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TECHNOLOGY REVIEWS
SHADING SYSTEMS

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This collection of technology reviews is considered to be a "growing" document and contains incomplete information. It is intended to serve the project needs throughout its duration, with revisions and additions inevitable throughout the life of this project. Information in this document may include opinions, conjecture, and other unverified data. Information here comes from a variety of sources and therefore may vary in quality and reliability.

We caution readers of this report to exercise caution when using any information contained herein.

TECHNOLOGY REVIEWS : SHADING SYSTEMS

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Executive Summary

We present a representative review of existing, emerging, and future technology options in each of five hardware and systems areas in envelope and lighting technologies: lighting systems, glazing systems, shading systems, daylighting optical systems, and dynamic curtain wall systems. The term *technology* is used here to describe any design choice for energy efficiency, ranging from individual components to more complex systems to general design strategies.

The purpose of this task is to characterize the state of the art in envelope and lighting technologies in order to identify those with promise for advanced integrated systems, with an emphasis on California commercial buildings. For each technology category, the following activities have been attempted to the extent possible:

- Identify key performance characteristics and criteria for each technology.
- Determine the performance range of available technologies.
- Identify the most promising technologies and promising trends in technology advances.
- Examine market forces and market trends.
- Develop a continuously growing in-house database to be used throughout the project.

A variety of information sources have been used in these technology characterizations, including miscellaneous periodicals, manufacturer catalogs and cut sheets, other research documents, and data from previous computer simulations. We include these different sources in order to best show the type and variety of data available, however publication here does not imply our guarantee of these data. Within each category, several broad classes are identified, and within each class we examine the generic individual technologies that fall into that class. Each technology section has the following format:

I. TITLE PAGE & CONTENTS

II. SUMMARIES

- Summary descriptions for each technology.
- Summary table(s) showing comparative performance characteristics or other comparative information.
- Brief discussion/summary of the most promising technologies and trends in this category. Emphasis is on electricity peak reduction and on potential for integration with other systems or technologies.
- List of product brand names for each sub-category.

III. DATA ENTRY FOR EACH TECHNOLOGY

Each sample technology is characterized through one or more of the following. Sections may deviate as required:

- Description
- Sources
- Status of availability
- Pros and con
- Energy performance
- Comfort performance
- Impact on building design
- Cost, per unit basis
- Life cycle cost economics
- Market share, expected trends
- Case study installations

IV. REFERENCES

TECHNOLOGY REVIEW: SHADING SYSTEMS

I. OVERVIEW

Proper building envelope design is the most direct and efficient way to reduce cooling loads, by controling the radiative, convective and conductive heat transfer through the building envelope.

The most effective way to reduce cooling loads is to prevent their generation by controlling the output of the heat sources and the heat transfer through the building envelope. Heat sources can be either external, i.e., direct and diffuse solar radiation along with the associated convective and conductive heat transfer, or internal, i.e., electric lighting, equipment and building occupants. From these sources, only the electric lighting system can be partially controlled by the building designer with respect to output. The strategies to control the generation of cooling loads from the rest of the sources concentrate on the heat transfer modes through the building envelope, focusing on reducing heat transfer from the exterior to the interior and increasing heat transfer from the interior to the exterior.

The high intensity of direct solar radiation makes it the most significant external source of cooling loads on both, design days, as well as on an annual basis. Direct solar radiation contributes to cooling loads by being transmitted through fenestration and, at a lower rate, by being absorbed by the exterior building elements and then reradiated, conducted and convected to the interior. Most strategies to prevent the generation of cooling loads are thus directed towards preventing primarily the transmission of direct solar radiation through fenestration and secondarily its absorption by the building envelope. Diffuse solar radiation from the sky, the ground, and external obstructions can also represent a significant cooling load averaged over all building operating hours. Both, direct and diffuse solar heat gain can be reduced using shading systems, but such strategies will also generally reduce daylight transmittance. Daylight admission through fenestration can contribute towards the required levels of interior illumination, allowing reduction of electric lighting output through use of appropriate electric lighting controls. Energy savings may then be realized from the reduction of the electric lighting output and its associated cooling loads, assuming that the daylight distribution offers an overall better efficacy, i.e., lumens/watt, than the electric lighting system.

