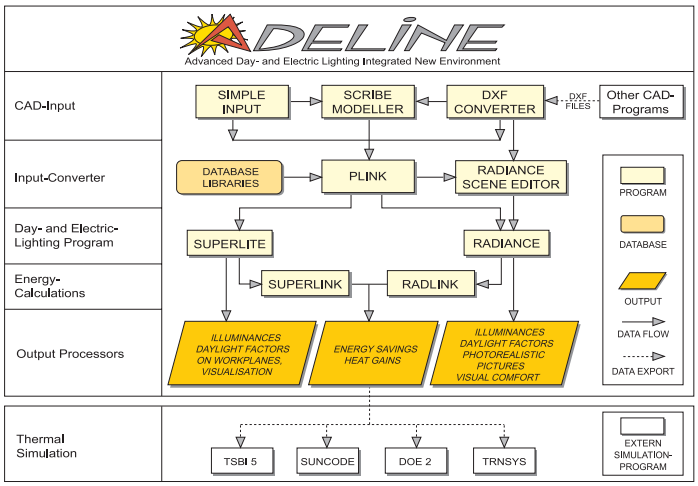
Results of Subtask C "Daylighting Design Tools"

A Report of
IEA SHC TASK 21 / IEA ECBCS ANNEX 29: Daylight in Buildings
December 1999



INTERNATIONAL ENERGY AGENCY
Solar Heating & Cooling Programme

International Energy Agency

Energy Conservation in Buildings and Community Systems Programme

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Fraunhofer-Institut für Bauphysik
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International Energy Agency (IEA)
Solar Heating and Cooling Programme Task 21
Energy Conservation in Buildings and Community Systems Programme Annex 29:

DAYLIGHT IN BUILDINGS

Fraunhofer Institut Bauphysik

edited by Jan de Boer & Hans Erhorn
Fraunhofer Institute for Building Physics
Nobelstraße 12
70569 Stuttgart
Germany

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PREFACE

The main objectives of the IEA Solar Heating and Cooling Programme (SHC) Task 21 and the Energy Conservation in Buildings and Community Systems Programme (ECBCS) Annex 29 "Daylight in Buildings" are to advance daylighting technologies and to promote daylight conscious building design. Task 21 continues until December 1999, and will endeavour to overcome the barriers that are impending the appropriate integration of daylighting aspects in building design. The participants in this task are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom and the United States. Denmark is the Operating Agent.

The objective of Subtask C "Daylighting Design Tools" of Task 21 is to improve the capability, accuracy and ease-of-use of daylighting design and analysis tools for building design practitioners, covering all phases of the design process. The practitioners will be able to predict the performance of different daylighting systems and control strategies and to evaluate the impact of the integration of daylighting in the overall building energy concept by using these design tools. Subtask C is divided into 5 Subgroups:

C1: Validation
C2: New Daylight Algorithms
C3: Integrated Systems
C4: Simple Design Tools
C5: ADELINE 3.0.

EXECUTIVE SUMMARY

The document presents work conducted as part of Subtask C, ''Daylighting Design Tools“, Subgroup C4, ''Simple Design Tools“, of the IEA SHC Task 21 and the ECBCS Program Annex 29 ''Daylight in Buildings“.

In addition, to further developing and promoting powerful daylighting design tools, a major focus of Subtask C was on simple design tools. Complex simulations are often not appropiate to outline basic daylighting strategies in early design stages and to solve simple, frequently occuring problems (e.g. the sunshine duration at considered spots or a general decision about the type of rooflights to select), because it takes too much time to use them, i.e., they are not cost-efficient. This survey rather reviews a cross-section of various types of simple daylighting design tools and their different applicatons. This survey covers tools based on analytical solutions, tables, nomograms, diagrams, so- called protractors, simple computer tools, typological studies, as well as scale models. These tools provide support at various stages of the design process helping to determine the impact of the design on natural lighting conditions: building site and building layout planning (i.e. sunshine duration at considered spots, shadow and reflection analysis), typological support for the selection of a daylighting strategy, determination of the type and size of daylight openings and the corresponding daylight factors for differently daylit rooms, as well als energetic aspects of lighting design.

Besides a number of basic and already well-known tools, a couple of new design tools developed recently by institutes participating in the Task are included. To allow for problem-sensitive selection, the survey includes a table to characterize the reviewed tools.

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1. Introduction

For the design of energy efficient buildings, it is essential that professionals have access to tools that can simulate their complex and dynamic behaviour under realistic conditions of use and operation. Until now, daylighting design and prediction of light distribution in building spaces has often been based on intuition. The extreme complexity of the problems to be solved sometimes leads architects to rely on the great adaptability of artificial lighting and to design buildings as if natural lighting did not even exist. Design tools in the early stage of the design process will not only improve the lighting performance of buildings, but will also lead to better architecture and the realisation of energy savings.

The objective of Subtask C is to improve the capability, accuracy and ease-of-use of selected daylighting design and analysis tools for building design practitioners. By using these design tools the practitioners will be able to predict the performance of different daylighting systems and control strategies, and to evaluate the impact of the integration of daylighting in the overall building energy concept.

The work within the frame of Subtask C "Daylight Design Tools" of IEA Task 21/Annex29 "Daylight in Buildings“ comprehends both simple and complex daylighting design tools. A survey presents different graphical, analytical and simple computer-aided procedures to be used in the early design phase. Various algorithms for lighting calculations (among others for raytracing and radiosity methods) are made available on a Web page in the form of symbolic programming language. To evaluate the thermal influence of atria on adjacent office spaces, a new simple design tool has been developed that allows for an integral determination of the energy consumption (illumination, heating, cooling) as a function of selected lighting parameters. A simple and intuitively applicable design tool called LESO-DIAL was developed within the frame of Task 21 by Switzerland and is available in both English and German. Furthermore, the work of the Subtask focussed on the advancement of the lighting calculation program ADELINE. In an extensive validation study, four different simulation programs were compared with both measurements and with each other by means of standardized test data sets. The work of Subtask C was divided into five working groups:

- validation
- daylighting algorithms
- integrated systems
- simple design tools
- ADELINE.

2. SIMPLE DESIGN TOOLS

TYPE	SUBJECT								TOOL
	Daylight Factor for Sidelit Rooms	Daylight Factor for Rooflit Rooms	Window Design	Rooflight Design	Atria Design	Energetic Behaviour / Daylight Autonomy	Shadow and Reflection Analysis / Sunshine Duration	Visual Comfort	
1. Formulae		■		■					2.1.1
	■	■	■	■					2.1.2
2. Tables	■		■						2.2.1
		■		■					2.2.2
3. Nomograms	■	■	■	■	■				2.3.1
	■				■				2.3.2
4. Diagrams	■	■	■	■		■	■	■	2.4.1
	■		■						2.4.2
						■			2.4.3
						■			2.4.4
5. Protractors	■	■	■	■					2.5.1
6. Computer Tools	■	■	■	■		■	■		2.6.1
							■		2.6.2
							■		2.6.3
						■			2.6.4
	■	■	■	■		■			2.6.5
7. Typology	■	■	■	■			■	■	2.7.1
8. Scale Models	■	■	■	■	■		■	■	2.8.1

Figure 1: Survey on simple design tools.

2.1 Survey of simple design tools

Based on questionnaires distributed in the participating countries, a cross-section of both different types of tools such as simple analytical procedures, tables, diagrams, nomograms, and of different ranges of application was set up (Figure 1). The tools used in the early design phase provide support for shadow and reflection analyses, design of the type and size of windows and roof-lights, and the evaluation of the thermal and energetical behaviour. The survey gives a short description of the different procedures and their range of application, as depicted in Figure 2.

