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WORKSHOP INTERACTION BETWEEN PHYSICS AND
ARCHITECTURE IN ENVIRONMENT CONSCIOUS DESIGN
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"Computer-Aided Learning in Bioclimatic Architecture"

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Computer-Aided Learning in Bioclimatic Architecture

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Assuming that teaching is a very complex process used by the teacher to transfer his knowledge to the educating people, this implies first that a body of knowledge related to the domain can be isolated and formalized adequately.

This is also true for teaching energy. Therefore, the first question, we are fronted with, is : "Is there a specific knowledge we can define in an objective way ?

Obviously, a huge amount of knowledge has been produced by a very serious and continuous research effort spread over fifteen years.

This is not the place where to list these results. Everybody have in mind what progress are. But, what is puzzeling now is to see how weak have been their impact on the actual professional practice.

The second question then is : "Who is the knowledge user ?" This will help us in defining the specific nature of the knowledge he requires and examining if the one developed so far is pertinent.

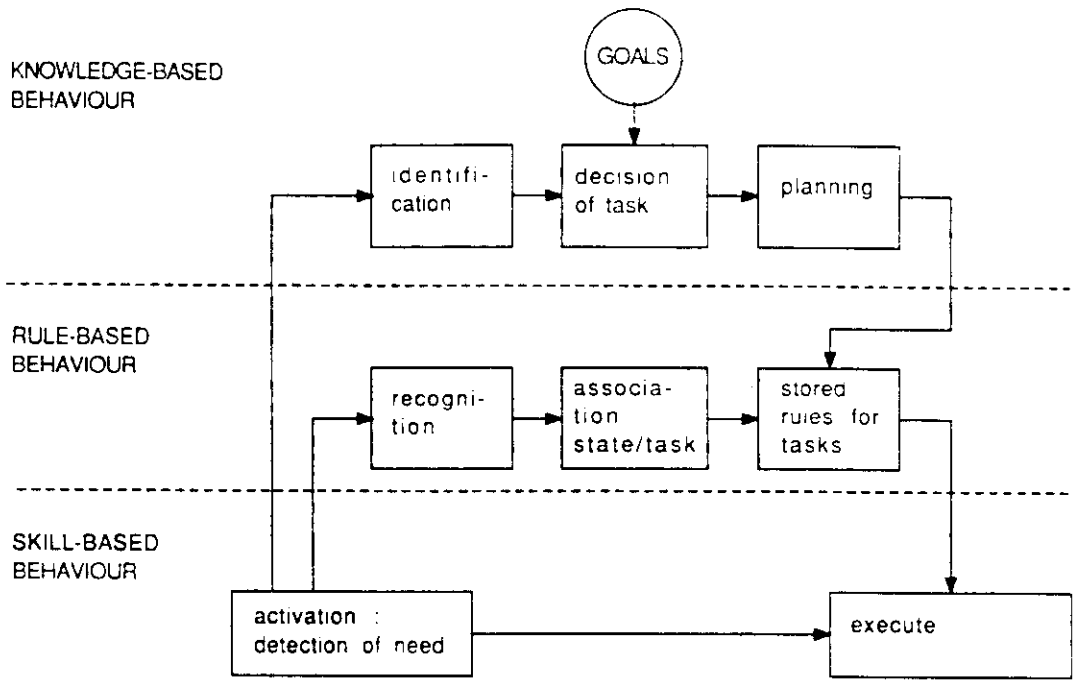
We recognized one main partition on the set of users. The first one contains the practitioner in his every day practice. And the second one refers to all the possible users of the available knowledge when they are seeking for education in the energy domain but not referring to immediate use in action. The learning attitudes are fundamentally distinct and consequently, the requested pedagogical modes are fairly different. We comprized, in the second class of users all under and post graduate students as well as mid career practitioners.

A second partition have been suggested on the set of users. It concerns mainly the point of view, or the rôle, people can play in birth and life of buildings. Let us say : manager (owner, property developer..) builder, engineer, architect...

The dichotomy of knowledge users into two classes, (off-line evaluation and planning and on-line, real-time, operation) led us to consider the relations of activities (including cognitive control and knowledge acquisition) regarding time. And we suggested to consider the first group as synchronic and the second one as achronic or at least diachronic.

