

An Environmental Design Assistant

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Abstract

One of the problems facing, students of architecture and those teaching, of architecture is that the body of information which needs to be borne in mind when designing is continually increasing. One area where there has been a rapid recent growth in interest and consequent legislation is in environmental or "green" matters. As an example recent legislation has been introduced in an effort to standardise the procedures for assessing building, and in particular their energy consumption.

This paper reports on the development of a Hypermedia based tool to aid the process of the Environmental design of buildings with the objective of producing a computer-based aid which encourages understanding and innovation rather than leading, the user through a mechanical process of form filling.

We conclude with comments on the effectiveness of the tool as a design aid and propose future developments for the work on computer-based Environmental Assessment.

Keywords:

Environmental Impact, Environmental Assessment, expert systems, HyperCard.

In contrast to the BREEAM assessment philosophy, the BREDEM assessment method is very specifically intended to assess energy use in dwellings. It is based on completing calculation sheets, either in computer form, or as a spreadsheet. Like many conventional environmental analysis packages, it is as a result, very mechanical and does not encourage imagination and innovation during the design stage. As it stands the BREDEM assessment method (see Fig. 1) is typical of the problem identified by Leclercq [6]

... architecture students, constrained with high level thermal courses forget the link between their mathematical relations and the material reality of their building project. When drawing a window on the elevation draft in the composition course, they forget their conclusions written after long calculations during the thermal course the day before.

It is the identification of this kind of problem which led us to try to develop the BREDEM calculation sheets into an information and idea rich computer-based tool which took BREDEM as the skeleton that was fleshed out with, for instance, graphical images and design alternatives (a kind of expert system).

The approach to the problem

In short we decided to use hyper-media to help to marry 'number crunching' with the design process. The resulting stackware which we are developing we refer to as the *GARD Environmental Assistant*.

The *GARD Environmental Assistant* aims to both inform and to encourage greater understanding of the effects of choice of construction material, building orientation, fuel type and so forth, on the architecture itself and the environmental consequences. We chose HyperCard [7] (with commands written in Hypertalk [8]) as the hyper-media format to develop the package because of its flexibility and user-friendliness both in its scripting and end use. It also had the particularly strong advantage that it is very widely available, so although an alternative such as SuperCard would offer the very important ingredient of colour, we decided to use HyperCard with colour added via a third part add-on, Colorizer.

Our philosophy in developing the stack is well stated by Brown:

During schematic design, information and problem analysis must be presented in a way that is generative of architectural form and that helps the designer understand how the forms suggested by energy concerns fit with the forms suggested by architectural issues such as composition or structure. The schematic design stage proceeds very rapidly, involving experimentation with many ideas and combinations of ideas. These considerations are broad and

conceptual rather than detailed and fine, so information should be accessible and quick to use. [9]

Architects design more often than not in a trial and error way, usually getting it wrong, before right. Therefore an environmental assistant must not only allow for this method of approach but in addition, should not interrupt the flow of the design process. The aim of the stackware is to be used both as an aid during sketch design and as an analysis tool later on during the working-up stage.

The stackware, while showing the user the simple basics of how and why a building, performs in respect of energy efficiency, does not aim to educate the student as a course in environmental studies would. The question it tackles is not how but why a building, loses or gains heat through its fabric. By asking this kind of question it is hoped that the user is encouraged to acquire intuitive knowledge enabling the designer to design with unrestricted imagination.

In developing the stack it was crucial to establish both what information the stack should contain and how that information should be structured. The family of stack structures has been described by Goodman and is illustrated in Figures 2.1 to 2.3.