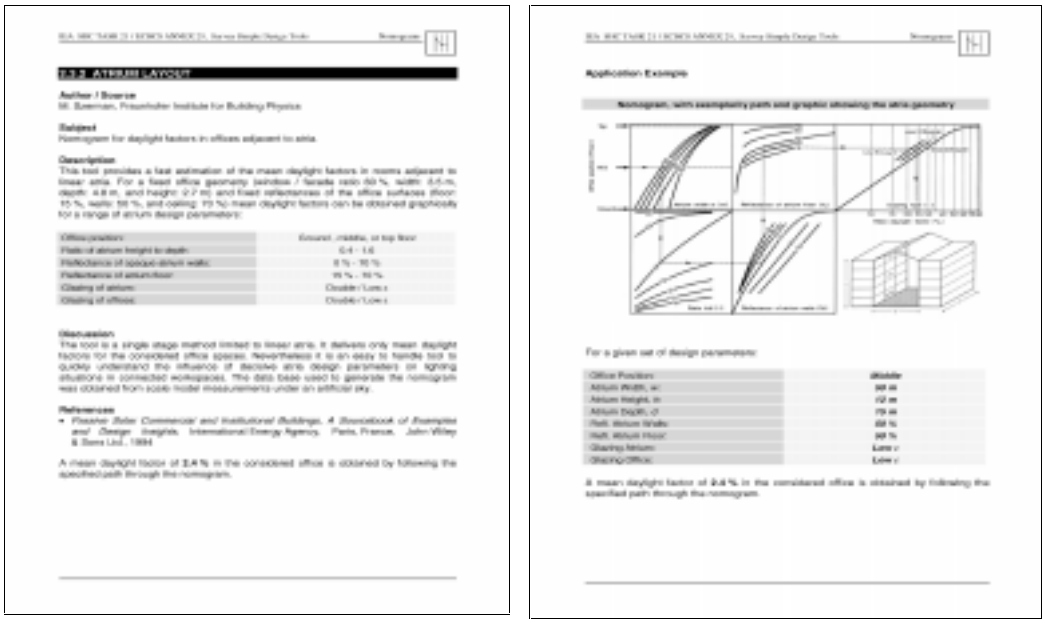

Figure 2: Example of a simple tool used to determine the mean daylight factor in office spaces adjacent to atria.

2.2 Simple tool to determine the energy consumption of office spaces adjacent to atria

Atria are becoming more and more popular. To determine quickly and easily the impact of lighting design parameters on the energy consumption of office spaces adjacent to atria, graphical design tools were created, based on a parameter study that was carried out with the simulation tools ADELINE and DOE 2. The design tools were created for Swiss and German locations. The lighting energy consumption dependent on a lighting index, which is a function of the parameters influencing the lighting energy of a building, is shown in Figure 3.

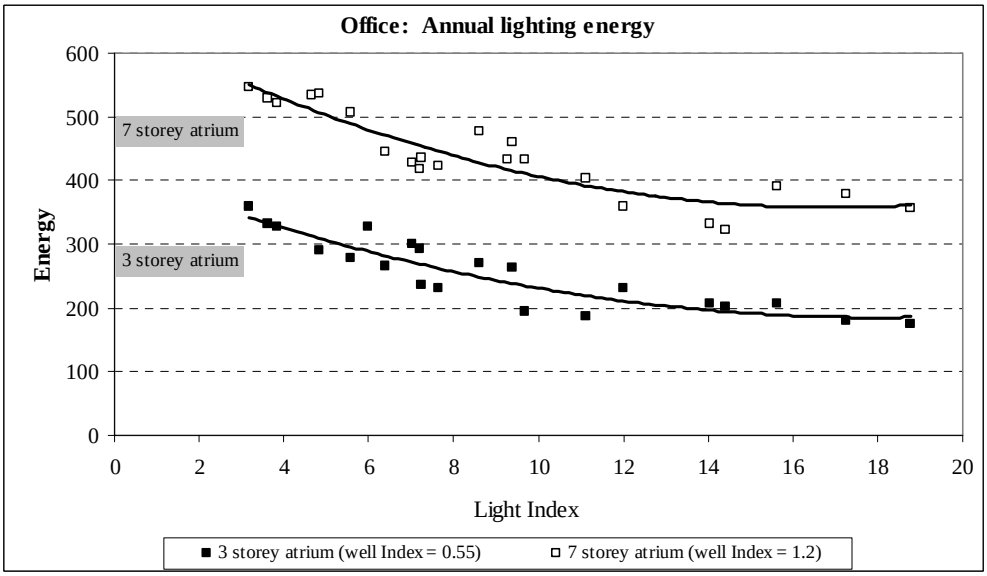

Figure 3: Diagram to determine the annual lighting energy consumption as a function of a light index for the location Würzburg for 2 atria with different heights. The light index is the product of the atria's skylight transmission and size, their effective reflectance and the adjacent office windows' transmission and size.

2.3 Intuitively applicable lighting simulation software LESO-DIAL

In the development of lighting calculation tools the early design phase is increasingly taken into account. During this design phase essential and often irreversible decisions regarding the natural lighting of a building are made. Moreover, in this phase the architect often still works and decides alone, without advice of any other design expert. The new software LESO-DIAL developed in Switzerland allows also non-specialists in lighting engineering to carry out easily and reliably lighting calculations by means of a qualitative description procedure of the relevant input data. Parameters and expert terms most often used only by design specialists can, but do not have to be used as input data. The output provides standard design values, such as daylight factors, illuminance values, etc., for various room geometries. However, the user is not left only with the results he or she gained from these calculations. Based on a set of expert rules (using fuzzy logic) the results are interpreted

and recommendations on how to improve the lighting situation are suggested. Figure 4 shows some self-explaining examples of input and output dialogs.

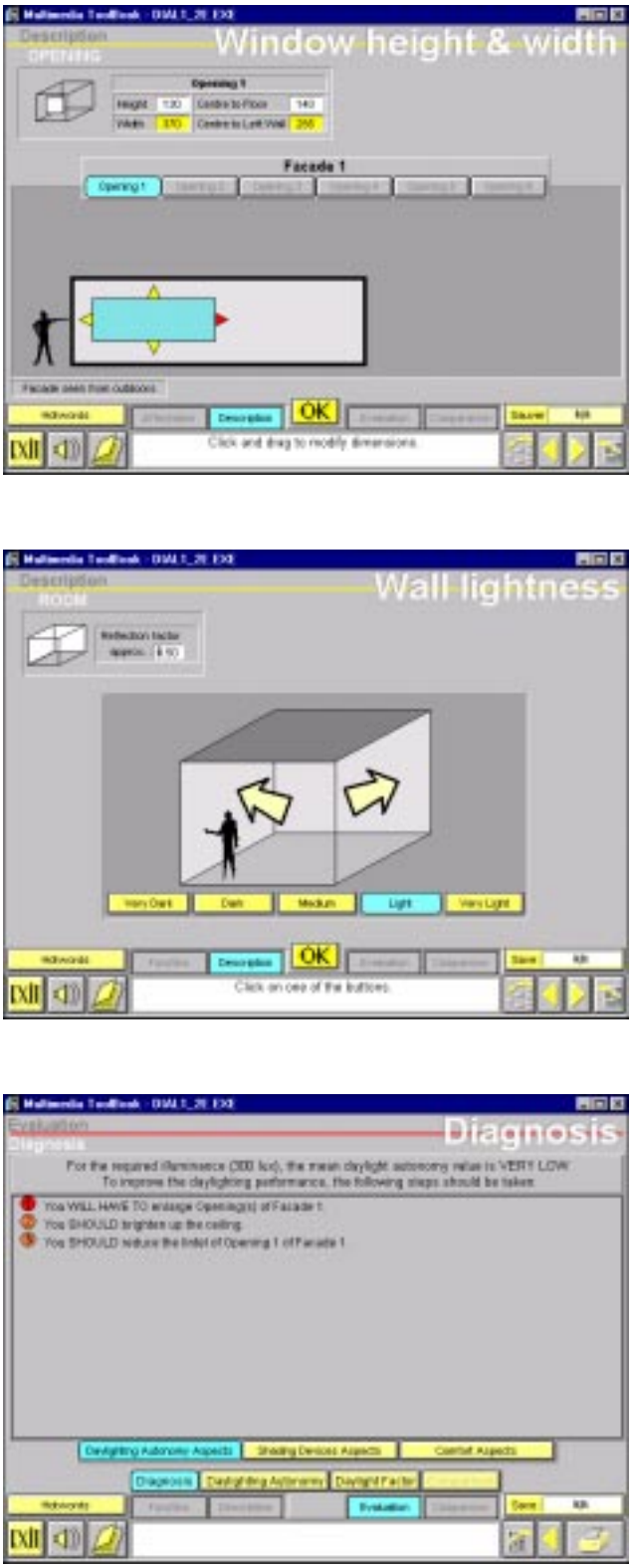

Figure 4: LESO-DIAL: Intuitively applicable design tool for the early design phase.

