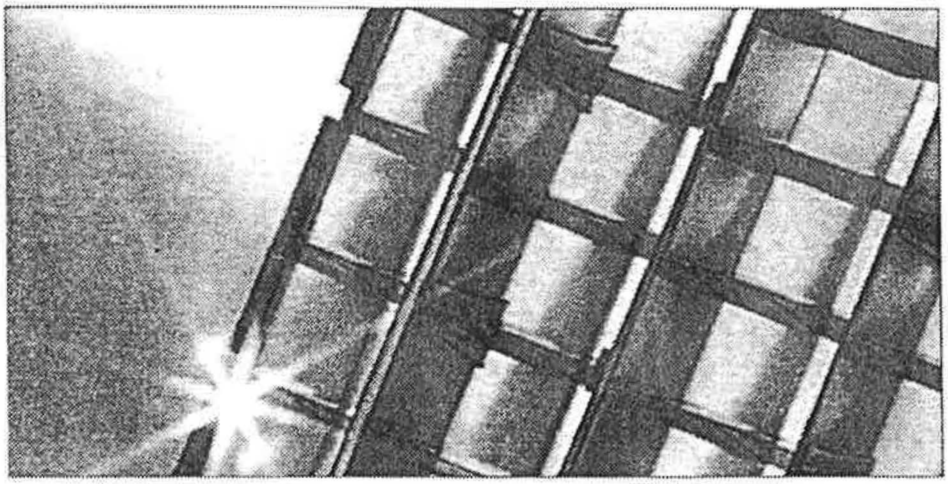
#11150

European Commission DG XVII for Energy
THERMIE Programme
Marketing Group Envelope and Integration



Market Study of Shading Systems in the European Union

University College Dublin

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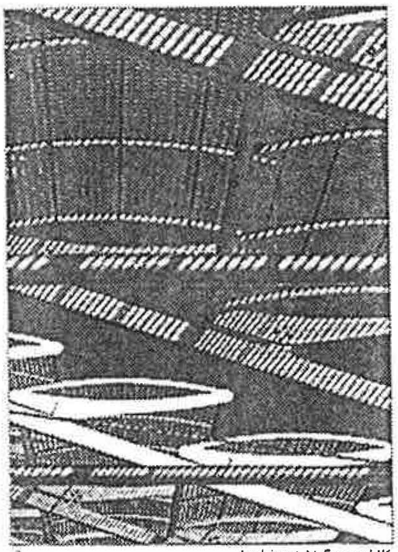
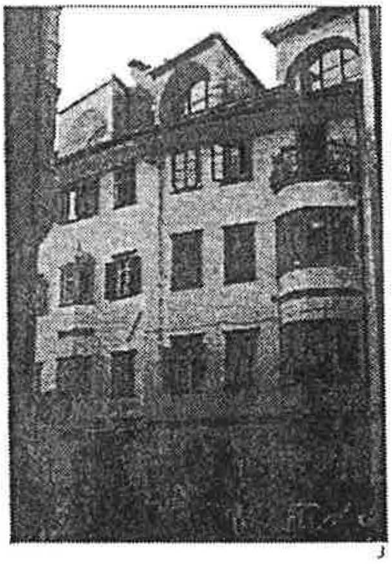
The Role of Shading

"Shading systems" refers to devices employed for solar control with the aim of excluding or redistributing light at or near the building skin. For the purposes of this study a shading device is defined as one which (at least by design) acts indiscriminately on light, regardless of wavelength. Thus, while tinted, holographic and low-emissivity glazing in windows could be considered as performing shading functions on certain wavelengths of light, they will be excluded from this report. (2)



2 *Architect N Foster UK*



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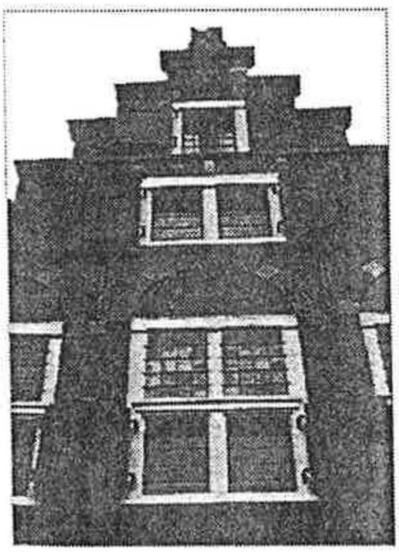

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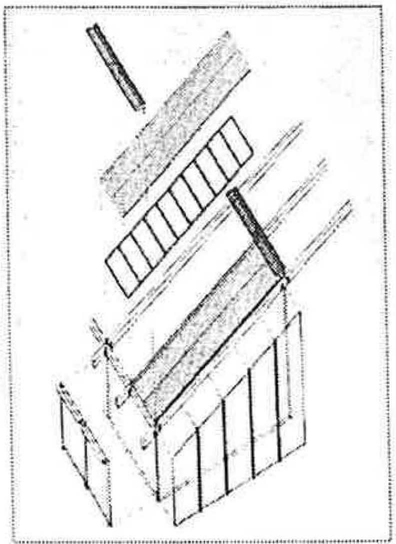


