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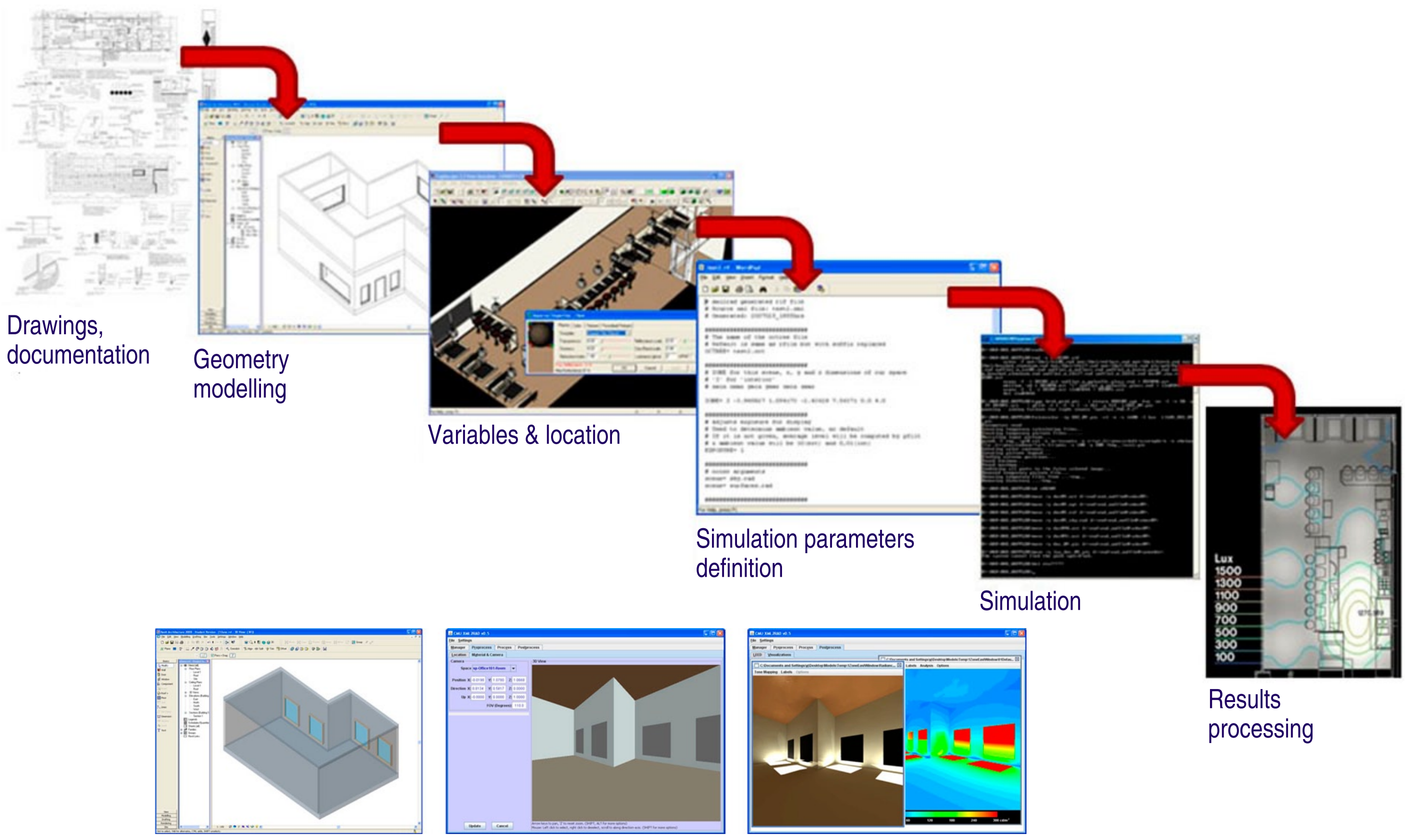


Inside:

- Articles on a multizone airflow and thermal analysis simulator and a scalable lighting simulation tool
- 19 events for your diaries
- News about a new sub-chapter of IBPSA-USA in New York City, a major new version of EnergyPlus, a new blog for simulationists, and software developments in China

The newsletter of the International Building Performance Simulation Association ISSN 1993-8586

Contents

President's message

IBPSA Members and Friends,

You are reading yet another issue of IBPSA News. This is the first issue by its new Editor-in-Chief Veronica Soebarto, whose day-job is Associate Professor at the School of Architecture, Landscape Architecture and Urban Design of The University of Adelaide, Australia.

I would like to take this opportunity to sincerely thank Larry Degelman very much for his efforts, enthusiasm and stamina to run IBPSA News during the last 8 years. The Board of Directors is very pleased that Larry Degelman has agreed to chair IBPSA's Public Relations Committee. This is a committee that discusses (or instigates) new ways of News sponsorship through advertisements, news content and news columns, and any other new ideas that could impact how we go about publishing a newsletter (frequency, size of each issue, expansion of content, etc.) as well as discussing/instigating/coordinating interactions with IBPSA's other news outlets such as the IBPSA website.

