# ENERGY AND COMFORT OPTIMISATION FOR THE HOMEBUILDER

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*A new service has been developed to assist new home-builders to examine the design options with a view to improving the energy efficiency and comfort of their new home. The service combines the skills of a trained advisor with versatility of a new computer package that enables thermal evaluation of the options within a one hour consultation. The developments that make this possible are described.*

## INTRODUCTION

The options for new home builders, seeking advice on the energy implications of decisions made at the design stage are limited. There is a plethora of generalised information with generic advice. However, for the homebuilder, making their most expensive lifetime purchase, information specific to their lifestyle and situation with quantification of the effects, is virtually unavailable. Computer models can give the necessary comprehensive results, but the expertise and time necessary to input sufficient quality data has kept computer simulation within the realm of research institutions, outside the reach of the general public.

The Scientific Services Section, of the Gas and Fuel Corporation, have developed a computer-based home Energy and Comfort Optimisation (ECO) evaluation service, to give specific, quantifiable design advice. The major programming innovation has been to increase the speed of data input. The service will be provided at suitable places, promoted appropriately and priced reasonably, to give housebuilders access to information previously unavailable to them. This paper describes the need for such a service, how it will operate, the technical approach taken to developing the software and aspects of marketing the final package.

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Other establishments in Australia and overseas, have offered advice on energy efficient design but the time consuming nature of computer simulation has restricted it's use, particularly for small projects. For example Building Research Establishment, in UK, offer an Energy Design Advice Scheme for projects over 500 m2 in floor area. Computer modelling is only used on the larger consultancies, taking more than one day, using a range of design tools. (Personal communication Mr D. Curtin - BRECSU)

## THE PERCEIVED NEED

When looking at houses built in Victoria today, it could be thought that nobody knows which way is North. In Victoria's relatively mild winter (around 1500 degree days, base 18), application of basic passive solar design principles, can reduce heating requirements by half without adding to the cost the building. Likewise, in Summer, attention to shading and thermal mass can remove the need for artificial cooling to provide human comfort. However, the average home buyer is either unaware of the effect that house design decisions will have on thermal performance or is concentrating on other aspects, such as views, cost or appearance.

Thus there appears to be a need to provide people building a new house with basic information regarding thermal design considerations and then specific advice regarding design details when they have selected a block of land and basic house design. The information required should relate the needs of the homebuilders lifestyle to the energy and comfort conditions resulting from design decisions.

## THE ECO (ENERGY & COMFORT EVALUATION) SERVICE

The Scientific Services Section has developed a service for new home buyers or those undertaking major renovations, which will provide a quantified heating energy and summer comfort evaluation and optimisation. This service, to be launched in 1993, is based on a software package developed by Scientific Services. Figure 1 gives a graphical representation of the service.

The ECO service is planned to be offered from several outlets, in Melbourne, initially. Clients planning to build a new home, or carry out a major renovation, bring a sketch floor plan and a prepared checklist to the consultation. A trained adviser enters the data for the base design to check the thermal performance. The adviser will then suggest options and evaluate the corresponding performance improvements.

A number of different options can be investigated, the program generates a report comparing those options. The report gives an estimate of heating bills and summer comfort without cooling, and shows the results of the different simulations on a graph of heating energy versus summer discomfort to illustrate improvements. An example of the output is shown in Figure 2. A further report showing the importance of each element of the building in contributing to heat losses and gains is planned.

The customer takes away a report showing the base design and construction and occupancy choices and then for each option investigated, a description of that option and the evaluation of the estimated benefits. The description shall be sufficiently detailed to allow the customer to get a quotation for additional costs/ savings to incorporate the change to the base design.

