Valerio Roberto Maria LO VERSO
PhD in Building Physics
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CURRICULUM VITAE

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1. Personal data

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2. Education

High school education (September, 1986 – July, 1990)

Graduated at Scientific High School "A. Volta" in Turin. Final marks: points 57/60.

University education (October, 1991 – October, 1998)

"Summa cum laude" degree in **Architecture** at University "Politecnico of Turin", Faculty of Architecture (field of specialization: **Technology**). Final marks: points 110/110 summa cum laude. The thesis was carried out under the guidance of professors Marco Filippi, Chiara Aghemo and Augusto Mazza. The work of thesis was titled "**Visual comfort indices: theoretical, design and experimental aspects**" focused on a lighting designed (in the field of electric lighting) aimed at producing visual comfort conditions for users. The first part was concerned with a theoretical research of different indices used at a both national and international level to analyze and quantify the achievement of visual comfort conditions. The second part consisted of an experimental campaign carried out inside real university classrooms of Politecnico of Turin. Physical quantities (such as illuminance on working planes and luminance values inside users' field of view) were measured to calculate visual comfort indices and verify whether they met requirements prescribed by technical standard. A subjective study was also carried out by means of specifically developed questionnaires handed to students, to verify the degree of correspondence with objective measured data and hence the reliability of indices as visual comfort descriptors. Classrooms equipped with fluorescent based fittings, different for layout, electric power and optic devices were taken into account. Final aim of the work was concerned with drawing some guidelines for designers to correctly design electric lighting systems, for applications such as school and tertiary sector environments.

The experimental results which were obtained have been the topic of a specific paper **[see publication # 1]**.

Ph.D. Research (November 1998 – February 2002)

Title of Ph.D. student in Building Physics gained in February 2002 at University of Genoa, Faculty of Engineering, Department of Thermal Energy Technology and Environment Conditioning, under the supervision of professor G. Guglielmini. The thesis, titled "Daylight simulation by means of artificial skies" was carried out at the partner University "Politecnico of Turin", Faculty of Architecture, Department of Energetics, under the supervision of professors M. Filippi e C. Aghemo. The work consisted of designing, achieving, calibrating and testing a facility equipped with an artificial sun and a sky scanning artificial sky. Such facility is able to reproduce both sunlight and daylight hence allowing daylight analyses inside scale models **[see publications # 2 through 10]**.

Post-Ph.D. Research (February 2003 – January 2005)

Granted a scholarship for a research project titled "Validation and implementation of the use of an artificial sun and an artificial sky for daylighting design". The research was carried out at the University "Politecnico of Turin", Faculty of Architecture, Department of Energetics, under the guidance of professors M. Filippi e C. Aghemo. The work was focused on:

- experimental measurements inside scale models under the artificial sun and sky facility, aimed at assessing environment performance of different typologies of traditional and innovative daylighting systems (both glazing and shades), such as overhangs, light-shelves, fixed and mobile louvers systems, sun-tracking systems and light-ducts for daylight
- scientific validation of results which were obtained with the artificial sun and sky facility
- further development of the artificial sun and sky facility.

The facility is the one achieved within the PhD. research carried out by Valerio Lo Verso **[see publications # 12-13]**.

Post-Ph.D. Research (March 2005 – March 2006)

Winner of a competition for a Research Grant specifically devoted to a research project titled: "Definition of photometric performance requirements and experimental testing and validation of the facility called "Alenia Sky Light Simulator" – Achievement of a daylight (sun and sky) simulator and of a night-light (moon and stars) simulator for aeronautical purposes". The project was carried out within a Research Contract signed between Politecnico di Torino (Department of Energetics) and Alenia Aeronautica (a military aircraft manufacturer) under the guidance of professor e C. Aghemo. The work dealt with the project and the achievement of a facility which consists of a sun simulator, a sky simulator and a moon/star simulator: these are aimed at reproducing daylight and night-light to allow aircraft pilots assessing operability and readability of all cockpit display during ground tests with controlled laboratory conditions (before flight) **[see publications # 14-19-33]**.

Post-Ph.D. Research (July 2006 – July 2007)

Granted a post-doc researcher position as "Canadian Government Laboratory Visiting Fellow" by NSERC (National Sciences and Engineering Research Council) on behalf of Canadian government and department agencies. The activity was carried out at the Ottawa-based Canadian Government Laboratory NRC (National Research Council), within the Department IRC (Institute for Research in Construction). NRC-IRC's Indoor Environment program integrates experimental, analytical and modeling competencies in the areas of lighting, acoustics, ventilation, indoor air quality, thermal comfort, energy efficiency and environmental psychology. These strengths are applied to provide cost-effective technologies to design and operate indoor environments that maximize the comfort, productivity, health and safety of building occupants. The uniqueness of the Indoor Environment program lies in its integrated multi-disciplinary projects that combine the broad range of indoor environment competencies with expertise from other NRC-IRC programs.

The research activity was carried under the supervision of doctors Guy Newsham and Christoph Reinhart and was concerned with daylighting design and occupant use of lighting and shading controls as part of green buildings and sustainable design practices. Activities included field studies in buildings, analyzing the resulting data and developing a deeper understanding of the relationship between occupant behavior and building form and control systems **[see publications # 15-16-20-21]**.

Continuing position as University Researcher (October 2007 – to date)

Winner of a competition for a continuing position as University Researcher within the Department of Energetics of the Politecnico di Torino. The position is as both assistant professor (for teaching activities) and for research officer (for research activities). The teaching activity covers all main filed related to the design of green buildings (thermal, lighting and acoustical aspects, with attention to both sustainable technologies and to the indoor environmental comfort for occupants). The on-going research activity is carried out within the TEBE Research Group (TEBE = Technology Energy Building Environment) concerned with the fields of daylight and electric lighting and their integration for both visual/thermal comfort and energy saving purposes.

3. National research activities (years 1998-2007)

Research activity is mainly focused on quantitative and qualitative aspects of luminous environment. Application field are summarized as follows:

- ***electric lighting***
  - characterization of artificial luminous environment both at a design stage and as verification and measurements of real environments
- ***daylighting***
  - definition and verification of design and prediction tool for daylighting: numerical simulation software and physical simulation through scale models under an artificial sun and sky facility
  - environment performance characterization of daylighting systems, both traditional and innovative, relative to transparent component (glazing, skylights), shading component (fixed and mobile overhangs, light-shelves, vertical fins, opaque and microperforated louvered systems) and daylight conduction component (light ducts, luminous atria)
- ***integration electric lighting - daylighting***, aimed at optimization of visual performance and energetic savings
- ***environment comfort***, in terms of both thermal and visual comfort, by an approach based on both objective measurements and subjective surveys. Aim of the research is the definition of new indices to quantify environment comfort, especially linked to daylight.

ELECTRIC LIGHTING

The approach has been of two kinds: on the one hand, it consisted of predicting environmental lighting conditions by means of specific numerical simulation software (*lighting design*). On the other hand, of analyzing lighting conditions inside real environments through field experimental measurements integrated by subjective surveys to assess which conditions are actually perceived by users (*lighting analysis*).
Within this kind of research, a particular attention has been paid to the field of schools (both high school and university classrooms).
University classroom constituted the objective of a specific Research Program (see "Research programs at Politecnico of Turin"). Relative to different comfort aspects (visual, acoustic, thermal and of air quality), detailed questionnaires were specifically developed to compare subjective evaluations expressed by students and objective measurements of micro-climate parameters, so as to verify the reliability of existing indices and determine a synthetic global comfort index **[see publication # 27]**.
As far as high school classrooms are concerned, a specific research has been carried out within a Research Contract signed between the Politecnico of Turin and the Provincia of Turin (Public Administration) (see "Research Contracts – C"). With the aim of improving environment comfort conditions for students and reducing buildings' management and maintenance costs, an experimental analysis of actual conditions inside classrooms was carried out and new solutions were proposed for both electric lighting and daylighting (use of different typologies of luminaries, of shades and of responsive daylighting systems). Several classrooms were investigated, representative of different typologies of school buildings, exposures, lighting fittings and daylighting systems.
A further application field was concerned with electric lighting in offices: relative to different buildings housing the Public Administration (see "Research Contracts – A"), both modern and historical, an ergonomic study was carried out to define lighting source and optics to assure suitable visual conditions in correspondence of work places (control of glare phenomena, both direct and reflected on VDTs) and to emphasize architectural objects and details of relevant artistic interest such as vaults, paintings and frescos. For this purpose, an in-the-field campaign was carried out in offices of different sizes (single offices up to large open-space offices) so as to detect main visual problems and to define suitable solutions.
Last but not least, the topic of lighting pollution is presently under investigation, with the goal of defining suitable lighting solutions for external fittings in large urban areas.

DAYLIGHTING

Daylighting is the main research field which both Ph.D. Thesis and subsequent post-PhD. research have been focused on.
The use of daylight in non-residential buildings has nowadays become an important strategy to improve environmental quality and energy efficiency by minimizing artificial lighting consumption, heating and cooling

loads. Daylighting design and building design should be inseparably linked to each other, in one only creative process aimed at generating appropriate architectural and technical solutions while reducing building energy consumption. Nevertheless, daylighting strategies are seldom considered in the earliest stages of a building design: this is often due to the lack of simple tools able to accurately predict the performances of daylighting systems exposed to lighting conditions varying continuously in distribution and intensity, according to seasons, day's hours and specific climate conditions.
As an alternative to a software-based approach, an efficient prediction tool for daylighting design is represented by the use of scale models under an artificial sky and sun, specifically designed facilities which enable reproducing daylighting conditions by means of artificial lamps and luminaries. This latter is the approach followed during the Ph.D. and post-PhD. research, aiming at achieving a facility consisting of both a sun simulator and a sky simulator.
Different types of artificial skies have been realized in the past: mirror skies, dome skies, spotlight sky simulators or scanning skies, each characterized by different advantages and disadvantages. Potentialities and drawbacks of each type of artificial sky were analyzed and compared (analyses and conclusion were summarized in a specific paper **[see publication # 2]**).
As a result, at the Daylighting Laboratory of the Politecnico of Turin it was decided to design and achieve a ***scanning artificial sky***, able to reproduce the diffuse skylight component, supplemented by an ***artificial sun***, able to reproduce direct sunlight component. The facility was achieved within the two year research program of national interest "Indoor Environment Engineering", co-funded by the Italian Research and University Ministry and coordinated by professor Marco Filippi This is the first and only facility of this kind operating in Italy and is conceived not only for research purpose, but also and especially as a tool for designers (architects, engineers, lighting designers) to predict which way daylight characterizes outdoor and indoor environments, since it allows both determining daylight levels (illuminance and daylight factor values, spatial distribution of daylight over an indoor room) and reproducing how a daylighted environment appears as well as what is the dynamic behavior of sun penetration. The design phase of the facility and its features and potentials were presented in a specific paper **[see publication # 3]**.
The "sky" reproduces one sixth of the vault, consisting of 25 individually dimmable luminaires, based on the model of subdivision of the sky hemisphere proposed by Tregenza for sky luminance measurements and assumed by the CIE in the IDMP (International Daylighting Measurement Program). In order to reproduce the entire sky dome, the model's stand produces a six-step scan rotation, modifying for each scan the luminance distribution. Global photometric quantities and pictures are therefore obtained adding the partial values and images. Different sky conditions are reproducible (overcast, clear and intermediate conditions) according to both standard models and real luminance values recorded at IDMP measuring stations.
The "Sun" is in a fixed position, so the model's stand is rotated an tilted to suitably reproduce the relative Sun-Earth position, according to solar geometry equations.
In short, main advantages as tool for daylighting design may be summarized as follows:

- good adherence with real situations
- possibility of simulating different sky conditions, referring to both standardized daylighting models and real skies, experimentally measured
- possibility of comparing performances of different daylighting systems, thanks to the feature of maintaining constancy and repeatability of luminance distribution of the sky vault and the apparent movement of the sun
- possibility to carry out an objective measurement of photometric data (quantitative evaluation)
- possibility of carrying out a perceptive assessment of the daylighted environment (qualitative evaluation), by taking photographs of the indoor simulated environment.
- possibility of carrying out studies with different aims and on different scales, from site planning to indoor environment to daylighting systems: environmental performances of daylighting systems (windows, sky-lights, shading devices, light ducts, etc.).