Members of this committee include Veronica Soebarto as the Newsletter Editor-in-Chief, Etienne Wurtz (IBPSA-France), and Marion Bartholomew (U.K.) as Newsletter Production Editor. Marion has served this function remarkably well over the past 12 or more years, and we are pleased to continue to have her services.

The Public Relations committee takes the lead in building an alliance with AIVC, the Air Infiltration and Ventilation Centre - **www.aivc.org**, which is the official Information Centre of the IEA (International Energy Agency) for ventilation and air infiltration in buildings. AIVC publishes a wealth of information on its website (which now has links to all papers published at the IBPSA International Building Simulation conferences) and in a quarterly newsletter, AIR (Air Information Review), which will occasionally carry IBPSA announcements of various conferences and other events.

In this IBPSA News you will find an update on IBPSA's official scientific journal, Journal of Building Performance Simulation (**www.informaworld.com/jbps**). First published in March 2008, the Journal has already become a widely respected scholarly journal of outstanding peer-reviewed building performance simulation works across the globe.

The next issue of IBPSA News will inform you about the outcomes of the annual Board of Directors meeting which was held on 6-7 October in Glasgow this year. If there is anything you would like to discuss with us or you would like the Board to address, please don't hesitate to contact us - see **www.ibpsa.org** for contact details.

What else is News? Read on and you will find that many of the regional affiliates and other organizations have building simulation events planned for the near future. IBPSA's main one will be Building Simulation 2009 in Glasgow. Judging from the quality and number of abstracts which have been submitted already, it is going to be a great conference. Don't miss it!

Best wishes,

IBPSA USA forming a new sub-chapter in New York City

A new sub-chapter of IBPSA USA has been formed, the IBPSA USA New York City chapter. IBPSA-NYC seeks to act as a forum and a resource for those interested in performing and utilizing building simulation services. The inaugural of IBPSA-NYC was successfully held in Buro Happold Offices at 100 Broadway, New York, NY, on Monday, September 15, 2008 from 6:30 to 9 PM, and attended by more than 50 people.

In this inaugural meeting the goals and plans for the next step as well as the organization's structure were presented and discussed. Some of the goals include: to liaise with local chapters of USGBC, NYSERDA, NATIONAL LABS, ASHRAE, to collaborate on programs and events held in the region, to provide quarterly social gatherings where professionals can discuss industry trends or just network, to establish workshops and technical discussions on simulation related topics, and to engage students and design professionals who want to know more about building performance simulation.

The Interim President, Secretary and Event Coordinator of IBPSA-NYC are (in that order): Andy McNamara (Bright Power), Rashmi Sonal (Buro Happold), and Sam Mason (Atelier Ten).

For more information about IBPSA-NYC, please visit **www.ibpsanyc.com**.

Journal of Building Performance Simulation

IBPSA's new scholarly journal, the quarterly Journal of Building Performance Simulation, has made an excellent start. The first edition included 5 papers:

- Efficient calculation of daylight coefficients for rooms with dissimilar complex fenestration systems
- Development of an adaptive window-opening algorithm to predict the thermal comfort, energy use and overheating in buildings
- Validation of methodology for utility demand prediction considering actual variations in inhabitant behaviour schedules
- An integrated adaptive model for overheating risk prediction
- Occupants' operation of lighting and shading systems in office buildings

These can all be downloaded free from **www.informaworld.com/smpp/title~content=g791558348~db=all**. To see what the next issue has to offer — and view them ahead of the print edition if you are a subscriber — visit **www.informaworld.com/smpp/title~content=g901701079~db=all**. It will soon be possible to browse the contents of forthcoming issues at **www.informaworld.com/smpp/title~content=g790936365~db=all~tab=forthcoming**.

IBPSA members can subscribe to JBPS at a special rate using the online form at **www.tandf.co.uk/journals/offer/tbps-so.asp**.

To make JBPS a continuing success, it will need a flow of contributions as well as subscribers. Instructions for prospective authors are available at **www.informaworld.com/smpp/title~db=all~content=g790936365~tab=submit~mode=paper_submission_instructions**. If you are a researcher in the field, do consider submitting a paper!