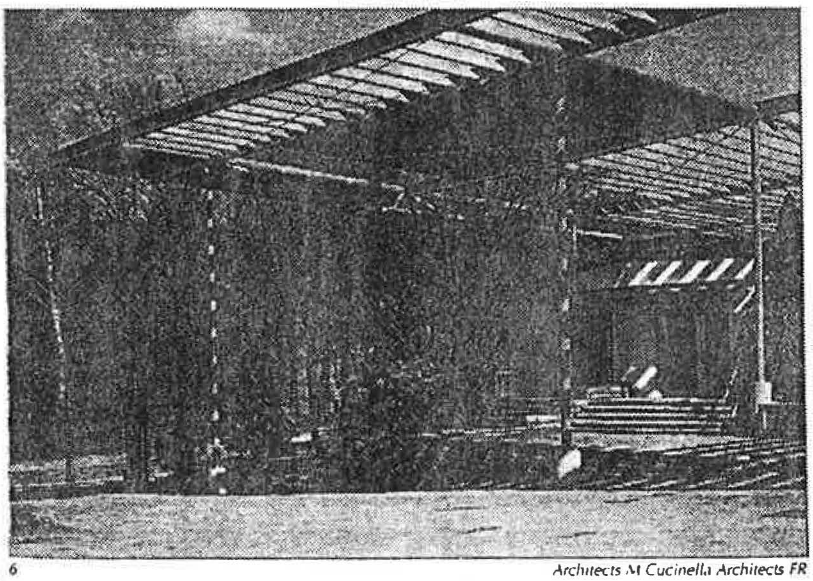
Architect R Piano Building Workshop IT 5

There is of course a long history of the use of shading in vernacular architecture in Europe, particularly southern Europe, where excluding solar gain and glare in summer is a major concern (3). By contrast, many "shading" devices traditionally employed in northern Europe (such as roof overhangs and shutters) have more important roles as shelter, draughtproofing, or insulation, only incidentally providing shade (4).

Shading has traditionally been used as a means of improving comfort, both visual and thermal. This role diminished in recent decades as technology made it possible to substitute electricity and fossil fuel for solar energy and good design to achieve a comfortable building environment. The flaws in such a trend are now all too evident.

Fluorescent lighting is less effective and less pleasant than well-distributed daylight; but no amount of good design can daylight a building at night. So shading can potentially be redefined as a means of saving energy that would otherwise have to be used to improve comfort: energy that would be used for cooling and even, perhaps, lighting (5).

Conversely, the interest in shading in recent years needs to be seen in the light of an increased emphasis on building design for style and appearance, sometimes neglecting comfort and function to such an extent that technological solutions are needed to rectify this. So, the use of large areas of unnecessary glass can bring the need for cooling, and thus for shading systems, to buildings and locations where they may not naturally belong. The illustration below is of retrofit shading to one such building in Northern Italy (6).



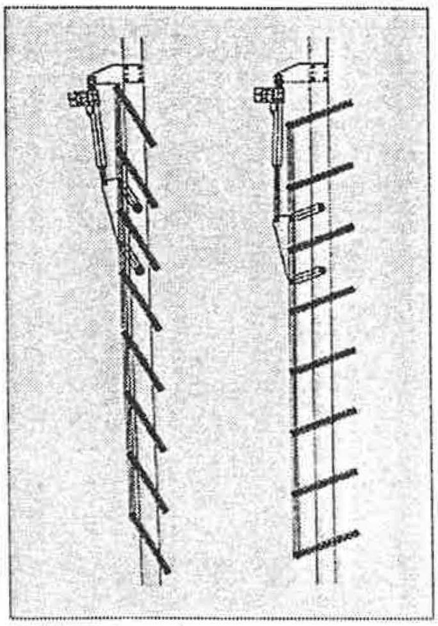
6 *Architects M Cucinella Architects FR*

Shading and Comfort

While sunlight can bring "sparkle" into a building and is often a welcome presence in public areas of a building, it is usually inappropriate to allow direct sunlight into an immediate working area. Sunlight striking windows typically causes three comfort problems:

- ***Direct sunlight*** striking the skin or nearby surfaces can give building occupants the sensation that the space is too hot.
- ***High light level*** and glare from a direct sunbeam make desk tasks more visually difficult.
- ***Bright windows*** can cause both direct and reflected glare if not properly controlled or balanced by other light sources in the working space.

Shading the windows from direct solar beams keeps both the space and the glass cooler.



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Shading and Energy: Cooling

Baker (1995) has considered the role of shading as an energy substitute and asked: will shading reduce energy consumption overall, or increase it? Since by our definition shading devices are indiscriminate with regard to wavelength, any reduction in solar gain (to save cooling energy) will involve a corresponding reduction in daylight.

