Kept in the dark: issues of solar access and energy efficiency

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CONTINUING EDUCATION FOR THE MANAGEMENT OF THE BUILT ENVIRONMENT

DEVELOPMENT APPLICATIONS

TRICKS OF THE TRADE

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Kept in the dark
issues of solar access and energy efficiency

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1.0 Introduction

1.1 The need for sunshine

Human beings' 'need' for sunlight seems rooted in evolution in natural conditions, and the extremely short distance in biological terms by which we have moved beyond this. It has proved extremely difficult to quantify. Generally, surveys show that people 'need' what they have, and are therefore inconclusive.

Little recent research has been done on social dimensions of preference for sun in dwellings. Dutch researchers in 1967 found that housewives expressed a preference for sunlight rather than a fine view from their living rooms, but no similar studies have been conducted in warmer climates. Brierley, in the U.K., concerned with low-rise, high density housing, concluded that the 'reasonable' spacing for privacy will usually 'automatically' allow for sufficient sunshine.

Studies have been conducted to try and determine why occupiers value sunlight, but have come up only with keywords suggesting romantic rather than pragmatic views: that it contributes to the 'feeling of warmth', 'pleasantness', 'sparkle' of interiors. It has been suggested that a view of sunlit surroundings may be enough to fulfil these. A *disinfectant* function of sunlight has long been recognized, and has entered the folk adages of many cultures, contributing to the reluctance to dispense with some sunshine in the home.

These various factors have led to the relatively recent attempts to incorporate provisions for minimum sunshine in a number of building codes. The inexactitude of knowledge in this area is reflected by the variety of the provisions. The basic principles still applied today, were laid down after World War 2.

In N.S.W. the Bunning Report of 1944 stated that a proposed building should not reduce to less than one hour the sun falling on the living room and main bedroom windows of an adjoining building between 9am and 3pm. This form of specification remains the one favoured by most local authorities, but the required period has been increased to either two, three and even four hours.

Various Municipal Councils in N.S.W. have in the past tried alternative approaches to specify varied periods of sunshine, on quite different percentages of variously elevated horizontal planes of adjacent blocks, with or without specifying times of the day, or periods of the year. This form of specification is/was favoured by those councils more preoccupied with 'solar opportunity' on the majority of undeveloped blocks in their area.

It is important to note that all such codes only seek to ensure sunshine reaching the building. It is up to the designer what to do with it.

1.2 Solar access: energy and amenity

Since the 1970's oil crisis, there has been some emphasis in state and local government policies on energy efficient design of dwellings. This has intensified more recently in response to the heightened awareness of the contribution of domestic household energy use to the generation of greenhouse gases.

As part of the strategy to reduce household energy use for heating and cooling, passive solar design has been encouraged by most jurisdictions. Conventional passive solar design is applicable in much of temperate Australia. All design guidelines for dwellings since the early 1970's have reflected this emphasis. The chief consequence has been a concern with protecting solar access for northerly facing windows of existing dwellings, and potential north glazing of future dwellings on vacant land.

More recent research following the introduction of widespread mandated house energy ratings has suggested that much of the individual home market is dominated by project home designs that are relatively insensitive to orientation. The thermal performance of these project homes is likely to be rather less influenced by solar gain than had been assumed. To this finding might be added the difficulty of predicting by calculation the likely impact on the energy use of any typical dwelling of marginal variations in solar gain. It quickly becomes apparent that in enforcing minimum solar access requirements, approving authorities would have problems relying on objective comparative measures where these conflicted with other considerations in a development application.

On the other hand, amenity resulting from guaranteed winter access to sunshine in much of Australia is relatively easy to demonstrate, both in terms of thermal comfort opportunities, and in terms of various other factors contributing to the usability of private outdoor space.

1.3 Mandating solar access

Where local government authorities mandate minimum solar access, they usually do so by provisions in their Residential Development Control Plans, sometimes with reference to other documents such as a more general code for energy efficiency. These DCP provisions are usually aligned with one of two model codes, being the *NSW Department of Planning* Residential Development Controls of 1990, and the Australian Model Code for Residential Development (AMCORD 95). These two models provide different levels of stringency, and it is not uncommon for applicants to refer to this discrepancy when seeking exemption from full compliance with Council's requirements.