Forthcoming events calendar

Date(s)	Event	Information
2008		
22-24 October 2008	**PLEA conference** Dublin, Ireland	www.plea2008.org
29-31 October 2008	**Building Physics Symposium** Leuven, Belgium	www.kuleuven.be/bwf/projects/BPS2008
4-5 November 2008	**IBPSA China conference 2008** Chongqing, China	www.ibpsa.cn
6-7 November 2008	**IBPSA France conference 2008** Lyon, France	http://conference2008.ibpsa-france.net
19-21 November 2008	**GreenBuild 2008** Boston, USA	www.greenbuildexpo.org
26-28 November 2008	**ANZAScA Conference** Newcastle, Australia	www.newcastle.edu.au/anzasca2008
1-12 December 2008	**UN Framework Convention on Climate Change Conference** Poznań, Poland	http://unfccc.int/2860.php
2009		
19-21 January 2009	**World Future Energy Summit 2009** Abu Dhabi	www.worldfutureenergysummit.com
24-28 January 2009	**ASHRAE** Chicago, USA	www.ashrae.org
27 January 2009	**Sustainable Building: Scotland** Glasgow, Scotland	www.sustainable-build.com/Conferences/tabid/72/Default.aspx#Glasgow
25-27 February 2009	**World Sustainable Energy Days** Wels, Austria	www.wsed.at/wsed/index.php?id=217&L=1
8-10 May 2009	**National Green Building Conference** Dallas, USA	www.nahb.org/conference_details.aspx?conferenceID=59
27-29 May 2009	**ICSDC 2009: International Conference on Sustainable Design & Construction** Tokyo, Japan	www.waset.org/wcset09/tokyo/icsdc/index.html
15-19 June 2009	**SASBE: 3rd CIB International Conference on Smart & Sustainable Building Environments** Delft, Netherlands	www.sasbe2009.com/index.html

15-18 June 2009	**IBPC: 4th International Building Physics Conference** Istanbul, Turkey	**www.ibpc4istanbul.itu.edu.tr**
20-24 June 2009	**ASHRAE** Louisville, Kentucky, USA	**www.ashrae.org**
27-30 July 2009	**Building Simulation 2009** Glasgow, Scotland, UK	**www.bs2009.org.uk**
8-10 September 2009	**BauSim 2009** (Preliminary announcement - no information yet on website)	**http://ibpsa.inf.bauwesen.tu-muenchen.de/index.php/IBPSA-Germany**
11-14 October 2009	**ISES Solar World Congress 2009** Johannesburg, South Africa	**www.swc2009.co.za**

29-31 October 2008
Leuven, Belgium
www.kuleuven.be/bwf/projects/BPS2008/index.php

Building Physics Symposium

Katholieke Universiteit Leuven, Laboratory of Building Physics

This symposium, organised in honour of Professor Hugo L.S.C. Hens, aims to give researchers and PhD students a forum to share and discuss the most recent and significant developments in building physics. The principal topics under discussion will be:

- Advanced modelling of building physics
- Hygrothermal performance — heat, air and moisture transfer in the building envelope
- Energy performance and energy efficiency
- Durability, sustainability and reliability
- Whole building modelling
- Developments in envelope materials and systems
- Interior environment - indoor air quality, acoustics, lighting

Further information is available on the conference website.

4-5 November 2008
Chongqing, China
www.ibpsa.cn

IBPSA China conference 2008

IBPSA China

IBPSA China will hold its 2nd Annual National Conference on 4 and 5 November 2008 in Chongqing. Around 100 delegates are expected. The conference topics include:

- Building Physics
- HVAC system simulation
- Human factors
- Advances in modeling
- Software development

6-7 November 2008
Lyon, France
http://conference2008.ibpsa-france.net

IBPSA France conference 2008

IBPSA France

The Fourvière's Basilica - Lyon

IBPSA France's biennial conference will be held at the Centre de Thermique de Lyon, France on 6-7 November 2008, hosted by the National Institute of Applied Sciences of Lyon.

The conference aims to bring together academics, engineers, architects and researchers who are interested in building simulation issues and developments and to provide a forum for discussions.

The main topic of the 2008 Conference is the use of simulation in designing energy-efficient buildings, with a particular focus on:

- Building physics, including the transport of heat, moisture and air
- Heating, ventilation and air conditioning systems
- Renewable energy, energy storage, and CHP
- Thermal and visual comfort
- Indoor air quality
- Control systems
- Recent developments in simulation, including user interfaces and methods for validation and calibration
- Optimisation and error correction
- Simulation case studies
- Energy-efficient building

Please visit the conference website at **http://conference2008.ibpsa-france.net for f**urther information.

27-29 May 2009
Tokyo, Japan
www.waset.org/wcset09/tokyo/icsdc/

ICSDC 2009: International Conference on Sustainable Design & Construction

World Academy of Science, Engineering & Technology (WASET)

WASET's International Conference on Sustainable Design and Construction, ICSDC 2009, aims to bring together researchers, scientists, engineers, and students to exchange and share their experiences, new ideas, and research results about all aspects of Sustainable Design and Construction, and discuss the practical challenges encountered and the solutions adopted.

ICSDC 2009 invites people working in the field to submit papers and/or proposals for organising workshops on foundational and emerging topics in Sustainable Design & Construction.

All full paper submissions will be peer reviewed and evaluated based on originality, technical and/or research content/depth, correctness, relevance to conference, contributions, and readability. Acceptance will be based on technical merit, interest, applicability, and how well papers fit a coherent and balanced technical program. Accepted full papers will be published in both hard copy book and CD-ROM before the conference, and distributed to all registered participants.

The conference has teamed up with the International Journal of Electrical, Computer, and Systems Engineering (IJECSE) for publishing a Special Journal Issue on Advances in Sustainable Design and Construction. All papers submitted to the conference will be considered for this Special Journal Issue, with selection carried out during the review process as well as at the conference presentation stage.