Apart from the advantages already listed a scanning artificial sky presents some drawbacks, linked to the finite distance between the model's stand and the portion of dome: especially when dealing with large models, an horizon line error and a parallax error (different parts of the considered model receive different quantities of daylight and sun-light) may occur.

The research activity consisted of defining the detailed project of the facility, specifying the performance requirements for the different parts of the structure, which are **[see publication # 5]**:

- a ***scanning sky simulator***. This is based on the subdivision model of the sky hemisphere proposed by Tregenza for sky luminance measurements and which is assumed by the CIE in the IDMP (International

Daylighting Measurement Program). According to the model, the dome is subdivided into 145 circular areas, each of which is considered of uniform luminance. In the scanning sky simulator, the areas are simulated by means of circular luminaires located on a hemispherical surface according to the angular coordinates established by Tregenza. A structure with 25 luminaires, corresponding to one sixth of the whole hemisphere (diameter equal to 7 meters) was constructed; real illuminance inside models are obtained by adding the partial values measured for a six-step scan of the scale model situated in the centre of the hemisphere. The luminance distribution of the whole sky is obtained by opportunely varying the luminance of each luminaire for each rotation. This way, different sky conditions can be are reproduced (overcast, clear and intermediate conditions) according to both standard models and real luminance values recorded at IDMP measuring stations.

Only one sixth of the sky dome was physically constructed, so as to reduce both construction and maintenance costs, calibration problems and energy consumption. Furthermore, not having an overall dome reduces the error that is obtained when simulating the desired sky condition due to undesirable reflections on the opposite luminaires. For this reason, the walls are all painted black.

Each luminaire is 0.67 meters in diameter and is equipped with ten 26 W compact fluorescent lamps that are radially positioned, while the optics is composed of a specular aluminum reflector, a central specular aluminum cone and an opal polycarbonate diffuser, to increase the luminance uniformity of the luminaire surface. The light output fits a Lambert distribution (mean luminance value: approximately 6300 cd/m^2) and a uniform luminance distribution on the diffuser (standard deviation of the luminance values with respect to the mean value of less than 8%). Five electronic ballasts allow the light output to be controlled in the 100%-3% range, therefore the corresponding luminance approximately ranges from 6300 to 200 cd/m^2.

- a ***sun simulator***. The Sun is simulated by a theatre luminaire positioned 8 meters away from the stand of the model. The optics was adequately modified so as to reproduce the principal photometric characteristics of sunlight: a luminous beam characterized by parallel rays and a uniform value of illuminance on the plane of the model. A specific optic system was designed to obtain such performance, which consists of two lenses with different bending (a 5 diopter condenser lens and a 2 diopter frontal lens). The projector that was used is equipped with a 1200 W halogen lamp. As far as the model stand surface is concerned, the luminaire features a illuminance distribution that is characterized by a standard deviation to the mean value ratio of less than 8%. Furthermore, no significant shadows were observed on the same surface for the zenith sun position
- a ***structure to rotate and tilt the stand of the model***. A stand was located in the centre of the artificial sky vault to support and move the scale model. It is equipped with two step motors, which produce a rotation around the vertical axis (reproduction of the sun's azimuth angle) and a rotation around the horizontal axis (reproduction of the sun's elevation angle). Another movement is manually carried out by the user: this concerns the vertical translation of the plane on which the models rest, a movement that is useful to align the upper lintel of the window with the horizon line of the vault in order to reduce the error relative to the simulation of the horizon line
- a ***photometric data acquisition system***. A quantitative assessment of the lighting conditions is made by measuring illuminances through 17 miniaturized probes (one of which is placed outside the model to measure the external unobstructed horizontal illuminance), which were specifically conceived to measure inside scale models. Each illuminance-meter is characterized by a reduced sensitive surface (3 mm in diameter) to minimize the scale error, a V(λ) match lower than 3% and a directional error (cosine correction) lower than 1.5%.

  Apart from quantitative measurements, the acquisition of digital images is also carried out, by means of a video-photometer that is placed inside the model and which is connected to the control unit. This instrument allows a qualitative analysis of luminous environments showing the spatial distribution of luminance values
- a ***control unit***. A specifically developed software governs all the functions and procedures that are necessary to simulate sunlight and daylight: rotating and tilting the model, according to solar geometry equations that have been implemented in it; calculating the luminance values of the 145 circular areas into which the sky vault is subdivided (all sun and sky models standardized by the international scientific community - CIE, IESNA, CSTB, "all-sky weather" model by Perez, SSLD model by Kittler, Darula and Perez presently standardized by the CIE - were analyzed and implemented [4]); dimming the luminous flux output for each of the 25 luminaires; acquiring and elaborating photometric data and digital images.

Testing procedures for the different part of the facility were also developed: laboratories measurements were carried out to verify whether photometric and mechanical performance met the required prescriptions **[6]**. Afterwards, experimental activities using scale models were started, aimed at assessing the environment performance of different typologies of daylighting systems (glazing, shading and conducting component), both

traditional and innovative **[see publications # 7-8-9-12-13]**. Since 2002, a number of different studies have been carried out at the Daylighting Laboratory, ranging from site planning to single indoor environments or daylighting components analysis.
Most studies carried out in the facility refer to one of the following categories:

1. comparison of environmental performance of different daylighting systems (openings, glazed surfaces, shading devices)
2. optimization, during the design stage, of a specific daylighting system.

The different goals of the studies belonging to the two categories imply different procedures in the use of the scanning sky simulator.

1. For the comparative evaluation of different daylighting systems models reproducing sample environments are used. Besides, reference conditions are assumed, both for sky conditions and sun positions, and repeated in order to compare environmental performances due to assessed systems. At present, for this category, most studies have been carried out to evaluate the performances of different shading systems (overhangs, vertical fins, venetian blinds, light-shelves, PVC, wood or aluminum louvered screens) for both residential and non-residential environments (e.g. attics, offices, classrooms **[see publication # 12]**, etc.).
2. The optimization of a specific daylighting system is carried out during the building design stage and it is related to the distributive and photometric characteristics of the space for which the system has been conceived. At present, for this category, most studies have been carried out to optimize the design of shading systems such as mobile or fixed, matt or specular, continuous or micro-perforated louver shades. Aim of the studies has been concerned with maximizing the amount of admitted daylight while screening direct sun-light, hence controlling glare and overheating phenomena and meeting at the same time the Daylight Factor standard requirements. In these cases, quantitative (illuminance and Daylight Factor levels) and qualitative (images taken inside the scale model) data were collected for different louver tilt angles and for maximum and minimum daylight availability during the year (clear and overcast skies, June and December, early morning and noon). This approach was adopted, for example, for the enlargement of the SACMI headquarter at Imola (Bologna, Italy), a building whose achievement was finished in December 2004: the designed daylighting system is an aluminum shade with fixed louvers. By the scale model under the artificial sun and sky facility, the ambient effect for different louvers' tilting was analyzed, determining the most suitable angle as compromise between screening sunlight and admitting skylight during the year. The building presented repetitive bays, so a scale model reproducing a single module of the whole building was made according to the real building sizes and the sky simulator characteristics and the problem of defining how to simulate the daylight that arrives from the adjacent parts of the building, which are not included in the scale model, was dealt with. A procedure was defined to correct photometric data measured inside the model so as to take these contributions of light into account **[see publication # 13]**.

Other research field related to daylight are:

- definition of a ***procedure to validate results*** obtained during experimental activities with the artificial sun and sky facility. Background aspects are analyzed to determine possible sources of errors: in general terms, possible errors in predicting illuminance and luminance levels as well as sunlight and daylight distribution in indoor environments are basically concerned with two categories. The former involves the capabilities of simulators of reproducing sunlight and daylight photometric properties: consistent reproduction of a sky luminance distribution, either standard or statistical (quantifying parallax errors or the effects due to continuous/non-continuous domes or to the repeatability of a sky condition…), of sun's luminous beam with parallel rays and accuracy of relative sun/sky – model position (reproduction of the horizon line…). The latter deals with the level of accuracy obtained though the physical achievement of the scale model: reproduction of internal and external geometry, of photometric properties of opaque and transparent materials, accuracy of photometric instruments and acquisition systems.
  Based on theoretical consideration, a detailed validation procedure was developed. Each topic was investigated, comparing data measured inside the laboratory with data coming from analytical calculations (i.e. for the external unobstructed illuminance value…) or real measurements (i.e. for the sky luminance distribution, opaque and transparent materials' optic properties…) or software simulations (i.e. for the effect of a non-continuous dome…). To validate the final reliability in prediction of photometric data, the errors connected to the scale model were analyzed by means of a comparison of illuminance values measured inside a test-room and its model under the same real sky conditions, whilst the errors connected to the performance of the simulators trough a comparison between the illuminance values measured inside the scale model under the real and the reproduced sky condition. The shadow patterns were also compared for this purpose. This

approach was adopted to define a procedure not only suitable for simple rooms and fenestrations, but also to account for complex daylighting systems (such as continuous/non-continuous, fixed/mobile louvered systems), as well as the effect of openings' position, of external obstruction and of the albedo. A comparison with results obtained by advanced lighting software, such as Lightscape or Radiance, will be also carried out

- further developments in the field of ***measurements of photometric quantities inside scale models***, with particular attention to videography techniques based on instruments equipped with solid-state sensors CCD as an alternative to traditional illuminancemeters and luminancemeters. Aim is concerned with obtaining luminance maps of light spatial distribution inside a scale model ("luminous environment"), so as to assess visual comfort conditions for users (luminance contrast, calculation of glare indices…). Each pixel of the picture taken by the video-photometer corresponds to a luminance value, based on a specific calibration grey level – luminance value. A thorough research lead to detect main advantages and drawbacks of this technique: on one hand features such as short measuring time (a scene is "mapped" in few seconds), high resolution of the image (hence giving a high number of measured points), V(λ) match constitute the advantages; on the other hand, limits such as a non-uniform distribution of the spatial resolution (resulting in geometrical distortion or lack of luminosity), the lack of a standardized measurement protocol and the higher cost with respect to traditional instruments constitute the drawbacks.
  As a result of the research, a suitable instruments was detected for measurement inside scale model as well as in indoor existing environments as well as for luminance mapping of the real sky

- definition of ***procedures, parameters and indices to analyze in quantitative terms the images of sunlight penetration into a scale model***. Two approaches have been adopted:
  - analysis of dynamic ratio area directly lighted by sunlight to total floor + walls area
  - subdivision of the environments into areas parallel to the windowed to analyses in details the sunlight penetration depth (approach valid for sidelighted environments only).

