Abstract

CLASSIFICATION OF SOLVING PRINCIPLES FOR SHAPE CONTRADICTIONS

This work, performed in the laboratory of Methods and Techniques for Innovation of the University of Florence, is part of the project PROSIT - "*Dall'innovazione allo sviluppo prodotto integrato*", and focuses on the part of this project providing for the development of a process that allows a concerted use of methods for systematic innovation and tools for structural optimization. The starting point is the observation that, when an object must be optimized to meet various operational and functional specifications, a single optimization process leads to a compromise solution. The methodology proposed by the project to prevent this, is to submit the model to a number of “single-goal” optimization process, identifying in this way the design parameters in conflict with each other and then change the starting model (using methods of systematic innovation: TRIZ), finally submitting it to a new optimization phase, repeating this process until there is no more conflict between the design parameters and the solution is not a compromise solution but the optimal one.

This thesis aims to identify specific guidelines to support the designer in the modification of the model to be submitted to the optimization process, looking among the inventive principles of the method TRIZ, for their simplicity and immediacy of use even for a designer that is not familiar with TRIZ.

The research was divided into 4 phases:

1. Finding case studies:

   Objects that in time had been subject to an evolution in their shape have been selected, using patent-search engines.

2. Analysis of problems:

   There was an analysis of the found case studies, first of all assessing the maturity for a more comprehensive vision: then consulting patents, it has been identified the problem solved by the introduction of the new shape. Every problem has therefore been modelled using the first steps of the Algorithm for Inventive Problem Solving, ARIZ85C. For each of them, therefore, have been identified the system components, has been defined the "mini problem", specifying the technical contradictions, and finally has been built its graphical representation.

3. Analysis solutions:

   Through a backward process, evaluating the solutions outlined in the patent, it have been found the principles that, when applied to the problems, would lead to them.

4. Finding correlations:

   It has been prepared an initial classification of the different types of contradiction identifiable in the course of the optimization phase:

   - *"Size" contradiction*: pertaining to lengths, areas and volumes, and then distinguished in 1D, 2D and 3D
   - *"Shape" contradiction*: on the geometry of the piece;
   - *"Topological" contradiction*: related to the distribution of the material in the piece or to the position and orientation of the features composing the model.
   - *"Constraint" contradiction*: related to areas of the piece called "invariant”, because they are not involved in the optimization process.

   The next step has been the identification of correlations between the inventive principles relating to solutions and the characteristics of the problems analyzed, like the kind of contradiction, the graphic model and maturity, not only to provide an initial selection of the most suitable inventive principles to the solution of conflicts identifiable during the optimization phase, but also to create a guide to the selection of the most useful among these.

With this work, although the number of case studies taken into account does not allow a full statistical validation, it was identified a preliminary list of inventive principles for the solution of

contradictions identifiable during optimization process, and especially it has been developed a method with which to proceed in the future to extend the list of sample cases analyzed and create a more comprehensive tool that could be directly integrated into structural optimization software.