The dynamic cyclic, contradictory, and unpredictable nature of incident solar radiation presents severe challenges for the specification of a sun control strategy that minimizes cooling while permitting daylight utilization. The technologies used to realize these cooling strategies are primarily related to building fenestration, focusing on glazing systems and shading devices, in an attempt to follow and control the dynamics of solar radiation. Shading devices may be either integral parts of the building, i.e., *architectural solutions*, or industrially manufactured devices, i.e., *window treatments*, or *window coverings*.

Common practice architectural elements include *window setback*, *overhangs*, *vertical fins*, *light shelves*, or combinations of the above in more articulate configurations. Common practice window treatments include *solar films*, *shades*, *sun screens*, *louvered systems*, *drapes* and *shutters*.

The shading effectiveness of shading systems depends on the context of their application, i.e., the orientation of the fenestration with respect to the local sun paths, as well as the local climate and the internal loads of the building. The same shading system may prove excellent for certain applications and disasterous for others. As a result, it is dangerous to make general statements about the energy performance of shading systems independent of context. Considering the fact that shading systems affect building performance with respect to many non-energy criteria as well, such as thermal/luminous/acoustic comfort, view, privacy, safety, esthetics, economics, etc., the design and/or selection of appropriate shading becomes a complicated design problem.

There are, however, some general principles related to the performance of shading devices, which we outline as part of an effort to classify shading devices. The primary classification criteria are their placement with respect to glazing and their operability.

The most common classification of shading devices is based on their placement with respect to the fenestration's glazing layer(s), resulting in *exterior*, *between glass panes*, and *interior* systems. The heat trapping properties of glass, which result in the familiar "green house effect," favors use of external rather than internal shading systems as cooling reduction strategies. For an exterior device, the majority of the absorbed energy is convected and radiated outdoors, so the distinction between absorption and reflection is not critical, unless the reflected radiation is directed towards the interior through the glazing. Unlike exterior devices, most of the energy absorbed by interior devices remains in the space, so high reflectance is a desirable feature. Exterior systems are usually more expensive than interior ones, because, being exposed to the elements, they require durable materials and construction.

Shading systems are also classified as *fixed* and *operable* ones. Operable systems are usually operated through manual or electric systems through switches and remote control devices. Leading edge technologies include automatic operation based on signals generated by wind, rain, and solar intensity sensors. They may be applied to exterior, between glass panes, or interior operable systems. Although promising for energy efficient operation, automatically operated systems have not been used widely, or effectively, to allow for adequate performance assessment.

Since performance is a function of context, operable shading systems offer the advantage of potentially following the dynamic exterior thermal and luminous conditions, as well as the dynamic performance requirements. Their effectiveness depends on their operation control strategy. The later, can be directed towards optimizing a single performance parameter, e.g., minimize electric lighting or cooling loads or peak electricity demand, etc., while complying with several performance constraints, e.g., block direct solar radiation, allow view from the interior, etc. Such operation control strategies may be either fixed throughout the course of the year, or variable based on various occupancy and/or performance characteristics.

Although hardware is available and compatible with most operable systems, there is little operational experience with motorized systems. Automated systems have the greatest potential benefits but there is little user experience with these technologies. To date, there is little guidance available for daily or seasonal adjustments by climate, building type, orientation, or indoor activity. Moreover, the interactions of fenestration controls with HVAC and lighting controls are not yet adequately understood. Automated technology is particularly interesting to this project as a vehicle for providing dynamic control of daylight and solar heat gain, prior to the commercial viability of optically switching materials.

Commonly used architectural solutions and various window treatments are further described along with general performance statements in the form of advantages and disadvantages, considering California climatic conditions and typical building applications. Specific products and manufacturers are listed at the end of this section for each category of window treatments.

II. STATE OF THE ART SUMMARY

1. ARCHITECTURAL SOLUTIONS

This category includes building elements that can be seen as part of the architectural design of the building rather than devices attached to windows and skylights. Window setback, overhangs and vertical fins have been common practice approaches for many years, while more sophisticated designs, such as light shelves, or articulated building envelope configurations represent the leading edge in architectural solutions.

1.1 Overhangs and Vertical Fins

Overhangs and vertical fins have been extensively used to block direct solar radiation during the summer and allow its penetration indoors during the winter. Their shading effectiveness is a function of their dimensions, the local latitude (sun paths), the window orientation, and the climatic conditions. In addition to affecting direct and indirect solar radiation from entering through a window, they may also affect the convective heat transfer through a window by altering the exterior air flow patterns. Overhangs and vertical fins have been used effectively for many years. In many cases they are an integral part of the building in the form of balconies and/or projected spaces. However, overhangs and vertical fins run counter to current trends that emphasize smooth-surfaced buildings.

