Dealing with solar access and overshadowing

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Dealing with solar access and overshadowing

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INTRODUCTION

When trying to deal with DCPs is an architectural consultant, and even more, trying to help council officers implement them as controls, I feel like I am watching in action the proverb: "If at first you don't succeed, try, try again." This could be said generally about many aspects of DCPs, but I would suggest that it is most true of those provisions that try to deal with amenity — with solar access and overshadowing by far the most frustrating. I think it is for that reason that the organisers of this seminar have asked me to speak about such a narrow topic.

Albert Einstein is reputed to have said: "The definition of stupidity is doing the same thing over and over again and expecting different results." I am not trying to offend anybody. But I suspect that our good intentions, and our general illusion that we are achieving some success in improving residential construction, blind us to the glaringly obvious: The way we are trying to implement controls in relation to solar access and overshadowing, generally do not work. They do not work for two reasons:

- Most of us do not really understand why we are trying to achieve certain quantitative standards of solar access for dwellings; *and*
- we understand even less about satisfactory ways of *investigating* solar access during the design of buildings, and then — having achieved the necessary standards — *demonstrating* compliance with the controls.

In this paper, I will address both those areas of concern in some detail, while mindful of the more general lesson that they may imply for the broader role of effective DCPs.

WHY DO WE REGULATE SOLAR ACCESS FOR DWELLINGS?

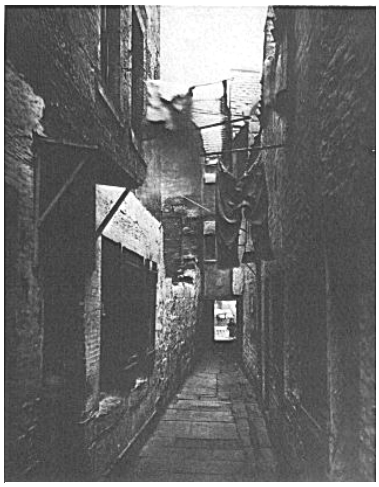


Figure 1: "Where the sun does not go, the doctor does."

Australia was one of the earliest to adopt regulations to mandate access to sunlight for dwellings. This should strike most people as odd. After all, not only are we living on a conspicuously sunbaked continent, but the edges that we inhabit also have some of the world's most benign climates. Why didn't the Europeans or the North Americans, with their cold winters, precede us? Why do the North Americans still appear to ignore mandated solar access?

In fact, the early adoption of solar access rules in Australia came about through the confluence of a number of factors. Early in the 20th century in northern Europe, the scientific link was made between the incidence of rickets and a particular vitamin deficiency. Uniquely amongst the vitamins, vitamin D is made in the body, and enough is produced only if the person is exposed to a certain minimum amount of ultraviolet radiation in sunlight. The same ultraviolet in sunlight was shown to be beneficial in the treatment of a variety of skin

conditions. Also put on a scientific basis was the vernacular knowledge ─ evidenced by the traditional preference for eastern orientation for bedrooms ─ that sunlight both dried and disinfected bedding and sleeping areas. This medical and scientific value placed on sunshine translated to it being embraced as a 'good thing', and bright sunny interiors became iconic in the modernist rejection of traditional architecture.

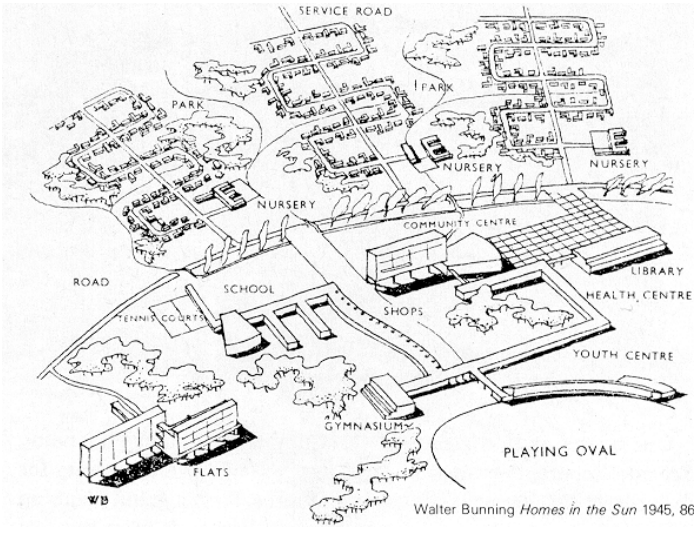
But the Europeans understood that the critical amount of sunlight involved was of a surprisingly short duration. Five to fifteen minutes of casual sun exposure of hands, face and arms two to three times a week during the summer months, is sufficient to keep one's vitamin D levels high. The minimum winter exposure, while longer, is still trivial; and vitamin D levels could be supplemented from other sources. This could be arranged by social programs more easily than by radically transforming the built environment of the traditional European city.