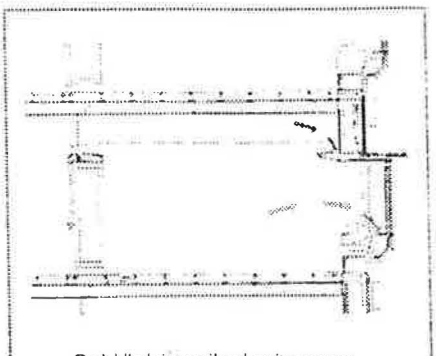
Thus, shading can save energy when cooling is a major concern, and when there is already excess daylight—otherwise extra lighting will eat up the savings in cooling energy. This leads Baker to three conclusions.

1 shading is unlikely to save much cooling energy in northern Europe, where frequently overcast skies lead to low light levels and external temperatures are rarely very high.

2 the varying intensity of daylight (a factor of ten between direct summer sun and overcast winter sky, which is still often quite sufficient for room lighting) means that it is much more effective, particularly in unpredictable climates, to employ *movable* shading systems than *fixed* ones—provided the former are used in an appropriate manner (7). If blinds are not raised when the sun goes in, they are little better than fixed shades.

3 it should be recognised (as mentioned above) that overheating problems which seem to call for shading as a solution may actually be caused by excessive glazing—much more than about 30%. This not only causes cooling problems but heating problems as well. More careful envelope design can avoid the problems before they start (8).

So shading devices may substitute for cooling energy. Can they also be used to substitute for *lighting* energy.



Dark blinds in ventilated cavity removes solar gain before room overheats

Architects M Hopkins & Partners UK 8

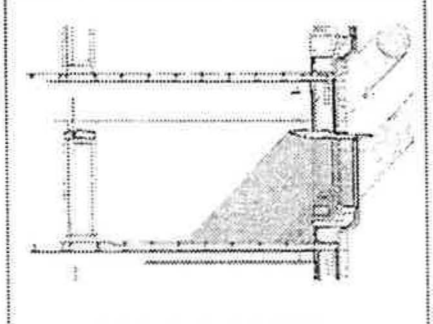
Shading and Energy: Lighting

Shading devices for redistributing light within a room start with the simple light shelf and include a great diversity of blinds, louvres, fins and prismatic systems. Their functions can be simply stated as improving uniformity of lighting, and reducing excessive light levels. A light shelf, for instance, improves uniformity by selectively shading the front portion of the room, thus reducing overall light level in that area (9). Because of the eye's adaptive response, people's perceived need for artificial light is less in conditions of uniform lighting. So even a simple light shelf can sometimes reduce the need for artificial lighting; whether it does so consistently is another matter.

The more complex devices (including some light shelves) are generally designed not merely to shade the front part of the room, but actually to increase lighting levels at the back (10). Littlefair (1996) carried out tests to assess the ability of a variety of systems to increase back-of-room light levels, improve uniformity, and cut direct light. The results were mixed—all systems improved uniformity, but the ones which also raised rear-room light levels (such as prismatic glass) did so only with direct sunlight and for certain sun angles, and lacked ease of operation (11).

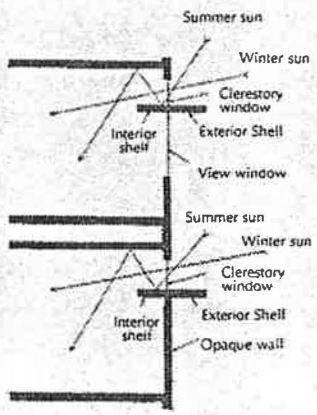
Overall, Baker (1996) concludes that simple devices such as light shelves and movable blinds are usually just as effective—and considerably more economical—than complex, high-technology devices.

In either case, it is relatively easy to design a shading system that will improve visual comfort while at least causing no net increase in lighting energy. A system that will actually cut annual lighting bills is much harder to achieve.

