this steps of the design phase, according to the TRIZ method, it is possible to find a general solution, and then, with a concretisation process, to design a specific solution.

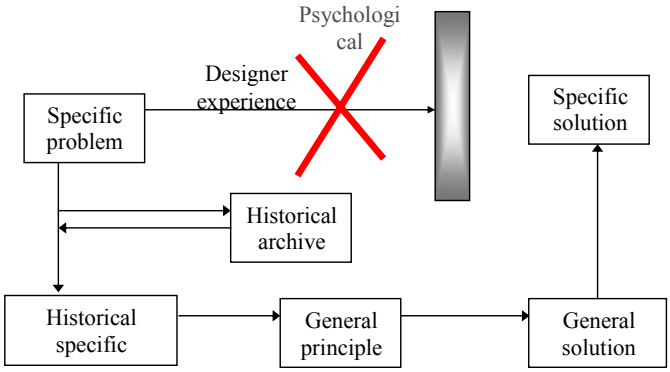


Figure 2. Logical schema of conceptual procedure to utilize the historical heritage

3. Example

As an example, we consider, as general problem, the level adjustment of a car suspension by means of mechanical devices.
Biggioggero and others realized an electronic archive [Biggioggero 2003] of a huge amount of car suspension constructive solution. Figure 3, extracted from [Biggioggero 2003], shows a German patent (1940), with a mechanical system to adjust the level of car suspension: this patent is an example of historical specific solution. Starting from the specific principle used in this solution, a general principle can be derived: vary the connecting point of the spring to the frame. According to the general problem, the displacement of this point has to be obtained by means of simple mechanical systems (Figure 4).

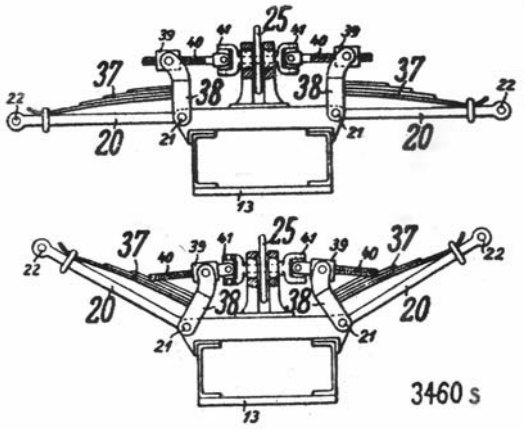
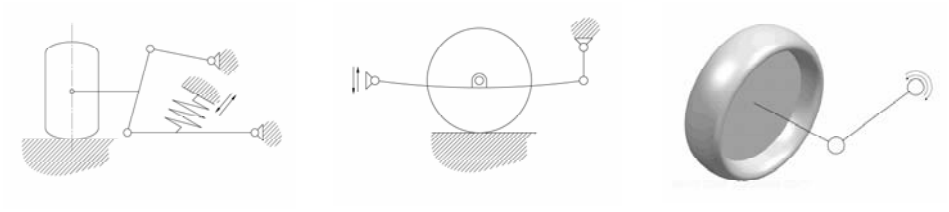


Figure 3. A mechanical system to adjust car suspension level (German patent, 1940)



(a) (b) (c)

Figure 4. Sketches of some solutions

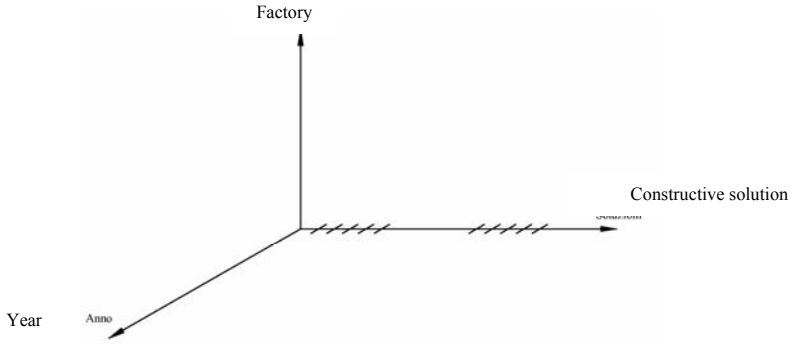


Figure 5. The "search-space": factory – year - constructive solutions

The highest level of archive organization is based on three orthogonal variables: the year when the solution has been conceived, the factory that manufactured the solution, and the solution type. This archive structure suggested us the geometrical representation depicted in Figure 5: factory, year and constructive solution are the coordinates of the ideal three-dimensional search-space.
Since we are interested in finding the evolution of specific constructive solutions, among all the solutions stored in the archive, the search-space has been sectioned by means of some planes; each of them corresponds to a constructive solutions that we are interested in (Figure 6). The found solutions have then been ordered on the basis of the other two variables. For example (see Figure 6), for a specific year, we pointed out the factories that used the constructive solutions that we are studying. The so obtained collection of constructive solution could be a useful basis for further analysis, in order to avoid already known and solved problem, or for a new synthesis, as to say for the design of a new solution that sums some of the positive aspects of each solution.