1.2 Window Setback

A window set back is the equivalent of using an overhang combined with vertical side fins for exterior shading. However, this shading approach belongs mostly to the past, since wall thickness in new buildings is held to a minimum to maximize interior space. Moreover, since lease agreements typically specify floor area to the glass line, there is a strong economic incentive to place the glazing at the outermost edge of the building.

1.3 Light Shelves

In addition to providing solar control as overhangs, light shelves contribute towards deeper penetration and better uniformity of the transmitted daylight, thus increasing the effectiveness of daylight utilization to totally or partially replace electric lighting in commercial buildings. In addition to conventional light shelves, a number of recently completed office buildings utilize a variety of articulated skins using new optical materials aiming at better light and heat control, but these are not representative of common practice. Advanced systems using new glazing materials to enchance daylight control are discussed in the Daylighting Optical Systems Review.

2. WINDOW TREATMENTS

This category includes a variety of devices that are attached to the exterior or exterior of windows and skylights. They include awnings, shades, solar screens, and various types of louver systems and blinds. In addition to the shading function, a number of exterior and interior shutters are also available to provide insulating value, privacy, and security.

2.1 Awnings

Awnings have traditionally been used in residential construction, but are finding increased application to low- and mid-size non-residential buildings. They provide the same functions as overhangs, using a frame to support a horizontal or sloped surface on the exterior of windows. They come in a variety of colors, sizes, shapes and materials. While the most commonly used material is fabric, awnings are also constructed using plastic and aluminum. Since, awnings may not be opaque to solar radiation, their solar transmittance becomes a critical performance characteristic. Awnings may be fixed, seasonally installed, or operable. Operable systems may be hand operated or motorized, and the systems may be individually controlled or linked to environmental sensors.

2.2 Shades

A large variety of shades is available for interior and exterior applications. They come in a variety of materials, mainly fabrics and plastics, with varying degrees of solar transmittance and reflectance. These products generally attenuate the incident light (reflect, absorb, diffuse) but do not distinguish between direct sunlight, diffuse sky, or ground-reflected light. For fabrics, the density of the weave and the color of the material control the transmittance. Darker materials control solar gain by absorption, whereas lighter materials reflect the greater percentage but also generally transmit slightly more. Shading coefficients for these systems fall in the range of 0.1 to 0.5. Aluminized polyester, dyed or clear (such as that used in glue-on sun control films), are also available as roller shades. Interior shadescan also be fabricated in multi-layer form, for example, a two-layer system with outer aluminized polyester to reflect some sunlight and an inner woven fabric to absorb and diffuse the remaining light. Exterior shades are usually mounted in frames, which in turn are mounted to the window system. Clearance is provided between the shade and the window so that heated air can flow easily around and over the shade rather than being trapped and contributing to convective heat transfer to the interior. These shades also provide some protection against flying objects and might also provide limited heat loss reduction.

2.3 Solar Screens

Solar screens are usually made out of metal or fiberglass. Two varieties of metal screens are available: punched and woven. Punched screens are generally fabricated from aluminum and have small tilted fins that provide some angular control of incident sun light. Woven metal screens consist of small louvers that are woven into place at a particular angle and cut off all but very low-angle sun. In either case, the shading effectiveness of such devices depends strongly on solar geometry. While they are available in various colors, darker ones offer better reduction of cooling loads since they absorb solar radiation and then dissipate it outdoors, rather than reflecting it indoors. In a few installations these screens can be motorized and slided above or below the window.

Fiberglass screens are similar to metal screens with respect to function and operation, but made from fiberglass coated yarn for weather and fire protection. Some of them are retractable either as a flat panel or serving as roll up shades.

2.4 Louver Systems & Blinds

Louver systems and blinds come in fixed and operable units for vertical, sloped, and horizontal applications. They are available as exterior or interior systems. Venetian blinds are also placed between glass panes as a compromise between exterior and interior systems. Louvers or blinds are either horizontal or vertical. Horizontal ones are better in blocking direct solar radiation from higher solar altitudes (i.e., South orientation), while vertical ones are better in blocking direct solar radiation from lower altitudes. Materials for exterior applications are usually sheet metal, aluminum, or plastic, some filled with insulation. Operable units can control daylighting, night time temperature, security, and noise. Costs, scale, appearance, durability, and performance vary widely.