ICSDC workshops provide a challenging forum and vibrant opportunity for researchers and industry practitioners to share their research positions, original research results and practical development experiences on specific new challenges and emerging issues. The workshop topics should be focused so that the participants can benefit from interaction with each other and the cohesiveness of the topics.

The key dates are:

Paper submission deadline	30 January 2009
Notification of acceptance	28 February 2009
Final paper submission & author registration	31 March 2009
ICSDC 2009	27-29 May 2009

Further information is available from the conference website, **www.waset.org/wcset09/tokyo/icsdc/** .

15-19 June 2009
Delft, Netherlands
www.sasbe2009.com/index.html

3rd CIB International Conference on Smart & Sustainable Building Environments

CIB

Are climate change and the depletion of natural resources a problem? Perhaps. We prefer to see them as the ultimate opportunity to do things right, the lever to propel sustainable development. We invite everyone to join us in presenting solutions rather than problems at SASBE2009.

Striving for efficiency has delivered performances close to 100%, but not in sustainability. We need to do things differently. Effectiveness before efficiency, creativity before directives.

The emphasis at SASBE conferences is on an integrated approach via different disciplines and different scales. SASBE2009 focuses on smart solutions for the built environment in a changing climate. It supports a positive approach that uses climate change and limited resources as a stimulus for better planning, design and construction, and the development of smart, clean and effective technologies, cradle to cradle.

Follow the example of a succession of great people who put sustainability on the political agenda and present the world with your own solutions at SASBE2009. Submit your paper, come to Delft from 15 to 19 June 2009 and join us in making the built environment a pleasant place for everyone.

11-14 October 2009
Johannesburg, South Africa
www.swc2009.co.za

ISES Solar World Congress 2009

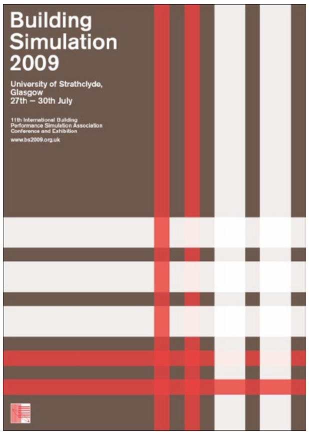
ISES and the Sustainable Energy Society of Southern Africa (SESSA)

ISES will hold its 29th Solar World Congress in Johannesburg on 11-14 October 2009. The program will include the latest findings in renewable energy research, technology, applications, education and good policy initiatives. It will focus particularly on issues for developing countries which, like Southern Africa, have an abundance of sun and other renewable energy resources.

The principal themes will be:

- Resource Assessment: Solar Energy Resources; Wind, Bio, Geo, Ocean Energy Resources
- Solar Heating and Cooling:
  - Solar Collectors and PVT
  - Thermal Storage and other Components
  - Domestic Hot Water and Combisystems
  - Solar Cooling Systems
  - Other Solar Thermal Applications
- Solar Electricity
  - PV Systems
  - PV Cells and Components
  - Solar Thermal Power
  - Wind, Bio, Geo, Ocean and Hybrid Systems
  - Fuels, Chemical and Photochemical Processes
- Solar Buildings
  - Solar Architecture and Building Integration
  - Building Material, Components and Daylighting
  - Rational Use of Energy in Buildings
- Solar Energy and Society: Strategies and Policies, Solar Cities; Marketing, Financing and Standards; Education and Training; Other Nontechnical Issues

Information about key dates and other issues is available from **www.swc2009.co.za**.



Building Simulation 2009
University of Strathclyde
Glasgow, Scotland
27th – 30th July 2009

www.bs2009.org.uk

Building Simulation 2009

IBPSA will hold its 11th biennial international conference, the leading international conference in building performance simulation, in summer 2009 at the University of Strathclyde in Glasgow. Glasgow, Scotland's largest city, has a wide choice of museums, theatres, parks, science centre and shopping, set within some of the finest Victorian architecture in Europe. In addition, Glasgow has a worldwide reputation as a welcoming city and is firmly established and experienced as a major centre for conferences and international events.

The main themes will be:

- Advances in building physics
- Human aspects of the indoor environment
- Building services
- Commissioning and operation
- Energy capture and conversion
- Advances in applications
- Validation and calibration
- Software issues
- Simulation in design practice
- Regulation/code compliance
- Application day case studies

One day of the conference will be devoted to practical applications, focusing particularly on simulation in practice with illustrative case studies.

The deadline for submission of abstracts has passed. Other key dates are:

Abstract acceptance	1 November 2008
Full papers due	1 February 2009
Paper reviews provided to authors	1 April 2009
Deadline for revised papers	15 April 2009
Deadline for final formatted papers	22 April 2009
Final acceptance notification	1 May 2009
Deadline for conference pre-registration	15 May 2009
BS '09 Conference	27-30 July 2009

Further information about Glasgow, the University of Strathclyde, the accommodation, the accompanying persons' programme, technical tours, travel awards for students presenting papers and other aspects of the conference is available from the conference website, **www.bs2009.org.uk**.