So, while ideals relating to sun access and ventilation clearly show up in architectural initiatives in Europe, it seemed less necessary to incorporate them in regulation. European pragmatism can be seen in a Dutch study of housewives in the 1950s. When asked about their preferences in apartments, they expressed a high level of satisfaction if they could look out on a sunlit view, where direct sun into the apartment was not available.

In contrast, in Australia we appeared to take a different attitude. In his *Ministry of Post-War Reconstruction Report* of 1944, Walter Bunning, architect and executive officer of the Commonwealth Housing Commission wrote:

". . . any proposed building should not reduce to less than one hour the sunlight falling on windows of the living and main bedrooms of any adjoining buildings between 9am and 3pm."

In this we recognise almost exactly the form of our prevalent current regulation of minimum sunlight for homes. However, we tend to forget the context in which such a rule made sense.



Walter Bunning *Homes in the Sun* 1945, 86

Figure 2

Australia was setting out on an unprecedented suburban expansion, of individual houses on individual lots. In his book *Homes in the Sun*, published in 1945, Bunning elaborated his strong belief that buildings should be designed to suit the Australian environment. Most tellingly he illustrated an ideal subdivision pattern, where every home had its living areas oriented to the north and was set in a sylvan landscape of mature vegetation. His rule of thumb was intended to recognise the likely opportunity for winter sun to clear that vegetation, and be available to those predominantly northern windows. He appeared to be conscious of the possibility that with a minimum of good design, a home in the climates of eastern Australia could minimise the need for winter heating, and he intended to assure that the sun access that was afforded by good subdivision layout was also utilised in the design of the houses.

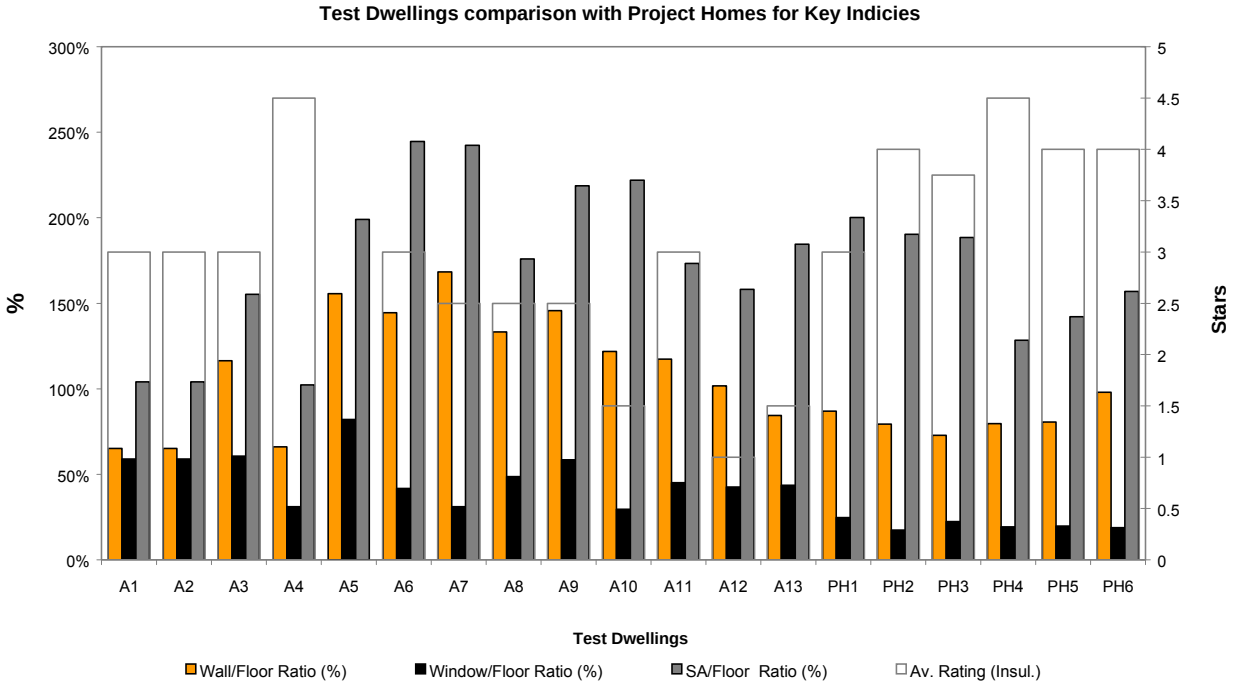
DO OUR PRESENT REGULATIONS MAKE SENSE?