Shielded systems, such as those between two glass panes, have proven effective in several new commercial buildings. Louvers are typically light in color, maximizing the daylight reflected into interiors. Shading parformance depends on angle of incidence for fixed systems and on operating strategies, as well, for operable ones.

Small exterior louvers or heavy-duty exterior Venetian blinds, long popular in Europe, are not commonly used in the U.S., although their popularity is increasing. These units can be raised and lowered, and the slats can be tilted automatically or manually operated from inside. Concerns include esthetics, view, and durability. Snow, wind, or rain may require the blind be automatically retracted in order to prevent system damage. These blinds have traditionally been under the local control of the occupants affected by them. Automatic controls that optimize their performance offer good load control potential but are considered leading edge since there is not a large body of experience with their use in the U.S.

Interior systems are more commonly used than exterior ones, either as vertical fins or Venetian blinds. Semi-transparent blind systems made of tinted plastics have also been developed over the last years, as have perforated metal slats. Each of these offers some additional degree for control compared to conventional metal and wood slats.

The large range of performance characteristics of louvered systems make them very promising with respect to optimizing energy performance. However, their detailed performance will be a function of their operation control strategy and implementation, which have not yet been explored adequately.

2.5 Shutters

In addition to providing security and privacy, exterior or interior shutters also offer insulating value and solar control. They are available in hinged, rolling, and sliding versions. The hinged shutter has by far been the most common in the United States, although its use has been largely decorative and applied primarily to residences and small commercial constructions.

Exterior rolling shutters have been extensively used in European buildings. They normally consist of a series of wooden, extruded metal or plastic sections that retract into a roll at the top of the window opening. Newer versions are being manufactured with thicker cross sections, with insulating foam filling the hollow cross section, and with tighter seals between each element to improve thermal performance. Even with these improvements, the added insulating value of the shutter system plus air space will generally not exceed R-2 to R-3. Added to single glazing, however, this will reduce the heat loss by about 75%; by perhaps 50% when added to double glazing. These devices are relatively expensive , but their costs can be justified because they provide multiple functions. Sliding shutters have been used primarily in a few residential buildings as a custom feature. However, their use is very limited within U.S.

A number of interior shutters are also available. However, they are used mostly for privacy, security, and esthetic reasons, rather than to provide shading. Their shading effectiveness is less than that of exterior shutters.

III. PRODUCTS AND MANUFACTURERS

Inclusion in this list does not imply applicability or endorsement. Additional companies may also manufacture these products.

Awnings

Alcan Awnings by Alcan Building Products of Alcan Aluminum Corporation.
Alcan Roll-Up Awnings by Alcan Building Products of Alcan Aluminum Corporation.
CTM™ (Constant Tension Mechanism) by John Boyle and Co., Inc.
ESPI Awnings by European Shade Products, Inc.
Faber Markiser by A/S GHR Fabers Fabriker.
Harosol® by Hamel, Inc.
Perma Awnings by Perma System.
Solair by The Astrup Company.
Solairette™ by Astrup.
Sun Tamer Products by Levolor Lorentzen, Inc.
Sunkit Fabrics by Sailrite Enterprises, Inc.
Sunrisor by Architectural COncepts, Inc.
Suntec Retractable Awnings by Suntec-Warema, Inc.
System 2000 by John Boyle and Co.,Inc.
Termo Awnings by abc Sun Control, Inc.

Shades

Exterior Shades

CTM™ (Constant Tension Mechanism) by John Boyle and Co., Inc.
Dual Insulating Shade™ by Mecho Shade Corporation.
Haroscreen® by Hamel, Inc.
Mirro Film™ by Mecho Shades Corporation.
Sol-R-Veil Shade System by Sol-R-Veil, Inc.
Suntec Retractable Awnings by Suntec-Warema, Inc.
Thermo Shade™ by Mecho Shade Corporation.
Thermo Veil™ by Mecho Shade Corporation.

Interior Shades

6100 Blackout Shade by Levolor Lorentzen, Inc.
Custom Window Shades by Kirsh Company.
Deco Shield by Coolux™, Inc.
Decoray™ by Sun Control Products, Inc.
Dual Insulating SHade™ by Mecho Shade Corporation.
EPSI Solar RollerScreen by European Shade Products, Inc.

