

Chapter 5

The Concept of Expert System Supporting the Increase of Energy Efficiency in Buildings

Arkadiusz Węglarz

Warsaw University of Technology, Poland

ABSTRACT

This chapter describes the concept of an expert system supporting improvements in a building's energy efficiency. An expert system is a computer program or group of programs that facilitates using knowledge and decision making. The main elements of an expert system are the knowledgebase and a conclusion system. The knowledgebase collects information about a particular area, which was beforehand written in using particular rules. The conclusion system uses the knowledgebase and user input facts to generate conclusions or prove the user's hypothesis. The proposed expert system contains information on building technology, modernization and installation activities, and the values for financial, environmental, and technical indicators characterising these technologies. The user of an expert system defines the problem to be solved using questions. Using the knowledgebase, the system will present the optimal solution or information that the technologies in the existing knowledgebase will be applicable in the case defined by the user.

INTRODUCTION

The improvement of energy efficiency in construction carries with it a lot of challenges and problems: technical, technological, and economic. Solving them requires the involvement of many experts. At the same time access to experts is difficult and costly, which is a problem for many investors, decision makers and designers. An interesting solution for this problem seems to be using expert systems. Described below is a concept for an expert system facilitating the improvement of energy efficiency in buildings. At present such system is being elaborated at the Faculty of Civil Engineering, Warsaw University of Technology, by the author of this chapter.

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BASIC INFORMATION ABOUT EXPERT SYSTEMS

According to (Mulawka, 1997; Tadeusiewicz, 2012) an expert system is a single piece, or a set of computer software, which facilitates the use of knowledge and decision-making. Expert systems can assist or even replace human experts in a certain field. They can provide the user with advice, recommendations or diagnosis in the problems related to the study field.

The following characteristics distinguish expert systems from conventional systems:

- Explicit representation of knowledge,
- Application to solving specific problems according to the reasoning procedures (inference),
- Ability to explaining the solutions found by the system,
- Knowledge processing mainly concerns symbol processing rather than numerical computations.

Unlike classical software knowledge in the knowledge, database describes the problem domain without providing an exact algorithm for solving a given problem. Knowledge is written according to a specific knowledge representation language, most commonly consisting of: a description of facts, description of the rules used in the inference process, and sometimes meta descriptions of the rules that show a strategy for solving a given problem.

Modern expert systems also use knowledgebase structures such as:

- Frames, which are partially identified with the object approach of the software,
- Decision networks,
- Semantic networks.

A key element of any expert system is its conclusion system, which uses rules and facts from the knowledgebase and user input to arrive at conclusions. There are two main methods of inference: forward chaining and backwards chaining. It is also possible to use mixed chaining which is a combination of the two mentioned above. Forward chaining begins with the facts supplied and engaging rules generating facts which will lead to the conclusion at the end of the process. Backwards chaining begins with a hypothesis (the goal), which the system, by generating appropriate facts, proves, disapproves, or indicates that solving the given problem is impossible.

In cases where multiple rules can be used in one situation the following rules should be applied (Tadeusiewicz, 2012):

- Highest priority,
- Most detailed conditions,
- Last used,
- Last added,
- Containing variable last used,
- Conclusion with highest confidence (in case there are weighted premises, the degree of a premise's truth).

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