We look forward to welcoming you to Glasgow and are sure you will enjoy the experience.

Software news

EnergyPlus version 3.0 available October 2008

Dru Crawley, DOE

The latest release of the *EnergyPlus* building energy simulation program, Version 3.0, became available in early October 2008. A few key new features include new ventilated slab, fully-coupled 1-D finite element heat and moisture transport model, thermal chimney, CoolTower, additional detailed refrigeration component models, DC-to-AC inverter and simple battery, and direct output to SQLite. We have updated and extended capabilities throughout the existing building envelope, daylighting, and HVAC equipment and systems portions of the program.

Version 3.0 includes widespread changes to input syntax. The complete set of input objects was revised to make *EnergyPlus'* input "language" more consistent, logical, and informative. Although the majority of words used to describe input object names, field names and key choices have changed, the underlying meanings remain the same. (Yes, this will require substantial changes to existing input data files—aided by the Transition program which can be accessed through the EP-Launch utility.)

The *Energy Design Plugin* beta was updated to handle the new EnergyPlus V 3.0 syntax, integrating the *EnergyPlus* simulation capabilities within Google's SketchUp drawing software.

Both *EnergyPlus* v3.0 and the *Energy Design Plugin* are available at no cost from the *EnergyPlus* web site, **www.energyplus.gov**. Other new *EnergyPlus* features include:

DATA SETS

- Refrigerant properties for R404a, R410a, and R507a added to the refrigerant database
- New library of compressor performance curves for refrigeration systems created
- New performance curves for condensing and high-temperature boilers
- California Title 24 Time Dependent Valuation (TDV) factor schedules (2008) dataset added
- California Title 24 operating schedules dataset added

INPUT

- New examples input files for all new features

ZONE MODEL

- New Ventilated Slab model includes radiant heating and cooling interactions with hollow core slabs

- Infiltration models now allow air flow rate per unit of exterior wall area as an optional input
- Interior pipe heat transfer loads added into zone air heat balance calculations
- New optional algorithms for fully-coupled, 1-D finite element heat and moisture transport model for simulating the movement and storage of heat & moisture in and through building surfaces
- The algorithm for variable system timestep was revised. Changes include uniform system timestep length across zone timestep and stricter management of history terms for zone air conditions

NATURAL AND MECHANICAL VENTILATION

- Additional hybrid (mixed-mode) ventilation controls added to allow global control of surface openings based on master zone, limit opening levels based on wind speed, and allow control of Mixing and Ventilation objects. Temperature limit controls added to Mixing and Cross-Mixing objects
- New Thermal Chimney model added -- uses solar radiation to enhance natural ventilation
- New CoolTower model added -- uses natural evaporative cooling to cool incoming air
- Added new outside air minimum and maximum fractions to easily model 100% (or any fixed value) OA systems, leakage or stuck OA dampers

HVAC

- Refrigeration system capabilities expanded with more detailed component models. Users can now simulate: (1) variable evaporating temperatures, (2) variable condensing temperatures, (3) mechanical subcoolers that transfer refrigeration loads from less efficient low- temperature systems to more efficient medium-temperature systems, and (4) liquid suction subcoolers
- Improved error trapping for refrigerant and glycol properties at extreme temperatures and pressures
- Single-speed cooling towers can now use fluid bypass as capacity control, saving water but requiring more fan energy
- New linear curve to complement other curve objects
- Absorption chiller now can connect to steam or hot water loop
- Enhanced absorption chiller model added
- Radiant-convective baseboard model added
- Boiler model upgraded to include performance curve which accounts for load as function of operating temperatures
- Set Point Managers now test for control node conflicts
- New system availability managers added: Scheduled On and Scheduled Off
- New Underground Pipe object added; upgraded Pipe Heat Transfer objects
- New Fluid Cooler objects added–single and two-speed dry cooling towers for hydronic loops
- Component sizing factors added for boilers, chillers, and cooling towers
- Added chilled water thermal storage tank models for both mixed and stratified tanks

- New Compact HVAC objects:
  - Packaged single-zone heat pump system (PSZ-HP)
  - Packaged variable volume system (PVAVS)
  - Constant volume chilled water/hot water system (single-zone and multi-zone)

ON-SITE ENERGY SUPPLY

- PV model restructured to separately model inverters and storage systems
- AC-to-AC inverter model added along with simple battery model
- Simple Photovoltaic-Thermal model added for pre-heating outside air and hot water heating

ECONOMICS

- Energy cost calculations now includes real time pricing, minimum monthly charge, and buy/sell/net metering as new inputs
- A new monetary unit object (Currency Type) added
- Additional economic reporting of energy and demand for each charge

OUTPUT

- SQLite added as another output format option, providing optional export of time-series results directly to database
- Standard monthly reports can now be specified by name in the predefined report object without having to include a detailed monthly report object

UTILITIES

- EP-Launch now handles blank weather files as if no weather file is specified in group simulations
- IDF Editor new features include wrapping long text strings over multiple lines within cells, required fields now shown with blue field names, and added recently used file list

DOCUMENTATION AND GUIDES

- Input/Output Reference and Engineering Reference updated and extended for all new features and updates. Total documentation now exceeds 3800 pages

And many other enhancements and speed improvements throughout.

