SIMULATION DATA MANAGEMENT IN THE DESIGN PROCESS

Antti Karola, Tuomas Laine, Kenneth Lassila, Hannu Lahtela, and Markku Jokela
Olof Granlund Oy
Helsinki, 00701, Finland

ABSTRACT

An integrated simulation system for the building services design and facilities management purposes is being developed by Olof Granlund Oy. The system covers the thermal simulation needs of the whole building life cycle from the preliminary design to renovations. The main components of the simulation system are simulation database, result module, calculation engine, which are all built in to a user interface RIUSKA, and building geometry modeller, SMOG. The building geometry modeller generates a 3-D surface model of the building and has IFC 1.5 import/export capabilities. The calculation engine of the first version is DOE 2.1E. The simulation database is linked to other design databases and design programs so that redundant input data is avoided.

INTRODUCTION

There are at least two big problems that prevent simulations from becoming a major part of the everyday design process. The first problem is related to the insufficient data exchange methods from the designers to the other participants. Already a very simple simulation requires a lot of input parameters to describe the building and the technical systems. Part of this data evolves during the design process and part of it has to be assumed as default values in some way. Designers have usually a lot of information that could be utilized in the simulations but the lack of knowledge (which data is important and in what format it should be delivered) prevents effective data exchange between different participants in the design process.

The second problem is related to the data that is not available from designers. Resolving the lacking data requires a good knowledge about several disciplines (building physics, thermodynamics etc.). The lack of expertise and the vague information about which data can be achieved from the designers and which data should be assumed, makes it difficult to market energy simulations as a standalone service. To make it even more difficult the default values are changed or updated in different design phases. Figure 1 shows the design process of the simulation model.

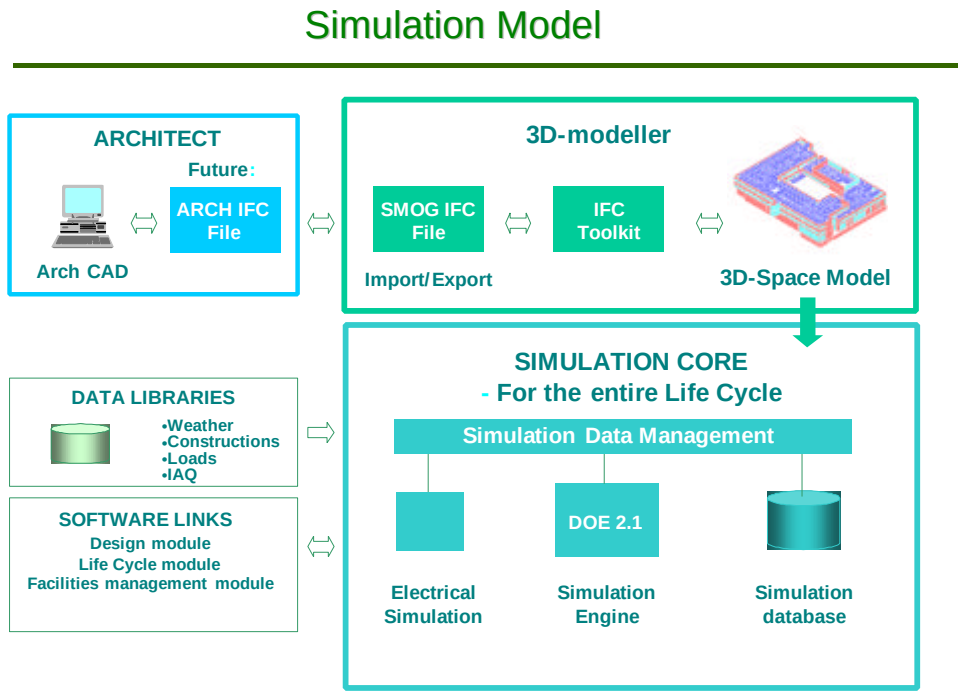


Figure 1. Simulation model in the design process.