3. COMPLEX DESIGN TOOL - ADELINE

Within the scope of Task 21 the daylighting system ADELINE was to be further developed. In the early phase of the task, the possible use of an integrated system concept as framework for daylighting design tools in general, and a specific application to the ADELINE program in particular, were examined.

3.1 Integrated Systems

The goal was to establish a link between integrated building design tools (COMBINE, EDA), selected daylighting design tools (ADELINE) and thermal simulation tools (powerDOE, Energy 10, etc.) in order to improve the design process. One of the main obstacles for practical use of advanced computer models for building analysis, such as analysis of thermal or daylight performance, is the work required to provide input data for the models. However, much of the input data used by different computer models are similar and therefore could be used for several applications. However, in order to use data, the different computer models need to have a common view of data, i.e. they must use a common building data model. A collection of computer applications based on a common data model is called an Integrated System.

A suitable data model and a format for data exchange between computer models is declared in the ISO standard 10303 - STEP, Standard for the Exchange of Product Model Data (ISO, 1993 and Fowler 1995). Specific parts of this standard are still under development, but fundamental parts have been a standard since 1994.

However, the STEP standard relevant for the building industry is still more or less missing. Therefore, the Industry Alliance for Interoperability (IAI) was formed. The scope of IAI is to develop a data model - called Industry Foundation Classes (IFC) – to be used by interoperable software systems, and to provide implementation of the IFC. It is intended to provide a fast approach to future generations of software for the Building Industry. The IFC is based on the STEP standard, and is partly including the STEP models.

In order to establish an integrated system of daylighting design tools there must be a common data model as framework. The most promising existing data model to apply is the IFC model. However, this model is under development, and recently a stable IFC model, version 1.5, has been released. This model has a rich geometry but no daylight aspects.

There exist no integrated systems for the building sector in use today. Only BDA is to be released in the near future, but this system is not STEP based, and cannot be used without major changes in conjunction with the IFC data

model. The toolkits used to create integrated systems are available. Most of them are based on file exchange between the applications.

As the IFC data model has been released very late and still needs to be extended with a daylight model, time is too short to establish an integrated system for daylighting within the scope of Task 21.

3.2 ADELINE

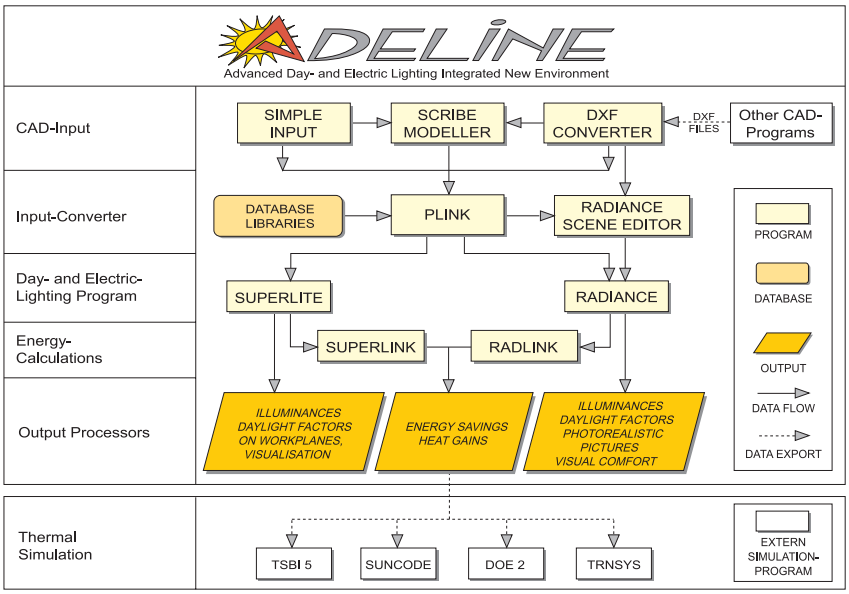

Figure 5: ADELINE 3 Program System.

The existing software ADELINE was mainly improved with regard to applicability and program integration. Within the international research project numerous work packages were developed, which have been integrated into a new program version 3 (Figure 5), available as from fall of 1999:

- The complete program system including RADIANCE is available as ported 32-bit program for Windows NT/95.

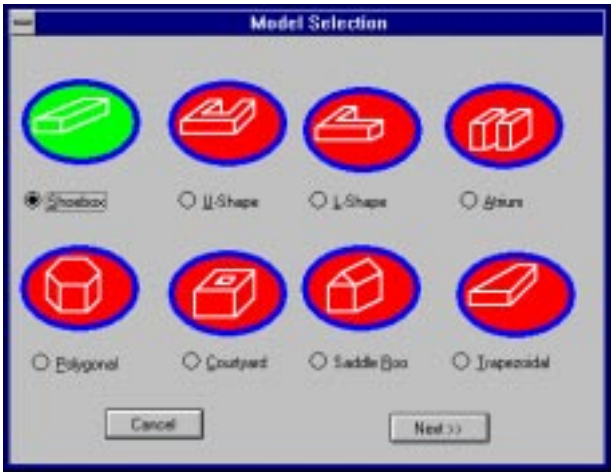

Figure 6: Parametrically definable basic geometries of the ADELINE program.

- The program system was supplemented with a comprehensive "Simple Input". Starting from the simple "shoebox" case, i.e. a room with rectangular ground floor plan, other basic geometries, general polygonal rooms and simple atria are offered for parametric description (Figure 6). Thus, it is no longer required to use a CAD tool to define numerous geometries. The program module automatically inquires for other relevant simulation parameters. With this, the required modeling effort could be significantly reduced. Input time of less than 10 minutes is possible. The "Simple Input" is integrated into the software package such that all modules of the ADELINE output can be used as well. The parametrically defined models can be used within the environment as starting point for complex models.
- In the previous integration of the RADIANCE program into the ADELINE environment, composing individual scenes of existing objects as well as the definition of viewpoints within scenes was possible only numerically. With the RADIANCE SCENE EDITOR (Figure 7) a graphically interactive composition of scenes is now possible in Wire Frame representation with integrated Hidden Line Removal. Objects can be translated, rotated and scaled freely by using the mouse. Material, luminaire and furniture data bases ensure a quick composition of detailed scenes.