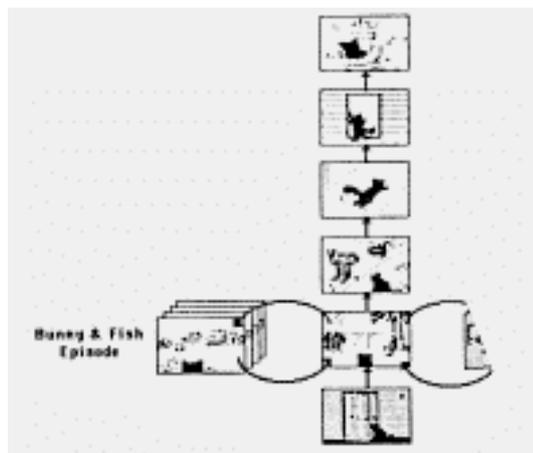


Figure 2.1: Linear Stack

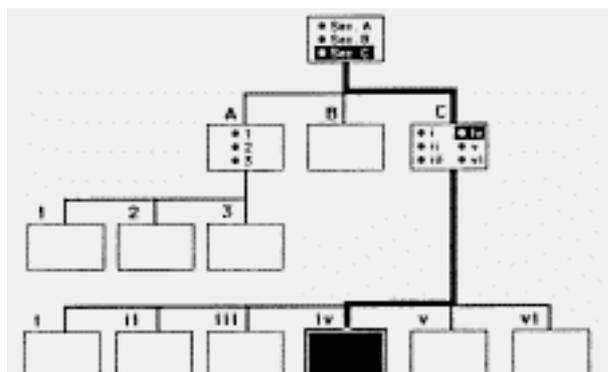


Figure 2.2: Tree Stack

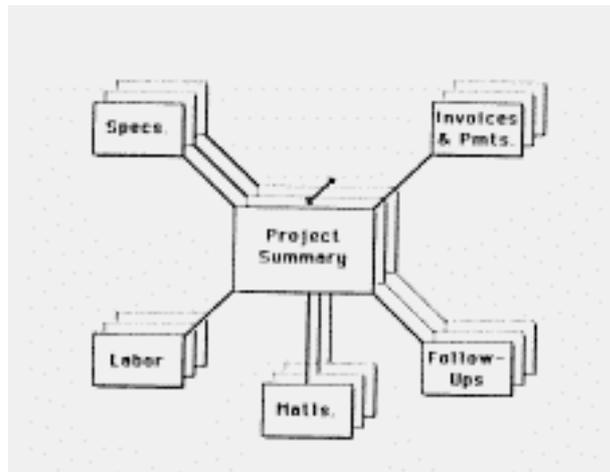


Figure 2.3: Web Stack

The GARD Environmental Assistant

As the application is aimed at architects the design tends more to use visual means to pass its information. For example the use of invisible buttons overlaid on a scanned image of a detail of, say, a cavity wall, allows the user to recognize and choose the appropriate wall construction quickly while also being informed of the make-up of a real cavity wall. Disadvantages of this are that the memory required is significantly increased, however, this minor disadvantage is greatly outweighed by the advantages:

- the graphical images are familiar and consequently quickly understood by architects
- a lot of information is conveyed very quickly
- the information is often less ambiguous than text alone



Figure 3: Typical card with buttons hidden behind scanned images

By using scanned images we aim to ensure that the user continues to be inspired and enthused by their design and to remind them of how the calculations can be an integral part of the design process. Also by incorporating this kind of images the stack can be used to explore the effect of say different construction methods without recourse to other sources of information such as books and journals.

The practical purpose of some of these images is to hide tedious calculations: and the amount of written text the user needs to read is kept to a minimum and where possible replaced by either images or sounds. Again the disadvantages of the use of sound are the large memory requirements, but as before the advantages can outweigh this pragmatic consideration. They can be used as:

- an alert to warn of mistakes
- to inform that results of calculations are now available
- to prompt when actions are required
- to punctuate at the end of a series of related cards

The stack

Although at an early stage the package is capable of calculating the total annual fuel costs of both proposed and existing domestic buildings from the information entered by the user. The user has to provide information on building dimensions, orientation, size and number of windows, materials, fuel type, and heating system. This data is elicited via a number of different cards containing either empty fields to be filled by the user or image buttons which calculate or take the user to the appropriate area of the stack where more information may be required.

The stack is, at present, split into 9 sections. The purpose of this is to allow the user to stop at each stage and return to previous topics and make adjustments depending' on that local result produced at the end of each section.

The current sections are, with stack type in brackets:

- House dimensions (linear)
- Hourly air change (linear)
- U values of various elements (tree)
- Heat losses through elements (linear)
- Specific heat loss through external fabric (linear)
- Internal temperatures (linear)
- Passive gains through fabric (tree)
- Energy requirements (linear)
- Annual fuel costs (tree)
- Pollution cost relating to fuels (linear)

The following sections are being added:

- Pollution cost relating to fabric (linear)
- Building zone requiring attention (linear)

Each section is separated by a punctuation card which contains a summary of the results so far from all the previous sections. This is to allow the user to instantly recognise which parameter makes the greatest change to the result. Buttons are again used here behind each piece of text used to label the section, by clicking on one of these buttons the user is taken back to that card or area where that parameter can be altered and entered into the calculation. The user is then taken straight back to the summary or continues through the stack. If the user is happy with the set of results on the summary card the options to carry on or print that data are given.

Once the user chooses to carry on they simply click on the appropriate button and are taken to a title card. This is used to both separate the sections and also convey some visual information about the next section. Scanned images and sound are used here.

The U value and Heat loss sections are somewhat more complex as a greater degree of navigation between the two is required. The connection is necessary, in order to allow access to the simpler heat loss figure when choosing insulation levels of the fabric. This connection is also required when calculating pollution emissions as a result of the material choice.

Comparison between heat losses and pollution emission is very important and is often overlooked in manual calculations, probably because such a comparison is laborious. However, with the use of Hypertalk scripting quantifying this balancing act has been accomplished. By comparing these two aspects the choice of material becomes easier, as you would not always choose the material with the best insulating value if its environmental cost was greater than any energy saved.

Pollution emissions are split into two main types:

- pollution produced during production and transportation, and
- pollution emitted after installation into the local environment directly affecting the occupants of the dwelling.

Taking the U value section separately, the user is presented with a range of types of fabric construction (which is periodically updated) ranging from the basic uninsulated solid brick wall to a light-weight timber frame. As mentioned earlier these are chosen by simply clicking on them. However, if the user has no idea what construction to use but only has a vague idea of what the U value should be, then, this is solved by giving a range of U values which when clicked on will recommend an appropriate construction and calculate the heat losses. There is also the option of defaulting to the minimum legally required level of insulation.

Future plans

To increase the visual feedback from the application (to compliment the visual assistance with data input and "expert" advice) it is planned to incorporate a package similar to Excel™ [10] in order to turn the data into graph or chart form. This will simplify comparison of alternative strategies.

In addition the application will be developed to be more applicable to renovation work. and a facility for calculating the energy improvements by adding solar spaces.

Initial feedback from the users of this prototype stack encourage us to believe that the approach which has been adopted and described here has the potential to make environmental assessment more intelligible by the designer, and more a true part of the design process.

Footnotes

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- [10] Excel™ (spreadsheet) is a trademark of the Microsoft corporation

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