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THE USE OF HISTORICAL DATABASE IN ENGINEERING EDUCATION

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1. Introduction

Modern engineers have to acquire more and more widespread information and knowledge which concern not only the traditional topics (i.e. Mechanics, Physics, etc.) but also regard different fields, such as marketing, economics, psychology, law and so on.
Furthermore, the development of software and computer facilities brings people more and more to informatic studies; but, even though the knowledge of such tools allows us to reduce time and consumption of "resources" in many activities (i.e. calculation), on the other hand it also carries the risk of belittling designers' "natural" skills, for instance: the tendency to follow "short cuts" in finding solutions and problem solving, or the lack of knowledge about engineers language and rules, which makes the designers "weak" in facing problems in different contexts.
It is clear, then, that the an in-depth education in the Design field, which helps students to understand both prescriptive and descriptive rules of design language, in order to increase their creativity and skills in problem solving, is needed.
In such a context, the study of technical solutions from past experiences represents an useful support for the present research work in the engineering design field, both from the formative and from the informative point of view. The goal of the paper is to describe and discuss the experience in introducing specific topics regarding the technical-historical heritage, within the methodical design theory teaching, both at Politecnico of Milan and at University of Rome "La Sapienza".

2. Background and motivations

In recent decades, the importance of the already existing solutions and experiences, in particular the ones considered surpassed, has been the more and more undervalued in engineering education field, because of the increasing number of technical disciplines and specializations, and because of the great variety of technical systems nowadays available.
On the other hand, as shown by many Authors in the field, the study of technical solutions from the past can contribute to enrich the designer's basic knowledge not only because some "old" solutions might be useful even now, but also because some ideas, which could not be applied in the past, might be feasible today, thanks to technical and technological progress (e.g. a typical example is the bicycle designed by Leonardo da Vinci, Figure 1, which represents first example of chain drive).
The study of the already existing solutions also represents the basis for several successful creative problem solving approaches (the TRIZ method developed by Altshuller, for instance, is based on these criteria).

Even if the role of the modern designer has significantly changed in last decades, his approach in problem solving can always be schematized as: “*to carry out constructive solutions to perform certain functions, respecting given bonds*”.
On the basis of this simple axiom, the research work carried out was focused on the study of the knowledge regarding constructive solutions from the past, as a tool to improve the background of design engineering students.

3. Methodology

With this aim in mind, an analytical study of the technical solutions concerning machine design in the last centuries was carried out: the aim of this part of the research was to define a clear classification of constructive solutions, pointing out their main aspects, such as the aim of the machine/technical system; the technical principles which characterize the machine; the embodiment solutions.
Secondly, the study concerned the introduction of both the classification criteria, and the technical solutions in suitable examples for students, according to the “Theory of Mechanical Systems” pri