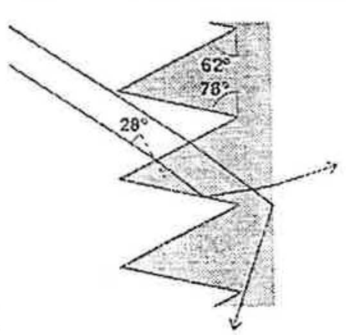


Solar shading. Facade lightshelf shades room area close to window

Architects M Hopkins & Partners UK 9

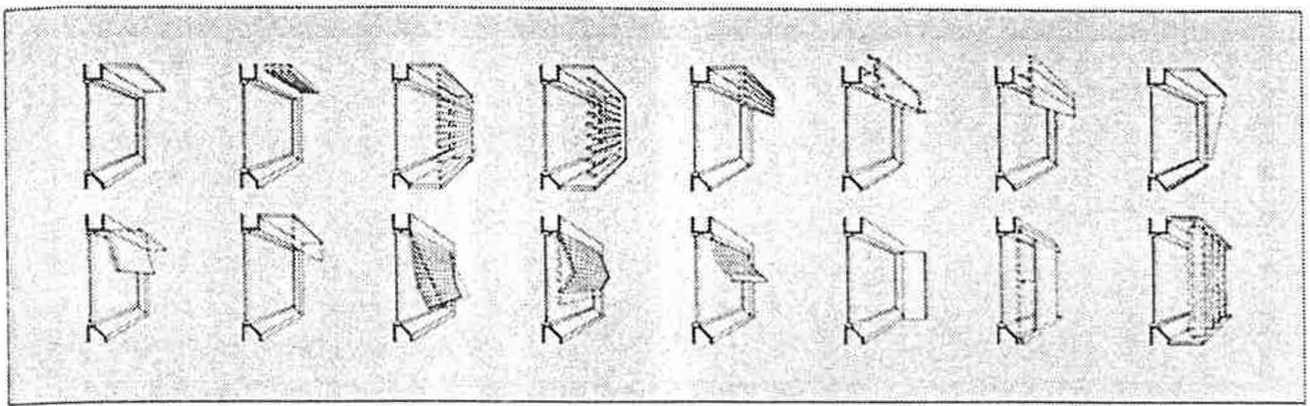


Source: BRE P J Littlefair 10



Prismatic film (sometimes referred to as holographic film) consists of microprosmatic elements moulded in plastic. Light incident at altitude angles greater than 28° are rejected by total internal reflection. This system is much cheaper than prismatic glazing, and can be applied to existing glass.

Source: BRE P J Littlefair 11



12 Source: *Working in the City EC Competition Information Pack*

A Typology of Shading Systems

There is such a variety of shading system designs that no attempt can be made here to survey them exhaustively. However, it is possible to characterise them in several different ways and thus to predict performance in a qualitative fashion (12).

Options for a shading typically fall into three categories, listed here in order of effectiveness:

- An exterior attachment to the building or window
- A film or coating treatment applied to the glass
- An interior window covering

Exterior shading systems intercept solar beams before they strike the glass, which is the most effective way to reduce solar loads. Exterior shading takes many forms, ranging from fully integrated architectural features to independent facade attachments. Exterior shading can eliminate up to 80% of solar heat gain, compared to 50-60% for internal shading.

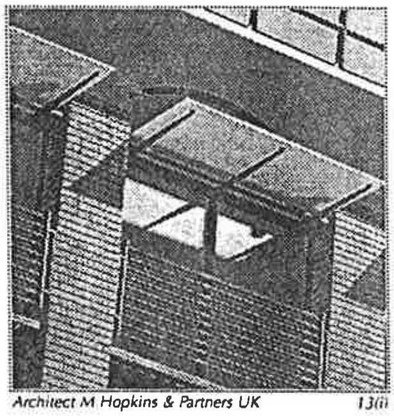
Movable systems, such as louvers, fins or awnings, can accommodate changing occupant needs and the moving sun. These are especially useful for low sun angles, as on east and west facades. An automated movable device optimises energy savings, occupant comfort, and view.

Fixed systems, such as overhangs, fixed louvers, fixed fins, fixed awnings, screens, and window setbacks work especially well on south facades. Fixed systems are typically easier to install and maintain, and less expensive than movable systems.
The most welcome exterior shading system is a leafy tree. An evergreen provides shade year round, while a deciduous tree can let through warming sunshine in the winter.

Glazing treatments, such as reflective coatings, glazing tints, spectrally selective coatings, or applied retrofit films, are good solutions when shading devices are not an option.

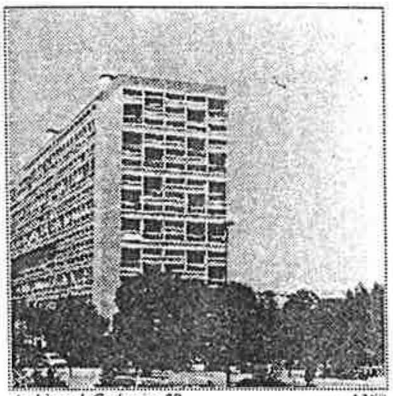
This implicitly divides shading systems into fixed and movable, and into simple and complex. Thus, an overhang or a light shelf is fixed and simple; a Venetian blind is movable and simple; a mathematically designed reflector system such as that described by Eames and Norton (1994) is fixed and complex; a rotating prismatic louvre system is movable and complex.

Fixed systems tend to have the advantage of the broken watch—at least they work twice a day. Given that daylight varies, it is usually better to have a system that performs adequately in many conditions than one which is perfectly attuned for a particular set of conditions—clear skies and high sun angles, for instance—which may seldom occur, especially in unpredictable maritime climates. A system that is designed to exclude high-angle light (from direct summer sun) may not adapt well to admitting diffuse light, which is concentrated at the zenith in overcast conditions (13(i),13(ii)).



