

主 論 文 要 旨

論文題名 Application of computational intelligence to engineering design problems in architecture-*firmitatis*, *utilitatis*, *venustatis*

ふりがな ざびつき まち だにえる
氏名 ZAWIDZKI MACIEJ DANIEL

主論文要旨

Over two millennia ago the Roman architect Vitruvius formulated the three principles of architecture:

1. Durability (L. *firmitatis*) - it should stand up robustly and remain in good condition.
2. Utility (L. *utilitatis*) - it should be useful and function well for the people using it.
3. Beauty (L. *venustatis*) - it should delight people and raise their spirits.

Presently, the first two problems belong entirely to the field of engineering design, and the third one at least partially.

Application of computational intelligence (CI) methods to these fundamental problems of engineering design is presented.

The novelty of proposed solutions is due to the paradigm shift in the sciences caused by

- the introduction of “computation” in the middle of XXth century and
- the resulting ability to effectively mimic natural heuristics for problem solving.

The outline of the thesis (sections):

1. **Introduction**- describing the general context of the problem, providing definitions of the engineering and architectural design, the role of creativity, expertise and related problems such as judgment calibration, knowledge representation; definition of computation and CI, description of the main Nature-inspired computer heuristic methods and the designing environment (software).
2. **Background**- The general concept of application CI to the engineering design and the survey of related work. Followed by three sections demonstrating new methodologies based on CI for particular problems:
3. **Functional layout optimization (*utilitatis*)** - a design support system with a new strategy for finding the optimal functional configurations of rooms for architectural layouts is presented. The method is based on constraint satisfaction problem (CSP) approach and backtracking algorithm.
4. **Creating structures with Truss-Z (*firmitatis*)** - an innovative modular truss system is introduced and a number of problems such as global optimization with genetic algorithm and fabrication are discussed.
5. **Creating cellular automata (CA) pattern on a skin of a building (*venustatis*)** - an application of CA for controlling the state of discrete members of a building envelope. The shading system based on a CA is

demonstrated and a prototype is documented. Triangular CA on any surface is discussed, followed by

6. **Conclusions** – summarizing that the new computer methods that were rapidly developed since the last mid-century enabled realization of the presented projects which demonstrate new qualities in the fundamental problems of the engineering design in architecture: *firmitatis, utilitatis, venustatis*.