SUMMERLY OVERHEATING OF BUILDINGS COMPARISON OF DIFFERENT CALCULATION METHODS AND DEVELOPMENT OF A TOOL FOR DESIGN AND PROOF

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INTRODUCTION

On one hand, regarding the energy efficiency of buildings and, in particular, the winter heat losses through the building envelope, it is state of the art to plan and build low-energy houses or even passive houses, that show significantly reduced heat energy consumption compared to older existing buildings. On the other hand not only in older buildings, but also in highly insulated new buildings, frequently uncomfortable, too warm indoor climate is occurring in summertime.

FUNDAMENTAL OF THE PROBLEM

Due to global warming and contemporary architecture, which uses a lot of glass and lightweight constructions, the problem of summerly overheating of rooms is ubiquitous. There is a simplified method acc. to the Standard B 8110-3, which is predominantly used for assessing the summerly heat protection in Austria. However, due to the simplified calculation approach, no good planning reliability can be assured and is thus far from the more realistic results and possibilities of thermal dynamic building simulation programs. Problem is, that building simulation programs are usually too complex and time-consuming to support architects in the design process. Many planning decisions, which are made in early planning phases, have significant influence on the summerly behaviour of the building and can hardly be changed afterwards or just with increased effort. Considerations regarding climate-friendly building should thus already take place in the design phase. Again, it is problematic that architects lack tools for evaluating the summerly heat protection that can be used easily.

Hence the goal is to develop a generally accessible, intuitive online tool that is not based on a simplified calculation methods, but generates realistic results. The architects will then be easily enabled to develop optimized designs regarding the summerly heat protection.

RESULTS

Important thermal steady state, as well as dynamic parameters are presented and discussed, especially the thermal storage capacity of building components and rooms is analysed in detail in order to eliminate often prevailing misunderstandings. In addition, various methods for assessing the summer suitability of rooms are compared, such as simplified (steady state) methods, more detailed 1D as well as 3D dynamic simulation methods. The advantages and disadvantages of these methods are analysed. A series of programs are presented that implement these methods. Furthermore, a major part of the dissertation is the validation of selected building simulation programs using the European Standard EN ISO 13791 and 13792.

All these steps were taken to achieve a sound foundation for the development of a tool for planners which is named Thesim3D: an intuitive online tool with a self-explaining interface that runs a detailed thermodynamic building simulation in the background.

The requirements for the tool have been set high: Simple and intuitive use, free accessibility to all target groups, no commercial programs, operating system independence, as well as independence of other programs, user based error minimization and the separation of user interface and simulation core. Thesim3D simulates the thermal behaviour of a room in the frequency domain using the so called periodically settled system (period length: 1 day). It is therefore in particular suitable for summer assessments acc. to the Standards. The periodic settled calculation approach as well as the description of the heat conduction and heat storage mechanisms by means of the component-matrix method (cf. [3]) have proven themselves as methods for the planning-accompanying computational simulation in such a good way that they were also incorporated into national and international standards (B 8110-3 [1], EN ISO 13791 [2], EN ISO 13786). Thanks to this method, results can be obtained in real time and different variants can be analysed very quickly. The dissolution of the heat balance equations using the periodic approach is described in the dissertation. The technology triad of the web, HTML, CSS and JavaScript was used to implement the user-interface Thesim3D. For the 3D-modeling of the room, Three.js, a 3D graphics API for the Web, based on WebGL, was used. On the server side, the simulation kernel is encapsulated by a Java web service, which enables communication with the client. The Java web service is the interface to the Geba V.10 simulation core, which is an extensive, thermal-dynamic building simulation program. Geba is validated according to the validation method of EN ISO 13792 to the best class 1.

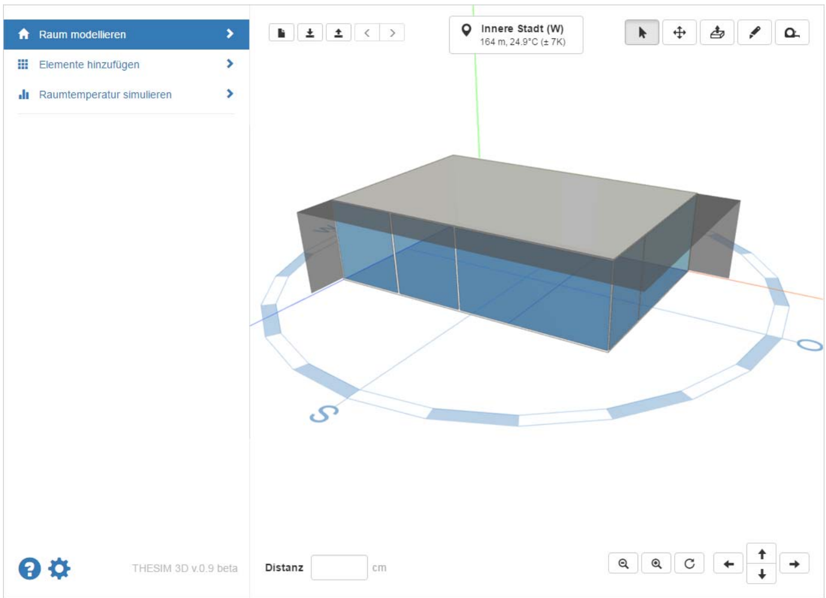
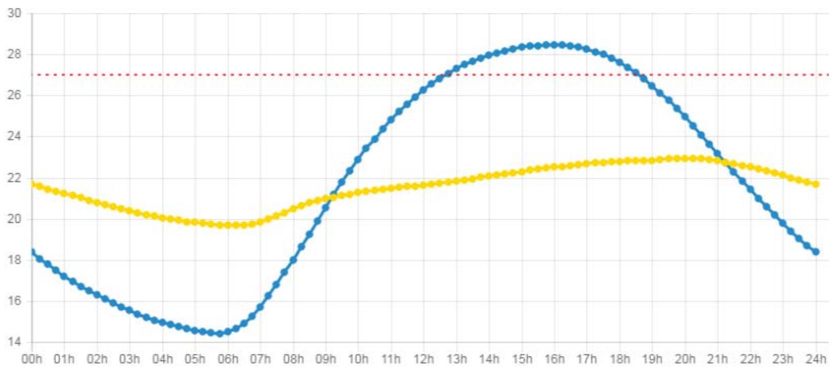


Figure 1: Thesim3D user-interface: easy modelling of 3D-room.



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1:00	17.2	21.2	13:00	27.3	21.8
2:00	16.3	20.8	14:00	28.0	22.1

Figure 2: Small extract of extensive simulation results.

REFERENCES

[1] ÖNorm B 8110-3:2012, Wärmeschutz im Hochbau, Vermeidung sommerlicher Überwärmung

[2] ÖNorm EN ISO 13791:2012, Thermal performance of buildings, Calculation of internal temperatures of a room in summer without mechanical cooling – general criteria and validation procedures

[3] Haferland, F., W. Heindl und H. Fuchs: Ein Verfahren zur Ermittlung des wärmetechnischen Verhaltens ganzer Gebäude unter periodisch wechselnder Wärmeeinwirkung. Berichte aus der Bauforschung, 99, 1975.