In principle, to assure that a dwelling has winter sun does make sense in most of Australia's climates.

Solar radiation provides free winter heating, which can be easily utilised by good design on suitably oriented sites. Most Australian climates favour such 'passive' design, in that the 'solar fraction' of the total heating load is potentially high. Also in those climates, the energy balance of suitably oriented single glazing can be positive ─ more solar energy comes in, than is lost by conduction through the glass ─ with the simple expedient of appropriate curtains or other window treatments closed at night.

Of course, a sunpatch behind glass can also be a very comfortable place; the thermal sensation in still air can be of up to 15°C higher than air temperature. This affords lots of choice to people as to how to manage their artificial heating, and can achieve very real energy efficiencies. However, the benefit of free solar heating in achieving *net energy saving for a household* is subject to many variables.

One such variable is the difference between glazing opportunities in response to site orientations. But to make it worse, a small study carried out some years ago by SOLARCH at



UNSW made clear that the thermal performance of project homes is typically almost insensitive to orientation, while the disposition of glazing in individually designed houses rarely responds to advantageous solar orientations. Of the other variables, the most influential of course, is user behaviours, including occupancy scenarios.

Figure 3: Rated thermal performance of individually designed vs project homes
Note the even distribution of glazing in the project homes, and that they all achieve four star or better ratings.

The energy efficiency benefit is therefore notoriously difficult to demonstrate, and may not correspond to the standardised predictions of simulation based rating calculations, such as AccuRate. To attempt to rely on such modelled thermal performance of dwellings in order to resolve a particular compliance issue ─ relating to solar access alone, and without due consideration of the other remedies such as improved insulation standards ─ would be untenable. It is also beyond the expertise of approval authorities, anyway.

Finally, to place this consideration altogether out of the scope of DCPs, we need to remind ourselves that as things stand at the moment, the regulation of thermal comfort and energy efficiency by any other planning instruments is explicitly proscribed by SEPP BASIX.

With regard to the other health benefits of sun that derive from its UV radiation component, it is difficult to make a case in Australia. Arguably, the opposite is true. Far more people appear to resent the destructive effects of UV radiation on furnishings and carpets, artwork and books, etc., and for that reason go to considerable lengths to exclude sunshine from at least formal living areas.

What is perhaps almost beyond argument is that when some sun is present in an interior, there is a general feeling of improved amenity. There are many colloquial descriptions of this amenity, but it is often simply expressed as the opposite of 'gloomy'.

The precautionary principle

The bottom line that ultimately justifies regulating for a minimum of available sun is a precautionary principle. You can assure access to sun, but you can't dictate how people will respond to it. You even cannot assume that professional designers will take appropriate advantage of the sun access that is protected for a site. However, ***if the sun access is not protected to begin with, the designer's and the resident's choice is forever curtailed.***

This precautionary principle then also opens up the issue of differences when we protect *solar access for future residents* ─ as for instance under the Residential Flat Design Code for apartments ─ and when we are seeking to protect *existing amenity enjoyed by neighbours*, or on public space near a proposed development. The former is usually referred to as assuring minimum *solar access*, while the latter is more usually referred to as limiting *overshadowing*. For clarity, I adhere to that terminology, and will return to the issue later.

The details

From the brief background above, it is obvious that the detailed specification of our present typical rules of thumb for minimum solar access, is increasingly arbitrary.

The time bracket for acceptable solar access

There would appear to be little justification for limiting the acceptable time span to the hours of 9am to 3pm.