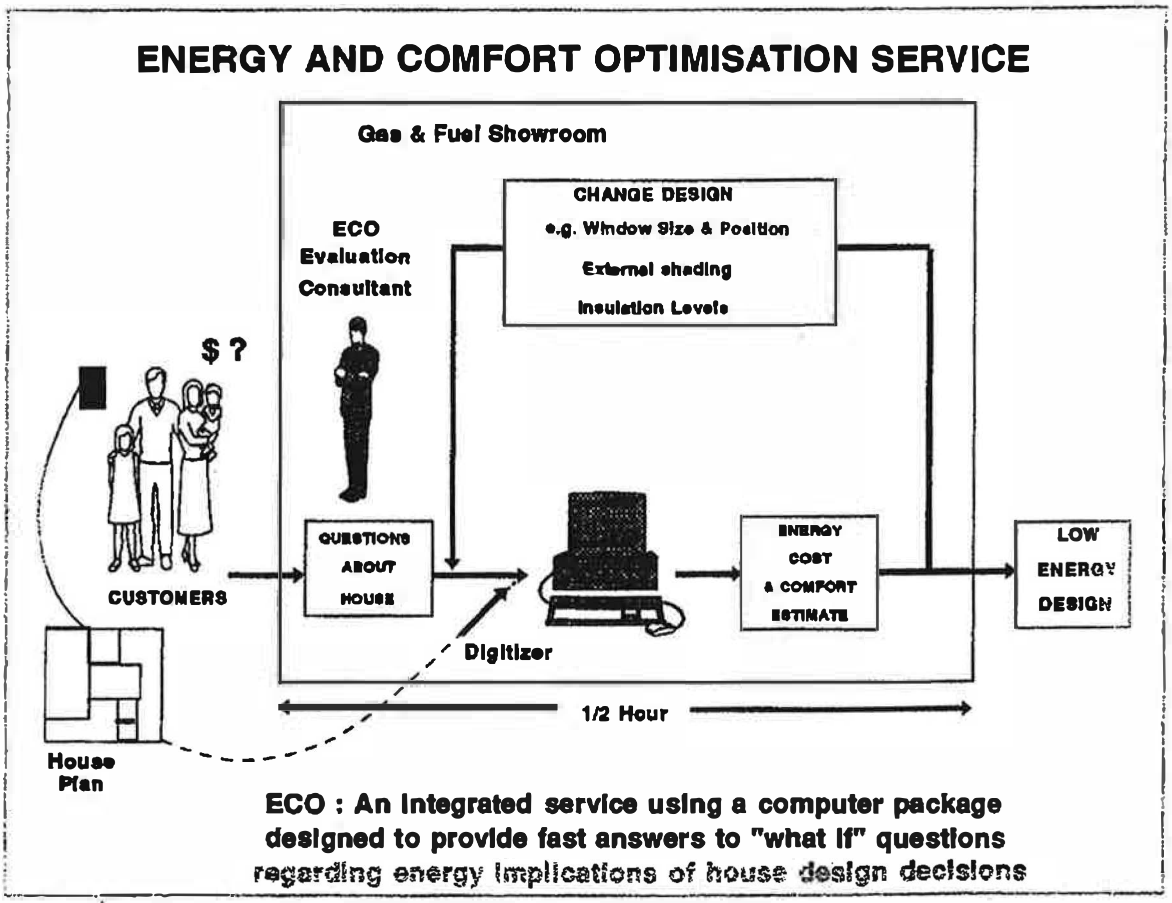



Figure 1. Representation of the ECO Service

**RUN 3** CHANGES

Change floor to concrete slab & carpet.
Change South windows to double glazing.

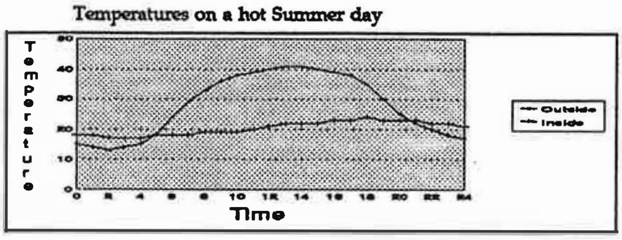
**RESULTS**

**WINTER**

| HEATING | LIVING ZONE | SLEEPING ZONE | TOTAL |
|---|---|---|---|
| HEAT REQUIRED GJ/yr | 15 | 11 | 26 |
| HEATING BILL (IN AVERAGE GAS HEATER) | $166 | $121 | $287 |

**SUMMER**

| COMFORT (without Cooling) | Hours hotter than 28°C |
|---|---|
| Living Zone | 202 |
| Sleeping Zone | 171 |