There are many different building simulation programs on the market varying from simple spreadsheet programs to supercomputer CFD applications. For a HVAC designer it is often difficult to choose the right simulation tools, because there is a need for many kind of simulations during the building life cycle. The purpose of the simulation varies from demonstration to detailed dimensioning and design, and the requirements on the program vary as well.

The design phase (especially energy economical decisions) has a great influence on the building life cycle costs. To develop a building design data management model and suitable simulation tools is extremely important for energy efficient building design.

The problem with existing energy simulation programs on the market is that they have been developed for research purposes and are quite massive for normal design use. This is a problem especially in the beginning of a design, because the time for calculations is limited and the information is mainly based on defaults. Developing simulation tools, where the calculation may be done fast and the results are easy to put to an illustrative form, are needed for decision making.

DESCRIPTION

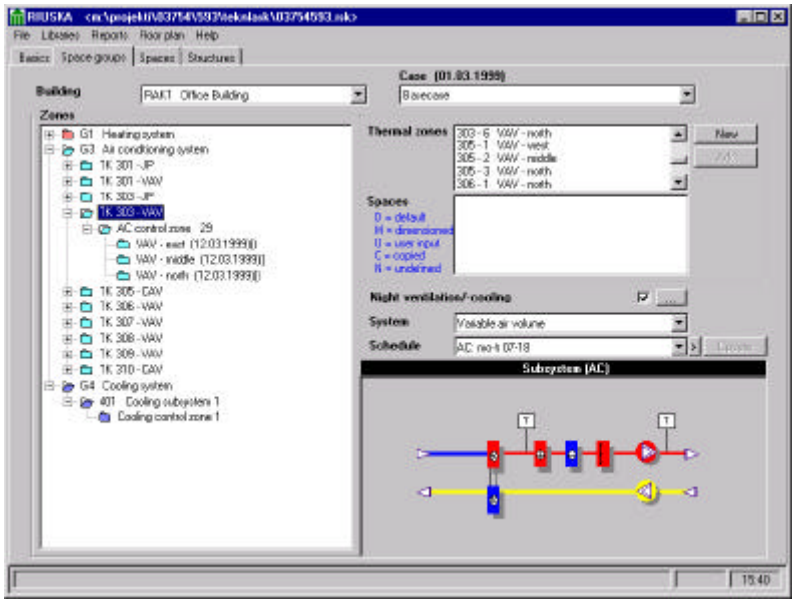
Olof Granlund Oy has developed an integrated simulation tool, RIUSKA. The idea of RIUSKA is to use the same core simulation system throughout the building life cycle. Only the user interface of the system varies according to the level of the user‘s knowhow and needs. The main components of the simulation system are a simulation database, user interfaces, a result module, a building geometry modeller and a calculation engine.

The core of the simulation system is the simulation database. The RIUSKA database structure only represents data to be used for one application area i.e. thermal simulations. The simulation database contains all parameters for a certain building or project. It contains both the input and output from the simulations. Thus the simulation results may be reviewed anytime together with the input values.

The simulation database is linked to other design databases and design programs so that redundant data is avoided. The same data can be used by the HVAC-designer for the calculation of the cooling loads and by the electrical designer for the dimensioning of the electricity distribution system. The data sharing can be extended to interdisciplinary design data exchange (e.g. the HVAC-designer will use occupancy data defined in the architect's design databases). Another example of data sharing via databases is a life cycle cost calculation tool that will use energy consumption values calculated by the simulation tool.

User interfaces

The user interface includes default value generation routines. If some input data is missing, default values for the missing data is generated according to the rules based on statistical data, know-how and library values. RIUSKA will have different user interfaces for different purposes. At the moment the development is concentrating on the user interface for the design phase. Figure 2 shows the space and system management interface with treeview technique. Figures 3a and 3b show examples of the user interface for geometry and structure definitions.