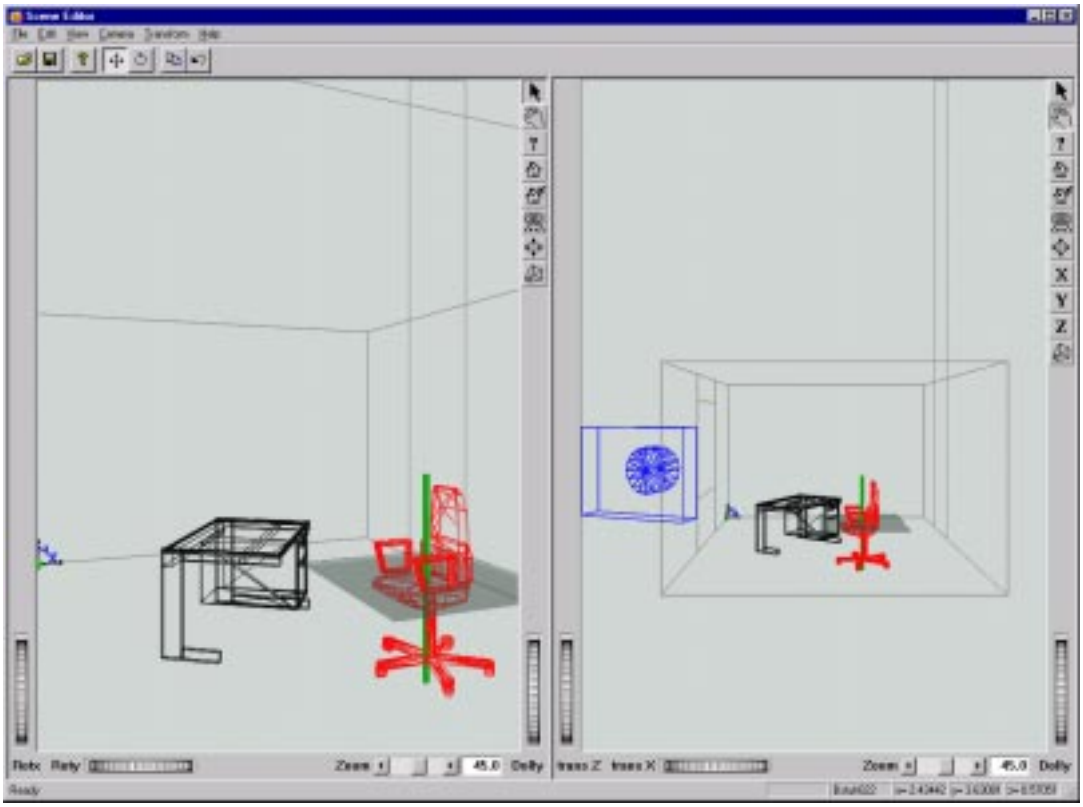

Figure 7: Wire Frame presentation of Radiance Scene Editor.

- With regard to the integrated systems approach, only one model, as well as one software, should be used for both daylighting and artificial (electrical) lighting design. Radiance and Superlite allow the calculation

of both daylighting and electrical lighting using only one model. The calculation of both is shown in Figure 8. The luminaire data base integrated in ADELINE is depicted in Figure 9.

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Figure 8: Combined daylight and artificial lighting calculation carried out with RADIANCE.

- Numerous other new dialogs and output procedures have been included into the ADELINE program system. As already possible with Superlite, it is now possible with Radiance, too, to freely define and place virtual work surfaces for which illuminances and daylight factors can be calculated.

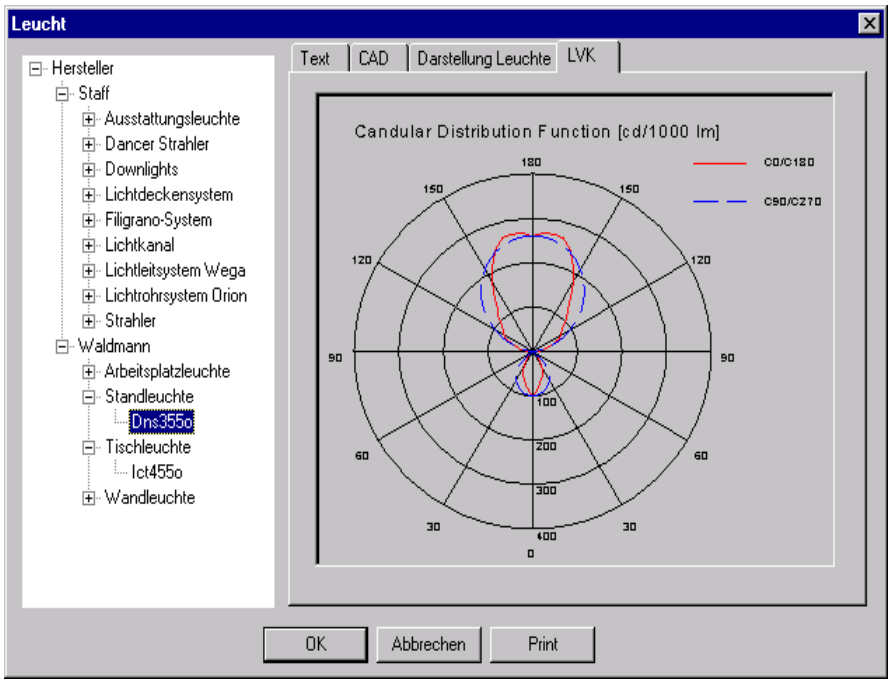


Figure 9: Dialog to use the luminaire data base.

- The interface between the daylight simulation programs and advanced CAD tools currently uses the DXF format which can be created by a wide range of different CAD programs. Figure 10 shows a wire frame representation of a simple hall that has been visualized and analysed for lighting engineering aspects. Some lighting calculation programs (such as Desktop Radiance, Siview) offer direct extensions to programs such as AutoCad for example.

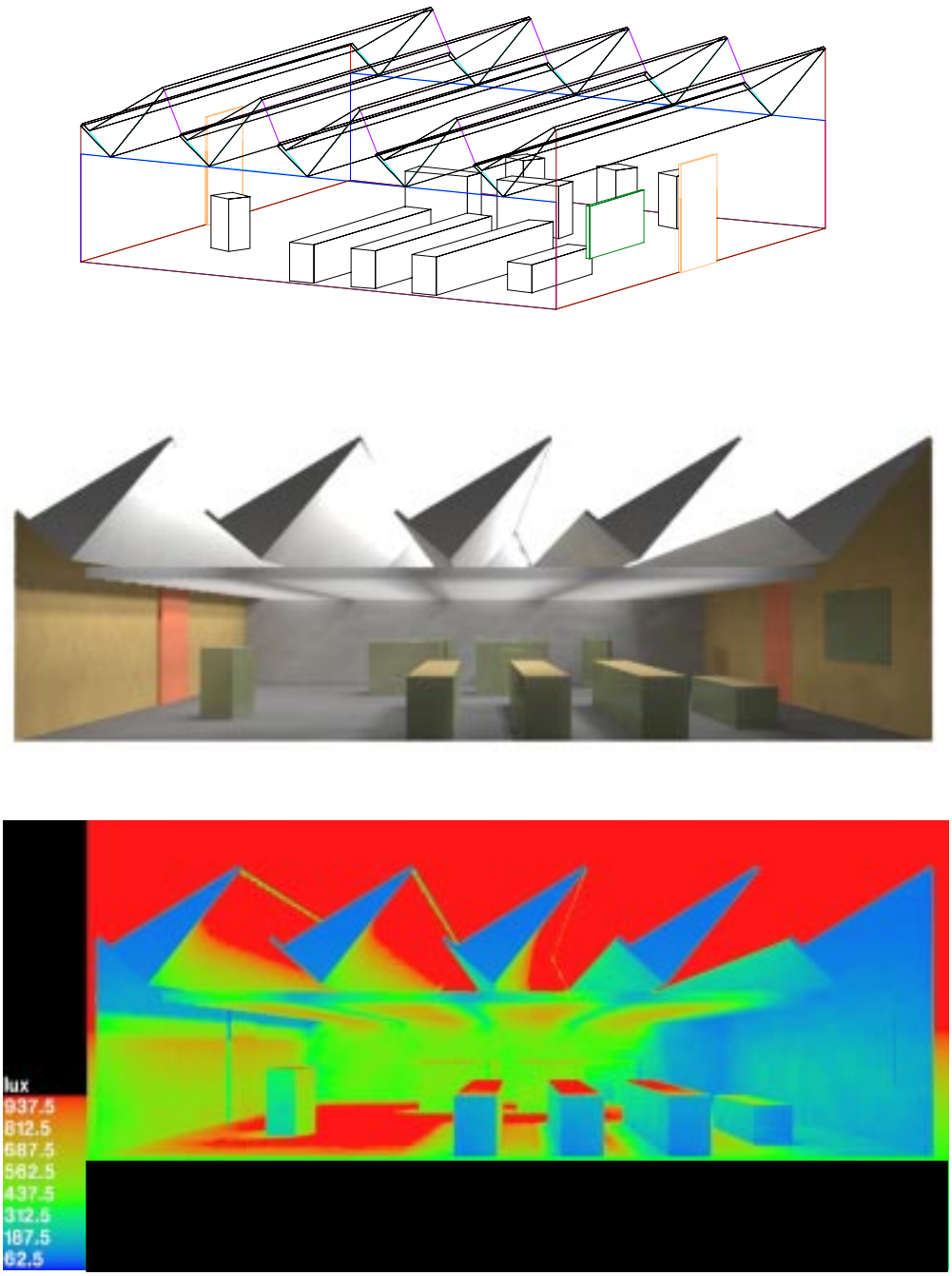


Figure 10: CAD wire frame presentation of a hall illuminated by shed roof-lights.