More information on these and other new features is available on the *EnergyPlus* web site, **www.energyplus.gov**.

TOP POSTS

- V-Ray Exterior Tutorials by Neoscape
- ILoveSketch - A 3D Sketch Pad
- 3ds Max Lighting Analysis for LEED Indoor Environmental Quality Credit 8.1
- Grazing the Web for Ecotect Tutorials
- Parametric Design Tool based on Rhino
- Generative Mesh Modeling Software
- Tensile and Pneumatic Structures in SketchUp
- Parametric Design in Rhino, Revit, AutoCAD
- Saxton, Leeds - Green Spaces
- How to Create a Neon Effect with V-Ray?

META

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- WordPress.org

BLOG STATS

15,417 hits

There's a new blog for simulationists – bldgsim

Using digital tools as a catalyst for better design

www.bldgsim.wordpress.com (no sign-up required for reading or commenting)

There is a new blog for simulationists, called "bldgsim". Authors Jens Voshage and Kerstin Mueller, two architects based in Vancouver, BC, say "[this blog] represents our ongoing findings on the vision and reality of digital tools in the architectural and urban design field."

Further, "[t]he blog focuses on green building design tools for architects and planners that are easy to learn and apply. We feel that the most valuable use of these tools is to define which design option would be the better choice over the other regarding sustainability. At the early stage of design the software simulation results do not need to be absolutely correct, what is important is the relative accuracy between the different design options. In order to be good designers, architects and planners have to consider the impact of their projects on the environment. Having access to this kind of information helps them to do so."

In the blog you will find various postings on topics such as BIM (Building Information Modeling), 3D visualisation and modeling, software tutorials, reviews and announcements, as well as news on environmental economics and policies. Voshage and Mueller hope the blog will evolve "into a platform to exchange experience and to host avid discussions within the architectural design community".

Building Energy Tools Directory

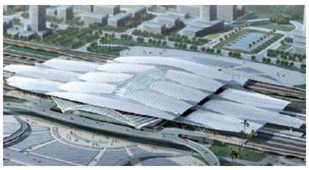
Dru Crawley, DOE

The web-based Building Energy Tools Directory at **www.energytoolsdirectory.gov** contains information on more than 350 building-related software tools from more than 20 countries around the world. Haven't visited lately? Since April 2008, more than 10 new tools have been added, including Cepenergy Management for Buildings, Degree Days.net, DeST, Energy Expert, Energy Gauge Summit, Photovoltaics Economics Calculator, Pipe Flow Expert, PolySun, PUtility Psychrometric, RETScreen, and Roanakh. For each tool in the directory, a short description is provided along with information about technical expertise required, users, audience, input, output, validation, computer platforms, programming language, strengths, weaknesses, technical contact, availability and cost. A link is also provided for directly translating the web pages into more than 8 languages.

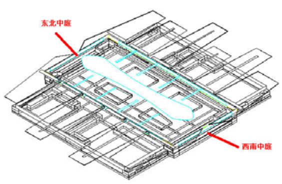
If you know of a tool (yours?) that isn't in the directory, send the information shown at **www.energytoolsdirectory.gov/submit.cfm** in an email message to Dru Crawley at **Drury.Crawley@ee.doe.gov**.

Designer Simulation Toolkit (DeST) developments

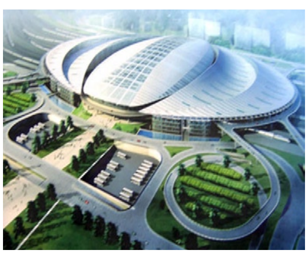
Development of 3D BIM and energy analysis software



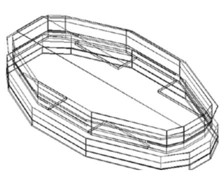
Guangzhou railway station



Tsinghua University and Bentley Systems have signed a Memorandum of Understanding for development and distribution of integrated software for Building Information Modeling (BIM) and energy analysis. This will incorporate the Bentley Architecture BIM application and the Tsinghua University's Designer Simulation Toolkit (DeST). Architects and designers employing the new integrated software will benefit from the ability to conduct an energy analysis application directly within Bentley Architecture, enabling them to immediately evaluate the impact of design changes on energy efficiency. In China, users of the new integrated software for modeling and energy analysis will only pay an affordable subscription fee covering services and support; the DeST software and Bentley Architecture licenses will be provided free of charge.



Beijing South railway station

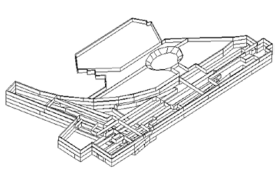


Dr. Jean-Baptiste Monnier, senior vice president, Bentley Asia-Pacific, said, "We are excited to be working with Tsinghua University in the development of this new software that will put powerful 3D BIM and energy analysis capabilities in the hands of architects and designers across China. This new standard platform for flexible design and highly accurate energy simulations will further advance the country's sustainable development efforts, and reinforce Bentley's global leadership in building analysis and simulation products for improved building performance. Bentley's new Building Performance Group focuses on software applications that address the global need to create and maintain energy-efficient, environmentally friendly, safer buildings that also set the benchmark for occupant comfort."