Architect M Hopkins & Partners UK 13(i)

A movable system, on the other hand, while it can potentially perform well under more conditions, needs to be controlled (manually or automatically) to optimise performance, otherwise it can be worse than a well-designed fixed system. This is not an insignificant consideration. Very few office workers know how to operate a simple venetian blind to bounce sunlight off the ceiling of a room; in fact few are even aware that the blind can be used in this manner. Training workers to operate shading devices is time-consuming (14).

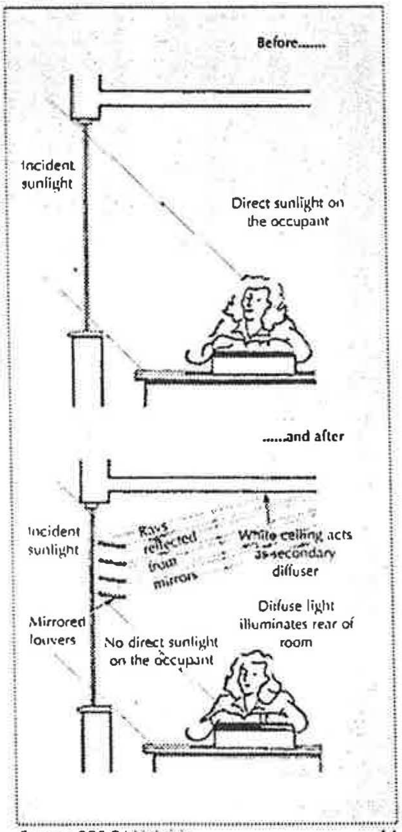


Architect leCorbusier FR 13(ii)

Computerised control becomes a virtual necessity with the more complex types of device. However, as Grehant *et al.* (1995) have noted, "a specific set point will lead to failure; the human eye tolerates variations in light... and it seems that our psyche needs them." The system described in that article uses a simple learning algorithm and takes account of occupants' preferences.

A number of other distinctions can be made: between internal and external shading devices (and by extension those which are positioned within or across the building envelope); between horizontal and vertical elements; between devices made of different materials.

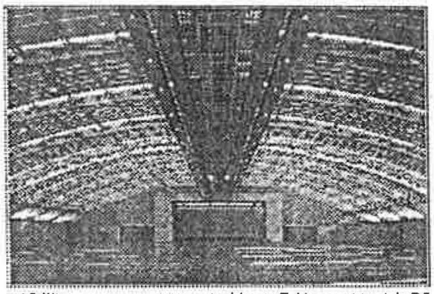
The imperfect transparency of glass, particularly in the infrared spectrum, means that external shading devices exclude solar gain much more effectively than internal ones. Energy reflected from an internal shade is often trapped by the glazing. However, internal devices present fewer difficulties of maintenance and operation, and can usually be made less robust, than external ones.



Source: BRE P J Littlefair 14

Examples of common shading devices are based on horizontal elements: venetian blinds, louvers, light shelves and overhang, and internal hanging blinds, are examples of vertical shading. (Here "horizontal" or "vertical" refers to the projection of the element onto the plane of the building envelope.) The geometry of shading devices with respect to sun paths is considered in depth in Santamouris and Asimakopolous (1996), chapter 10, and elsewhere. Horizontal elements can effectively select incoming light by elevation, whereas vertical elements can select by azimuth (the point of the compass from which the rays are coming.) Intensity of solar radiation is closely associated with elevation at all times of the day and year. As a result horizontal elements are more useful in most applications. On east and west facades in particular, however, vertical elements can sometimes be more appropriate.

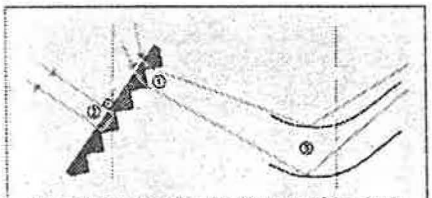
Materials are a fairly good guide to the general character of the device, and a cloth awning is very different from a wooden shutter, which is different from a mirrored metal louvre, which in turn is a world away from a PV-covered window blind of the type discussed by Sala *et al.* (1996). The choice of material may be influenced by the architecture of the building rather than by strict performance criteria (15(i), (ii), (iii), (iv), (v)).