4. VALIDATION

Validation activities consisted in

- a photometric (optical) performance assesment of daylighting simulation tools against data sets measured in artificial skies
- a study on the applicability of daylighting computer models in a real case study building including long-term energy predictions.

4.1 Photometric (optical) Performance Assessment

The daylighting softwares RADIANCE, SUPERLITE, GENELUX, ADELINE and LESO-DIAL have been used in an international task for comparison of similar results, as well as for comparison with data obtained from measurements in scale models located in artificial skies. Three major building configurations have been tested, and surface reflectances have been varied to test the sensitivity of the results to surface reflectance. The simulation of the surfaces specularity has also been included. Results show that the calculation of illuminances inside buildings due to daylighting require a careful description of the luminances of the sky section seen through the window. Direct illuminances inside buildings can be computed with an accuracy of about 5 %. The accuracy of the multiple reflections calculations depends on the assumptions on the surfaces optical characteristics. When diffusing finishes were used in the scale models, the assumption that they are perfectly diffusing was satisfactory as long as the point of comparison was not situated too far from the window (error below 10 %). For locations far away from the window, the assumption of perfectly diffusing surfaces led to an under-estimation of the illuminances. This is due to the fact that most diffusing surfaces are not "perfectly diffusing" and tend to reflect more light in the direction opposite to the light source. Finally, it became obvious that the programs should be used with a lot of care, since lighting calculations are very sensitive to the quality of the input file: light source description, material photometry, building geometry and simulation parameters.

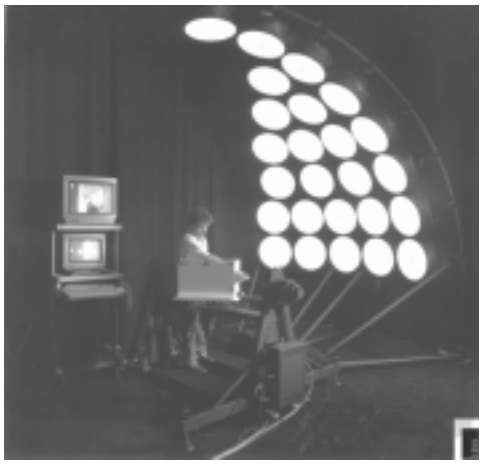
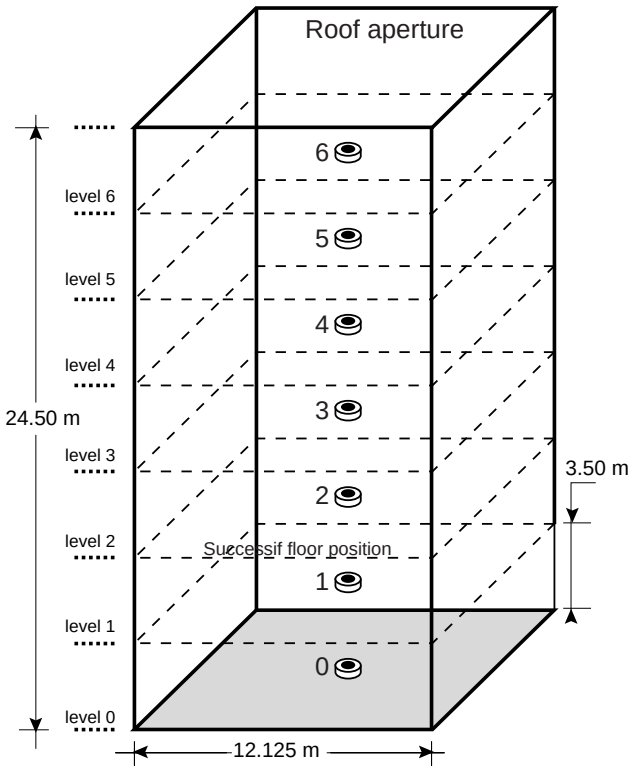


Figure 11: Artificial skies of BRE, Watford, United Kingdom (left hand picture) and of LESO at EPFL in Lausanne, Switzerland.

Two of the three artificial skies used are shown in Figure 11. The geometry of the simple atrium configuration and the daylight factors obtained from measurements and simulations are shown in Figure 12.



Point	BLACK (4%) BRE Scale	Superlite (LBNL)	Genelux (ENTPE)	Adeline	DIAL
0	10.7	10	10.14	10.12	10.00
1	13.7	13.3	13.26	13.13	13.30
2	18.9	18.3	18.16	18.25	18.30
3	26.7	26.5	26.47	26.53	26.40
4	40.2	40.4	38.71	40.12	40.10
5	61.9	63.1	61.81	63.01	63.00
6	89.9	90.8	91.26	91.16	91.60

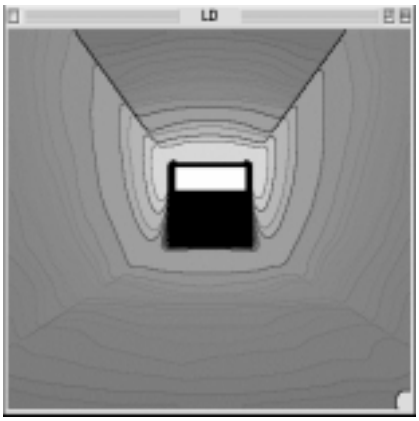
Point	DARK GREY (30%) BRE Scale	Superlite (LBNL)	Genelux (ENTPE)	Adeline	DIAL
0	15.6	12.4	12.49	12.5	13.60
1	19.8	16.4	16.30	16.28	17.30
2	25.7	22.4	21.90	22.22	22.70
3	34.5	31.5	31.11	31.41	31.40
4	47.2	45.9	43.62	45.6	45.90
5	67	68	65.93	67.74	69.80
6	92.2	92.7	94.25	92.96	99.50

Point	LIGHT GREY (48%) BRE Scale	Superlite (LBNL)	Genelux (ENTPE)	Adeline	DIAL
0	19.1	15.3	15.28	15.32	17.50
1	23.9	20	19.78	19.82	21.50
2	30.7	26.8	26.01	26.54	27.40
3	39.9	36.6	35.94	36.43	36.60
4	53.3	51.3	48.51	50.89	51.70
5	71.8	72.5	69.98	72.13	76.30
6	94.4	94.5	97.03	94.56	100.00

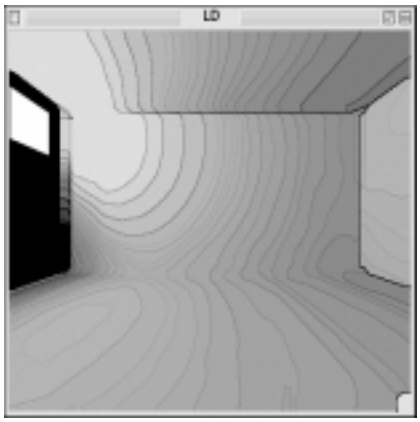
Point	WHITE (85%) BRE Scale	Superlite (LBNL)	Genelux (ENTPE)	Adeline	DIAL
0	40.3	38.1	38.19	35.27	43.20
1	47.2	45.5	45.35	42.66	48.50
2	54.7	54.4	53.15	51.87	55.80
3	64.2	65.1	63.91	62.93	66.30
4	75	77.7	73.38	75.85	82.60
5	87.7	91.6	88.49	90.27	100.00
6	98.3	100.7	107.70	100.23	100.00

Figure 12: The BRE "simple atrium". An adjustable floor can be moved to 7 levels. Major results (daylight factors) for various indoor surfaces reflectances (Black 5%, Dark Grey 30 %, Light Grey 48 %, White 85%).