Kuva 2. Space and system management interface with treeview technique.

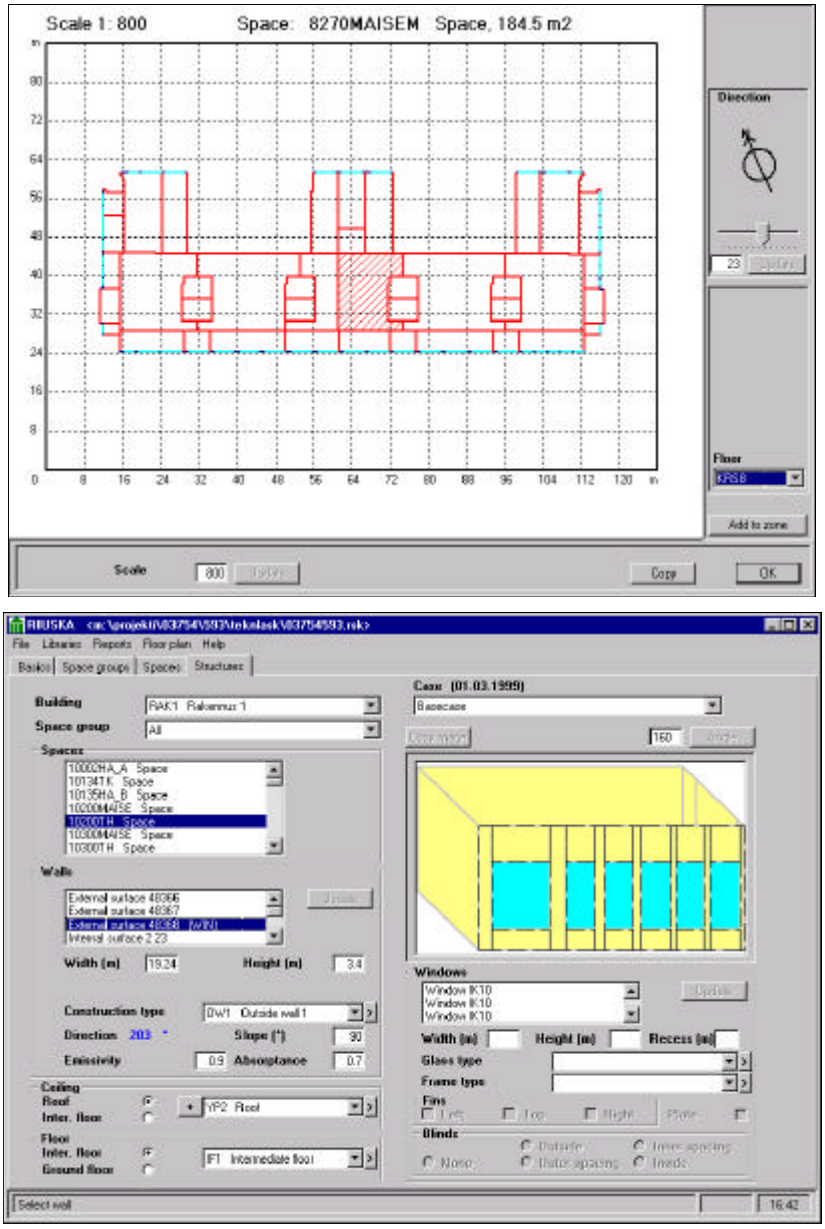


Figure 3 a,b. An example of floor plan and definition of constructions in RIUSKA interface.

The result module

Simulation results can be viewed within the program and with a stand-alone result viewing application. Thus the designer can view and compare different simulations with a light and easy-to-use program. This also enables a team work method in which the experts do the simulations and designer only study the results of different simulations. Figure 4 shows examples of energy consumption simulation outputs.