DeST applications

DeST is now widely used in China for research, design, commissioning and education. Up to today, more than 4000 users have used DeST as their building simulation tool. In 2008, five DeST training programs (totally around 100 users) have been conducted. Many projects have benefited from DeST, including:

Tianjin railway station



- Beijing International Airport Terminal 3
- Guangzhou Railway Station
- Tianjin Railway Station
- Beijing South Railway Station
- Guangzhou Pearl River Tower
- Shanghai Jinmao Tower

DeST was awarded the 2nd prize of China National Science and Technology Progress Award in August, 2008. This prize awards outstanding work in the Chinese construction field and DeST is the first building simulation tool to win this national award.

COOLVENT: A MULTIZONE AIRFLOW AND THERMAL ANALYSIS SIMULATOR FOR NATURAL VENTILATION IN BUILDINGS

Maria-Alejandra Menchaca-B. and Leon Glicksman
Massachusetts Institute of Technology, Cambridge, MA

ABSTRACT

Understanding the effects of natural ventilation on the comfort levels of a building, during the early stages of its design, can have a considerable positive impact on its final energy consumption. CoolVent is a user-friendly natural ventilation simulation tool that allows visualizing such effects, requiring only the building's bulk characteristics. Unlike similar programs, it couples multi-zone airflow and thermal analysis to predict zone temperatures and airflow rates. This paper provides an introduction to CoolVent's interface, its physical model, and typical results. It is expected that the use of simple tools like CoolVent will promote a wider and smarter use of natural ventilation in buildings.

INTRODUCTION

The use of natural ventilation has become increasingly popular in the sustainable building design community. If well implemented, it results in great energy savings, while maintaining the indoor thermal and air quality conditions within the desired comfort levels. Furthermore, some studies indirectly suggest that the use of natural ventilation may also be a factor of increased productivity in the workspace (Loftness 2004).

Natural ventilation consists on driving air through a space by taking advantage of the pressure differences caused by a) wind, b) buoyancy forces due to internal temperature differences, or c) a combination of both. Ideally, a natural ventilation strategy should be defined from the early first stages of a building's design, when aspects such as dimensions or construction materials of a building are still flexible.

Unfortunately, there is a lack of simple natural ventilation simulation tools to assist architects during this design phase. The current options include Computational Fluid Dynamics (CFD) tools, and airflow modeling programs. The use of CFD software, like PHOENICS, requires not only an advanced understanding of the boundary conditions, but also a great amount of details regarding the geometry of the building –parameters which are usually not known while conceiving the design of a building. Moreover, modeling an entire building with CFD is extremely time-consuming. On the other hand, airflow modeling tools such as CONTAM, although relatively simpler to use than CFD, do not account for heat gains or losses. They therefore do not provide any information regarding the variation of the internal building temperature with airflow; they require an input temperature, which is assumed to be constant throughout the simulation. The dependence of the indoor temperature on the air flow rate is an essential piece of information when assessing the comfort levels of a building.

CoolVent is a simple, user-friendly and robust tool that couples airflow and thermal analysis to estimate the comfort conditions inside a naturally-ventilated building. The program was first developed by Tan (2005), and further expanded by Yuan (2007). This document summarizes their work and the later improvements made to the simulation.

USER INTERFACE

The interface of CoolVent was designed to be simple. In a two-step process, the user can define the input parameters: those characteristics of the building that will mostly influence the effects of natural ventilation, without requiring more detail than what the early design of a building can provide.

The simulation requires less than a minute to run. Results are presented in a format that enables one to clearly visualize the temperature and airflow in each zone of the building. Although the main output interface is visual (i.e. color-based), the user can also access detailed data for each simulation, and store it as a text file.

Input parameters: General information

Two sets of data are required to run a CoolVent simulation: general and detailed building information. The general information about the building and its location is entered by the user on the window presented in Figure 1.

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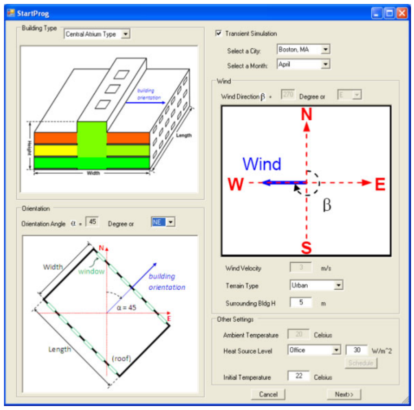

Figure 1 CoolVent interface. Input window for general information of the building (type, orientation, occupancy and weather information, etc.)