- to the field of daylighting belongs a thorough research about daylighting systems, both traditional and innovative, with respect to glazed components, shading components and conduction components. This research is based on both numerical simulation and physical simulation though scale models under the artificial sun and sky facility, aimed at analyzing environment performance of overhangs, light-shelves, Venetian blinds, vertical fins, louvered shades and light-ducts.
  The both theoretical and experimental knowledge which has been acquired led to write (in Italian) the book "**Daylighting design guide**", committed by the Italian Lighting Association AIDI **[see publication # 36]**. Valerio Lo Verso played a major role in the research phase as well as in the writing of the text.

- The topic of simulation of daylighting conditions through artificial skies has been extended to an application field different from buildings: the aeronautical one. A Research Contract was signed between Politecnico and Alenia Aeronautica (a military airplanes manufacturer – see Research Contracts - D) to achieve a ***"Sky Light Simulator"***, an artificial sun and sky facility to assess readability and visibility of display inside cockpit for any flight condition, both in day-time and in night-time.
  Optimization of display's luminous performance so as to allow aircrew to correctly perceive the information represents a research field of relevant international interest. Nowadays, display are proposed by manufacturers as multipurpose elements, different for color, materials and way of visualization of flight information (emitting display, reflecting display and transparent display such as Head-UP Display HUD). Furthermore, the ambient light also changes during the day-time (from cloudy to clear skies and with Sun in different critical positions) and during night-time (moonless skies, skies with Moon…), this resulting in a change of display photometric properties such as light levels or colors. Therefore, cockpit design is based on both realizing new cockpits and updating existing ones by inserting new typologies of panels. The most suitable display layout and readability is assessed directly by pilots through ground tests.
  This led to designing and realizing a Sky Light Simulator, a facility able to reproduce photometric characteristics of both daylight (sun and sky dome) and night-time light (moon, stars and dome) conditions. Light photometric properties need to be reproduced with great accuracy not only in qualitative terms, but also in terms of light quantities, spectra and continuity of luminous surfaces. Light spectrum is of great importance since some instruments, such as Night Vision Goggles, have themselves a spectral response, thus interacting with spectrum of sky light in a way which has to be taken into account.
  Different light conditions can be reproduced, so different cockpit configurations can be analyzed under the same reference conditions and hance compared. Such conditions refer to some "worst-cases", according to

aeronautical standards: Sun forward, causing direct glare to and display in shadows; Sun rear, resulting in veiling reflections on display (reflected glare); a moonless sky (starlight and cloudy sky); a sky with full Moon and quarter Moon.
Final aim of the lighting tests are concerned with a subjective appraisal of readability of cockpit display, integrated with an objective measurements of light quantities so as to determine indices and guidelines for cockpit manufacturers, considering a substantial lack of verification procedures in standards. So, research has been focusing on:

- definition of technological solutions to accurately reproduce the photometric properties of daylight and night light sources (Sun, sky, Moon, stars). Different typologies of sources (fluorescent, LEDs) have been considered, having a suitable spectrum and high luminous efficiency performance so as not to determine excessive thermal loads
- definition of meaningful critical conditions, representative of real flight conditions
- detailed definition of photometric performance specification of different elements the Sky Light Simulator consists of
- critical evaluation of technical solutions proposed by manufacturers, verifying they met the performance specification

Main research topics are concerned with:

- experimental assessment of photometric performance of prototypes representative of different elements of the simulators (Sun, sky, Moon, stars)
- analyses of visual tasks from a point of view of visual perception, visual comfort and ergonomics
- definition of spectral distribution representative of both lunar light and star light, to be reproduced by means of a suitable electric lighting system. LEDs sources have been identifies as suitable to reproduce both light levels and spectra of moon and star light and are currently under experimental evaluation
- definition of instruments suitable for objective measurements of quantities of light, in terms of both levels and spectra, incident onto cockpit display. Both traditional (illuminancemeters, chromameters, spectroradiometers) and innovative instruments (video-photometers) are investigated
- definition of test procedures for both subjective and objective assessments, so as to get a statistical correlation between measured parameters and judgments
- definition of suitable assessment indices.

In short, main difference between the aeronautical Alenia Sky Light Simulator and the Politecnico sky scanning simulator for buildings are concerned with:

- use of 1:1 mock-up or real cockpits and airplanes instead of scale models of buildings
- realization of subjective assessment expressed by pilots
- facility's size (to house real military aircrafts) and consequent increase in electric powers and thermal loads
- necessity of reproducing Sun and sky photometric properties (in absolute values and as spectral distribution) and geometric characteristic; so, the sky is a continuous surface, since pilots are supposed to directly watch the sky with the same perception as they would have watching the real sky, while night sky need to be spectrally accurate so as to correctly interact with aided-vision tools as Night Vision Goggles NVGs.

Within the 5 years long research (2002-2006), 25 technical documents, named Work-Sheets *were written, relative to intermediate results which were obtained during the development of the project. Furthermore, two overall reports were also written, describing all the research which was carried out during both the design phase and the realization and testing phase (see "list of documents written within the research carried out for Alenia Aeronautica", below).*
According to a contractual constraint required by Alenia Aeronautica, results of interest which were obtained during the research will be published, at both a national and an international level, after the end of the contract. Such results will be presented to the International Community, both in the lighting and in the aeronautical field, starting from 2007 ***[see publication # 14]****.*

LIST OF DOCUMENTS WRITTEN WITHIN THE RESEARCH CARRIED OUT FOR ALENIA AERONAUTICA

Work-Sheets

WS1 *Documento di analisi critica dei requisiti prestazionali di base* – June 13, 2002
WS2 *Calcolo del numero di LED per lo Sky Light Simulator di Alenia* – July 8, 2002
WS3 *Alenia Sky Light Simulator performance requirements – Lighting requirements - Lighting Sub-system* – July 2002

WS4 *Confronto delle prestazioni di diverse sorgenti luminose al fine di una verifica di fattibilità per lo Sky Light Simulator* – July 24, 2002

WS5 *Analisi dell'offerta tecnica di Targetti Sankey relativa al Lighting Sub-system dello Sky Light Simulator* – December 6, 2002

WS6 *Valutazione dell'offerta tecnica relativa agli aspetti illuminotecnici per il progetto Sky Light Simulator – Società Delta-Light* – November 25, 2002

WS7 *Simulazioni relative a diverse configurazioni di lighting panels per lo Sky Light Simulator* – January 20, 2003

WS8 *Proiettore riproducente il sole per Alenia lighting test.* February 2003

WS9 *Test di verifica dell'incremento di temperatura dovuto a proiettori riproducenti il sole - Proiettore Arri Sun 120 – 12 kW*. October 2003

WS10 *Procedura per le prove sperimentali e sistema di illuminazione notturna per Alenia Sky Light Simulator.* February 2004

WS11 *Valutazione degli aspetti illuminotecnici relativi alle prove sul prototipo di lighting panel per il progetto SLS*. March 2004

WS12 *Technical report*. July 2004

WS13 *Valutazioni sulle prestazioni fotometriche del prototipo di lighting panel realizzato da Targetti Sankey*. October 2004

WS14- *Definizione del sistema di illuminazione notturna e della procedura e strumentazione per le prove sperimentali per Alenia Sky Light Simulator.* February 2005

WS15 *Valutazione sperimentale delle prestazioni fotometriche dei lighting panels dello Sky Light Simulator - Prototipo di lighting panel LP7. Misure di marzo – aprile 2005*. April 2005

WS16 *Definizione delle strumentazioni necessarie per le prove sperimentali per Alenia Sky Light Simulator.* May 2005

WS16/2 *Caratteristiche di luxmetri per le operazioni di collaudo dello Sky Light Simulator Alenia. Integrazione al WS16 del maggio 2005*. February 2006

WS17 *Contributo alla Critical Design Review del 20/10/2005*. October 2005

WS18 *Valutazione sperimentale delle prestazioni fotometriche dei lighting panels dello Sky Light Simulator - Procedura per la verifica delle prestazioni fotometriche dei lighting panels realizzati da Targetti Sankey*. September 2005

WS19 *Valutazione sperimentale delle prestazioni fotometriche dei lighting panels dello Sky Light Simulator - Prototipi di lighting panels LP1 – LP3 - LP4 – LP5 – LP6. Misure di aprile - giugno - luglio – settembre 2005*. September 2005

WS20 *Considerazioni sui requisiti minimi da garantire come prestazioni fotometriche dello Sky Light Simulator.* December 2005

WS21 *Considerazioni per la definizione delle procedure di verifica di rispondenza del lighting subsystem ai requisiti di progetto.* February 2006

WS22 *Prove di valutazione delle prestazioni fotometriche dello strumento "Moon/starlight simulator" – Hoffman LM-33-80A*. January 2006

WS23 *Misure e valutazioni sulle prestazioni fotometriche del sole artificiale progettato per lo SLS*. March 2006

WS24 *Commenti al documento "Acceptance Test Procedure" di Bertolotti, n° 9775 0F 001 Rev. A*. February 2006

WS25 *Definizione delle procedure di collaudo in opera dello SLS (integrazione al documento "Acceptance Test Procedure ATP" in relazione agli aspetti fotometrici) - Risultato del collaudo in opera dei lighting panels e del collaudo del worst-case "HUD"*. May 2006.

Reports relative to the activity research

- *Requisiti prestazionali, caratterizzazione illuminotecnica e verifica sperimentale del progetto "Sky Light Simulator" – Relazione relativa alla fase di progettazione.* Report relative to the design phase, January 2003
- *Requisiti prestazionali, caratterizzazione illuminotecnica e verifica sperimentale del progetto "Sky Light Simulator" – Relazione relativa alla fase di realizzazione e collaudo.* Report relative to the realization and testing/calibration phase, June 2006
- *Critical overview of existing standards to identify procedures and performance metrics to assess display legibility,* May 2010
- *Definition of a step-by-step operative procedure to assess legibility of aircraft cockpit displays in both objective and subjective terms,* May 2010
- *Implementation of routines to analyze luminance images to calculate legibility performance indices,* May 2010.