When solar access standards are disputed by applicants, Councils should be wary of relying on their requirements being based on the NSW *Department of Planning* Residential Development Controls. In my opinion, the provisions of that document are unsafe. Specifically, they are:

- *Ambiguous*, in that, the recommendations fail to make clear whether it applies to adjacent properties, or to within a proposed development. It may be inferred that the former is more likely.
- *Anomalous*, in that the Explanatory Notes, Solar Access specifies, *inter alia* "The predominant feature is that access decreases as density increases…….", but Clause 2.7.2 Sunlight Standards specifies only one access standard independent of density.
- *Insufficiently specified*, in that they make no reference as to what *portion* (eg. living space glazing) of the dwelling, or what *proportion* of open space they are applicable.

AMCORD recommends slightly less stringent solar access criteria, but makes some nominal distinctions between amenity and energy objectives.

2.0 Demonstrating compliance in applications

2.1 The Shadow Diagram

For demonstrating compliance of proposed designs with minimum projected solar access, the ubiquitous requirement is submission of Shadow Diagrams.

Such diagrams are always specified as plan projections for mid-winter, with some Councils also requiring Equinox and possibly Summer projections. Most commonly, the diagrams required are for 9am, 12 noon and

3pm. This bracket of time is itself based on notional usefulness of the received solar radiation as an energy source.

Some Councils explicitly require documentation of projected shadows at the same times on potentially affected building elevations. In my experience this requirement is rarely if ever enforced.

2.2 Why are shadow diagrams always wrong?

This rhetorical question deserves serious attention. In fact, shadow projections on an hourly or less frequent basis, almost always only in plan, are a very poor basis for establishing compliance with minimum guaranteed solar access. There are a variety of reasons for this:

- Shadow diagrams are onerous and time consuming to construct.
- Plan projections rarely contain much of the relevant information, such as accurate response to slope, etc. because the 3D geometry is difficult to visualise.
- Detailed answers to questions of solar access, to points of interest (such as windows) in vertical planes of different orientations and heights, are difficult or impossible to infer from plan projections.

In addition, shadow diagrams are prone to error and abuse through several mechanisms:

- *Wrong orientation.* The prime source of this error is the use of Magnetic North from survey plans. All solar projection relates to True North. In critical situations, typically involving narrow separation of buildings, this error can easily make the difference between apparently complying design, and severe and unacceptable overshadowing.
- *Misreading of sun position information.* The standard graphic source of apparent sun position data is unfamiliar in construction, and often misread by infrequent users.
- *Operational failure* of the projection. In other words, someone didn't know how to cast shadows.
- *Approximate or distorted shadow lengths.* This may be deliberate, or the result of incompetence. Even competent shadow casts may result in such distortion (usually in the applicant's favour), because the reference plane onto which the shadows are cast is arbitrary and elevated above natural ground level.
- *Misunderstanding of the 3D geometry* necessary to translate from sun angles relating to North, to those seen in the conventional architectural drawings — which are usually orthographic to the main walls of the building. Usually confusion of Altitude and Vertical Shadow Angles.
- *Missing detail.* Most commonly shadows of vegetation and other obstructions. Though the reasons for such omissions may be various, they invariably affect the judgement of comparative degrees of overshadowing.

So why are such Shadow Diagrams required by Councils, and obligingly provided by applicants? Because they are intuitive to look at — they look vaguely like the shadows that may eventuate. Yet, put simply, a shadow diagram cannot answer the key question: how much sun does a particular point in space receive?

All alternative means of analysing and presenting the solar access data are less intuitive abstractions.

2.3 Preferred analysis tools

There are a number of representations of solar access and overshadowing, which emphasize the representation of sunlit periods, rather than shaded conditions, and do so with much greater precision than shadow diagrams.

2.3.1 Computer based

Computers may be used to produce normal shadow diagrams, if the 3D model of the building and potentially affected surfaces have been entered. These may be animated, etc. and even accurately rendered. However, that is not the preferred use of the computational power, as the legibility of cast shadows is still deficient.

The preferred output from a comprehensive computer model is views of the building and its environs from the direction of the sun. Such views clearly and unambiguously distinguish sunlit from shaded surfaces — only sunlit surfaces can be seen.