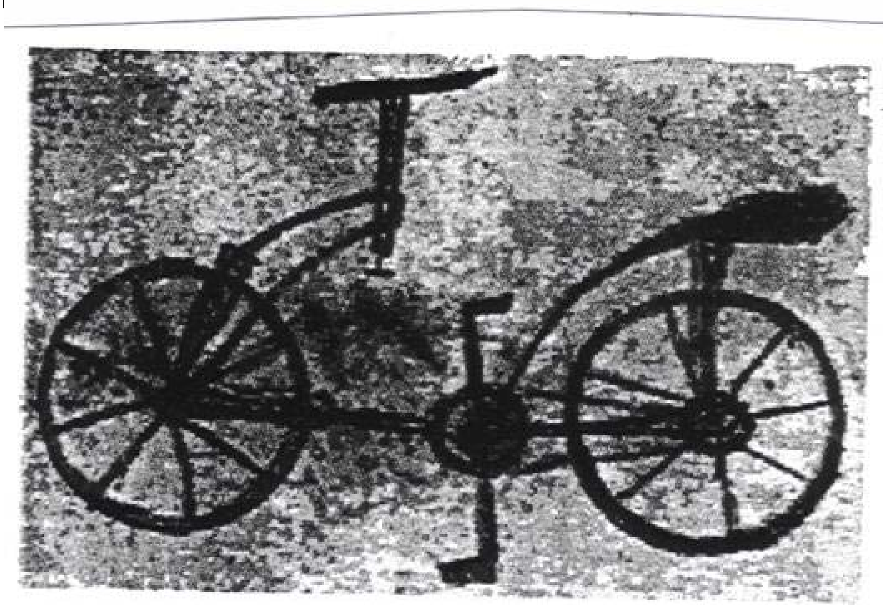

Figure 1. The bicycle by Leonardo da Vinci (XVI century).

In order to obtain this, it was necessary to determine the historical evolution of constructive solutions of machines.
Such constructive solutions can be an interesting tool for students (in Engineering and in Industrial Design) to learn a research method, to critically analyze the “how” and the “why” of the constructive choices in the past and to find “new” solutions, by considering past constructive experiences and historical heritage.
The fundamental steps of the determination of the historical evolution of constructive solutions are, in general, as follows:

- **a)** The determination of the constructive solution to be investigated (in terms of function and/or constructive characterizations);
- **b)** The singling out of references concerning the historical and social context, the country, etc.;
- **c)** The determination of the sources (museums, archives, libraries, etc.);
- **d)** The individuation of the most relevant solutions;
- **e)** A detailed reproduction of the selected cases (e.g. in most cases, objects from museums can only be photographed, since they require particular care);

f) The informatic restoration, if necessary, of the damaged drawings;

g) The individuation of the data-base to link with each image. Such data-base can be considered to be constituted in two parts:

g.1) relative to the image (type of image, such as photo, drawing, 3D model), type of applied projection(orthographic, axonometric, prospective), white/black or colours, hand or computer drawing)

g.2) relative to the contents of the drawing(general and component functions performed by the represented object, principles and constructive solutions of each function).

It was also necessary to develop criteria to select suitable keywords in order to have an easy to use access to the archive.

An experience was applied to the car suspensions: an archive of about 500 cases was studied and realized.

The **g.2)** part of the data-base contains the following data:

1. general data of the product (such as: make, model, year, country, etc.)
2. general data of the constructive solution (position: front or rear; motive or not motive wheel, etc.)
3. couplers (rigid axle, independent suspension: transversal arms(single or double), longitudinal arms(single or double), oblique arms (single or double), MacPherson, multilink, etc.)
4. Elastic organ(helical spring, torsion bar, leaf spring, air spring, rubber spring, etc.)
5. Shock absorber(mechanical, rotate hydraulic, telescopic hydraulic, etc.)
6. Anti-rolling devices
7. Anti-pitching devices
8. Levelling devices
9. Controlling devices.

Some examples and applications are now presented.
In Figure 2 some sketches are presented. They are made by Vincenzo Lancia and Battista Falchetto (1919-20), by developing the first constructive solution of independent suspension. The developed type was the 4th on the second column and was realized on the car Lancia Lambda(1922)(fig. 3).
Note that in the sketches it is possible to recognize some solution with double transverse arms that were generally adopted after many years: in the first application, the Fiat 508 (1935) (fig. 4).

