Automation and Robotics in Construction XVI © 1999 by UC3M

AUTOMATION ANALYSIS OF ENERGY PERFORMANCE IN BUILDING FACADES

M. Casals, M. Etxeberria, P. Alavedra, P. Antentas

Department of Construction Engineering
Universitat Politécnica de Catalunya
Terrassa. Barcelona. Spain
E-mail: Miquel.Casals@ec.upc.es

Abstract: At the initial stages of the construction projects, the objectives are to be clearly explanated. The later phase always depend of this first stages. Into this initial studies, one of the most important preocupation is to improve the energy response of the buildings. This paper introduces a program developed in order to do this primary energy studies. Another aims of this development are increase the productivity of the designer tasks and achieve better quality levels in buildings.

Keywords: Building design automation, designer productivity, facades energy performance, energy pasive design

1. INTRODUCTION

Energy use remains at a consistently high level in all the world. Although the energy comsuption has fallen as a result of economic restructuring, it is expected to rise again, that is when it will be necesary to introduce the idea and the practice of energetic saving in our life, as life quality.

Therefore sustainable development for buildings should be so defined that a quality of indoor environment is a primary component. Moreover, sustainable development should not be considered as attained unless the quality of the indoor environment in buildings meets commonly accepted standards.

Although the energy saving potentials within the existing building stock are quite high, the topic of improvement of the energy performance of existing buildings is only considered by a small number of countries. There is a need for new retrofit technologies that are economically affordable to building owners. A big effort is needed now in the existing stock, especially because the low energy prices we are currently witnessing are a powerful disincentive when it comes to saving energy. In the developing countries, similar effort

should be made where space heating is needed.

Many people stress the importance of safeguarding indoor air quality and climate in connection with strong penetration of energy saving technology in building design.

Many people in the world have become aware that the productivity is dependent on a good indoor environment. This is why the expression Indoor Air Quality (IAQ) seems to be replaced by Indoor Environment Quality (IEQ).

Indoor climate has become more important for health and confort during recent years. As people stay indoors approximately 90% of the time, the quality of indoor air for the health is even more important than outdoor air. Good indoor climate reduces illness and the symptoms of sick building syndrome. It also influences comfort and working efficiency.

Good indoor climate is one of the most important factors in assessing the quality of a

building. Research and practice have, unfortunately, shown that good indoor climate is not always achieved. Indoor climate is influenced simultaneously by several factors, such as heating, ventilation and air conditioning, construction methods and materials operation, maintenance and use of buildings.

For this reasons, an important challenge in planning new and refurbishing old buildings is to create an excellent environment for productivity as well as for comfort [1].

2. OBJECTIVE

Usually automatization is needed to increase productivity and/or quality in construction processes.

Construction processes include also initial stages of the design project. Often the analysis of the buildings energy response promote many revisions of the design. In order to find the minimum energy consumption balanced against the minimum initial cost, some different designs are usually tested and studied.

At the initial stage, the project's objetives are to be clear. These objetives are to be clearly explanated, due to the posterior phases of the design depends of this initial stage. So that the initial phase is essential in construction process.

One of the most important preoccupation for the construction people currently involved at the beginning of the XXI century, is the improve of the construction quality levels [2].

For this, new tools are needed. The final objective is to increase the professional and the projectist productivity, to increase project added value and to increase services to the client to differentiate adequately from the competitiveness and to achive the client's satisfaction.

Add to this, nowadays new emerging new energy saving technologies marked as being successful in the next decade involve super insulation, passive heating/cooling, day lighting/passive lighting together with the use of renewable energy sources. These technologies will require new designs of the roof, facade and foundations (e.g. for heat/cold storage). Another consequence is that architects and designers should integrate their building and system designs allowing easy retrofit of these components during the lifetime of the building.

The demand will not only focus on new buildings but also on the existing stock. The consequence will be that the developed systems must also be easily retrofitted in the existing building fabric.

To save energy adequate buildings design and a correct choose of building materials are of great importance. For this reasons we are developed a new tool to analize the building's behaviour energeticaly in a quick and adequate way.

The objective of the utilization of this program is to study the behaviour of the buildings in projects with different designs to know which of the designs is the best one energetically or which of them works the best way to save energy getting a sustainable buildings. Another objectives of this tool are the greatest ease of the use and the wide range application. So is, this program can be used in design of new buildingsbut also in evaluation of existing ones to refurbish them.