15(iii) Architects T. Herzog Munich DE

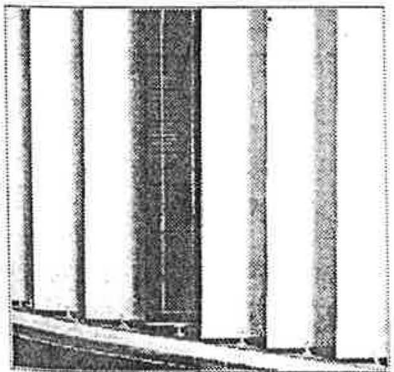
Shading Systems in Retrofitting

There is considerable potential for shading systems to be used in retrofit applications. In particular, they can effectively reduce the cooling needs of large, and mostly non-domestic, buildings that suffer from insufficient insulation or excessive glazing. An example is described in della Fontana (1996). Such applications of shading are most appropriate as part of a comprehensive energy retrofit programme. However, shading has often been neglected as an element in a successful energy retrofit, and it would be appropriate for the European Commission to support demonstration projects to help rectify this by showing that shading can form an effective, aesthetically non-intrusive, and inexpensive part of an energy retrofit programme.

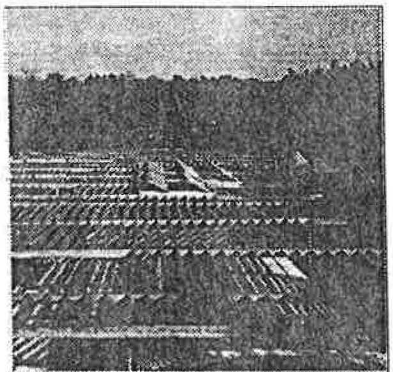


Prismatic louvers reflect the direct rays of the sun (2) away from the building and allow diffused daylight to enter (1). Partly perforated louvers deflect light into the depths of the rooms (3).

15(iv) Source: Solar Energy in Arch. & Urban Planning



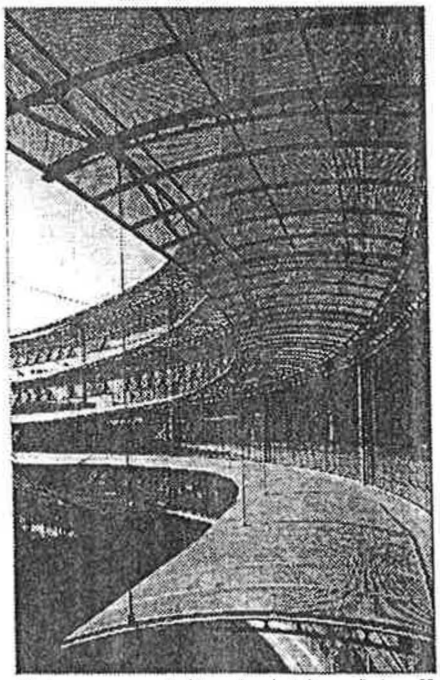
15(i) Source: ETA Florence IT



Architects M. Cucinella Paris FR 15(ii)

Analysis and Testing

A majority of the papers in the bibliography consist of performance testing or analysis for existing and/or new shading devices. (See Sciuto (1995 & 1996), Grehant (1995), Littlefair (1996), Tombazis and Vratsanos (1995), Coronel *et al.* (1995), Blanchet and Girard (1993), and Eames and Norton (1994).) It is difficult to generalise about



15(v) Architects Jourda & Perraudin Lyon FR these, except to say that there seem to be no standard methodologies for testing shading devices, which is perhaps unsurprising when the range of devices and the diversity of possible tests is considered. The best attempt to unify testing of different systems is that of Littlefair (1996), but it cannot easily be compared with other researchers' work. A standardised testing regime for shading systems is needed.

BLINDS, GENERAL

APIMEX (F)
APPEAL BLINDS LTD (U.K.)
BCN CAMBRA LÓGICA (E)
BIRMINGHAM GUILD, THE (U.K.)
BRUGMANN FRISOPLAST GMBH (D)
COSTA & HENRIQUES LDA (P)
CRANFIELD UNIVERSITY (U.K.)
ESTORES VITORIA LDA (P)
FEILDEN CLEGG DESIGN (U.K.)
FRANCIAFLEX (F)
GLASEREI+FENSTERBAU SCHMIDT (D)
GOTZ (D)
GREENWOOD AIRVAC (U.K.)
HALCROW GILBERT ASSOCIATES (U.K.)
HELIOSCREEN (B)
HELLA VERTRIEB GESMBH (A)
HOME FERTIGELEMENTE GMBH (D)
INGENIEURBURO RONE (D)
LOPES & GONCLAVES LDA (P)
LUGAL SPO (CRO)
PELK AB (S)
PERFECTA ROLLADEN GMBH (D)
PETAL PORTUGUESA (P)
REFLEX-ROL UK (U.K.)
ROLLETTA JALOUSIE GESMBH (A)
SCAN-MAT BAUELEMENTE (A)
SELEKT (FL)
SOLARARCHITEKTUR (CH)
SUNWAY BLINDS LTD (U.K.)
VELUX COMPANY LTD (THE) (U.K.)
WESTERN AVERY LTD (U.K.)