Home & Castle Pacifica Roman Shade by Home & Castle, Inc.
Home & Castle Warm Window™ Roman Shades by Home & Castle, Inc.
Insalume® by John Boyle & Co., Inc.
Insul-Clear Shades by Solar Systems.
Insul-Shade by Insul-Shade, Inc.
Insulating Curtain Wall by Thermal Technology Corporation of Aspen, Inc.
Insulider by Jaksha Energy Systems, Inc.
Levolor Woven Aluminum by Levolor Lorentzen, Inc.
Lyverscreen® by J. Brochier et Fils.
Mirro Film™ by Mecho Shade Corporation.
Roman Quilt FR by TDS Industries, Inc.
Roman Quilt by TDS Industries, Inc.
Rominsulated® by TDS Industries, Inc.
Roof Window by Andersen Corporation.
Saxon Window Films by Saxon Industries, Inc.
Scandia® Roller Blinds by Kalmar, Inc.
See Through Window Shades by Plastic-View Transparent Shades, Inc.
Skyview SHade by Skyview Control Systems, Inc.
Slip-In-Panel™ by Aerius Design Group, Inc.
Softlight Shades by del mar Window Coverings.
Solr-R-Veil Shade System by Sol-R-Veil, Inc.
Starshade by Star Technology Corporation.
Sun Control Shades by Sun Control Products, Inc.
Sun Shades by The Plastic Sun Shade Company.
Sunpleat™ by Hunter Douglas, Inc.
Supershade by Thermal Technology Corporation of Aspen, Inc.
Temlite Loomwood Shades by Aeroshade, Inc.
Termo Verosol by abc Sun Control, Inc.
Thermax™ Insulating Board by Jim Walter Plastics.
Thermo Veil™ by Mecho Shade Corporation.
Thermo-Shade by Solar Energy Components, Inc.
ThermoShade™ by Mecho Shade Corporation.
Thermocell™ by Thermal Technology Corporation of Aspen, Inc.
Transparent Shades by M & B Enterprises.
Verosol® by Verosol USA, Inc.
Warm Window™ by Warm Window, Inc.
Window Comforter® by Appropriate Technology Corporation.
Window Fashion Shades by Graber Company.
Window Quilt® by Appropriate Technology Corporation.
Window Showcase™ by Appropriate Technology Corporation.
Window Warmers® by Creative Energy Products.
Winsolate™ by I. Layton Creations, Lic. Mfg.
Woven Woods Graber Shades by Graber Company.

Solar Screens

Exterior Screens

3s Halu-Rollscreen Moveable Solar Screens by Selinger Sun Screen.
5100 Sun Tamer Screen by Levolor Lorentzen, Inc.
EPSI Solar RollerScreen by European Shade Products, Inc.
Haroscreen® by Hamel, Inc.
Kaiser Shadescreen by Phifer Wire Products, Inc.
KoolWall by KoolShade Corporation.
Lyverscreen by J. Brochier et Fils.

PhiferGlass SunScreen by Phifer Wire Products, Inc.
Solar Shield with Eclipse Solar Screening by VIMCO Virginia Iron & Metal Company.
Solar-Grille Screens by Brown Manufacturing Company.
Interior Screens
In'flector by Chemstyle, Inc.