3. METHODOLOGY

We are discused that nowadays it is very important to build acknowledging the future energy comsumption in buildings. Our tool helps one to know how the building behaves energeticaly.

This tool is a program which is designed and created to use very easily. It is formed with six modules and three databases, and it uses commercial packs and applications in windows environment

The blocks can be distinguished between them by their funtions and contents. To understand how this software works, a flowchart is shown in Figure 1.

In the initial phase (module 1) the designer will insert data like the facade´s measurement and the building orientation. Depend of the dimensions and the building orientation the effect of the sun in to the building is different.

After that, in module 2, we can define the place where the building is located and the periode which we want to know the response of the

building. This module 2, has a database which gives the climatic conditions (temperature, humidity...) of the place that the building is situated or the designer thinks to locate it.

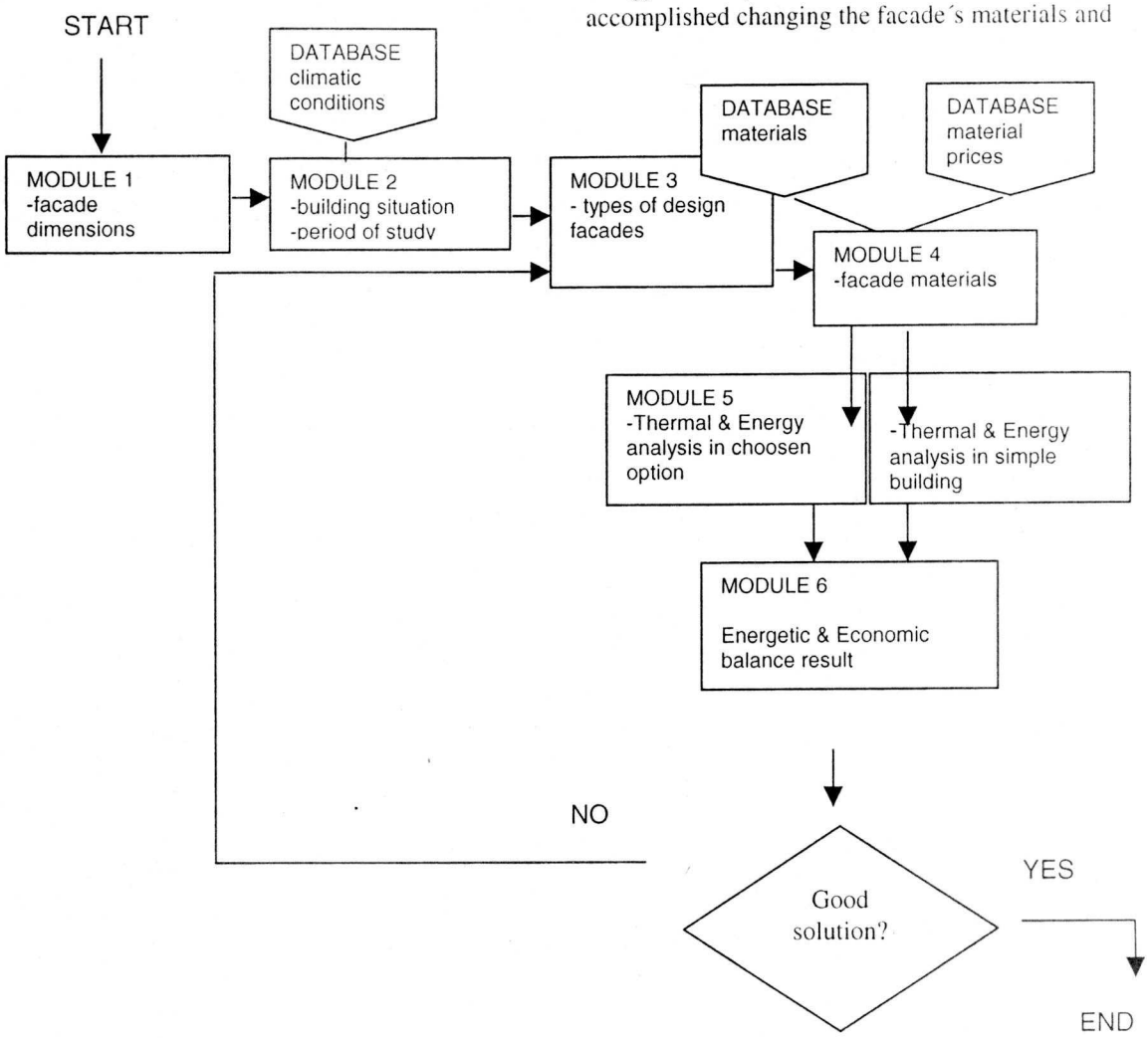

Figure 1. Program flowchart

These two modules, normally, are not changed along the project. If the building is already existing these aspects are invariable. And if we are designing a new one, this first aspects are defined at the beginning of the study and usually are not changed during this.