Folding blinds, external

ACRIMO - DANMARK A/S (DK)
ASPA PLAST HELLAS SA (GR)
AVENUE TECHNOLOGY LTD (U.K.)
COLT INTERNATIONAL LTD (U.K.)
GREENWOOD AIRVAC (U.K.)
TECHNICAL BLINDS LTD (U.K.)
WAREMA RENKHOFF (D)
WESTERN AVERY LTD (U.K.)

Folding blinds, internal

ACRIMO - DANMARK A/S (DK)
AGERO AG (CH)
ASPA PLAST HELLAS SA (GR)
AVENUE TECHNOLOGY LTD (U.K.)
BOUILLOT (JEAN) ARCHITECTE (F)
GREENWOOD AIRVAC (U.K.)
PROLUX (IRL)
REFLEX-ROL UK (U.K.)
TECHNICAL BLINDS LTD (U.K.)
TIDMARSH & SONS (U.K.)
WAREMA RENKHOFF (D)
WESTERN AVERY LTD (U.K.)
ROLLETTA JALOUSIE GESMBH (A)
SILENT GLISS (U.K.)
TECHNICAL BLINDS LTD (U.K.)
TIDMARSH & SONS (U.K.)
WAREMA RENKHOFF (D)
WERU AG (D)
WESTERN AVERY LTD (U.K.)

Roller blinds, internal

ACRIMO - DANMARK A/S (DK)
AGERO AG (CH)
ALLUSIDER (I)
ASPA PLAST HELLAS SA (GR)
BAUEN + FORSCHEN (D)
BEHRENS GMBH & CO. C (D)
DORAL SA (GR)
EDUARDO FRANCO (P)
ESQUADRIA (P)
FABRICA CHAVES AREEIRO (P)
GARLAND (P)
INSTALLA (D)
MATTHEW HISCOCK PRODUCTS (U.K.)
REFLEX-ROL UK (U.K.)
REMIS ENTWICKLUNG (D)
ROLLETTA JALOUSIE GESMBH (A)
SILENT GLISS (U.K.)
TIDMARSH & SONS (U.K.)
WAREMA RENKHOFF (D)
WERU AG (D)
WESTERN AVERY LTD (U.K.)

Shutters, external

ACRIMO - DANMARK A/S (DK)
ADLER-SOLUX GESMBH (A)
ALULUX BECKHOFF GMBH (D)
BEHRENS GMBH & CO. C (D)
BRUGMANN FRISOPLAST GMBH (D)
DASOLAS INTERNATIONAL APS (DK)
ISOLUIK NEDERLAND BV (NL)
KLOTZNER GESMBH & CO KG (A)
PERFECTA ROLLADEN GMBH (D)
TIDMARSH & SONS (U.K.)
WAREMA RENKHOFF (D)
WO & WO GRUN GESMBH (A)

Shutters, internal

ADLER-SOLUX GESMBH (A)
ALULUX BECKHOFF GMBH (D)
BEHRENS GMBH & CO. C (D)
FARBERBOCK GESMBH (A)
INSTALLA (D)
ISOLUIK NEDERLAND BV (NL)
SOLAR HOUSING DESIGN BUILD (U.K.)
TIDMARSH & SONS (U.K.)
WAREMA RENKHOFF (D)
WO & WO GRUN GESMBH (A)

Venetian, external

ACRIMO - DANMARK A/S (DK)
ADLER-SOLUX GESMBH (A)
ALUPLAST GMBH (D)
ANWIS (PL)
AVENUE TECHNOLOGY LTD (U.K.)
BCN CAMBRA LOGICA (E)
BRUGMANN FRISOPLAST GMBH (D)
COLT INTERNATIONAL LTD (U.K.)
DOLENZ, ERNST (A)
DORAL SA (GR)
FOLIFLEX GESMBH (A)
GRAVENT SA (E)
ISOLUIK NEDERLAND BV (NL)
KLOTZNER GESMBH & CO KG (A)
PETAL PORTUGUESA (P)
SCAN-MAT BAUELEMENTE (A)
TIDMARSH & SONS (U.K.)
WAREMA RENKHOFF (D)
WESTERN AVERY LTD (U.K.)
WO & WO GRUN GESMBH (A)

Venetian, internal

ACRIMO - DANMARK A/S (DK)
ADLER-SOLUX GESMBH (A)
AGERO AG (CH)
ALUPLAST GMBH (D)
ANWIS (PL)
AVENUE TECHNOLOGY LTD (U.K.)
BCN CAMBRA LOGICA (E)
DOLENZ, ERNST (A)
FOLIFLEX GESMBH (A)
INSTALLA (D)
ISOLUIK NEDERLAND BV (NL)
KLOTZNER GESMBH & CO KG (A)
PETAL PORTUGUESA (P)
REFLEX-ROL UK (U.K.)
SCAN-MAT BAUELEMENTE (A)
TIDMARSH & SONS (U.K.)
WAREMA RENKHOFF (D)
WESTERN AVERY LTD (U.K.)
WO & WO GRUN GESMBH (A)