A detailed comparison of radiation intensities transmitted through a north facing vertical window would indeed demonstrate a benefit, as the low winter morning and afternoon sun contribute little useful heating through such a hypothetical, idealised solar collector. However, where the glazing is oriented north east, the low morning winter sun is very nearly normal to the glazing, deeply penetrates into the room, and provides a usually welcome early warm-up at the most useful time of the day. For glazing of that orientation, the optimum time span would begin as soon after dawn as the sun clears any topographic and other obstructions remote from the site, and may end by noon. The benefits of north-west orientation and late afternoon sun are not as clear, mainly because of the penalty of summer overheating that is an unavoidable corollary.

If one also considers likely occupancies, we realise that for most working people, and those with school age children, the 9am to 3pm time bracket actually defines the period when those people are *not* at home ─ except, perhaps, on the weekend. In other words, the occupancy scenario the rule of thumb suits best is the elderly and some stay at home carers of very small children.

The issue therefore resolves to the notion of 'effective sunlight', pretty much independent of the time of day. For some orientations of glazing ─ that may be desirable for reasons other than simply maximising total free winter solar heating ─ sun may be effective at dawn, because it efficiently penetrates the glass, and contributes disproportionately to amenity. For others, it may be desirable to allow late afternoon sun, for the same reasons.

The terminology 'effective sunlight' derives from a Planning Principle incorporated into the judgement of *Parsonage v Kuringgai Council* by the Land and Environment Court. That *Planning Principle* sets out a number of issues for consideration. At least two such Principles

are then framed in ways clearly gives rise to unforseen problems, but the fundamental issue of solar access protection being directed to achieve effective sunshine is the core of the Principle, and the Court has consistently accepted its application for that purpose, even to the exclusion of its own other problematic provisions. I will also return to these in my summary recommendations.

What is an appropriate minimum total time?

SOLAR ACCESS

Were it possible to require effective *passive solar design* for all dwellings, the appropriate minimum solar access would be no winter loss of sun exposure at all, during an optimised time span appropriate to the dominant site orientation. This is actually achievable, but only in new developments at a significant scale, where sometimes complex envelope geometries and building spacings can be enforced by master planning. It is also only justified, where the climate is sufficiently extreme that the winter heating benefits are beyond doubt.

In a typical Australian suburban context, it is impracticable to rely on this criterion, for reasons already explained. With that clear performance criterion unavailable, the answer to this critical question becomes entirely subjective.

For what it's worth, my experience tends to suggest that in Sydney, the requirement by the current majority of Councils for three hours of assured solar access at mid-winter for new developments is generally reasonable. The common qualification that in closely built up areas, two hours is acceptable, also seems achievable with reasonable design effort. A few Councils seem to feel like they have to demonstrate virtue by requiring four hours — in my experience, this increase introduces an order of magnitude greater difficulty for designers.

OVERSHADOWING

For overshadowing of existing neighbouring dwellings, the issue is only a little clearer, but the principle is easier to clarify:

- An occupier enjoying any amount of existing sun access may perceive any loss as undesirable, or even catastrophic.
- If the projected loss is due to development that conforms to the same bulk and scale controls to which that existing dwelling may have been built, a consideration of equity has to be applied, such that the existing neighbouring user's expectations do not curtail the development rights for a site.
- However, projected loss may be due to development exceeding other rules that may govern bulk, scale, or disposition of building massing on site, but for which the approving authority may be willing to make concession for other reasons. In this case, the equity principle suggests that any loss of amenity due to the 'non-complying' portion is much less acceptable, and may not be acceptable at all.

It should surprise no one that the Land and Environment Court has had to consider these matters, and has incorporated them in one of its Planning Principles, in *Pafburn v North Sydney City Council*.

Where and how should sunlight fall?

When considering solar access and overshadowing, it is necessary to distinguish how it affects glazing, and open space.

GLAZING

Glazing serves to admit sunshine to the interior of a room. To do that, any sun falling on it must do so as to achieve effective penetration of the glass. The optical properties of glass dictate that the angle of incidence cannot be too great, as refraction will limit transmission, until at a particular angle too acute to the surface of the glass, total external reflection will occur. At those acute angles also, the sun patch in the interior would reduce to a trivially small size. This is the

basis of the Parsonage Principle's dictum to exclude from consideration sun that is at 'less than 22½° to the glass in plan'. Setting aside the fact that angles of incidence are more properly expressed as being in relation to the 'normal', the limitation should of course be observed in 3D, rather than only in plan.