4. International research activities (years 1998-2007)

Over the period of time July 2006 – July 2007, Valerio R.M. Lo Verso was a post-doc researcher as "Canadian Government Laboratory Visiting Fellow" at the Ottawa-based NRC (National Research Council), within the

"Lighting Group" of the Department IRC (Institute for Research in Construction). Under the supervision of doctors Guy Newsham and Christoph Reinhart, he played a major role in the development and writing of a new daylighting design guide for North America (project NRC/CCTI # B3226), titled "***Daylight 1-2-3 – Daylighting design guide***". This documents is intended to be part of an integrated design approach for early daylighting/energy design analyses, approach which consists of two complimentary components, the text guide itself and software (named "*Daylight 1-2-3-Software*". Both components can be downloaded free-of-charge from the dedicated site www.daylight1-2-3.com and represent an integrated design procedure to the cost-effective design and to the implementation of daylighting concepts in commercial buildings, aimed at sensitizing the users to the interaction of daylighting with other key design aspects such as energetic consumption and possible savings due to the electric lighting, cooling and heating systems occupant satisfaction with the indoor environment and the coordination with electric lighting and mechanical systems **[see publication # 16]**.
'*Daylight 1-2-3-Guide*' is organized into two main parts, a ***guide*** section and a collection of ***work sheets***. The '***Guide***' section deals separately with diffuse skylight and direct sunlight, introducing specific design solutions and rules-of-thumb. The window sizing and the choice of glazing and shading technology is the result of the trade-off between these two approaches.
The diffuse skylight design approach is based on a Radiance-validated three-step daylighting design sequence, consisting of interconnected rules-of-thumbs. During Step one a simple screening test is used to help the design team to quickly estimate whether different zones within a building have a high daylighting potential (being worth developing daylighting strategies during the design development stage) or not (being dropped from further consideration concerning cost-efficiency energy saving strategies). At this step, design parameters such as window-to-wall ratio and glazing type are set. Steps two and three of the sequence only need to be applied to those zones showing good daylighting potential. During Step two interior room proportions are set as a function of window-head-height and mean interior surface reflectance. Step three links a desired daylight factor level back to a minimum window-to-wall ratio and allows determining the necessary "net glazing area" **[see publication # 15]**.
The direct sunlight design is mainly addressed using '*Daylight 1-2-3-Software*': using the design parameters determined through the '3-step procedure' (room dimensions and glazed and opaque surfaces' photometric properties), it's possible to run a simulation in less than 2 minutes, obtaining as output the annual profiles of both static and dynamic daylight metrics as well as monthly charts of energy use and peak loads for heating, lighting, and cooling. After using the software, sizing of shading systems such as overhangs, light-shelves and vertical fins are addressed through rules-of-thumbs provided in the '*Daylight 1-2-3-Guide*' document.
The '***work sheet***' section consists of a series of forms to be completed by the design team to derive and document key analysis findings and design decisions as the design advances. Several copies of the same work-sheet set are provided so that calculations can be carried out in parallel for different daylighting zones. A zone groups a series of rooms with similar characteristics in terms of orientation, obstructions, elevation (ground floor rather than top floor in high-rise buildings) and usage of the room (for example repetitive classroom on the same floor facing the same urban context within a high-rise educational building).

Other tasks Valerio R.M. Lo Verso was involved in are concerned with investigating the link between daylighting design and occupant use of lighting and shading controls: activities included field studies in buildings, analyzing the resulting data and developing a deeper understanding of the relationship between occupant behavior and building form and control systems.

5. Research Activities (years 2007 – to date)

The research activity carried out at both a national and an international level by Valerio Lo Verso over the last years for the TEBE Research Group of the Department of Energetics of the Politecnico of Turin (www.polito.it/tebe) was mainly focused on the topics of daylighting and electric lighting and their integration for both indoor environmental comfort for occupants and energy saving purposes.
The conducted research activities refer to national research programs (co-funded by the Italian Ministry of Research and University MIUR), to research contracts signed between the Department of Energetics and public or private companies or administrations and to Technical Committees within the CIE (International Commission on Illumination).

- Research activities within national/international research programs or research contracts:

- 2011-13: ODALINE ""*Oled Devices Application in Luminaires for INterior and Exterior lighting*", industrial research project, funded by the Innovation Pole - Polight, Project Trajectory: ES1 – HVAC and lighting systems for eco-efficient buildings; Development Line: ES 1.4 Lighting. Scientific coordinator: Anna Pellegrino
- 2010-13: SEEMPUBS "*Smart Energy Efficient Middleware for Public Spaces*" Collaborative Project financed within the VII Frame Program of European Union. International coordinator: professor Anna Osello
- 2010-12: Relevant National Research Program PRIN, co-funded by the Italian Ministry of Research and University MIUR. Title: "*Daylighting design for energy saving purposes: climate-based parameters, dynamic modeling indices to assess the environmental quality, evaluation tools and methodologies, innovative technologies, performances of daylighting –electric lighting systems, ventilation and photo-voltaic systems.* National Coordinator: professor Chiara Aghemo. Activities of the Politecnico's Research Unit: "*Daylighting design for energy saving and visual comfort purposes: climate-based dynamic modeling CBDM, glare indices and integration with ventilation systems*"
- Research Contract Politecnico of Turin – Alenia Aeronautica, "*Performance requirements, photometric characterization and experimental assessments within the 'Sky Light Simulator' projec)*". Topics: definition of photometric requirements relative to the design of a sky simulator, critical assessment of technical solutions proposed by manufacturers, verification if the Sky Light Simulator met required photometric performance, definition of test protocol and measurement procedures inside military airplane cockpits, testing of the achieved facility. Scientific reference: professor Chiara Aghemo.
- 2004-10: contract E54 – Regional Competition for applied scientific research for year 2004 in the field of […] Aeronautic and space. Title: "*Definition of a methodology and experimentation for visual ergonomics for the man-machine interface in aircraft cockpits*". Topics: starting from the results obtained during the previous research contract (see part D), which led to achieving a Sky Light Simulator for military aircrafts, this contract is aimed at defining a methodology to support and assist subjective assessments given by pilots. This methodology is based on physical measurements to be carried out within the cockpit of the ambient light and of the light over the display surfaces by means of a video-photometer. Determining a correlation between measured data and subjective appraisals and deriving new indices to assess display visibility and readability is the final aim of the research. Scientific reference: professor Chiara Aghemo
- 2003-2005: research program of national interest, "*Electric lighting and daylighting systems and their integration for visual comfort and energy savings purposes*", co-founded by Italian Ministry for University and Research MIUR. Topics dealt with by the Research Unit: assessment of environment performance of innovative technologies for daylighting and their integration with electric lighting systems. Daylighting systems' environment performance are assessed though scale models under the artificial sun and sky facility, aimed at determining their behavior during a year to efficiently manage the electric light integration for both visual comfort and energy savings purposes. Research Unit reference: professor Chiara Aghemo. National Coordinator: professor Chiara Aghemo
- contract CESMO (Service Centre at Mondovì, Cuneo, Italy). Title: "*Introduction of renewable energies in urban centers in the Province of Cuneo (Italy) and their social-economical and territorial-architectural impact*" financed by the Bank of Cuneo CRC. Activities of TEBE Research Group: "*Daylighting and electric lighting for energy efficiency in buildings*". Scientific references: professors Valentina Serra and Anna Pellegrino.

Valerio Lo Verso played and plays an active role within the above Programs and Contracts which obtained to secure extramural research funding.

- Research activity within CIE Technical Committees:
  - CIE TC 3-51: "*CIE Standard General Sky guide*". Coordinator: Stanislav Darula (Slovak Academy of Sciences, Bratislava, Slovak Republic)

In short, the main research topics addressed by Valerio Lo Verso can be summarized as follows:

A. Effects of daylighting and its integration with electric lighting on energy saving and on environmental comfort for occupants

B. Physical experimentation by using scale models and sun/sky simulator facilities

C. Definition of a procedure to analyze display visibility (legibility and readability) within aircraft cockpits

D. Analysis of luminous environmental quality in health care buildings

E. Livingscape-based approach to assess and enhance the quality of urban spaces.

A. EFFECTS OF DAYLIGHTING AND ITS INTEGRATION WITH ELECTIC LIGHTING ON ENERGY SAVING AND ON ENVIRONMENTAL COMFORT FOR OCCUPANTS

This research activity has been carried out (and is still in progress) within the above mentioned national Program PRIN 2010 and within international research groups.
Valerio Lo Verso has in particular deal with the following topics:

- analysis of energy demand for lighting in response to building's architectural characteristics, lighting and control systems and occupant behavior
- analysis and application of new dynamic metrics (Dynamic Daylight Performance Metrics DDPM) to determine the daylight availability within a room throughout the year and the consequent integration with electric lighting
- analysis of relation between energy demand for lighting and other energetic performance indices for building energy certification
- definition of validated procedures for window sizing based on the use of 'rules-of-thumbs' for both vertical windows and skylights.

ANALYSIS OF ENERGY DEMAND FOR LIGHTING IN RESPONSE TO BUILDING'S ARCHITECTURAL CHARACTERISTICS, LIGHTING AND CONTROL SYSTEMS AND OCCUPANT BEHAVIOR

Latest standard introduced prescriptions so as to reduce the energy demand of non-residential buildings under a given limiting value. These buildings are actually characterized by integrated performances concerned with heating, cooling, ventilation and lighting and offer great potential for an overall energy saving. Within this frame, the attention was at first paid to the topic of the energy demand for lighting, which depends on several inter-connected aspects:

- daylight availability outside the building, as a function of site latitude as well as of climatic characteristics throughout the year (presence of clear rather than of overcast or intermediate sky conditions, atmosphere turbidity, pollution etc…)
- building's architectural characteristics, concerned with the size of room and glazing systems, the visible transmittance properties of transparent components and with the fraction of sky 'seen' through the windows as a function of external obstructions and/or shading systems
- building usage, based on which the target illuminance value required by standard is set and the user occupancy profile is determined (in terms of presence/absence in the building, user control of blind and lighting systems)
- lighting systems' characteristics, in terms of installed power density and of lighting control systems.

Considering the lack of information in literature and of technical datasheets provided by manufactures, an experimental study was undertaken aimed at determining the influence of above parameters on the final building energy demand for lighting, expressed through the LENI index (LENI stands for *Lighting Energy Numeric Indicator*). This index was introduced by the European Standard UNI EN 15193/2008 ("*Energy performance of buildings – Energy requirements for lighting*") and quantifies the global annual energy demand for lighting (in [kWh(m^2 year]) as a function of the installed electric power and of the parasite power due to electric auxiliary systems (such as ballasts) and of control systems (such as on/off or dimming systems). The study had the final goal of providing designers with a series abacus of performances the help them selecting suitable strategies and technologies (transparent and opaque components; control systems), highlighting for which combination of architectural parameters it is worthwhile adopting a more efficient but more expensive automated photo-dimming control system rather than an on-off system managed by users.
The carried out study was parametric. A large number of case-studies representing an office room with different characteristics was selected. The characteristics which were changed are: orientation (south, west, north), location (Turin, Palermo, Berlin), window size, height of an obstructing building in front of the window (determining an obstruction angle ranging from 0° - unobstructed window – to 75° - highly obstructed), control system (on-off and photo-dimming system). For each case-study, the daylight availability and the LENI index were calculated by

means of the software Daysim and the results were shown in terms of variation of both the DDPM and the LENI values for the different changing parameters.
This work was presented at a CIE international conferences in 2010 **[see publication # 22]**.
This research activity is still on-going: further simulation have been run so as to increase the number of parameters taken into account (for instance, the presence of a Venetian blind) and the results of the overall database will be used to create a mathematical model linking the DDPM and/or the LENI values to the architectural or systems characteristics and to the user behaviors and action towards lighting and shading systems. The work was presented at a preliminary stage at the International Conference COBEE 2012, which took take place in Bolder, Colorado, USA, in August 2012 **[see publication # 35]** and will be submitted in their final version to international journals.