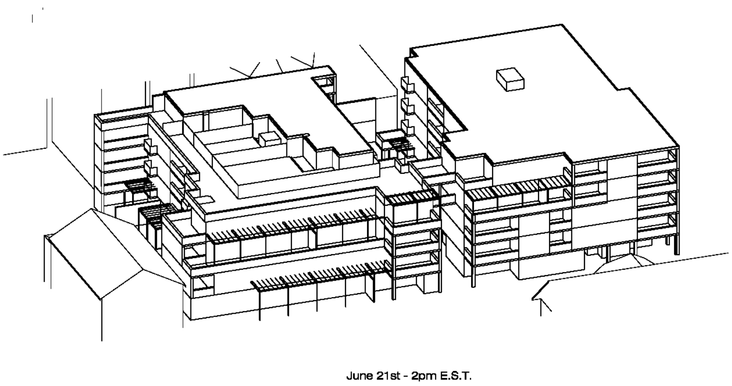

Figure 1 View from the direction of the sun

2.3.2 Computer or manually based

The most powerful of all technique for answering precisely how much sun a point receives over a whole year can be carried out readily by both manual and computing methods. It consists of projecting onto the stereographic sun position diagram the horizontal and vertical 'shadow angles' subtended from the point of interest by potential obstructions. Computers speed up the computation and representation.

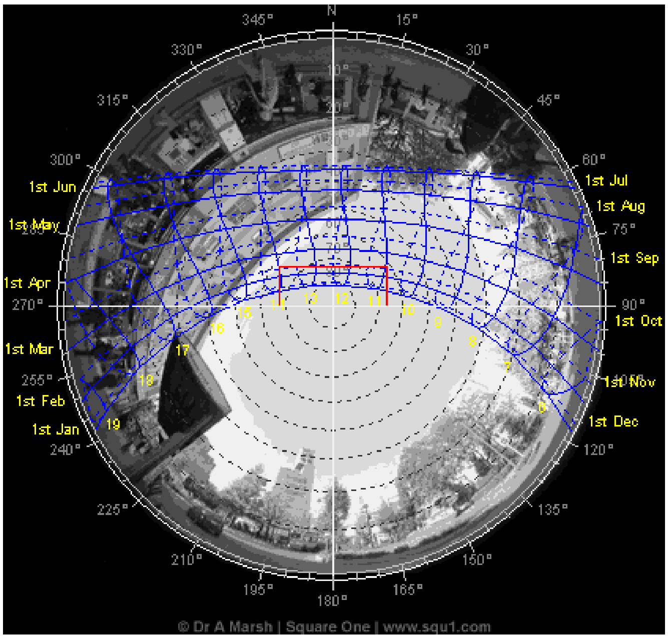

Figure 2 Potential obstructions superimposed on stereographic diagram of sun positions

2.3.3 Manual analysis

SUNLIGHT INDICATORS

Effectively a derivation of the previous technique, but most suitable where only key dates of the year are of primary interest, pre-printed Sunlight Indicator templates may be used as transparencies superimposed on the hard copies of conventional architectural drawings. Relying only on simple computation of relative levels, they yield impressively accurate schedules of shaded and sunlit times for individual points in space.