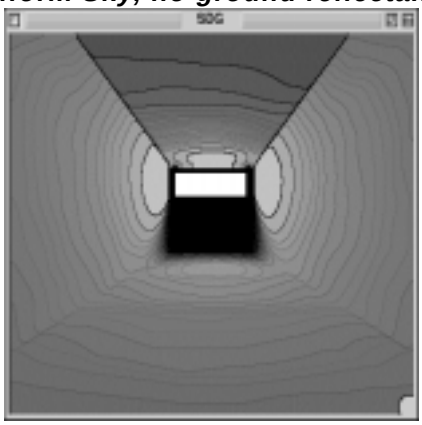
The initial scope of Task 21 intended to also extend the validation to the performance of daylighting systems. Due to delayed and still not totally completed reference measurements of selected systems, this part of the validation could not be performed. Nevertheless, Figure 13 shows in a first study on a light redirecting glass the general possibility to include these systems appropriately into the simulation engines.



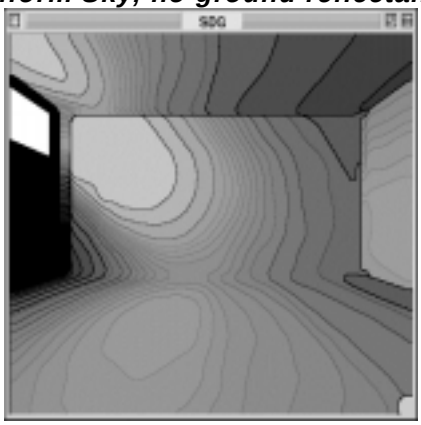
Lambertian Diffuser, Uniform Sky, no ground reflectance



Lambertian Diffuser, Uniform Sky, no ground reflectance



Sun Directing Glass, Uniform Sky, no ground reflectance



Sun Directing Glass, Uniform Sky, no ground reflectance

Figure 13: Front and side views of bi-directional glazing samples by means of equivalent luminance distribution functions. The light source is a uniform sky, and the ground reflectance is set to zero. Software: Genelux

4.2 Applicability of Daylighting Computer Modeling in Real Case Studies

The purpose of the study was to compare the computed outputs (illuminance levels and lighting energy savings) using the modules Superlite, Superlink and Radiance included in the software ADELINE against data collected in a real atrium-type building.

An enclosed atrium space located in Ottawa, Canada served as case study (Figure 14). The atrium is a three-storey octagonal construction roofed by a pyramidal skylight made of several glazing systems. The space is equipped with an automatic on/off lighting control system operated by a daylight photosensor located in another atrium space, which is part of the same facility. Field work was conducted for both summer and winter conditions and included measurements of horizontal indoor and outdoor illuminance, solar radiation and electrical lighting system time-of-use. The computer simulation phase consisted in the creation of two computer models, a Superlite/Superlink simple model and a Radiance model used to simulate the daylighting performance of the atrium space as shown in Figure 15. The accuracy of the Superlite and Radiance programs in simulating interior daylight levels was

evaluated based on comparisons between the predicted and the on-site measured illuminance. In addition, the Superlite simulated outdoor illuminance was compared to the measured outdoor illuminance. The amount of electrical lighting displaced by daylighting via the automatic on/off lighting control system was also compared in order to evaluate the prediction of lighting energy savings.

Figure 14: Outside view of the simulated atrium building located in Ottawa, Canada. The atrium under investigation is located underneath the middle glas pyramide.

The data showed that the Superlite predicted outdoor illuminance was closer to the measured outdoor illuminance for clear sky conditions than for overcast sky. Despite the fact that the distribution profiles of simulated illuminance followed closely the profiles of measured illuminance under both sky conditions, the instantaneous illuminance was significantly underpredicted especially under overcast sky. Under a summer clear sky, the outdoor illuminance was slightly overpredicted and the discrepancy between the measured and the simulated instantaneous illuminance was between 1 and 16 %. Under a winter clear sky, the outdoor illuminance was slightly underpredicted and the difference between the measured and the simulated instantaneous illuminance was between 12 and 29 %. The range of measured illuminance differed greatly from the predicted range for overcast sky conditions, the outdoor illuminance being in this case notably underpredicted by up to 60 %.

The discrepancy between the outdoor measured and simulated illuminance reflected on the simulated indoor illuminance, which was underpredicted by 50% for both a winter clear sky and an overcast sky. This underprediction was likely to affect the subsequent Superlink long-term energy calculations and suggested that annual savings from daylighting may in reality be higher than predicted. Summer data showed a good agreement in overall range and distribution pattern between the measured and the simulated indoor illuminance under a clear sky. However, despite this good overall agreement, the instantaneous illuminance differed sometimes by 3 to 10 times from the

measured value. This high instantaneous discrepancy was attributed to the geometrical differences between the real and the simulated space, and was not likely to alter the long-term energy calculations since both the measured and the simulated illuminance were considerable above the space design illuminance.

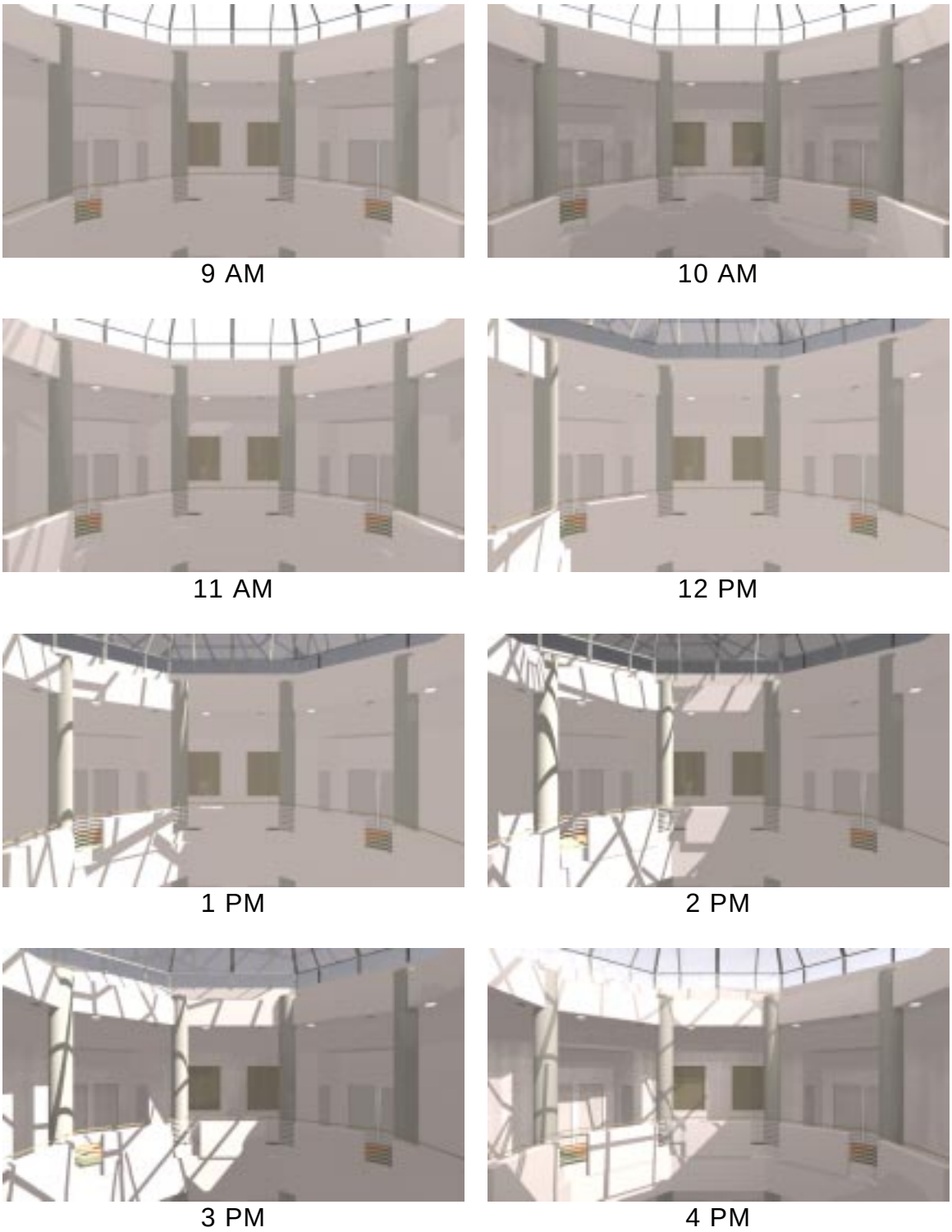


Figure 15: Radiance representation of the atrium 3rd floor under a clear summer sky (simulated day: June 8, 1995; south-east view).