ANALYSIS AND APPLICATION OF NEW DYNAMIC METRICS (DYNAMIC DAYLIGHT PERFORMANCE METRICS DDPM) TO DETERMINE THE DAYLIGHT AVAILABILITY WITHIN A ROOM THROUGHOUT THE YEAR AND THE CONSEQUENT INTEGRATION WITH ELECTRIC LIGHTING

This research activity, strictly is correlated and complementary to the one described earlier and which represents one of the main themes of the National Program PRIN 2010, is concerned with an important international research topic (the CIE TC 3-47 and an IESNA Committee were set to investigate this topic): the definition, validation and applicability to the design process of the new Dynamic Daylighting Performance Metrics DDPM. They are synthetic statistical elaboration of the illuminances calculated within a space throughout the year as a function of the specific climate conditions of the considered site, accounting for specific clear, overcast and intermediate sky conditions as well as for the specific atmosphere turbidity (the overall approach is called Climated-Based Daylighting Modeling CBDM). The DDPM are meant to be introduced into national and international standard to replace/integrate the concept of daylight factor, which is the sole parameter to be verified for daylighting purposed according to current lighting codes. Within this frame, the research activity which was undertaken was concerned with:

- developing a survey to submit to designers of the Faculties of Architecture so as to highlight which simulation tools are actually used during the different design stages
- analyzing the characteristics of the DDPM through the state-of-the-art and new international developments
- analyzing the characteristics of the numerical simulation programs which allow running an annual CBDM (LightSolve, Radiance, Daysim, Spot)
- comparing DDPM values with daylight factor values for the same case-studies, analyzing the reliability and consistency of DDPM in describing the daylight availability within a room and the correlated energy saving as architectural characteristics, lighting control systems and occupancy profile vary (the parametric study is described earlier)
- identifying a number of existing buildings/rooms to use as case-studies and for which: to determine the luminous environmental quality during the year as perceived by occupants and by an expert panel; to develop 3D models to run annual simulations; to compare subjective assessment to simulation results so as to determine reference values for DDPM
- defining guide-lines to provide to designers to allow them adopting a climate-based design approach from the early design stages and through the design process to pursue energy saving and environmental comfort goals.

The final aim of this work was the creation of a graphical analysis tool to visualize the DDPM values obtained from the parametric study (see previous section). This tool is intended for building designers and practitioners, to be used since the earliest design stages to adopt more conscious daylighting strategies in terms of glazing and shading systems.
As mentioned earlier, the first results were presented to international conferences in 2011 **[see publication # 27 and # 32]**.

ANALYSIS OF RELATION BETWEEN ENERGY DEMAND FOR LIGHTING AND OTHER ENERGETIC PERFORMANCE INDICES FOR BUILDING ENERGY CERTIFICATION

Within the frame of national and regional legislation for the building energy certification, the recent "*National guide lines for building energy certification*" (Ministry Decree 26 June 2009) introduced the global energy performance index of a building (EP_{gl}) as simple sum of 4 energy performance indices for winter heating (EP_w), hot water production (EP_{hw}), summer cooling (EP_s) and electric lighting (EP_l):

$EP_{gl} = EP_w + EP_{hw} + EP_s + EP_l$.
These 4 contributions are therefore considered as independent on one another; furthermore, the standards does not specify the procedures to calculate the energy performance index for electric lighting (EP_l).
Within this frame, a research activity was undertaken aimed at analyzing the interconnection between the energy performance index for electric lighting and the energy performance indices for winter heating, hot water production and summer cooling, based on the assumption that the 4 indices are dependent on one another: actually, a reduced daylight availability within a space results in a higher energy consumption for lighting (and hence in an increased EP_l value) but on the other hand in an increased energy consumption for heating in winter (EP_w value) and in a reduced energy consumption for cooling in summer (EP_s value). And viceversa. This mutual influence was calculated by calculating the four indices for both a sample 7-storey building and for two exisiting building of the Politecnico di Torino. For all buildings the impact of different parameters was analyzed, such as:
- location (Turin vs Palermo)
- different daylighting systems (both transparent and shading)
- different lighting control systems (on/off control, operated by occupants, occupancy sensors, photo-dimming sensors).

For each configuration, the LENI value was calculated and used to estimate the energy performance index for electric lighting (EP_l). On the other hand, the LENI value was used to calculate (together with an estimate of the load concerned with appliances and people) the internal gains, using then this data to calculate the energy performance indices for winter heating (EP_w) and summer cooling (EP_s). The final global energy performance index was eventually calculated, analyzing the resulting difference also in terms of eventual shift in terms of energetic class for the building.
This work is the object of a paper currently under revision for submission to an international journal for publication.

DEFINITION OF VALIDATED PROCEDURES FOR WINDOW SIZING BASED ON THE USE OF 'RULES-OF-THUMBS' FOR BOTH VERTICAL WINDOWS AND SKYLIGHTS
Beside the research on the topic of a Climate-Based Daylighting Modeling CBDM (see previous sections) for the design process, a research topic dealt with the definition of validated design procedures based on the daylight factor criterion, as this is the sole parameter required by Italian and European standards and legislation to assess the quantity of daylight within the room. Beside the daylight factor, a number of empirical rules-of-thumbs are provided in literature, without any scientific evidence.
Within this frame, Valerio Lo Verso with the cooperation of Christoph Reinhart, developed and validated design sequence for the early design stage: the sequence interconnects and refines earlier proposed rules of thumb and is intended to be used during the earliest design stages when concepts regarding programming, floor plans, massing, and window areas are initially explored. All steps within the sequence were 'validated' using Radiance simulations of over 2300 sidelit spaces. During step one is of the sequence the effective sky angles are calculated and target daylight factors are defined for all potential daylit zones within a building. In step two a refined version of the 'daylight feasibility study' is used to help the design team to identify building zones with high daylighting potential based on a minimum mean daylight factor criteria. During step three suitable interior room dimensions and surface reflectances are determined using a combination of the Lynes' limiting depth, 'no sky line', and window-head-height rules of thumb. Step four provides a more accurate estimate of the required glazing area for each zone based on the Lynes daylight factor formula which is also validated as part of this work. The effect of external obstructions is considered throughout the process.
The results of this research were presented at an international conference in 2007 **[see publication # 15]** and published in '*Lighting Research & Technology*' **[see publication # 20]**; this paper was also awarded the Leon Gaster Award for the best paper published in the journal in 2010. The work was also published in book chapters **[see publication # 37]** and was then expanded to the case of toplighting systems and presented at an international conference **[see publication # 21]**.

B. PHYSICAL EXPERIMENTATION BY USING SCALE MODELS AND SUN/SKY SIMULATOR FACILITIES

This research activity is based on the use of the sun/sky simulator facility achieved at the Department of Energetics of the Politecnico di Torino. The project, achievement, calibration and use of this facility was the object of Valerio Lo Verso's Ph.D and of a subsequent post-doc bursary.

In the laboratory, experimental measurements within scale models (urban, building, room, component models) for both research purposes or for contracts signed with architectural studios (for instance, with the studio of the architect Mario Cucinella).
Within this research theme, two applications are meaningful:

- characterization of environmental performances concerned with different shading systems
- characterization of light transmission performances of light pipes.

CHARACTERIZATION OF ENVIRONMENTAL PERFORMANCES CONCERNED WITH DIFFERENT SHADING SYSTEMS
The study was focused on an existing classroom of a high-school located in Turin. The geometrical sizes of the room as well as the photometric properties of both opaque and transparent components were measured and consistently reproduced in a 1:10 scale models. The effect of different shading systems (overhang, specular and diffusing light-shelf, louvers with different geometry and reflection properties) on sunlight/skylight penetration and distribution within the classroom was then analyzed.
For each technology, the analyses dealt with:

- the penetration of direct sunlight within the space, through a qualitative analysis carried out by using the sun simulator, so as to highlight glare phenomena and possible overheating problems
- the distribution of diffuse skylight across the space, through a quantitative analysis carried out with the sky simulator, aimed at determining the daylight factor and illuminance values and the compliance with standards requirements. Both clear and overcast sky conditions were used for this purpose.

The analyses were repeated for different periods of time during the year (winter and summer solstices, equinoxes) and for different hours during the day (morning, noon, afternoon), so as to account for the variation of internal conditions with time.
The results of this research were published by the journal '*Building and Environment*' **[see publication # 17]**.

CHARACTERIZATION OF LIGHT TRANSMISSION PERFORMANCES OF LIGHT PIPES
The topic of determining the light transmission properties of guidance systems (light pipes) was thoroughly investigated during the years 2007-2010, through a series of experimental measurements campaigns. Different approaches were adopted to characterize light transmission properties of collectors and guidance components.

- the light transmission efficiency of collectors were measured by using the sun/sky simulator and real prototypes provided by manufacturers. It was taken advantage of the possibility of using 1:1 scale components, hence overcoming the problem of simulating their geometry and redirecting properties by means of a software
- the light transmission efficiency of guidance systems were analyzed through both measurements on scaled pipes, lined with real materials (highly reflecting films provided by manufacturer), using the sun/sky simulator facility and through the simulation software SkyVision **[see publication # 37]**. The results obtained through the two approaches were then compared.

Final outcome of the research was the definition of an experimental procedure to assess the global light transmission efficiency of guidance systems, as a function of the specific efficiency with regard to direct sunlight and diffuse skylight, being determined for each component: collector, pipe and diffuser.
The results of this research were presented at an International Conference in 2007 **[see publication # 18]** and then published in the international journal '*Solar Energy*' **[see publication # 31]**.

C. DEFINITION OF A PROCEDURE TO ANALYZE DISPLAY VISIBILITY (LEGIBILITY AND READABILITY) WITHIN AIRCRAFT COCKPITS

This research activity is focused on the topic of how aircraft crewmembers (i.e. the pilots) or car drivers can correctly read the information being visualized by the display in any drive/flight condition. This topic refers to a human-system (machine) interface domain, within the science of Visual Ergonomics. This latter focuses on analyzing visibility condition and on improving visual performance. It involves visual system and body postures of the individual, environment lighting, job stress and other factors and it consists of setting up a work space in which clear and comfortable vision occurs. In the aeronautical and automotive fields, Visual Ergonomics is concerned with a more efficient interaction of pilots'/derivers' vision with the task they are performing in the cockpit. In every conditions, all cockpit display visual information must be clearly and immediately perceived by pilots/drivers to allow them carry out their task in safety condition and reducing eye-strain problems. The optic and photometric features of cockpit displays can be highly different due to their construction technology

(emissive, reflective, transmissive displays; head-down, head-up displays; analog, digital displays) and their dynamic behavior as the environmental lighting conditions change. During flight as well as while driving a car, these conditions vary of several orders of magnitude, ranging from clear sky with sun in different critical positions (characterized by illuminance levels as high as 10^5 lux, to cloudy sky and to nightlight sky (down to 10^{-4} lux). As the real world natural ambient illumination is both too variable and too complex for every condition to be taken into account in the design of cockpit displays, a few worst-cases scenarios were identified and standardized in literature, with reference to both daylight and nightlight conditions. In particular, for aircrafts each worst-case was identified through reference illuminance values on the display surfaces and on pilots' eyes.
In this regard, a methodology to assess lighting condition and visibility was developed, based on both objective measurements taken within cockpits and on subjective interviews to pilots/drivers. The methodology as well as the preliminary results which were obtained were published by some of the authors in a previous paper. In particular, three main fields were identified and addressed as contributing issues to evaluate display legibility: the "man" field is directly concerned with the workload and task properties; the "machine" field involves the display characteristic and position within the cockpit; the "ambient" field involves the physical quantities characterizing the environmental illumination, both internal and external with respect to the cockpit.
The developed procedure is based on both objective measurements and subjective appraisal expressed by the pilots. The following steps were taken so as to develop a steb-by-step procedure to assess display legibility:

- analysis of literature in the automotive and aeronautic fields aimed at identifying the existing proposed metrics to assess display legibility (Perceived Just Noticeable Difference PJND; Index of Discrimination ID; luminance contrasts)
- analysis of methods for subjective surveys which are commonly used in the automotive and aeronautic fields (basically concerned with the 'Haworth-Newman Avionics Display Readability Rating Scale', based on the 'Cooper-Harper Handling Qualities Rating Scale')
- identification of 'objective' factors which contribute to determine the display legibility: glare, specular reflection, contrast reduction, luminance uniformity, chrominance characteristics
- definition of a measurement protocol to measure these objective factors for reference boundary conditions (sun forward, sun rear, sun dusk, night): illuminance values over the display area and in correspondence of pilots' eyes and luminance distributions across the pilots' visual field were measured, these latter by using an Image Luminance Measuring Device ILMD available at the Department of Energetics of the Politecnico di Torino
- application of the developed procedure to a series of real cockpits: both cars, motorgliders, helicopters and military aircrafts were used for these purpose. The experimental campaigns took place both under real sun/sky conditions and within a laboratory called 'Sky Light Simulator'. This is an innovative ambient lighting facility achieved by Alenia Aeronautica (a leader Company in the aeronautical design, integration, testing and production) in 2006 **[see publication # 14]**, which is able to reproduce the photometric characteristics of daylight and sunlight (sun rear/forward), dusk/dawn transition and nightlight (starred moon/starred moonless sky) and which guarantees the constancy and repeatability of reference boundary conditions. It can house real aircraft hence allowing pilots to give subjective assessment of cockpit display visibility and readability
- development of mathematical routines and programs by using MatLab and/or Mathematica to automatically calculate, starting from the luminance images taken with the ILMD, any existing or new (user-defined) index to assess display legibility and readability
- correlation of analytical indices with subjective appraisals from pilots about the legibility of the displayed information.