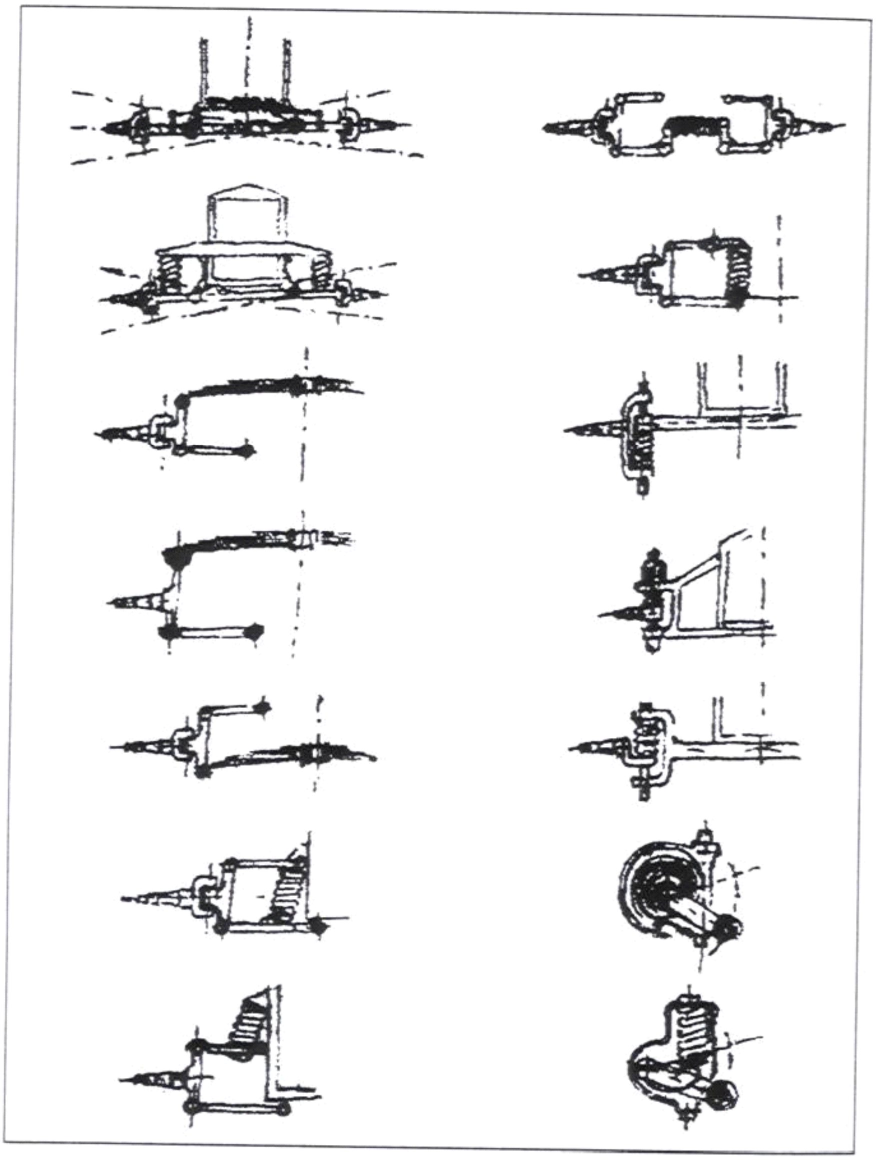

Figure 2. The sketches of front independent suspensions by Vincenzo Lancia and Battista Falchetto: some types are an anticipation of modern double transverse arms suspensions.