The building geometry modeller

The most novel part of the simulation system is a space modelling tool called SMOG (Space Modeller by Olof Granlund Oy). SMOG is an AutoCAD-based modelling tool which enables easy generation of the geometrical model of the building. It makes the geometry input reliable, fast and easy. SMOG creates 3-D objects of walls, windows, doors and spaces and also creates connections between these objects. For example a wall object knows its neighbour objects, and a space object knows all its wall objects. See figure 5 for 3D-model examples.

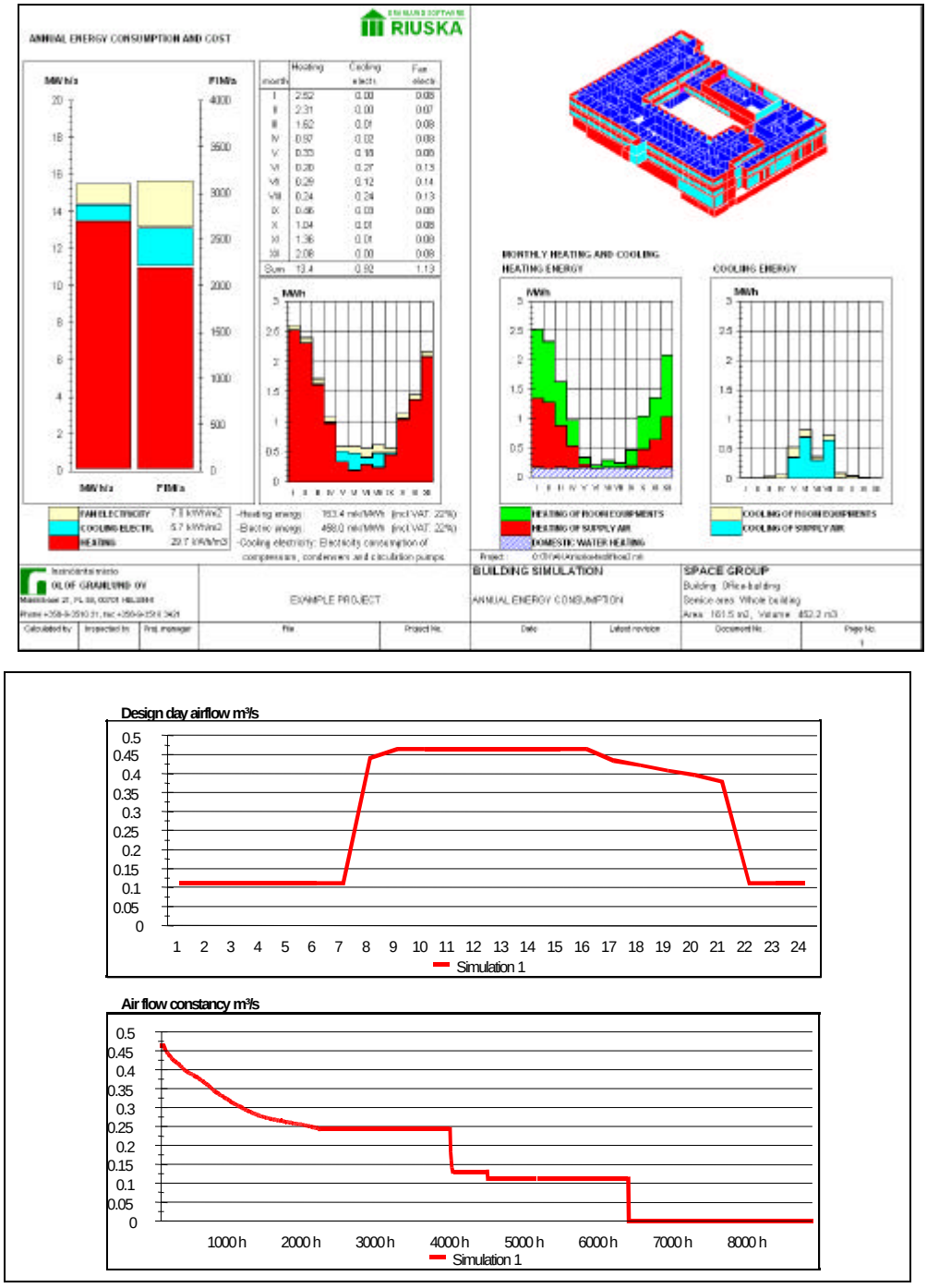
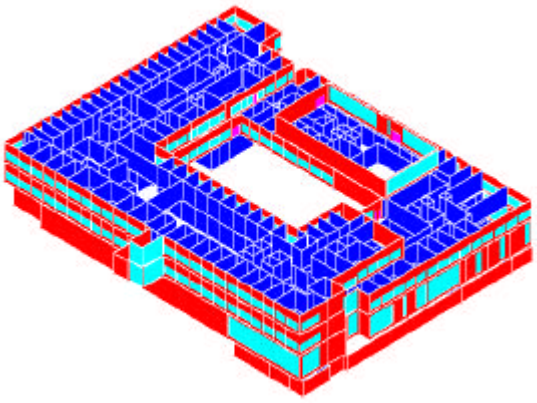
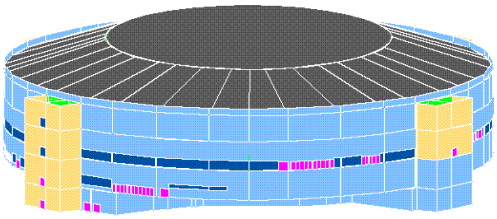