The developed procedure and the findings which were obtained were presented at the international conferences LuxEuropa 2009 **[see publication # 19]** and CEAS 2011 (a conference in the aeronautical field) **[see publication # 33]**. In the former paper the procedure and first experimental results were presented, while the latter describes a procedure in MatLab which was developed to allow the determination of contrast indices under critical conditions (displays in sunlight): actually, the main problem in processing images taken in sunlight condition is that displays are partly in light and partly in shadows or present areas with a veiling luminance. As a result, target and background pixels tend to have similar luminance values and do not result clearly distinguishable from each others. This makes it difficult to correctly identify target and background pixels for contrast calculations. To overcome this problem, two series of measurements are taken: a first HDR luminance image is captured in controlled ambient lighting conditions for which the contrast can be easily and quickly calculated: this implies that luminance of the display targets and background are uniform over the target and background area and quite different for each other. An easy condition for this purpose is achieved when displays

are exposed to a dark lighting environment. Measurement is then repeated in actual day-time conditions (after removing the curtains): a second HDR luminance image is taken, paying attention to keep the lens in the same position so as to have a new image which is perfectly corresponding to the previous one. The program applies the target/background coordinates to the new image and couples them with day-time luminance data.
A paper to be submitted to an international journal is currently under preparation.

D. ANALYSIS OF LUMINOUS ENVIRONMENTAL QUALITY IN HEALTH CARE BUILDINGS

This research activity is focused on investigating the role played by the luminous environment on both the well-being (especially for patients) and the performance (for the nursing staff) in health care buildings. Moving from the concept "health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (World Health Organization, 1948), hospitals should be designed to be places for both "cure" from a medical point of view and "care" in terms of global user needs; in other words, a user-centered design approach should be pursued as much as possible. This implies to suitably design the different spaces used by patients and by the nursing staff based on Human Factors and Ergonomics methods, tools and concepts. Within this frame, the Italian Ministry of Health launched a research project titled "Technical, organizational and managerial principles to realize and manage high technology and service hospitals", which set the criteria for the 'third millennium hospital', intended as an user-centered and homely facility, a place for hope, recovery, care acceptance and serenity of mood (Italian Legislative Decree 502/1992, 1992).
Within this frame, a study consisting of a series of experimental field campaigns was carried out aimed at analyzing how the lighting conditions can actually influence user acceptance, comfort and performance of both patients and the nursing staff. A number of hospitals was investigated, both in Asti and in Turin, with different characteristics (construction year, lay-out, lighting characteristics – daylit room, rooms with electric lighting only - , utilization profiles and typologies of diseases being addressed). For each ward, both the "patients' area", with reference to the dwelling rooms and the common rooms, and the "medical area", with reference to rooms where the nursing staff manage patients' medical records and prepare medications, were analyzed. Measurements were carried out for both daytime and night-time conditions; daytime measurements were repeated in the same rooms in different times of the day (morning and afternoon), so as to account for different lighting boundary conditions, depending on external daylight conditions and settings of electric lighting and shading systems. The analysis was carried out in both objective terms (measuring the illuminances on working planes such as bed surfaces in patients' rooms, desk and VDT surfaces in receptions, diagnosis and analysis laboratories, and luminance distributions as perceived by users by using an Image Luminance Measuring Device) and in subjective terms: two different anonymous questionnaires were specifically developed for the two categories of users: patients and relatives and doctors, nurses and nursing aids. The subjective data provided by the different groups of users were analyzed by calculating mean values and the relative standard deviation and by comparing the mean values through Student's t-tests, analysis of variance (ANOVA) and Pearson's correlation coefficient and then compared to data from objective measurements.
The research was aimed at:

- assessing the lighting conditions within both the patients' area and the medical area in both objective and subjective terms
- comparing the objective data to the subjective appraisals expresses by users
- identifying critical conditions, in terms of non-compliance with standards (objective values) or low-acceptance for users, and then proposing some guide-lines and strategies to enhance the llglobal satisfaction and performance, in terms of typologies of lighting sources/luminaires, lay-out, control systems for both blinds, shading systems and luminaires.

The results obtained from this research activity were presented at a national conference on Ergonomics **[see publication # 23]**, with regard to the results in the first hospital which was analyzed. An extension of the work, including all the investigated health care buildings, was presented at the International Conference COBEE 2012, which took take place in Boulder, Colorado, USA, in August 2012. Furthermore, a paper was submitted to an international journal.

E. LIVINGSCAPE-BASED APPROACH TO ASSESS AND ENHANCE THE QUALITY OF URBAN SPACES

The topic of " quality of urban spaces" as important support to urban planning and management was carried out through the livingscape approach (urban blight, soundscape, lightscape, thermalscape, questionnaires) within the

historic district 'San Salvario' in Turin. To account for the multidimensional character of the urban quality in towns, an integrated analysis of three aspects was addressed, involving: 1) psychometric tools to measure the perception of environmental quality; 2) different aspects related to the urban blight (both in architectural and environmental terms); 3) objective investigations of environmental quality through the measurement of acoustic, visual, thermal and IAQ physical parameters. Subjective and objective data were collected in-the-field during summer 2010 and winter 2011, collecting 496 questionnaires (240 in summer and 256 in winter) along 13 key-spaces of the district (interviews carried out every 30 m) and measuring for the same points the physical quantities. The urban blight's survey was filled by some experts.
From a previous study carried out by the authors on a number of different historic sources (archival, cartographic, literary and documentary) from the 19th century onwards, 13 key-spaces (10 streets, 2 squares and an arcade) were selected as meaningful to characterize past and present district livingscape and then divided into nodes, paths and edges/borders based on Lynch's mental mapping approach. The key-spaces were subdivided into 30 m long parts: for every part, urban blight evaluations, environmental measurements and user judgments through questionnaires (soundscape, lightscape, thermalscape) were carried out to investigate the livingscape.
The measurements of the acoustical parameters were carried out through many soundwalks during the daytime (10a.m. – 2p.m.) and the nighttime (7 p.m. – 2 a.m.). To investigate the key-spaces, binaural audio signals (16 bit/44.1 kHz) were recorded with a portable two-channel device "M-Audio Microtrack 24/96" and with binaural headphones "Sennheiser MKE 2002". A total of 40 binaural recording files of 10-15 minutes and 40 punctual noise levels 10 minutes long were measured during summer and winter period, in the daytime and nighttime. The files were then uploaded to the elaboration software dBSonic to calculate the equivalent level Leq (dBA) and psychoacoustic parameter for each part. For the lightscape parameters horizontal, vertical and cylindrical illuminance levels and correlated color temperature (CCT) were measured every 60m using an illuminancemeter. The Sky View Factor (SVF), was determined the Ecotect software to measure the solid angle view of the sky from each considered point. Finally, air temperature, air velocity and relative humidity were collected every 60 meters to detect the thermalscape parameters. Photo and video acquisition was carried out in situ at the same time and used together with the GIS data and satellite images to construct realistic representations. For the urban blight investigation 46 statements were analyzed based on a 5-point scale (1-unpleasant to 5-extremely pleasant) and concerning livability and quality of life architectural and urban assessments, social life, physical environment, security, activities and utilities, place identity and site arrangement.
Environmental perception and well-being were delineated through the analysis of the questionnaires submitted to the users of the area in the same points of the in-field measurements (496 questionnaires were filled in).
This paper presents some results related to the livingscape analysis in an urban open public space, based on in-field surveys during Summer 2010 and Winter 2011. Starting from an historical previous study thirteen key-spaces were selected, which characterize past and present soundscape of the district. These spaces were then subdivided in nodes, paths and edges (or borders).
Thirteen factors were singled out from the factorial analysis on environmental data collected in situ based on 33 objective parameters related to the sound, light and thermal scape. The results which were obtained were used to define a list of priorities of interventions to improve the overall urban quality of the area.
The livingscape approach is intended to be a general approach which can replicable in other urban context to define the strategies based on objective measurements and on the perception expressed by the end-user of the considered area.
The large amount of results which were obtained was presented at a number of international conferences and journals **[see publication # 24-25-26-30-34]** and was published on the web-journal 'Journal of Temporal Design in architecture and the environment' **[see. publications 28-29]**.

6. Teaching Activities

The teaching activity of Valerio Lo Verso is carried out mainly for the Faculties of Architecture of the "Politecnico di Torino". Single contributions in terms of lectures and seminars are also given for the Faculties of Engineering and of Psychology. Furthermore, Valerio Lo Verso is part of the teacher board of the Research Doctorate in "Applied psychology and ergonomics", organized by the University of Turin.
Beside this, Valerio Lo Verso supervises a number of works of thesis (bachelor, master, PhD) and gives lectures and seminars for several post-degree masters.

COURSES WITHIN THE FACULTIES OF ARCHITECTURE OF THE "POLITECNICO DI TORINO"

Courses for bachelor degrees (junior degrees)

- Building Physics (in English)
  Academic year: 2011-12. Topics: basic design issues concerned with building energy certification, building energy demand for heating, air conditions and lighting, integration daylight - electric lighting, acoustics (sound insulation and sound reverberation), indoor environmental comfort for users.

- Building Physics (in Italian)
  Academic year: from 2000-01 to 2005-06 and from 2007-08 to 2010-11. Topics: same as for the above mentioned course "Building Physics" in English.

- Indoor environment science and physics (in Italian)
  Academic years: from 2001-02 to 2004/05. Topics: basic design concepts of lighting and acoustics.

- Principles, techniques and technologies for environment comfort (in Italian)
  Academic year: 2002/03. Topics: environmental comfort (thermal, visual and acoustical) and knowledge of systems (lighting, HVAC, photo-voltaic and solar systems) for both comfort and energy saving purposes.