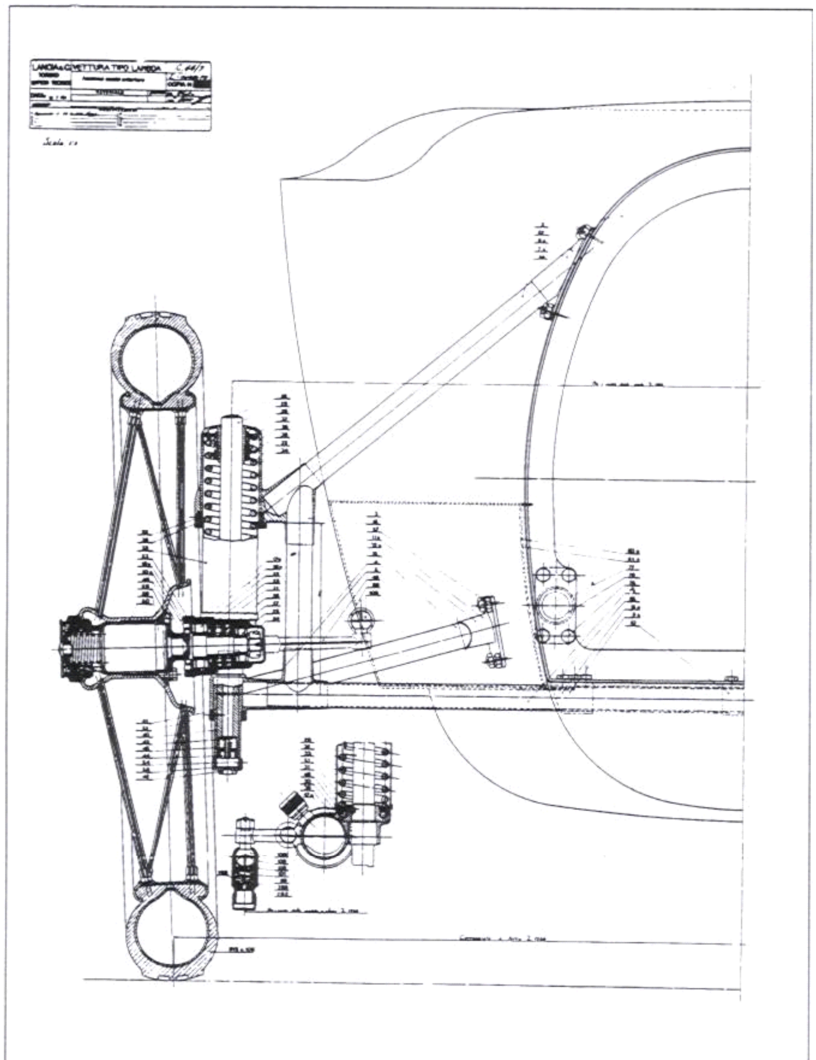

Figure 3. The Lancia Lambda (1922) front independent suspension

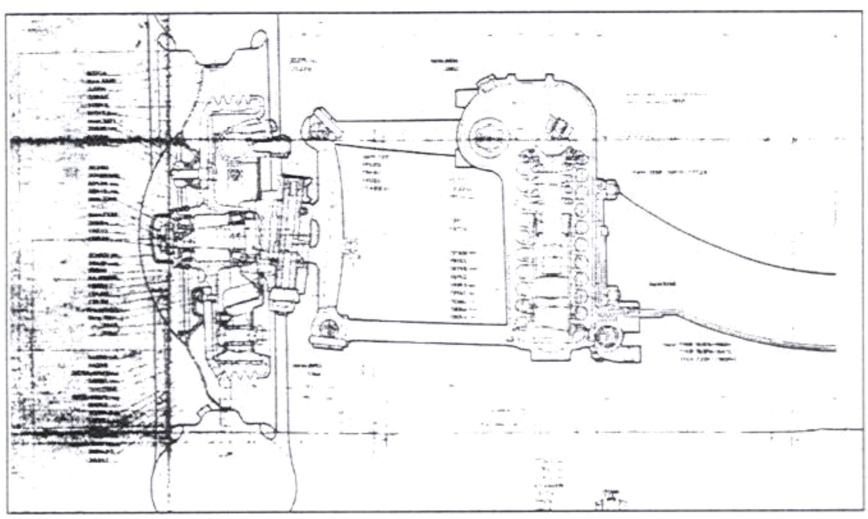

Figure 4. The Fiat 508(1935) independent suspension: the adopted constructive solution is the double transverse arm.

An other example is illustrated in Figure 5: the represented suspension is a Fiat patent (1926) that anticipates the MacPherson constructive solution (first applications in the 50s).