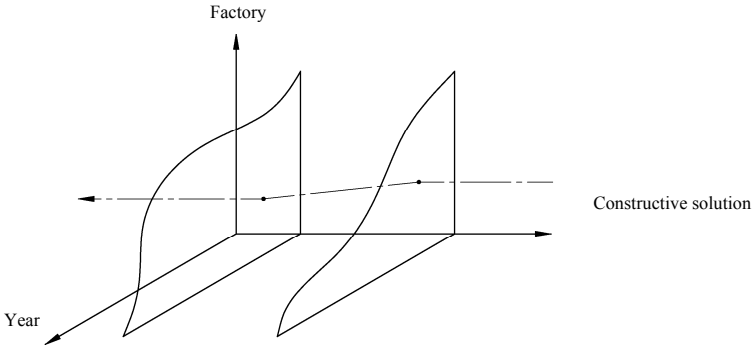


Figure 6. Search-space factory-year-constructive solutions sectioning by means of planes corresponding to given constructive solutions (Solution = constant)

In the above-mentioned archive, we found some solutions of suspensions with transverse arms and longitudinal torsion bars: Figure 7, Figure 8 and figure 9 show some examples.
Figure 10 shows a specific constructive solution that applies this general principle: the displacement of the point connected to the frame of the torsion bar is a rotation, electrically actuated by level and screw-nut system.
Figure 11 shows another example of constructive solution: a helical spring with the possibility of mechanical displacement of the fixed section of the spring self. The innovative characteristic of this suspension is the system built up by the longitudinal arm and the helical spring: one of the ends of the spring is rigidly connected to the chassis, while the other one is rigidly connected to the longitudinal arm in order to realise a mechanism based on the schema shown in Figure 4 (a).

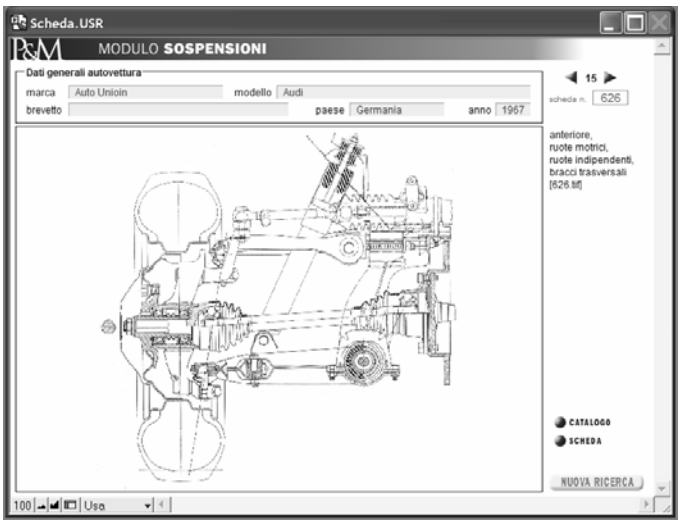


Figure 7. Audi AutoUnion suspension (1967)

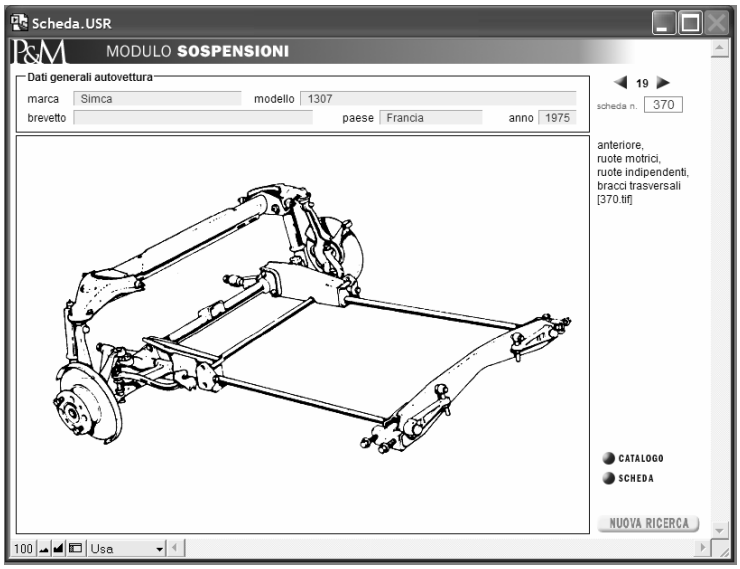


Figure 8. Simca 1307 suspension (1975)