Louver Systems and Blinds
Exterior Louvers
All-The-Way Horizontal Adjustable Sun Controls by Brown Manufacturing Company.
All-The-Way Vertical Adjustable Sun Controls by Brown Manufacturing Company.
Brown Louvers by Brown Manufacturing Company.
Canopy by Brown Manufacturing Company.
Faber Maximatic by The Joseph C. Maillard Enterprises.
Fixed Louvered Screens by Brown Manufacturing Company.
Luxalon Facades and Sun Louvers by Hunter Douglas, Inc.
Moore Louvers by The Moore Company.
Interior Louvers
FOCUS™ by Howmet Aluminum Corporation, Commercial Remodeling Division.
Faber Venetian Blinds by A/S Chr. Fabers Fabriker.
Flaxalum by Hunter Douglas, Inc.
Integral Blind Windows by Hope's Architectural Products, Inc.
Kaptron Solar WIndows by Kaptron, Inc.
Levolor by Levolor Lorentzen Inc.
NANIK's Secondary System Window by NANIK Division of Wausau Metals Corporation.
Pella Slimshade by Rollscreen Company • Pella.
TRACO Series by TRACO™, A Three Rivers Aluminum Company.
Weatherstrol by DISCO Aluminum Products Company, Inc.
Window Blinds by Andersen Corporation.
Exterior Blinds
Baumann Exsotrol Blinds by Baumann, Inc.
Faber Maximatic by The Joseph C. Maillard Enterprises.
Faber Solarmatic by The Joseph C. Maillard Enterprises.
Perma System by Perma System Sun Control, Inc.
Super 80 by Suntec.
Interior Blinds
100% Pure Wool by Louverdrape, Inc.
Bali Blinds by Marathon Garey-McFall Company.
Faber Blackout BLinds by A/S Chr. Fabers Fabriker.
Faber Venetian BLinds by A/S Chr. Fabers Fabriker.
Flexalum® Decor™ Blinds by Hunter Douglas, Inc.
Graber Verticals by Graber Company.
Kane by Louverdrape, Inc.
Levolor by Levolor Lorentzen, Inc.
Louverdrape® Vertical Blinds by Louverdrape, Inc.
MARK II Blinds by Alcan Building Products, Division of Alcan Aluminum Corporation.
Nanik by Nanik
Optix Blinds by Nanik.
Perma System Custom Mini Blinds by Perma System Sun Control, Inc.
The Ultimate Verticals by European Shade Products, Inc.
Trackstar™ by Home & Castle Architectural Window Shading Systems.
Wood Mini Blinds by Kirsh Comany.
Woodland™ by Hunter Douglas, Inc.
Woodvue Blinds by Judkins Company

Shutters
Exterior Shutters
Aawn & ROll Security Shutter by Security Shutter Corporation.
Alulac by Beckhoff Gesellschaft Mbh.

Alulof by Beckhoff Gesellschaft Mbh.
American Rolling Shutter by American Rolling Shutter Corporation.
Ameroll Rolling Solar Shutters by Ameroll Corporation.
Flexalum® Rolop™ by Hunter Douglas, Inc.
Insul-Shutter by Insulshutter, Inc.
Pease Exterior Rolling Shutter by Pease Company of Indiana, Ever-Strait Division • Rollnig Shutters.
Roll-A-Shield by Roll-A-Shield, Inc.
Rolladen by American German Industries, Inc.
Roll•a•way by Prime Marketing Group, Inc.
Shutteroll by Shutter Haus, Inc.
Solaroll by Solaroll Shade & Shutter Corporation.
Soleil by Division ELR, Inc.
Suntec Rolling Shutters by Suntec.
Therma-Roll Vertical Rolling Shutters by Therma-Roll Corporation.
Therma-Shutter Vertical Rolling Shutters by Therma-Shutter, Inc.
afgo Rolling Shutters by afgo Corporation.

Interior Shutters

ESPI ROller Shutters by European Shade Products, Inc.
Rolladen by American German Industries, Inc.
Skyview Shade by Skyview Control Systems, Inc.

Motors and Motor Systems Manufacturers

ADO Corp., Spartanburg, SC
Allison Window Fashions, Charlotte, NC
Am-Source International, Wauconda, IL
Awning & Supply Co., Lafayette, LA
Bamboo Abbott Florida Corp., Hollywood, FL
Barker Supply Co., Phoenix, AZ
Comfortex, Cohoes, NY
Conrad Imports, Inc., San Francisco, CA
Drapery Hardware Unlimited, Fayetteville, NC
Elero USA, Inc., Dallas, TX
Faber Industries Ltd., Fredericksburg, VA
Franklin Corp., Kansas City, MO
JAG Corp., Tulsa, OK
John Dixon, Inc. Cleveland, OH
L.E.G. Motorized Systems, Miami, FL
Lafayette Venetian Blind, Inc., Lafayette, IN
Lightwood Manufacturing, Inc., Clackamas, OR
Louver Magic, Inc., West Babylon, NY
SM Automatic, Culver City, CA
SM Automatic, Culver City, CA
SOMFY Systems, Inc., Edison, NJ
Silent Gliss USA, Inc., Loganville, GA
Simu U.S., Inc., Altamonte Springs, FL
Solar Drape Ltd., Tonawanda, NY
Sunray Control, Van Nuys, CA
Tempo Industries, Inc., Vernon Hills, IL
Williamson Supply Co., Inc., Houston, TX

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