The comparison between the measured and the Radiance computed data showed that, for any particular sky condition, the computer model has the potential to accurately model the daylighting performance of a space if relevant input data, such as precise space geometry, construction materials properties and actual sky description are available. For the case study, the range and distribution pattern of the simulated horizontal indoor illuminance were in good agreement with the predicted illuminance under diffuse daylight for both a summer and a winter clear sky. However, the instantaneous simulated illuminance differed at times by as much as 100 % from the measured values under direct sun. Indoor illuminance was very well predicted by Radiance for an overcast sky. The instantaneous discrepancy between the measured and the simulated illuminance was in this case below 20 %, confirming the fact that diffuse daylight was simulated more accurately than the direct component. The occasional high discrepancy between the measured and the simulated illuminance under direct sun was partly attributed to the overall average transmittance used to account for the three glazing systems of the atrium skylight. Spending more time in reproducing the exact configuration of the atrium fenestration would lead to more accurate results.

The discrepancy between the measured and the Superlink computed lighting energy savings was 22 % for June 1995. On-site lighting control problems lead to measured savings that were 3 times lower than predicted for December 1995. The small discrepancy obtained for the summer month was attributed to the overprediction of daylight availability in the weather file. The significant difference between the measured and the simulated data for the winter month was attributed to the snow and frost that covered the skylight during the entire month and the unusual operation of the lighting control system under these conditions. If the control system had functioned properly, the measured savings would have been much closer to the predicted values. The poor winter performance of the lighting control system affected greatly the discrepancy between the measured and the simulated annual energy savings. While the predicted annual savings were about 28700 kWh/year, the savings estimated from measurements were only 17830 kWh/year, which is 61 % lower than predicted.

5. INFORMATION DISSEMINATION ON DAYLIGHTING ALGORITHMS

The objective of this subgroup was to coordinate the countries development activities, and to document and disseminate algorithms for the simulation of the performance of daylighting and control systems. This was accomplished by an extended search for applicable methods and algorithms available online and applicable to the development of advanced daylighting analysis tools.

For information dissemination an innovative reporting strategy was used: Because much of the information about methods and algorithms is now available

online, the core formats are electronic and used to produce a printed form only secondarily. The electronic forms include both WWW pages and a downloadable PDF file with the same appearance and content. Both electronic forms include live primary and indirect links to actual information sources on the WWW. This in turn allows the report to be very concise, letting the links speak for themselves. The report consists of only about 10+ pages but includes 100+ primary links and thousands of indirect links. This form has other benefits: It is easily maintainable and evolvable, and is always available to anybody that wants to access it. A printed report can be derived directly from the electronic versions by simply printing either of them. All report forms have explicit link addresses that can be followed up or referenced manually. This report, entitled "Daylighting Simulation: Methods, Algorithms, and Resources" is available on the WWW at:

http://eande.lbl.gov/Task21/dlalgorithms.html.

The content can be summed up as follows:

- METHODS and ALGORITHMS
  - General Methods and Collections
  - Radiosity Methods
  - Ray Tracing Methods
    - Backward Ray Tracing
    - Forward and Bi-directional Ray Tracing
  - Bi-directional Transmission / Reflection Distribution Functions (BT/RDFs)
  - Geometric Algorithms
    - Geometric transformations and graphics primitives
    - Form Factor calculations
    - Surface-to-surface Visibility (Occlusion)
    - Surface Meshing
  - Solar / Sky Illumination Models and Data Resources
  - Validation
- SIMPLE METHODS
- ORGANIZATIONS
  - Research Groups
  - Professional Societies
- TOOLS
  - Forward Ray Tracers
  - Tool Lists
- INFORMATION RESOURCES
  - Books and Papers
  - Bibliographies
  - Archives
  - Link References

6. SUMMARY AND OUTLOOK

The activities of Subtask C took into account the increasing pressure of costs and time involved in the daylighting design processes by focussing on simple design tools, the further development of program integration and the improvement of tool application with regard to more complex problems. The reliability of simulation results has been proved in an elaborated validation study. Furthermore, an extensive study showed the usefulness of applying these tools to real building structures. Information collection and dissemination has been performed with a survey on simple design tools and a Web-based collection of daylighting algorithms and Websites related to daylighting design tools.

With the increasing number of so-called "intelligent glazings and façade systems", the simulation of light directing and glare protecting components will become more and more demanding and complex. For some of these systems (prismatic elements, anidolic systems, laser cut panels) computer models exist already. The modeling of a large number of systems, some of which are still being developed, need to be made available to designers in validated, user-friendly, and integrated design tools. This implies that, apart from an entirely photometrical modeling and the development of comprehensible parameters, more detailed models will be developed to evaluate the visual comfort, and that the energetic and thermal behaviour of these systems will be taken into account as well.

7. LITERATURE & WWW ADDRESSES

Reports on the Work of Subtask C

The work of Subtask C is documented by the offical reports and working documents listed below:

Report No:	Title, Author:	Institution:
T21/C1-21/CAN/98-11	Applicability of Daylighting Computer Modeling in Real Case Studies: Comparison between Measured and Simulated Daylight availability and Lighting Consumption, A. D. Galasiu, M. R. Atif, NRC, CAN	National Research Council, Ottawa, Canada
T21/C1-26/FR/99-09	Validation of daylight simulation programmes within task 21 C1 of the International Energy Agency, Final Report C1, M. Fontoynont, ENTPE, FR	Ecole Nationale des Travaux Publics de l'Etat, Lyon, France
T21/C2-05/USA/99-09	Daylighting Simulation: Methods, Algorithms, and Resources IEA SH&C Task 21, Subtask C2, W. L. Carroll, LBNL, USA.	Lawrence Berkeley National Laboratory, Berkeley, California, USA
T21/C4-10/GER/98-05	Survey Simple Design Tools, J. de Boer, H. Erhorn, FHG-IBP, GER	Fraunhofer Institute of Building Physics, Stuttgart, Germany
T21/C4-12/SUI/98-05	Working Procedure and results for the atrium and adjacent office parametric study: Daylighting and Energy Consumption in an Office Adjacent to an Atrium, N. Hopkirk, EMPA, SUI	Swiss Federal Laboratories for Material Testing and Research (EMPA), Building Equipment Section, Duebendorf, Swtzerland
T21/C4-15/SUI/98-05	LESO-DIAL - Daylighting Design Software, B. Paule, J.-L. Scartezzini, S. Citherlet, LESO-PB, SUI	Laboratoire d'ènergie solaire et de physique du bâtiment, EPFL-LESO-PB/ITB, Lausanne, Switzerland
T21/C3-06/DEN/98-05	Survey on Available Integrated Systems and STEP Toolkits, K. Grau, SBI, DEN	Danish Building Research Institute, Energy and Indoor Climate Devision, Horsholm, Denmark
T21/C4-08/BEL/97-10	LESODIAL: Validation report on "Daylight Factor calculation", M. Bodart, CUL, BEL	Université Catholique de Louvain, Architekture et Climat, Louvain-la-Neuve, Belgium
T21/C4-16/SUI/99-05	"Methodology for the Development of a Simple Design Tool for the Energy Demands in Offices Adjacent to Atria", N. Hopkirk, EMPA, SUI	Swiss Federal Laboratories for Material Testing and Research (EMPA), Building Equipment Section,

		Duebendorf, Swtzerland
T21/C4-21/GER/99-09	Simple Design Tool for Lighting plus Heating and Cooling Energy in an Office Adjacent to an Atrium - Lighting Results, A. Röhrig, J. de Boer, M. Dirksmöller, IBP, GER	Fraunhofer Institute of Building Physics, Stuttgart, Germany
T21/C5-12/GER/99-04	ADELINE 3, incl. Documentation, M. Dirksmöller, FHG-IBP, GER	Fraunhofer Institute of Building Physics, Stuttgart, Germany