Then this rises the third question : "How to adapt the knowledge to the users'needs, context and status ?".

This is an awkward question. We don't know how to answer it in a some-what reasonable way. As a first step, we would like to consider the designer's attitude in respect of knowledge in a design context (see figure)



The activation of the process is produced by the detection of a need (left bottom part of the diagramme). If the situation is familiar and penalties for failure are light the answer can be a highly automated performance which takes place without much conscious control. We call that the skill-based behaviour. This is by far the most efficient way of doing.

In case of ambiguity, or deviation from of design models, a rule-based performance can be activated. It is based on recognition of situations related to a sort of rule reservoir by means of an implicit association of state/task. The so called rule-based behaviour consists, in fact, in the control and coordination of a sequence of skilled acts.

When proper rules are not available to cope with unfamiliar situations where the risk of error is unpredictable, it can be necessary to develop new activities at the knowledge-based level. This action is aimed at producing new rules and new plans for action. Input information is perceived here as symbolic and the funtional structure is

characterised by an explicit representation of the whole system. Recognition of past situation is not possible any more at this level and an identification process is requested.

Explicit goals must also be introduced to allow the decisions.

According to the least-effort-law any designer is inclined to use as much as possible his skill to solve problems. If it's not possible, he will recall past similar situations and try to derive applicable rules. Almost never he will have recourse to the expensive and time consuming knowledge-based behaviour. Therefore, we can say that the major part of the design activities are based on implicit or indirect knowledge.

The transfer of knowledge done directely from research to practice is probably not effective mainly because it is too far from the actual problems the practitioners are requested to solve.

Then the last question, can be formulated as follow : which is the best structure for the knowledge transfer from research to practice ?

Two different, non-exclusive, approaches have been proposed.

The first one is classical but can be very useful in many situations. It concerns the creation of an institution taking in charge the development of an interface service between the research domain and the various users of that knowledge. The activity of this institution will be three fold :

- diffusion of the existing knowledge directly towards the users, trying to fit as much as possible their requirements as they are known;
- gathering of the existing knowledge and transformation of it in order to fit, not the "market", but the use in an innovative way, creating the market;
- feed back the research with the actual needs from the professional practice for filling the remaining gaps.

The second approach intends to take advantage of existing new technologies. The main feature here is that the user is seen as an active participant to the knowledge transfer. He is linked to the whole system through an Expert-System enabling him to define clearly the problem he is fronted with. Another advantage of this interface is the possibility to involve his expert knowledge in the system to produce heuristics.

The ES is than linked to a knowledge base management system giving specific views on the KB according to the requirements specified by the SE.

STRATEGY : an application of CAL technics to the training of architects in the field of energy conscious design

STRATEGY is a Computer Aided Learning (CAL) tool allowing students in architecture to perform on a theoretical model representing a given design situation all the experiences he would consider indispensable for his best perception of the solution space.

The proposed design situations are specified through a set of theoretical parameters describing, in a non-univocal way, different building classes and their possible context.
For example :

* major geometric factors describing the building shape;
* geometrical and physical factors specifiying the fenestration;
* thermal factors;
* occupancy factors.

In order to facilitate the student's acces to the programme, all the required factors are filled in with default values attached to the different buiding class definition.
All the factors can be reached using buttons activated with the mouse and the default values changed with the key-board. Each factor is limited in value with upper and lower bounds the student is not allowed to go beyond. He is also provided with "Help" functions attached to almost every button appearing on one of the screens.

Primary factors are reorganized into performance indexes related to the different building qualities expected by the user :

* global heat loss coefficient;
* solar recuperation factor;
* temperature without heating;
* inner mean-maximum temperature.