The same *Parsonage Principle* also addresses itself to how much glass needs to be sunlit to be qualified as complying. Here, the *Principle* is deeply flawed, in that it requires a 50% proportion of the proposed glass to be sunlit, without specifying useful areas. It has produced a regressive tendency, where designers adjust the area of glazing to conform with the rule, rather than examining whether the area of sunpatch is actually adequate.

It would be useful to have a minimum area of sunlit glazing commonly accepted as reasonable. But to derive such a minimum qualifying area is likely to be difficult, not least because ─ as I suggest ─ we don't have any reasonable basis in solar heating potential on which to base it. Nevertheless, it is worth pointing out that for otherwise energy efficiently designed dwellings, the areas of glazing necessary to achieve effective sun penetration for both amenity and solar heating are actually quite small. On the other hand, areas of glass that are too large in proportion to the rooms they serve, lead more easily to heat loss in winter, and overheating not just in summer, but also in the mild Sydney winters.

I have tried to turn my mind to how this balance might lead to an indicative figure for a minimum sunlit glazing area. To explain my logic is well beyond the scope of this paper, and I do not claim an adequate research base for my conclusions. I have arrived at the proposition that it may be more useful to specify an *absolute* figure of no more than approximately 5m^2 of glazing per dwelling, and that such glazing may be spread between more than just the living spaces at any one time. However, I note that any such area specification is highly dependent on the size of the space to which it relates. Five square meters of glazing oriented north for a single room such as a small studio flat, may well cause frequent overheating, in spite of being less than the area typically provided for contemporary dwellings of that type. A similar area for a large dwelling ─ that also has large areas of other glazing badly oriented to receive sun ─ would contribute trivially to passive solar performance.

It brings us to the inevitable conclusion that thermal performance and energy efficiency in most Australian climates gives us little or no basis for specifying the minimum area of qualifying solar glazing. The contribution of free solar heating, but also the penalty of excessive areas of glazing in both heating and cooling energy predictions, is in fact better captured in BASIX as part of a more complex consideration of thermal performance. Left with only amenity as a criterion, I would suggest that the surprisingly small areas I suggest above are actually quite workable.

PRIVATE OPEN SPACE

Winter sun is desirable for private open space in all of the climate zones in NSW. It is a significant contribution to the usefulness of such space for extended living, and where possible for clothes drying. The same arguments concerning the possible mandated spans of time apply as do to glazing, except that there is perhaps more merit in preserving the emphasis on effective sun being within the 9am to 3pm time bracket. Of more pressing concern is the attempt to define what area, or what surface can be qualified as complying.

There are quite adequate approaches to defining minimum areas and useful dimensions of private open space for dwellings in the variety of denser multi-unit arrangements. The difficulty arises where those same rules, that also generally have something to say about visual privacy, are not appropriately translated when considering solar access.

Thus for instance, the *Parsonage Principle* can be read as not allowing the recognition of any sunlit area that is not on the ground (or floor) surface of such private outdoor space. Yet it is easy to demonstrate that for an otherwise complying *small* courtyard, or apartment terrace, the walls and other elements necessary to satisfy privacy requirements themselves create much of the overshadowing of the ground plane. It is equally easy to demonstrate that in such spaces, if

say a table height plane receives enough sun, a normal person may actually find it almost impossible to avoid being in the sun.

The evaluation of compliance is therefore highly dependent on context, particularly on the size of otherwise complying private open space.

DEMONSTRATING COMPLIANCE

Our present methods of demonstrating and assessing compliance do not work. Specifically, the convention of requiring plan projection shadow diagrams at the key times of 9am, 12 noon and 3pm on June 21, fails to answer the questions of how much sun is available, where and how effectively.

When presented with such plan shadow diagrams, that meet most Councils' specified format for development applications, most assessing officers are left guessing at the required answers, or worse, have to carry out their own new analysis. Which they usually get wrong.

This is a double affront, considering the difficult, onerous process for the applicant of producing plan shadow diagrams. Or a triple affront, because it usually reflects that applicants probably also did not use satisfactory techniques to establish likely compliance while they were designing.