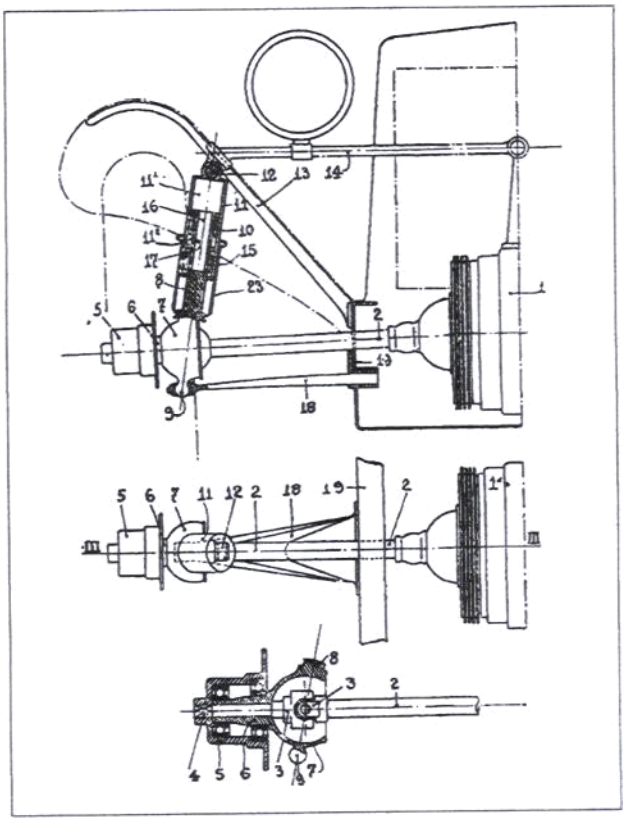

Figure 5. FIAT patent (1926).

3. Key Conclusions

The classification of numerous technical systems and the definition of the innovative ideas and technical solutions were carried out: these results were analysed and implemented in a technical database throughout the use of ease-to use checklists. From a didactic point of view, students were stimulated in designing mechanical systems, following the rules of Methodical Design and using them for developing innovative solutions.
The first results of such an experiment showed an increase of new ideas in students projects and an improvement in understanding both design principles and technical issues.
An example of didactic application is in figure 6. The represented object is a suspension with levelling possibility, inspired by a German patent(1940).
At Politecnico di Milano in this academic year(and at University of Rome “La Sapienza” it is programmed in future) there will be a “History of Mechanics” course.
The aim of this course is the application of the described methodology to the systematic realization of the historical evolution of machines. Such an evolution, could be critically analyzed using design methodologies, such as TRIZ method.

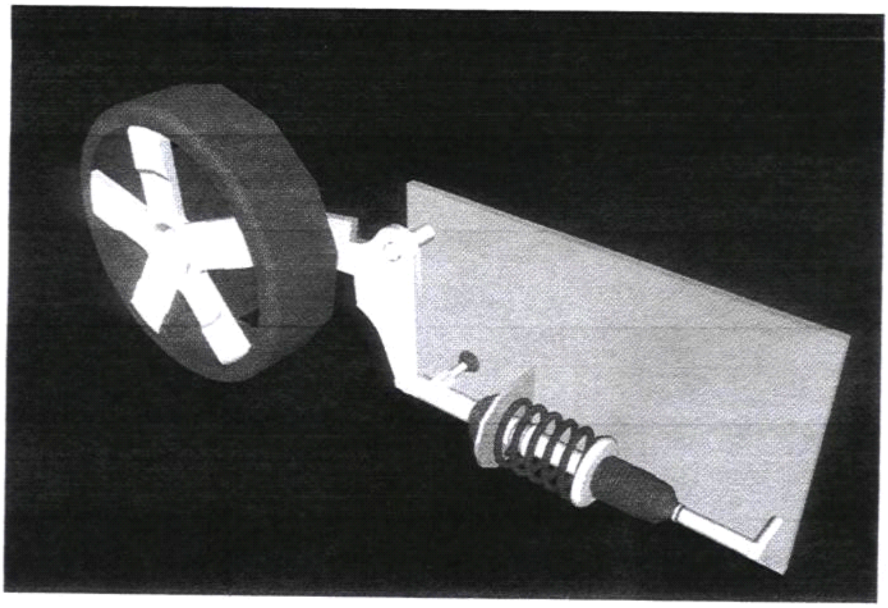

Figure 6. Didactic application inspired from the suspensions historical archive.

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