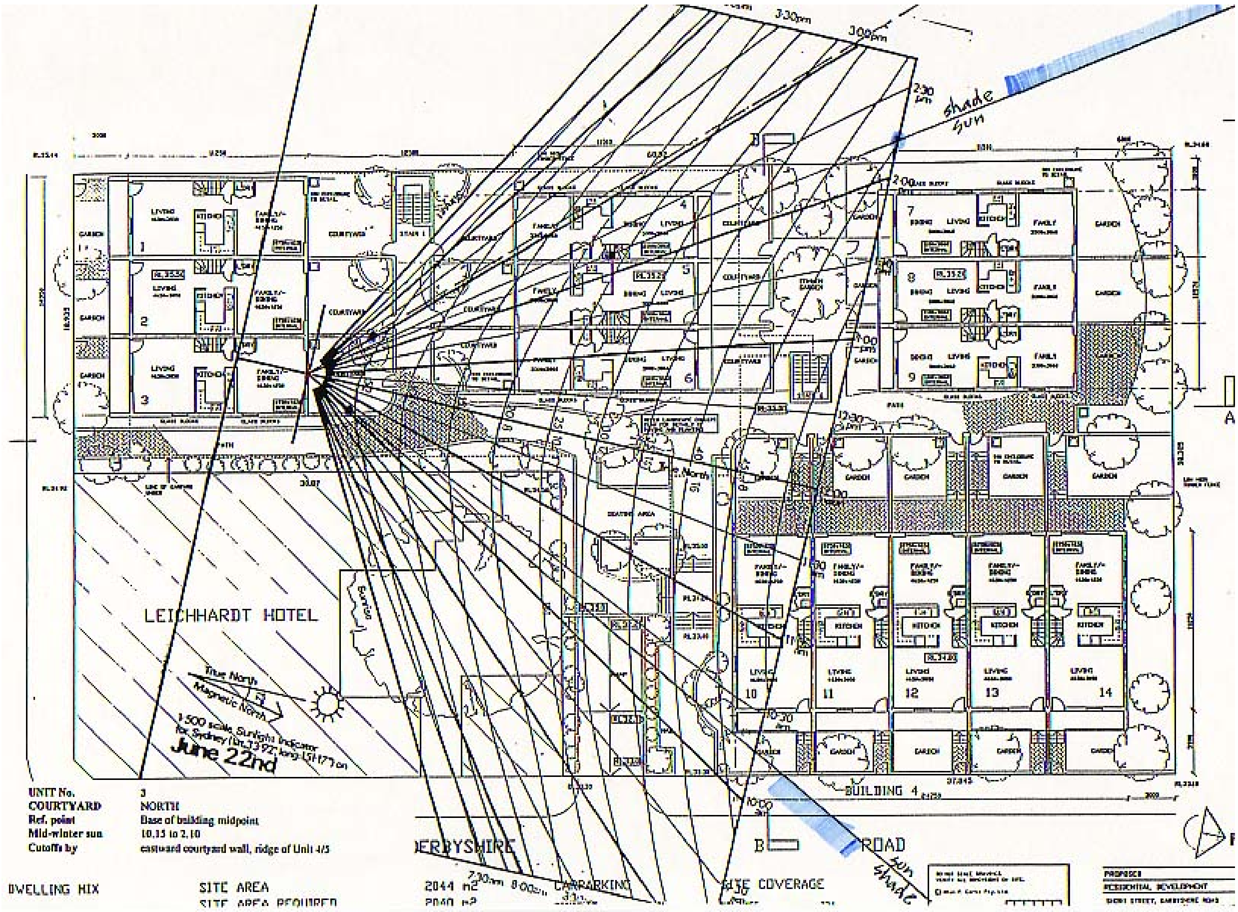

Figure 3 Sunlight Indicator for Sydney, June 22 superimposed on plan.

Sunlight indicators are by far the quickest and most effective way for Council staff to carry out compliance checking.

MODEL STUDIES

Where physical models are produced for other purposes, they may be examined for solar access and overshadowing by use of a simple polar sundial. The accuracy of the shadows is dependent on the distance of the light source, and the alignment between model and sundial.

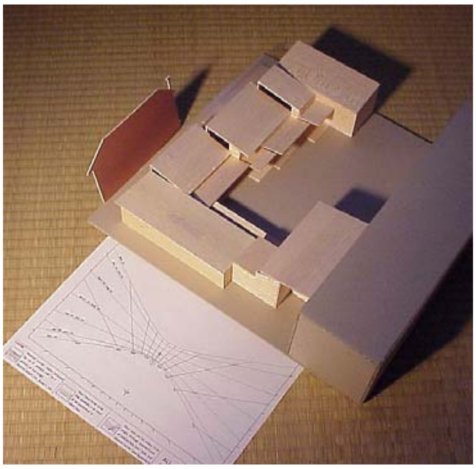

Figure 4 Model with polar sundial

Model studies may be recorded by photography, and minuted. They are particularly well suited to pre-application conferencing.

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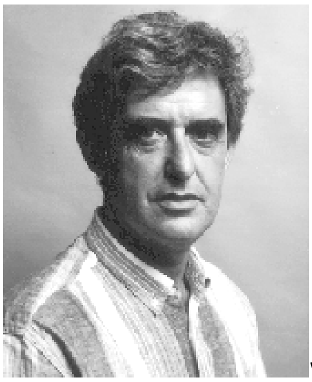

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As a practice oriented member of the research team at SOLARCH, and with his specialisation in passive environmental control of buildings, Steve King has been responsible for projects affecting the evolution of energy performance expectations for both domestic and institutional buildings in Australia. He provides the technical oversight of the NSW HERS Management Body, which accredits assessors under the National House Energy Rating Scheme, NSW, and of a number of studies for the SEDA NSW to improve the implementation of minimum energy performance requirements for dwellings. He is the principal author of *SITE PLANNING IN AUSTRALIA: Strategies for energy efficient residential planning*, published by AGPS—and of the RAIA Environment Design Guides on the same topic. Through UNISEARCH, Steve conducts training in solar access and overshadowing assessment for Local Councils, and as part of professional development courses.

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