**ENERGY DISCOMFORT DIAGRAM**

**The lower the number the better. L = Living Area B = Bedrooms.**

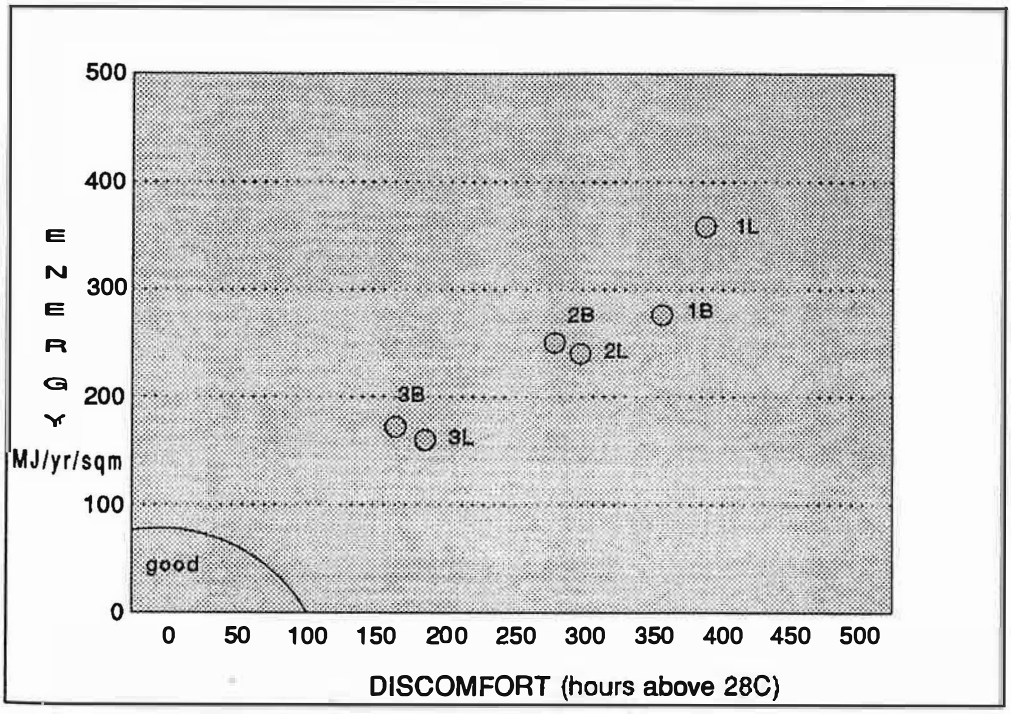



**Figure 2. Sample Output**

## TECHNICAL APPROACH

The computer package consists of several programs run serially in a Microsoft Windows PC environment.

- Graphical data input.
- Logical data input
- Data conversion and derivation.
- Thermal simulation
- Report Generator

This approach, while allowing the use of commercial packages that provide some of the required features, does mean that the package is less integrated than one might wish. i.e. variations in wall properties are done by choosing from a list (e.g. 1st North wall in Living Area) rather than by pointing to the wall in the graphical display. The overhead of additional software licenses for the CAD program is acceptable due to the small number of sites. Recent language developments in the area of Windows based applications, such as Borland Pascal with Objects, enable a version suitable for wider distribution, based on our current "prototype", to be produced.

The major strength of this package is the efficiency of data entry. A full data set can be input in about ten minutes. However it usually takes about twenty minutes, allowing for interaction with the clients.

## GRAPHICAL DATA INPUT

Dimensional data is input graphically from a scale drawing or sketch, by the use of a digitiser. As long as the sketch is drawn to scale and one dimension is known then input is very fast. The outline of each zone is entered by pointing to each corner. Similarly, windows are entered by choosing a height from a popup menu then pointing to the ends of all windows with that height. Shading by external objects, buildings and evergreen or deciduous trees, is also input graphically.

The operator is guided through the drawing process by a series of macros activated by on screen "buttons", as shown in Figure 3.

The graphic input stage is a Windows-based CAD program, which has five key features that we needed:

a. Runs in the Windows environment.
b. Programmable macros initiated by buttons.
c. Functions to calculate areas of polygons.
d. Libraries of symbols with associated attributes.
e. Exports drawing data in a standard ASCII format.

The first conversion program takes data exported from the CAD program and converts the collection of polygons, lines and notes into the required building attributes: Areas, lengths, azimuths. It also derives the logical information embodied in the drawing: Which wall is each window part of, which walls are internal rather that external, which windows will each tree shade etc. This data is stored in a range of databases.