Courses for master degrees

- Atelier "Design of sustainable buildings: indoor comfort and energy efficiency of systems" (in Italian)
  Academic year: 2011/12. Topics: advanced concepts and application to an architectural project of principles and technologies for indoor comfort (thermal, visual and acoustical) by the integration of sustainable and energy efficient systems (integration daylighting – electric lighting, HVAC, photo-voltaic and solar systems); application of different simulation software (Daysim, EcoTect, Dialux, Echo 4; Thermolog, Retscreen) to the design of a sustainable building and to calculate the building energy performance (energy certification).

- Laboratory "Urban planning and architectural project" (in Italian)
  Academic year: 2009-10 and 2010-11. Topics: definition of the site master-plan within an urban project (outdoor lighting, acoustical zoning, photovoltaic systems); definition of a sustainable building from both the indoor comfort and energy saving points of view (energy certification, integration lighting - electric lighting).

SUPERVISION OF WORKS OF THESIS (YEARS 2008 - TO DATE)

Over the last 10 years, Valerio Lo Verso has supervised over 50 works of both bachelor, master and Ph.D. thesis. In the following, a selection among the most recent works is reported. This list is intended to show the variety of topics which were addressed, mostly in cooperation with other researcher, professors and architects working in different departments. Through these works, the building physics and lighting expertise of Valerio Lo Verso was applied to different projects and application field related to the architectural design practice from an overall point of view. The final output was the result of an integrated work based on a cross-disciplinary approach.

Bachelor and master degrees (faculties of architecture)

YEAR 2008

- Bertino C. *Daylighting and energy saving: calculation methods and design criteria.*
- Calosso F. *Light pipes in architecture: performance characterization through physical measurement in scale models under a sun/sky simulator facility.*
- Fiore G. *A dynamic approach to daylighting design.*

YEAR 2009

- Barbieri G., Bertone E. *"Living the sustainability": a social-housing project in Turin.*
- Bevacqua C. *A high-rise building in the 'La Défense' area in Paris.*

- Di Fede G. *A glazed office building: energy savings and visual comfort.*
- Dujani C. *Energy certification and indoor environmental quality for an existing library: analysis of performances and proposal of new solutions.*

YEAR 2010
- Arrigo V., Tucci G. *Quality of the luminous environment and ergonomics in healthcare buildings.*
- Bianco G. *Sustainable and energetic requalification and retrofitting of an old rail-way station in Turin: transformation into a museum* (Faculty of Engineering).
- Bostica A. *An architecture as a "light experience": a project for the Velux International Award.*
- Campra E., Rosso E. *Designing a sustainable and eco-compatible hotel at Limone Piemonte (Italy).*
- Laurella M. *Lighting analyses for the new design of the façade of an existing building in Turin: verification of performances of a specifically designed shading system.*
- Lazzari S. *Heating and lighting related energy performance for a complex of residential buildings in Venaria (Turin).*
- Marangoni L. *A lighting, heating and conditioning study applied to an industrial buildings.*
- Mitrangolo F. *Designing office modules for modern industrial buildings: a study on the use of daylighting systems.*
- Pedrazzo M., Rostagno M. *The influence of lighting control system on the energy balance of a building: link between the LENI index and the global energy demand in winter and in summer.*
- Sosello D. *Passive house: a critical analysis of standards and performance characterization.*
- Porto Bonacci L. *Architecture and sustainability: retrofitting project of the Central Library of the Faculty of Engineering of Politecnico in Turin* (Faculty of Engineering).
- Tamburini C. *The project of a new library in Turin based on accessibility criteria and on a daylighting analysis.*
- Valenti S. *From passive houses to 'zero energy' buildings: guide lines and design strategies.*

YEAR 2011
- Anselmino C., Aurelio D. *Energetic performance of a real office building. Assessment of the energy demand for lighting, for heating and for cooling.*
- Brusati C., Chino S. *Lighting in healthcare buildings: an experimental analysis of performance and ergonomic aspects.*
- Camissassi V. *Sustainable design based on the LEED protocol: application to the lighting field.*
- Cavigliasso F. *Classes of sound and light quality based on objective/subjective soundscape and lightscape: a case-study in Turin.*
- Deda F. *Energetic requalification of existing buildings: two case-studies.*
- Demo G. *Shading system and their impact on daylighting availability and energy demand for lighting in office buildings.*
- Gervasone S. *The GIS tool to analyze and disseminate of livingscape data: a case-study in Turin.*
- Gillono A. *Project of refurbishment and energy certification for a sport hall in Quincinetto (Turin) .*
- Messina F. *A livingscape approach as tool to analyze urban historical areas: a case-study in Turin.*
- Mossetto A. *Energy certification of an existing building with different usages.*
- Polato A. *A modern industry: reflections and experimentations for an innovative concept.*
- Politi A. *Basic design of reflecting pools in modern industrial buildings.*

YEAR 2012
- Brunetti E. *Lighting design for historical cities: the case-study of Cirié (Turin).*
- Mandrile M. *Use of Fresnel grids to achieve a sound installation at San Salvario district (Turin).*
- Galfré P., Muratore E. *New school complex at Borgo San Dalmazzo, Cuneo (Italy)*
- Pera A. *Building-HVAC systems integration: renovation solutions for non residential buildings*
- Giovannini L. *Transparent envelope and energy performance in office buildings. Optimization criteria from the lighting viewpoint*
- Iennarella S. *Transparent envelope and energy performance in office buildings. Optimization criteria from the thermal viewpoint*
- Indaco I. *Health care buildings: solutions to improve the energy efficiency for lighting and of well-being of both patients and the nursing staff.*

PhD degrees
- Blaso L. *Lighting and control systems* (PhD. in "Technology Innovation", organized by the Politecnico di Torino), 2009

- Chiaraviglio L. *Assessment of discomfort glare in daylit rooms. Evaluation of different shading devices and comparison between measurement and simulations* (Ph.D. in "Technology Innovation", organized by the Politecnico di Torino), 2010
- Caffaro F. *My home is… Affective and functional aspects about the relation between individuals and their domestic environment: a qualitative/quantitative analysis* (PhD in "Applied psychology and ergonomics", organized by the University of Turin). Thesis to be defended in February 2012.
- Pochettino T. *Environmental-energetic assessment for existing health care buildings. Field measurements and definition of criteria and verification methodologies* (PhD. in "Technology Innovation", organized by the Politecnico di Torino). Thesis to be defended in February 2012.

LECTURES AND COURSES FOR POST-DEGREE MASTERS PROFESSIONALS

- post-degree Master in "Sustainable Architecture" (in English), organized by the European Institute of Design IED and coordinated by the architect Mario Cucinella (MCA studio). Topic: daylighting; physical simulation by using scale models and sun/sky simulator facilities. Further activities: supervision of some Master final theses
- post-degree Master in "Lighting Design", organized by the University "La Sapienza" in Rome. Topic: daylighting; integration daylighting – electric lighting, physical simulation by using scale models and sun/sky simulator facilities, numerical simulations (Radiance, Daysim), visual comfort, shading and control systems
- post-degree Master in "Management of cultural heritage", organized by COREP, a dedicated consortium in Turin. Topic: visual comfort, daylighting
- post-degree Master in "Engineering of safety and risk analysis", organized by COREP, a dedicated consortium in Turin. Topic: visual comfort, daylighting
- post-degree Master in "Ergonomics", organized by COREP, a dedicated consortium in Turin. Topic: visual comfort, daylighting.

7. Publications

PAPERS PUBLISCHED ON JOURNALS OR CONFERENCE PROCEEDINGS

1. *La valutazione dell'abbagliamento molesto negli ambienti confinati: analisi critica delle procedure esistenti (Assessment of discomfort glare in electrically lighted indoor environments: critical analysis of existing procedures)*, proceedings of National Conference AIDI (Italian Lighting Association) "lighting towns", Cagliari, Italy, October 15-16, 1998, pp. 2-15 (in Italian, with C. Aghemo, A. Pellegrino)
2. *La progettazione dell'illuminazione naturale mediante cieli artificiali: rassegna delle strutture esistenti (Daylighting design by use of artificial skies: overview of existing facilities)*, proceedings of National Conference AIDI (Italian Lighting Association) "Culture and technology of light", Genoa, Italy, November 25-26, 1999, pp.72-85 (in Italian, with A. Pellegrino)
3. *A Research Center for electric lighting and daylighting design*, Luce, number 2, March 2000, pages 76-92 (with M. Filippi, C. Aghemo, A. Pellegrino)
4. *Progetto di un cielo artificiale a luminanza variabile: equazioni relative ai diversi modelli di cielo (Design of a sky scanning simulator, luminance dimmable: different sky models' equations)*, proceedings of National Conference CODEA (National Coordination Ph.D. students in Energy and Environment fields), Matera, Italy, September 20-21, 2000, Politecnico di Torino Internal Publication n° PT DE 555/FT (in Italian)
5. *Realisation and testing of a portioned dome artificial sky*, proceedings of VII International Conference Clima 2000, Naples, Italy, September 15-18, 2001 (with M. Filippi, C. Aghemo, A. Pellegrino)
6. *Daylighting design by use of an artificial sky*, proceedings of XII International Conference Light 2001, Strabske Pleso, Slovak Republic, October 10-12, 2001 (with M. Filippi, C. Aghemo, A. Pellegrino)
7. *La progettazione della luce naturale in cielo artificiale: possibilità e prospettive di utilizzo (Daylighting design through an artificial sun and sky facility: potentials and use perspectives)*, proceedings of National Conference AIDI (Italian Lighting Association), Perugia, Italy, December 4-6, 2001, pp. 1-5 (in Italian, with C. Aghemo, A. Pellegrino)