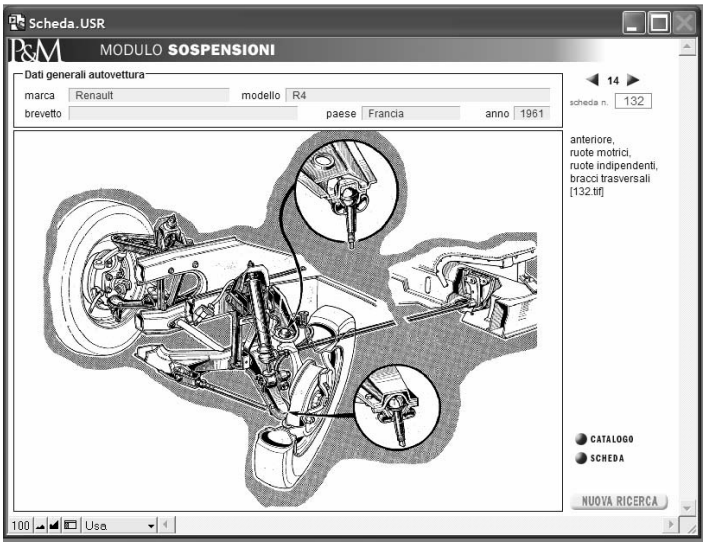


Figure 9. Renault R4 suspension (1961)

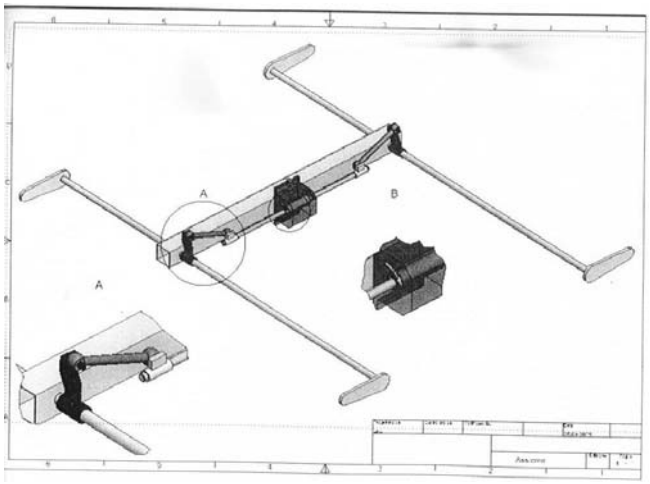


Figure 10. Torsion bars with level adjustment

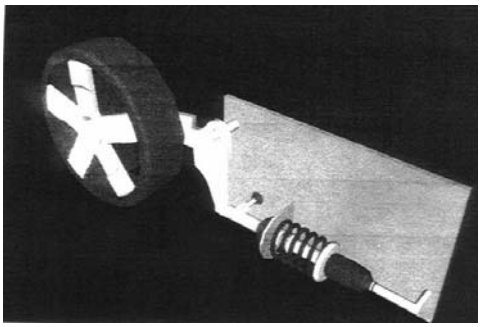


Figure 11. Helical spring with mechanical level adjustment

4. Historical evolution of constructive solutions

As stated and showed above, the historical heritage, after some critical considerations, could be an interesting complement to the TRIZ. The main problem of this integration is the formalization of the historical heritage. In order to solve this problem, it is useful to realize historical evolutions of correctly formalized constructive solutions.
The logical layout followed during the constitution of the suspensions archive [Biggioggero 2003] could be a basis.
The fundamental steps followed in the realization of the car suspension archive are summarized in the following list:

1. individuation of the constructive solution to be investigated and, eventually, of the factory, or period of construction, or country;
2. individuation of the sources: museums, archives, libraries;
3. individuation of the cases of interest;
4. scanning of the images of the found and selected cases (the objects in museums should be photographed);
5. informatic restoration if necessary (many, particularly ancient, drawings has damages, that makes difficult to read technical informations);
6. determination of the database field and records to be linked to each image. This data-base should be, in general, composed of two different levels:
    a. information about the image: type of projections, hand drawing or CAD, black/white or colour, and so on;
    b. information about the represented object: general and component functions, principles and constructive solutions of each function;
7. link between drawing and database.

5. Conclusions

The importance of a critical analysis of historical heritage in the modern design has been underlined.
Furthermore, this analysis could be also an interesting complement to the TRIZ method.
In order to establish a bridge between these two research fields, it is then very important to determine a method to realize historical evolutions of constructive solutions, as reference database to the modern design activity.
The authors hope that this present paper will be the starting point of discussions and development in the research on design methods and its integration with the engineering history.

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