BLIND CONTROLS

ACRIMO - DANMARK A/S (DK)
ADAMS GREEN LTD (U.K.)
AVENUE TECHNOLOGY LTD (U.K.)
BCN CAMBRA LOGICA (E)
COSTA & HENRIQUES LDA (P)
DASOLAS INTERNATIONAL APS (DK)
GOTZ (D)
JOBE INTERNATIONAL (NL)
LOPEZ BARRANA (LI SA (E)
PELK AB (S)
PERFECTA ROLLADEN GMBH (D)
PRACK EXKLUSIV ELEKTRONIK (D)
PRESTO GEBR VEDDER GMBH (D)
REFLEX-ROL UK (U.K.)
SELVE ERNST GMBH & CO KG (D)
SOLARARCHITEKTUR (CH)
SOMFY INTERNATIONAL SA (F)
VELUX COMPANY LTD (THE) (U.K.)
WESTERN AVERY LTD (U.K.)

AUTOMATIC SHADING SYSTEMS

ACRIMO - DANMARK A/S (DK)
DASOLAS INTERNATIONAL APS (DK)
DGT-VOLTMATIC A/S (DK)
HAROL GMBH (D)
LINEA (CH)
SIEMENS AKTIENGESELLSCHAFT (D)
SOMFY INTERNATIONAL SA (F)
SPACE-ON-EARTH LTD (U.K.)
WAREMA RENKHOFF (D)

EXTERNAL SHADING SYSTEMS

COLT INTERNATIONAL LTD (U.K.)
COOPER GROUP. (UK) LTD (U.K.)
ENVIRONEERING LTD (IRL)
HELIOSCREEN (B)
HELMUT FISCHER GMBH (D)
THYSSEN ROM SA (E)

Fixed

ACRIMO - DANMARK A/S (DK)
AHRENDS,BURTON & KORALEK (U.K.)
COLT INTERNATIONAL LTD (U.K.)
COOPER GROUP. (UK) LTD (U.K.)
DASOLAS INTERNATIONAL APS (DK)
DAYLIGHT INSULATION LTD (U.K.)
REFLEX-ROL UK (U.K.)
SERDA NV (B)
TIDMARSH & SONS (U.K.)
WAREMA RENKHOFF (D)

Movable

AHRENDS,BURTON & KORALEK (U.K.)
COLT INTERNATIONAL LTD (U.K.)
COOPER GROUP. (UK) LTD (U.K.)
DASOLAS INTERNATIONAL APS (DK)
ENVIRONEERING LTD (IRL)
HELIOSCREEN (B)
REFLEX-ROL UK (U.K.)
SOMFY INTERNATIONAL SA (F)
TECHNICAL BLINDS LTD (U.K.)
TIDMARSH & SONS (U.K.)
WAREMA RENKHOFF (D)

REFLECTING BLINDS

ACRIMO - DANMARK A/S (DK)
GOTZ (D)
MATTHEW HISCOCK PRODUCTS (U.K.)
REFLEX-ROL UK (U.K.)
REMIS ENTWICKLUNG (D)
SILENT GLISS (U.K.)
SOL-ACE (CY)
TOUR & ANDERSSON (S)
WAREMA RENKHOFF (D)

16

Conclusion

Ideally a marketing study should include analysis of suppliers, availability and costs of products available. While the limited time available did not allow for primary research of this nature to be carried out, such work would amplify the information available.

A list of suppliers of shading systems drawn from the European Directory of Sustainable and Energy Efficient Building Products (James and James) is attached (16). There are 205 listed names under 14 headings. Making allowances for the fact that some names appear under all the headings and some are consultants, not suppliers, it could be estimated that there are approximately 120-130 suppliers of such products. This is information drawn from only one publication.

The recommendations of the study are as follows:

1 An analysis of products available should be carried out with the objective of gathering information on availability of products, and assessing gaps in the market. The methodology of the survey might be as follows:

- Draw up a list of required information under headings such as cost, type, materials, performance.
- Draw up a list of suppliers using the information above and other sources.
- Contact suppliers, send the questionnaire.
- Gather completed questionnaires and analyse the information
- Present results in tabulated, diagrammatic and broad analytical formats. The results of such a study will indicate the present situation 'on the ground' in Europe, enabling measures to be undertaken to fill in gaps relating to supply and demand.

2 A standardised performance rating regime for shading systems should be developed.

3 The European Commission should consider promoting projects to demonstrate the effective use of shading systems as part of energy-saving retrofit programmes in non-domestic buildings.

Bibliography

The *European Directory of Sustainable and Energy Efficient Building* (1997) lists many companies that supply shading devices or accessories, but provides little information about their products. To the authors' knowledge there is no comprehensive study of what is available from where for how much, let alone how it performs. The *Architects' Journal* December 1994 focus piece on "windows, blinds, lintels & louvers" confines itself to giving very basic information about availability and cost from UK suppliers. A more extensive market study of commercial availability could usefully be undertaken.

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