EVALUATION OF DESIGN PERFORMANCE

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Building design is distinguished from other fields of design endeavour by three significant characteristics:

a) the magnitude of the "solution space" (e.g. there are some 7 million ways of arranging 12 spatial units within a 3 x 2 x 2 unit envelope)

b) the multi-variate nature of the problem (e.g. the need to satisfy structural, servicing, functional, aesthetic and other performance requirements), and

c) the temporal variation in objectives over the lifetime of the building.

Reluctance or inability to face the problems arising from these characteristics has led, respectively, to:

1) a retreat into stylism (the magnitude of the solution space being thus reduced to a sub-set representing the arbitrary but currently accepted consensus among the self-appointed architectural cognoscenti)

2) a strict hierarchical ordering of design decisions (in which 'form' is crystallised prior to and independent of structure which in turn is crystallised prior to and independent of service distribution etc.)

3) a perverse commitment to a single concrete 'statement' in terms of built form (resulting in buildings in which the mismatch between need and provision starts the day after the building is opened and increases daily thereafter).

Recognising these facts, it is appropriate for anyone who intends to produce computer design aids to make some clear statements about his "design beliefs" and to use these as objectives. Stated baldly, the "design beliefs" held by ABACUS are:

THE PLAN IS THE PROCESS - the role of the professional designer is to develop and make available the processes for design decision-making, rather than to produce solutions

THE PROCESS IS DESIGN-IN-USE - design is a continuing activity; the processes for decision-making should be as relevant to building modification, adaptation, growth and management as to the generation of the original built form

DESIGN-IN-USE IS PARTICIPATORY - design decision-making is the province of those affected by design decisions; the processes must therefore be usable by naive, as opposed to professional, designers, i.e. clients and users.
Consideration of the role of the computer in the three processes within the design activity (Figure 1) reveals the following:

i) whereas the computer is a most effective aid to ANALYSIS, the applications are not unique to architectural design and will be developed in other design disciplines without expenditure of scarce resources in the architectural profession.

ii) automatic SYNTHESIS of solutions to multi-variate design problems have been shown again and again to be "pessimum" rather than optimum, and

iii) APPRAISAL packages, with which the designer can conveniently interact, provide powerful and multi-purpose design aids.

What then is computer-aided appraisal? Essentially it comprises three aspects:

**REPRESENTATION** - the formulation of a model of the built form layout which is input to the computer, either graphically or in terms of coordinate geometry. The proposed form may be the result of an intuitive process or of some other generative mechanism.

**MEASUREMENT** - the computation of economic and physical characteristics of the built form. The product might be measures of capital cost, running costs (heating, lighting etc.), movement, heat loss/gain, planning efficiency, daylighting levels etc.

**EVALUATION** - the comparison of the measures already produced with criteria which may be explicit or implicit in the brief. Criteria may be mandatory constraints (e.g. minimum daylight factor), norms (established from previous designs) and optima (where they can be defined).

The object of design appraisal is to provide the designer with sufficient information as to the cost and performance characteristics to direct him in modifying his scheme towards a cost/performance profile agreeable to his client. An essential attribute of the package is that the model input to the computer should be readily modifiable; participants in the workshop sessions can judge whether or not existing packages offer this facility.

Typically then, the architect (or any other member of the design team) would come to the computer terminal with a built form hypothesis. Using the representational conventions relevant to the program he would input a description of the site and of the hypothesised scheme. The computer program has access to filed data on climate, environmental requirements, movement patterns, costs, thermal transmittance factors etc. and is thus in a position to carry out and print measures of cost, spatial performance, functional performance and environmental performance. The machine can compare these measures with constraints already held in file or with norms recorded from previous schemes.
Figure 1: An attempt to see down an incomplete taxonomy of current developments.

**APPRaisal**
- Characteristics of layout
- Characteristics of cost and performance
- Measurement and evaluation

**SYNTHeSIS**
- Whole
- From layout to design
- Hypotheses of a specific built
- Collection, collaboration, co-
- Relation and manipulation of
- Analyzing
Apart from using appraisal packages for converging on a best solution or for choosing between alternatives to satisfy a particular brief, they can be extremely useful in two other contexts.

Causal Relationships: the causal relationship between any design variable (e.g. building shape) and a performance variable (e.g. heating cost) is not readily formulated, a priori, because of the very complex physical laws pertaining. An appraisal package can, however, simulate, in a controlled way, a large number of alternatives in a short space of time and thus offers a unique chance to study the causal relationships which govern building performance. For example, geometry can be systematically varied (while keeping other design variables constant) to establish, from the output, the effect on capital cost; variations in glazed area can be made to determine the effect on thermal performance; etc.

Performance Profiles: as previously stated, the cost/performance measures for any scheme can automatically be compared with the norms of previous schemes. It is thus possible to plot, for any particular scheme, a "performance profile" showing the deviation of each cost/performance characteristic from the norm (see Figure 2).

The production of causal relationships and of performance profiles provides data on which future design decisions can be more sensibly based and promotes the establishment of sensible constraints and performance specifications.

Now how does the existence of appraisal packages alleviate the problems and fulfill the objectives set out at the beginning of this paper? First, the problems:

While the packages do not actually reduce the magnitude of the solution space they do promote a very much more rapid and directed search within the solution space than is possible manually. The output from the packages is, as we have seen, multi-variate, allowing consideration of economic, environmental, spatial and functional aspects of design. Used repeatedly, the packages allow investigation of hypothesised future requirements over the anticipated lifetime of the building.

As to the objectives:

The fact that architectural practitioners are getting involved with working parties for the specification and commissioning of packages such as those described, indicates that there is a growing interest in the mechanisms relevant to design decision-making; this I interpret as a move towards the view that THE PLAN IS THE PROCESS. That the mechanisms are as relevant to building modification, adaptation, growth and management I take to indicate their applicability to situations in which THE PROCESS IS DESIGN-IN-USE. The fact that the performance characteristics of alternative design hypotheses are made explicit to those who will finance and exist within the building makes it possible to create a situation in which DESIGN-IN-USE IS PARTICIPATORY.
Figure 2: Performance profiles for 3 hospitals
REFERENCES


5 ANSIM is a statistical technique which, given an association matrix as input will produce a point plot of the elements of the matrix in 2 or 3-dimensional space. See Kernohan, D., Rankin, G., Wallace, G., Walters, R. (1971) Relationship Models: analytical techniques for design problem-solving. ABACUS Occasional Paper No.17


11 HELP 1 and HELP 2 are computer packages being developed by ABACUS to appraise alternative housing development layouts

12 ECOLE 1, 2 and 3 are the equivalent packages to SPACES 1, 2 and 3 but relevant to scheme design as opposed to outline proposals. They are currently under development by ABACUS.