8. *Scale models under an artificial sky as tool for daylighting design: possible applications*, proceedings of International Conference "CIE International Light & Lighting 2002", Bucharest, Romania, November 28-30, 2002 (with C. Aghemo, A. Pellegrino)
9. *La progettazione della luce naturale mediante l'uso di modelli in scala in cielo artificiale: esempi di applicazioni (Daylighting design thorugh an artificial sun and sky facility: example of applications)*, proceedings of International Conference AIDI (Italian Lighting Association) "Light as innovation", Perugia, Italy, December 3-5, 2002 (in Iatlian, with C. Aghemo, A. Pellegrino)
10. *The project of daylighting systems using an artificial sky*, Frames n. 108, pages 40-45, February-March 2004 (with C. Aghemo, M. Filippi, A. Pellegrino)
11. *Daylight as a design element for indoor environments*, Frames n. 109, pages 20-25, April-May 2004 (with C. Aghemo)
12. *Daylighting design by means of a scanning sky simulator: applications to different typologies of daylighting systems*, proceedings of International Conference EuroSun 2004, Freiburg, Germany, June 20-23, 2004, pp. 2-312 – 2-322, paper n° 768 (with C. Aghemo, A. Pellegrino)
13. *Daylighting simulations in sky scanning simulators: applications to buildings with repetitive bays*, proceedings of International Conference IESNA (Illuminating Engineers Society of North America), Tampa, Florida – USA, July 25-28, 2004 (with A. Pellegrino); with referee
14. *A skylight simulator for assessing cockpit display and ambient visibility for day time and night time conditions*, proceedings of the CIE International Conference, 26th edition, Beijing, China, July 4-11, 2007 (with C. Aghemo, A. Pellegrino, M. Fabbri, A. Russo), publication CIE # 178:2007, ISBN: 978 3 901 906 59 6
15. *A 3-step sequence for early daylight design*, proceedings of the CISBAT 2007 International Conference, Lausanne, Switzerland, September 4-5, 2007 (with C.F. Reinhart)
16. *Daylight 1-2-3: a text guide and software as integrated tools for initial daylight/energy design*, proceedings of the CISBAT 2007 International Conference, Lausanne, Switzerland, September 4-5, 2007 (with C.F. Reinhart, D. Bourgeois, F. Dubrous, A. Laouadi, P. Lopez, O. Stelescu)
17. *The approach to daylighting by scale models and sun and sky simulators: a case study for different shading systems*, Building and Environment, BAE1907, Vol 43/5 pp 917-927, DOI information: 10.1016/j.buildenv.2007.01.020 (with C. Aghemo, A. Pellegrino)
18. *Characterization of light pipe performances through a sun/sky simulator and a software based approach*, the 4th Conference CIE (Commission Internationale de l'Eclairage) BalkanLight 2008 and the 17th International Symposium Lighting Engineering 2008, Ljubljana (Slovenia), October 7-10, 2008, Lighting Engineering Society of Slovenia, pp. 323-332, ISBN 978-961-248-127-8 (with A. Pellegrino, V. Serra)
19. *Evaluation of display legibility through luminance mapping: an application to aircraft cockpits*, 11th European Lighting Conference "Lux Europa 2009", Istanbul (Turkey), September 9-11, 2009, Turkish National Committee on Illumination (ATMK), pp. 197-206, ISBN 978-975-561-352-9 (with C. Aghemo, A. Pellegrino, C. Petrigni, L. Rossi)
20. *A Rules of Thumb Based Design Sequence for Diffuse Daylighting*, Lighting Research & Technology, v. 42, n° 1, pp. 7-26, ISSN: 1477-1535, first published on January 5, 2010 as doi:10.1177/1477153509104765 (with C. Reinhart)
21. *Validation of the Lynes mean daylight factor formula and the of the daylight feasibility study in toplit spaces*. Proceedings of the International Conference CIE "Lighting quality and Energy efficiency", Vienna, March 14-17, 2010 (with C. Reinhart)
22. *The energy demand for electric lighting as a consequence of different architectural building features and lighting plant characteristics.*. Proceedings of the International Conference CIE "Lighting quality and Energy efficiency", Vienna, March 14-17, 2010, pp. 695-703 (with A. Pellegrino)
23. *Qualità ambientale in ambito ospedaliero (Environmental quality in healthcare buildings)* IX Congresso Nazionale SIE (Italian Society of Ergonomics) "Ergonomia: valore sociale e sostenibilità", Rome, October 27–29, 2010 (in Italian, with C. Aghemo, C. Petrigni, F. Caffaro, V. Arrigo, G. Tucci)
24. *Il livingscape come strumento per riqualificare gli spazi urbani delle città storiche (Livingscape as a tool for qualifying urban spaces in historical cities).* In: AIA 2011 38° Convegno Nazionale dell'Associazione Italiana di Acustica (National Italian Association on Acoustics), Rimini (Italy), June 8-10, 2011, pp. 1-8 (in Italian, with F. La Malva, A. Astolfi, P. Bottalico, F. Bronuzzi)
25. *Sistemi informativi spaziali per implementare la tutela, valorizzazione, progettazione e divulgazione del soundscape in ambiente storico-urbano: Torino negli ultimi 150 anni (Spatial informative systems to implement the protection, valorization, project and dissemination of soundscape in historical-urban contexts).* In: AIA 2011 38° Convegno Nazionale dell'Associazione Italiana di Acustica (National Italian Association on Acoustics), Rimini (Italy), June 8-10, 2011, pp. 1-8 (in Italian, with F. La Malva, A. Astolfi, P. Bottalico, A. Lingua)

26. *City's quality of life based on livingscape approach (urban blight, soundscape, light-scape, thermic-scape, subjective replies of users) to improve an urban historical place*. In: Forum Acusticum 2011, Aalborg, Denmark, June 26 – July 1st, 2011, pp. 2031-2036 (with F. La Malva, A. Astolfi, P. Bottalico) -
27. *Climate-based metrics for daylighting and impact of building architectural features on daylight availability*. Proceedings of the 27th CIE Quadrennial Session, Sun City, South Africa, July 10-15, 2011 (with A. Pellegrino, C. Aghemo, S. Cammarano)
28. *Livingscape approach to improve urban historical places*. In: Journal of Temporal Design in architecture and the environment (web journal) 11(1): 20-24, available on-line at: http://www.jtdweb.org/ (with F. La Malva, A. Astolfi, P. Bottalico, F. Bronuzzi)
29. *Livingscape multi-sensory experience in urban historical places: subjective assessment from the local people and quality of the urban environment*. In: Journal of Temporal Design in architecture and the environment (web journal) 11(1): 25-29, available on-line at: http://www.jtdweb.org/ (with F. La Malva, A. Astolfi, P. Bottalico, F. Bronuzzi)
30. *Multi-sensory experience in urban historical places*. In: 10th International Congress on Noise as a Public Health Problem (ICBEN 2011), London, July 24 - 28, pp. 938-944 (with F. La Malva, A. Astolfi, P. Bottalico, F. Bronuzzi)
31. *Light transmission efficiency of daylight guidance systems: An assessment approach based on simulations and measurements in a sun/sky simulator*. Solar Energy 85 (2011) 2789-2801, doi:10.1016/j.solener.2011.08.017 (with A. Pellegrino, V. Serra)
32. *Limits and potentials of different daylighting design approaches based on dynamic simulations*. Proceedings of the CISBAT International Conference, Lausanne, Switzerland, September 14-16, 2011 (with A. Pellegrino, S. Cammarano)
33. *Luminance image analysis for display visibility in cockpits*. Proceedings of the 3rd CEAS 2011 Air&Space International Conference and 21st AIDAA Congress, Venice, Italy, October 24-28, 2011 (with C. Aghemo, A. Pellegrino, A. Fossella)
34. *Livingscape approach to characterize urban historical places*. In: 162nd Meeting of the Acoustical Society of America, San Diego, California, USA, October 31st – November 4, 2011, p. 2531. (with F. La Malva, A. Astolfi, P. Bottalico)
35. *Prediction of energy demand for lighting in buildings with different architectural features*. Proceedings of the '2nd Conference on Building Energy and Environment COBEE2012', editors: Zhiqiang (John) Zhai, Xiangli Li, Haidong Wang, August 1-4, 2012, Boulder, Colorado, USA, pp. 152- 159 (with C. Aghemo, A. Pellegrino, F. Pellerey)
36. *Environmental quality for comfort and performance in healthcare buildings: a lighting experimental study and simulations*. Proceedings of the '2nd Conference on Building Energy and Environment COBEE2012', editors: Zhiqiang (John) Zhai, Xiangli Li, Haidong Wang, August 1-4, 2012, Boulder, Colorado, USA, pp. 497- 504 (with C. Aghemo, F. Caffaro)
37. *Increasing energy efficiency in existing public buildings through the implementation of a Building Management System based on interoperable networks*. Proceedings of the '2nd Conference on Building Energy and Environment COBEE2012', editors: Zhiqiang (John) Zhai, Xiangli Li, Haidong Wang, August 1-4, 2012, Boulder, Colorado, USA, pp. 929- 936 (with A. Acquaviva, L. Blaso, D. Dalmasso, A. Osello, E. Patti, A. Pellegrino, P. Piumatti)
38. *From historical buildings to smart buildings via middleware and interoperability*. Proceedings of the '14th International Conference on Computing in Civil and Building Engineering (ICCCBE 2012)', editors: Valery Telichenko, Andrey Volkov, Irina Bilchuk, June 27-29, 2012, Moscow, Russia, pp. 1-8 (with A. Acquaviva, L. Blaso, D. Dalmasso, M. Del Giudice, G. Fracastoro, E. Macii, A. Osello, A. Pace, E. Patti, A. Pellegrino, P. Piumatti)
39. *Energy consumption management using CAFM and BIM*. Proceeding of the international conference 'Le vie dei Mercanti - X Forum Internazionale di Studi'. May 31 - June 2, 2012, Aversa-Capri, (Italy), Editor: La Scuola di Pitagora editrice, Napoli, pp. 213- 222 (with A. Acquaviva, L. Blaso, D. Dalmasso, M. Del Giudice, G. Fracastoro, E. Macii, A. Osello, E. Patti, A. Pellegrino, P. Piumatti).

BOOKS AND HANDBOOKS

40. *Daylighting design handbook* (in Italian), a daylighting handbook for designers written for the Italian Lighting Association AIDI, Toriazzi Editore, Parma, January 2003 (with C. Aghemo)

BOOKS CHAPTERS

41. *Environmental comfort in university classrooms – thermal, acoustic, visual and IAQ aspects*, edited by: J. Carmeliet, H. Hens & G. Vermeir; published by: Taylor & Francis/Balkema, ISBN: 90-5809-565-7, AK Leiden (The Nederland) 2003; pp. 945-955 (with A. Astolfi, S.P. Corgnati); with referee

42. *Experimental assessment of environment performance of different typologies of light pipes*, edited by: P. Fazio, H. Ge, J. Rao, G. Desmarais; published by: Taylor & Francis/Balkema, ISBN 10: 0-415-41675-2, ISBN 13: 978-0-415-41675-7, AK Leiden (The Nederland) 2006; pp. 809-817 (with C. Aghemo, V. Serra); with referee
43. Sections "*Natural light sources: basis for design*", "*Daylight control system: transparent and shading component*", "*Daylight guidance systems*", "*Calculation and simulation tools for daylighting design*" (in Italian) as part of the book "Lighting handbook" (curator: Marco Frascarolo), Mancosu Editore, Architectural Book and Review, Rome, ISBN: 978-88-96589-03-8.

8. Publications in progress

PAPERS ON INTERNATIONAL JOURNALS

- *Validation of the Lynes mean daylight factor formula and the of the daylight feasibility study in toplit spaces*. Extended paper describing the work presented at the International Conference CIE (see publication # 21), under revision for submission to "Lighting, Research & Technology" (with C. Reinhart).

BOOKS CHAPTERS

- Section "*Sky simulators*" within the upcoming CIE publication "CIE Standard General Sky Guide", final report of the CIE TC 3-51, in press
- Chapter "*Daylighting systems for sustainable indoor lighting*" as part of the book "Sustainable indoor lighting", due out in early 2012 by the publisher Springer.

PAPERS IN CONFERENCE PROCEEDINGS

- *An experimental and numerical analysis of daylighting performance for an office building*. Proceedings of the international conference 'Improving Energy Efficiency in Commercial Buildings (IEECB 2012)' April 18-19, 2012, Frankfurt, Germany (with G. Nardini, M. Paroncini).

9. Foreign languages

- *English* very good knowledge of both oral and written language.
  Certificate "FCE" (First Certificate of English)

- *French* very good knowledge of both oral and written language.
  Certificate "Alliance" at "Centre Culturel Français" in Turin

10. Computer skills

CAD programs: AutoCAD® (all versions); Sketch-Up. Basic concepts of Rhyno.
Vocational training certificate as CAD designer (level: specialization)

Lighting software: Radiance, Daysim, Spot, Windows, Lightscape®, DiaLux, Relux, Daylight 1-2-3, EcoTect®.

Turin (Italy), November 15th, 2012

Valerio Roberto Maria Lo Verso

Valerio Robert Maria Lo Verme