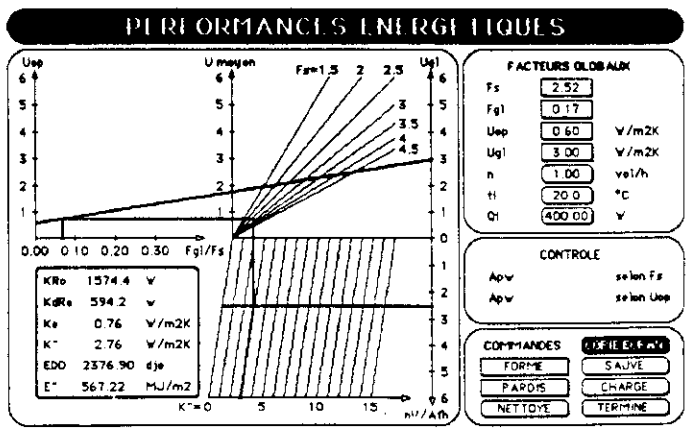
These indexes are in turn combined in a global index called "equivalent degree-days" allowing comparison between different projects or between various alternative proposals to the same project.

STRATEGY allows the student to train himself for an energy conscious designing. Through simulations, it fastened the acqusition of good basic reactions and it helps defining efficent trends of development from the very beginning of the scheme design.It also forces the student to recognise the complex imbrication of energy and architectural problems.

STRATEGY provides, at the present time, three complementary approaches in the analysis that can be accessed in sequence or in any order. They are located on three screens :

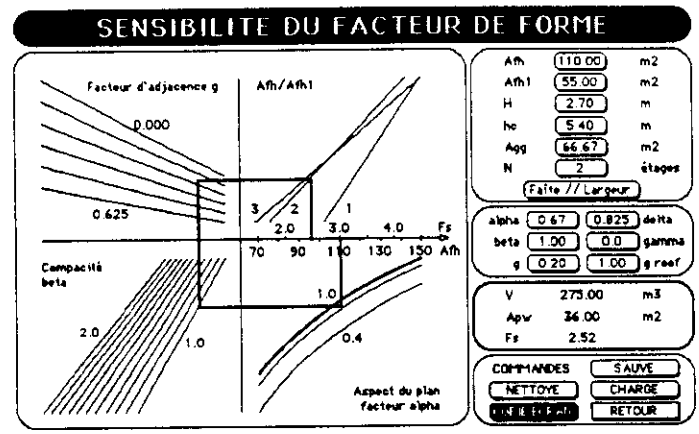
1. Main screen

It provides a support for the development of energy performance evaluations of the building described by the user.
The parameters at the sudent's disposal are only the ones linked to the ocupancy behaviour :
natural ventilation, casual heat, required design temperature.



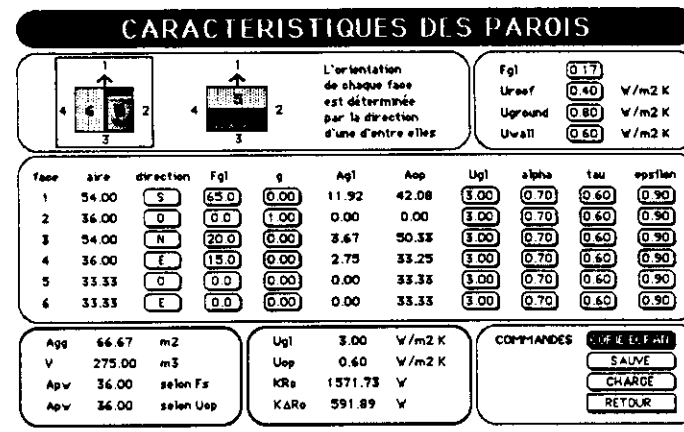
2. Shape factor analysis

The second screen allows to evaluate the impact of geometric transformations realized on the heated volume . Thirteen parameters can be used for the manipulation of the external envelope of the architectural project. The global result obtained is the improvement of the building shape factor (Fs) it's to say the ratio of the outer envelope area to the floor area.



3. Wall geometry and fabric definition

It gives, for each face of the building envelope (wall, roof,...) the area, orientation, glazed and opaque surface distribution as well as the physical properties of the chosen fabrics. this screen provides the sudent with the global thermal conductance of the building and its solar fraction.



The user can question any parameter, sentence or word appearing on the screen. Its designation, using the mouse, opens an information panel.
The two first screens contain a diagrammatic representation of the processed equations. Thanks to these diagrams, the sudent is provided with a efficient means to perform a qualitative evaluation of the performance trends when changing the main parameters.

STRATEGY is usually used by the students of the department of civil-engineer architect at the University of Liège during the second year of their curriculum.