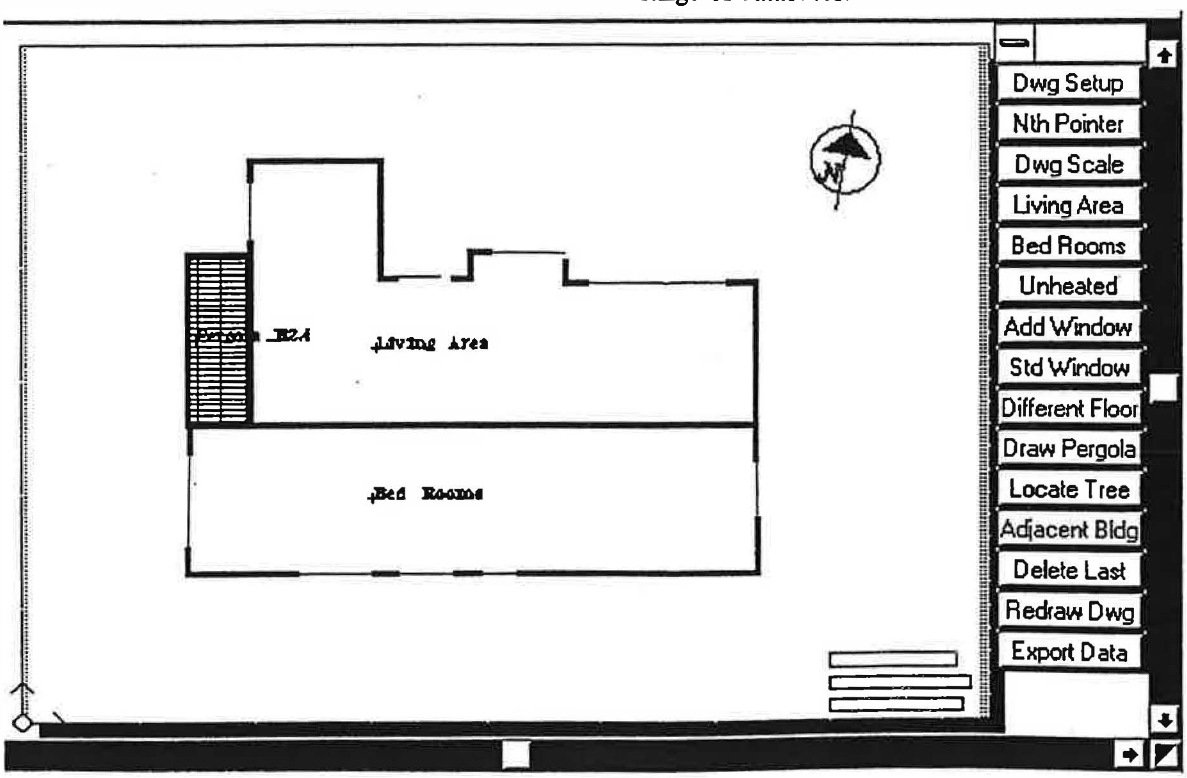



**Figure 3. Graphic input environment**

## LOGICAL DATA INPUT

Non-spatial data is entered using an application developed with a forms-based data input program. All derived spatial data is read in from the databases. Material data and occupancy data is then entered quickly from a set of forms with "picklists" of standard options. Only data relevant and easily obtained is input, the automatic post-processor generates the requirements which follow on from the house description. For example, if there is a sloping roof, a roofspace zone does not need to be described by the user; the roofspace zone model is automatically generated from the other data. Similarly, occupancy patterns are characterised by the number of occupants and their lifestyle. e.g. Home all day, Away during working hours, etc. From these two data, schedules for heat gain from people, lights and equipment and heater operation in each zone are derived.

The second conversion programs converts the menu choices into the detailed data and format required by the simulation program. e.g. "Cavity Brick" and "R1.5 insulation" is converted to the codes for: Brick 110mm, Airgap 50mm, Fibreglass 75mm, Brick 110mm, Plaster 10mm.

## THERMAL SIMULATION

The thermal simulation program used is ZSTEP3 (Delsante and Spencer 1983), developed by CSIRO as a research tool. A version of ZSTEP3, called CHEETAH (Delsante 1987), is currently available to the public. ZSTEP3 performs an hour by hour, dynamic simulation of the house modelled as several thermal zones. ZSTEP3 was chosen as an appropriate simulation tool after examining a range of options (Moller and Guthrie). CSIRO were commissioned to add some improvements to ZSTEP3 for this project:

- Shading by adjacent buildings or trees.
- Two independently heated or cooled zones.
- Up to eight independent wall orientations.
- Skylights.
- Output of hourly results for post-processing.

Time to run a ZSTEP3 simulation for a full year is approximately three minutes, using a 25 MHz 386 PC. Using currently available 486 PCs this would drop to less than one minute.

## MARKETING ASPECTS

The majority of houses in Victoria are built by small companies to partly standardised designs. Architects are rarely involved, so the service has been pitched at the buyers and the builders. Decisions regarding orientation and window sizing etc. must be made before much, if any, drafting work is finalized. Therefore, the service will be promoted through a range of activities, designed to inform home builders of the service early in the design phase. The ECO service will be provided in convenient locations, near new building estates and priced at a level which will allow expansion with growing demand and yet not deter interested customers.

## PROJECT STATUS

At the time of writing (March 1993), the package is close to completion. Public trials have been conducted on a prototype to determine utility, timing and marketing aspects. The service is planned to be launched in mid 1993, following a period of training and publicity activities. The ease of use of the package has attracted interest from a range of quarters. Opportunities for future development are being investigated.

## REFERENCES

Delsante, A.E. and Spencer, J.W. 1983. *"ZSTEP3, A Program for Simulating the Thermal Performance of Buildings"*. User Manual. C.S.I.R.O. Division of Building Research, Highett 3190, Australia.

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