Figure 4. Examples of Energy simulation outputs.

SMOG currently has IFC 1.5 import/export features (and will have IFC 1.5.1 by mid 1999). This enables direct transfer of digital building geometry and construction data from IFC-compliant architect software. SMOG makes it possible to reuse this data for space management as well as in design tools, such as energy and comfort simulations, visualizations and life-cycle cost analyses. Results obtained in technical calculations can be exported to other IFC-compliant software. IFC (Industry Foundation Classes) is a file format, which will in the future provide wide coverage of the needs for data transfer in building design, construction and facilities management and will offer totally new opportunities for the life-cycle-based data management of buildings. IFC‘s are defined and published by the IAI (International Alliance for Interoperability) [1].



Office building



Ice hockey stadium

Figure 5. Examples of 3D-model of buildings created with SMOG.

SMOG allows users to :

* draw basic objects such as walls, windows and doors
* move and edit objects, the SMOG modeller maintains connections between objects and updates properties related to these objects (e.g. changes space areas when you move a wall)
* analyze areas quickly and efficiently
* calculate statical heat losses
* visualize the building
* import/export IFC 1.5 geometry and construction data.

The users can export the 3-D objects to be used in special visualization programs.

The calculation engine

The calculation engine in the current version of RIUSKA is DOE 2.1E.[2] DOE was chosen because

it is widely known among Building Services designers around the world, and it is well optimised for building services engineering purposes in terms of calculation accuracy and calculation time. Also the support and development strategy for this selected calculation engine are reasonably good.

The calculation engine is a standalone module that reads data from and sends data to the database through ASCII-files. This approach does not demand any changes to be made to the actual calculation engine.

Thus the calculation engine can be changed by writing new converters for a new calculation engine. Other simulation engines will be implemented if needed.

CONCLUSIONS

At the moment, RIUSKA has already been widely used in design projects for room, system and building energy simulations. Practically all buildings are modelled by using SMOG 3D geometry modeller. The development work in the future is concentrating in using new simulation engines (e.g EnergyPlus) and implementing of the facilities management simulation.

REFERENCES

[1] IFC, http://www.interoperability.com.

[2] DOE 2.1 E Program documentation and manuals.

[3] Lassila, K., Jokela, M., Lahtela, H. and Laine T. 3-D Space Modelling With DOE-2: The RIUSKA Energy Simulation Tool. Building Energy Simulation User News, Volume 18, No. 4. Winter 1997.