For this reason, this two modules are completed before the more specific modules and before the feedback study as it is shown in the flowchart.

In modules 3 and 4 the designer can choose the materials and the design of the facade.

The designer can change the data of the modules 3 and 4 to achieve the balance between energy consumption and initial cost. This balance is accomplished changing the facade's materials and it's design, and when the new energy evaluation obtained is better than others possibilities studied.

In module 3 the designs of the facade are chosen. There are different kind of facades.

The first option is a simple facade with windows but without any elements colocated in it.

The second one is a facade doing variable angle between the wall with the windows. The

windows are in the bottom part as one can see in the Figure 2.

The third facade is like the simple one but with a sunshade up the windows. The second and third facades are especially designed for to be used with high solar radiation.

These three facades can be combinated either with big or small windows.

In module 4 the materials of the facade are chosen: the kind of glass, blinds, walls...This module use two databases. One of them gives all kinds of materials and the other gives the prices of materials. When module 4 is completed, we had finished to insert the data.

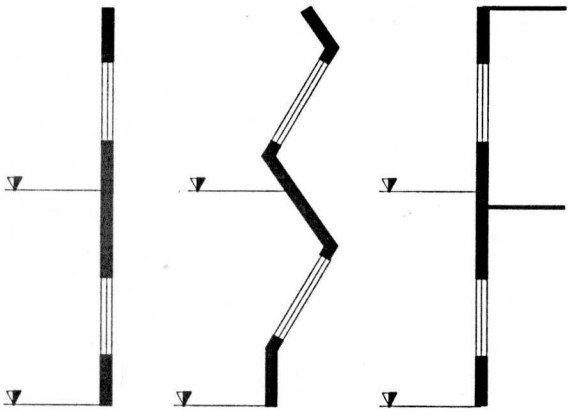

Figure 2. Kinds of facades predefined

In module 3 and 4 is possible change data if we need realise more studies about the same building. So is, with the same design can be succesful search the optimum result changing materials in order to find more sustainable buildings.

In module 5, we compare the energy gains across the diferent options of facades choosen and the most simple option that usually is the cheaper too.

To reduce the energetic comsuption, usually it is necessary quite big investments in materials like glass, wall...and in time of designer. We need to analyse if the initial investment could be amortized in an acceptable recover period.

Module 6 makes this economic analysis between the initial investment of the choosen solution and the cheapest solution. Obviously we can calculate if is posible to recover it in an acceptable time period.

As soon as the result is obtained, it is analysed. The result gives the energetic consumption and analyse the initial economic investment in facades.

Then, if the solution is good, the analysis is finished and we can follow the building design works.

But if the solution is not quite good, this means that to get the confort inside the building is needed too much energy consumption and usually is possible improve. Here the program allow to return to module 3 and there change some variables until to find the best result.

4. CONCLUSIONS

This tool has a high potential of success application in a building projects. Indoor air quality and indoor confort are some of the most important current points to design and to get a sustainable buildings.

The previous analysis of the building energy comsumption is really an important point today. For this is advisable to use pasive means instead of active means. This way, the power's comsumption in buildings will be reduced and also it will be done savings a long term.

The explained tool allows to analise projected and built buildings and values the initial investment in buildings facades against long term energy consumption.

And although this tool is not absolutelly accurate because there are some points that are not taken into account: internal furnitures or funtion of the building, the tool is very usefull to get a primary idea of the building performance using pasive solutions. All with aim to get the best behaviour of the building with minor energetic comsumption.

This tool also is very simple to use. This mean that is quite quickly to get an first idea of the future energy response of the buildings.

For this reason, this tools also allow increase the productivity and competitiveness of the building design teams.

Finally we should mention also that the quality levels of the buildings designed using this tools are improved, and the energy response of they are more sustainable according to the current world-wide environmental objectives.

REFERENCES

[1] L. Bordeau et al. *Sustainable development and the future of construction*. CIB Publication 225. 1998.

[2] M. Casals. *Estudio de la aplicabilidad de distintas técnicas de gestión de la calidad en la elaboración del proyecto de construcción.* PhD Thesis. Universitat Politècnica de Catalunya. 1997.