There are a number of other techniques for more meaningful representation, which do justice to appropriate analysis, and which convey the information more reliably. There are some problems with specifying these alternative techniques in DCPs. One problem is that which technique may be the most appropriate really does depend on the particular context in which it is applied. Another is that none of them are as 'intuitive' for the lay person to recognise; the outcomes simply do not 'look' as real as do plan shadows.

Thus, the fear of objectors' reactions actually distorts the choice of techniques asked for by Councils. Yet it is objectors who are most typically, and unnecessarily spooked by the misinformation that typifies plan shadows. Plan shadows are almost always drawn such that they 'overlap' existing buildings, and are often projected onto a single arbitrary plane that fails to acknowledge differences in levels of the affected surfaces, they tend to make it seem like neighbouring properties are more overshadowed than is really the case. They specifically fail to answer whether windows above ground level are in the shadow or not, at the same time as the lower proportion of the wall may be intercepting the shadow drawn in plan.

My personal favourite technique is 'Views from the Sun' produced from a digital 3D model, and showing all sunlit surfaces at the same time. But alternative techniques include the use of vertical shadow angles, plotting all shadow angles onto a stereographic sun chart, use of the *Sunlight Indicator* templates, and even physical model studies using a simple sundial. Only in very adversarial situations would I suggest elevation shadows as inevitable, notwithstanding that I advise Council officers to make sure they get them if their present DCP asks for them.

CONCLUSIONS AND RECOMMENDATIONS

In my view, Councils have a continuing role in incorporating requirements for amenity in buildings, and therefore can and should legitimately incorporate in DCPs some provisions for solar access, and limitations on overshadowing. However, this needs to be done with considerably greater regard to what such provisions are meant to achieve. DCPs that make reference to energy efficiency objectives appear to risk being challenged in law because of the conflict with SEPP BASIX. Most especially, the DCP provisions need to avoid unnecessary uncertainty and argument about compliance.

However, some uncertainty is likely to be induced by any DCP that seeks to serve a higher aim of encouraging appropriate 'design effort' to achieve best outcomes, rather than merely complying developments. The general difficulty this introduces is having to rethink the accepted form of a performance based code which has been adopted in most DCPs, and is also seen in

the Building Code of Australia, and in the model Residential Flat Design Code. Those codes all suffer from the same disability, in that they resolve to specific controls which serve as deemed to satisfy standards. Thus, for instance in response to the RFDC, rarely do applicants seek to maximise solar access opportunity, but are content to achieve the minimum compliance quantification called for by the 'rules of thumb'.

I would therefore suggest that it would be appropriate to introduce a top level objective to 'maximise solar access' and 'minimise overshadowing'. While no Council officer should step in the shoes of the designer, this opens the possibility of formally testing an application against alternative solutions.

Quantitative standards for the controls seem to me generally reasonable, except where Councils have over-reached in requiring four hours of solar access. The general approach of the Parsonage Principle can guide the definition of 'effective sun', but the concept should necessarily include any time of day when sun relates appropriately to glazing of given orientations. It is assumed that early morning and late afternoon winter sun can only be given weight where it can be established that the low altitude sun at those times is unlikely to be alienated by future development.

Quantification would be helped by a clearer idea of absolute acceptable glass areas, rather than relative proportions of glazing. My personal opinion is that any area corresponding to one normal sized window cannot be ignored. The limit of 50% to define the minimum acceptable partial sun exposure seems reasonable.

The current practice of requiring plan shadow diagrams is so counter-productive as to warrant being abandoned. In my view it would be ill advised to substitute any particular technique as the mandated submission requirement. More useful would be to employ terminology along the following lines:

"Applicants are required to demonstrate by a suitable method of analysis the projected quantity and quality of solar access achieved for all relevant points of interest. Points of interest may be appropriate parts of glazing and private open space, for which minimum solar access is mandated."

It is important to recognise that while the DCP should clearly put on the applicant the onus of employing the appropriate means to establish and then demonstrate the level of solar access or overshadowing compliance, Councils are best served by adopting an advisory role in making the correct choice. After all, both applicant and approving authority have an interest in getting out of the way any source of dispute about the accuracy of predictions, to allow Council officers to concentrate on the application of the compliance criteria. And in particular, to have the quality of analysis to hand, that the discretion in decision making that is implied in a DCP may be transparently exercised.

If there is any area in which such discretion needs to be intelligently applied, solar access and overshadowing is it.