WWW Addresses:

All reports can be downloaded from:

Task 21, Subtask C:	**http://www.iea-shc.org/task21/subtask_c.htm**
Collection of algorithms:	**http://eande.lbl.gov/Task21/subtask-c2.html**
Inform. on LESO-DIAL:	**http://lesowww.epfl.ch/anglais/Leso_a_frame_sof.html**
Fraunhofer Institute of Building Phyiscs:	**http://www.ibp.fhg.de**
Information on ADELINE:	**http://www.ibp.fhg.de/wt/adeline/index.html**
Information on Genelux	**http://genelux.entpe.fr**
Information on Radiance:	**http://radsite.lbl.gov**
Information on Superlite:	**http://eande.lbl.gov**

8. LIST OF CONTACT PERSONS

Task 21 & Annex 29 Operating Agent:

Kjeld Johnson
Danish Building Research Institute
Energy and Indoor Climate Division
Dr. Neergards Vej 15
DK - 2970 Hørsholm, Denmark
Fax: +45-45-86-75-35

Leader Subtask A:

Nancy Ruck
University of Sydney
Dept. of Architecture & Design Science
Sydney NSW 2006, Australia
Phone: +61 2 9351 4029
Fax: +61-2-9351-3031

Leader Subtask B:

Laurens Zonnefeldt
TNO-TUE
Centre for Building Research
P.O.Box 513
NL - 5600 MB Eindhoven, The Netherlands
Fax: +31-40-243-8595

Leader Subtask C:

Hans Erhorn
Fraunhofer Institute for Building Physics
Nobelstraße 12
D - 70569 Stuttgart, Germany
Fax: +49-711-970-3399

Leader Subtask D:

Poul Erik Kristensen
Danisch Technological Institute
Division of Energy
P.O. Box 141
DK - 2630 Taastrup, Denmark
Fax: +45 4350 7222

Members of Subtask C:

Australia:

Geoffrey Roy
Murdoch University
School of Engineering
Murdoch, WA. 6150, Australia
Fax: +61 9 360 2941

Belgium:

Magali Bodart
Université Catholique de Louvain
Architecture et Climat
1, Place du Levant
B - 1348 Louvain-la-Neuve, Belgium
Fax: +32 1047 2150

Canada:

Anca Galasiu
National Research Council Canada
Indoor Environment Research Program
Ottawa, Ontario, K1A 0R6, Canada
Fax: +1-613-954-3733

Denmark:

Karl Grau
Danish Building Research Institute
Energy and Indoor Climate Division
Dr. Neergards Vej 15
DK - 2970 Hørsholm, Denmark
Fax: +45-45-86-75-35

France:

Marc Fontoynont
ENTPE/DGCB
Rue Maurice Audin
F - 69518 Vaulx-en-Velin, Cedex, France
Fax: +33-4-7204-7041

Pierre Laforgue
ENTPE/DGCB
Rue Maurice Audin
F - 69518 Vaulx-en-Velin,Cedex, France
Fax: +33-7204 7041

Germany:

Hans Erhorn
Fraunhofer Institute for Building Physics
Nobelstraße 12
D - 70569 Stuttgart
Fax: +49 711 9703399

Jan de Boer
Fraunhofer Institute for Building Physics
Nobelstraße 12
D - 70569 Stuttgart
Fax: +49 711 9703399

Michael Dirksmöller
Fraunhofer Institute for Building Physics
Nobelstraße 12
D - 70569 Stuttgart
Fax: +49 711 9703399

Sweden:

Nils Svendenius
University of Lund
Dept. Of Atomic Spectroscopy
Sölvegatan 14
S - 223 62 Lund, Sweden
Fax: +46-46-222-4709

Switzerland:

Nicole Hopkirk
EMPA
Überlandstr. 129
CH - 8600 Dübendorf, Switzerland
Fax: +41-1-823-4009

Bernard Paule
LESO-PB
Ecole Polytechnique Fédérale de Lausanne
CH - 1015 Lausanne, Switzerland
Fax: +41-21-693-5550

Jean-Louis Scartezzini
LESO-PB
CH - 1015 Lausanne, Switzerland
Fax: +41-21-693-2722

United States:

Bill Carroll
Lawrence Berkeley National Laboratory
Bldg. 90 - 3026
Berkeley, CA 94720, USA
Fax: +1-510-486-7290

9. IEA INFORMATION

OVERVIEW OF THE IEA AND THE SOLAR HEATING AND COOLING AGREEMENT

INTERNATIONAL ENERGY AGENCY

The International Energy Agency, founded in November 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD) which carries out a comprehensive program of energy cooperation among its 24 member countries. The European Commission also participates in the work of the Agency.

The policy goals of the IEA include diversity, efficiency and flexibility within the energy sector, the ability to respond promptly and flexibly to energy emergencies, the environmentally sustainable provision and use of energy, more environmentally-acceptable energy sources, improved energy efficiency, research, development and market deployment of new and improved energy technologies, and cooperation among all energy market participants.

These goals are addressed in part through a program of international collaboration in the research, development and demonstration of new energy technologies under the framework of 40 Implementing Agreements. The IEA's R&D activities are headed by the Committee on Energy Research and Technology (CERT) which is supported by a small Secretariat staff in Paris. In addition, four Working Parties (in Conservation, Fossil Fuels, Renewable Energy and Fusion) are charged with monitoring the various collaborative agreements, identifying new areas for cooperation and advising the CERT on policy matters.

IEA SOLAR HEATING AND COOLING PROGRAM

The Solar Heating and Cooling Program was one of the first collaborative R&D agreements to be established within the IEA, and, since 1977, its Participants have been conducting a variety of joint projects in active solar, passive solar and photovoltaic technologies, primarily for building applications. The nineteen members are:

Australia	Japan
Austria	Mexico
Belgium	The Netherlands
Canada	New Zealand
Denmark	Norway
European Commission	Spain
Finland	Sweden
France	Switzerland
Germany	United Kingdom
Italy	United States

A total of 26 projects or "Tasks" have been undertaken since the beginning of the Solar Heating and Cooling Program. The overall program is monitored by an Executive Committee consisting of one representative from each of the member countries. The leadership and management of the individual Tasks are the responsibility of Operating Agents.

These Tasks and their respective Operating Agents are:

*Task 1: Investigation of the Performance of Solar Heating and Cooling Systems - Denmark
*Task 2: Coordination of Research and Development on Solar Heating and Cooling - Japan
*Task 3: Performance Testing of Solar Collectors - Germany/United Kingdom
*Task 4: Development of an Insulation Handbook and Instrument Package - United States
*Task 5: Use of Existing Meteorological Information for Solar Energy Application - Sweden
*Task 6: Solar Systems Using Evacuated Collectors - United States
*Task 7: Central Solar Heating Plants with Seasonal Storage - Sweden
*Task 8: Passive and Hybrid Solar Low Energy Buildings - United States
*Task 9: Solar Radiation and Pyranometry Studies - Canada/Germany
*Task 10: Solar Material Research and Testing - Japan
*Task 11: Passive and Hybrid Solar Commercial Buildings - Switzerland
*Task 12: Building Energy Analysis and Design Tools for Solar Applications - United States

*Task 13: Advanced Solar Low Energy Buildings - Norway
*Task 14: Advanced Active Solar Systems - Canada
Task 15: Not initiated
*Task 16: Photovoltaics in Buildings - Germany
*Task 17: Measuring and Modelling Spectral Radiation - Germany
*Task 18: Advanced Glazing Materials - United Kingdom

*Task 19: Solar Air Systems - Switzerland
*Task 20: Solar Energy in Building Renovation - Sweden
Task 21: Daylighting in Buildings - Denmark
Task 22: Building Energy Analysis Tools - United States
Task 23: Optimization of Solar Energy Use in large Buildings - Norway
Task 24: Solar Procurement - Sweden
Task 25: Solar Assisted Cooling Systems for Air Conditioning of Buildings (Task Definition Phase)
Task 26: Solar Combisystems - Austria

**Completed*