__Building type and orientation.__ Four pre-defined building types (ventilation strategies) can be modeled: single-sided ventilation, cross ventilation, central atrium ventilation and side atrium ventilation (Figure 2). These geometries represent the most common shapes in newly-built naturally-ventilated buildings. Single-sided ventilation only accounts for the air flow driven by buoyancy forces in a single zone. Cross-ventilation, on the other hand, only addresses the effects of wind. Finally, both central and side atrium designs include a combination of wind- and buoyancy-generated forces. The former involves an occupied zone at each side of the atrium, while the latter has only one occupied zone on the side of the atrium (similar to a solar chimney or wind scoop design).

The user can choose between eight building orientations (N, NE, E, SE, S, SW, W, NW).

__Occupancy heat loads and initial temperature.__ The type occupancy determines how much heat is being generated inside the building. In CoolVent, the user can define the occupancy type as residential, office, or educational (predefined heat gains per unit area), or by an arbitrary heat load density, with the option of defining an occupancy schedule. These heat gains represent occupancy, lighting and equipment loads. An initial building temperature must be defined, in order to initialize the calculations.

__Terrain information.__ The profile of the wind enveloping the building greatly depends on the terrain information. It is thus important for the user to define the type of terrain (urban, rural, or airport) and the average height of the surrounding buildings.

__Weather conditions.__ The simulation can be run for a 24-hour period (*transient case*) or for an instant in time (*steady case*). The transient model uses monthly-averaged typical meteorological year (TMY2) weather data for ten pre-defined cities (Atlanta Boston, Charlotte, Chicago, Houston, Los Angeles, Miami, Puerto Rico, San Francisco and Seattle). The steady simulation requires the user to define the free stream wind speed and its direction (N, NE, E, SE, S, SW, W, NW), and the ambient temperature.

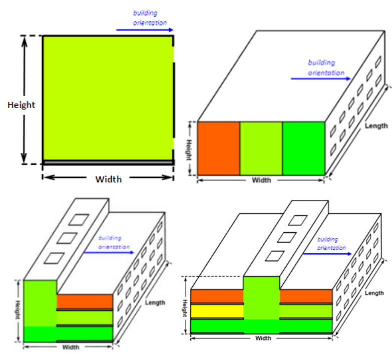

Figure 2 Building geometries (top to bottom, left to right): single-sided ventilation, cross-ventilation, side atrium, and central atrium ventilation.

Input parameters: Detailed building information

Once the general building information has been specified, more precise parameters about the building dimensions must be specified. Figure 3 shows the interface through which the user enters such data.

__Building dimensions.__ The building is characterized according to the following parameters: number of floors, occupational floor height, length and width, and roof height and atrium width (for central and side atrium building types only).

__Glazing/opening dimensions.__ In CoolVent, the window properties are divided into glazing and opening parameters. Glazing properties determine how much solar heat load is allowed into the building – independently of whether the windows are open or not—, while opening properties directly affect the air flow rate in or out of the building. The user must specify first the areas for glazing and window openings, and secondly, depending on the building type, the vertical location of the openings (single-sided ventilation), roof opening area (central and side atrium type), and internal door area (cross ventilation).

__Thermal mass description.__ Users can characterize the thermal mass of the building by defining: slab thickness, surface (expressed as a percentage of the occupational floor area), building material (concrete, brick or steel), a floor type (exposed, carpeted, raised), and a ceiling type (exposed or suspended). Including the effect of thermal mass in the simulation is optional.

Window control strategies. For simulations in winter conditions, CoolVent offers the possibility to a) close the windows if the ambient temperature drops below a user-specified temperature; and/or b) close the windows and turn on the heating if the inside temperature of any of the zones drop below a user-specified temperature.

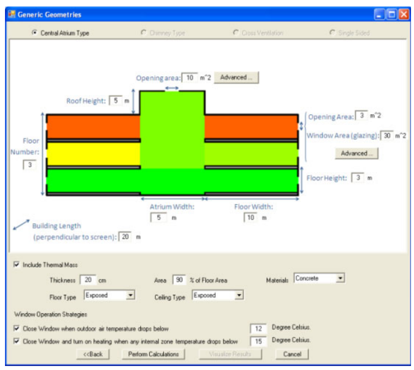

Figure 3 Window used to enter detailed information of the building (dimensions, thermal mass properties, control strategies, etc.).

Output

The simulation can be run once all the input parameters have been specified. Running the calculations takes less than a minute. Results (zone temperatures and airflows) can be presented in three different formats: as visualization, as data plots, or as a text file.

Visualization

Figure 4 shows the output of a simulation for the building at a specific instant (screenshot). Each zone of the building is colored according to its temperature, based on a chromatic scale (darkest blue and red for lowest and highest temperatures, respectively). Colored arrows indicate the direction and temperature of the air flow into and out of each zone, and numerical displays provide the magnitude of the airflow rate, in cubic feet per meter (cfm). A list of the temperatures (in ºC) for each zone can be found on the lower part of the visualization window. In the near future, a wider availability of output units (e.g., ºF, L/s) will be implemented.

Transient simulations are visualized as an animation, with an adjustable time interval between each screenshot. Steady simulations are presented as a single screenshot.

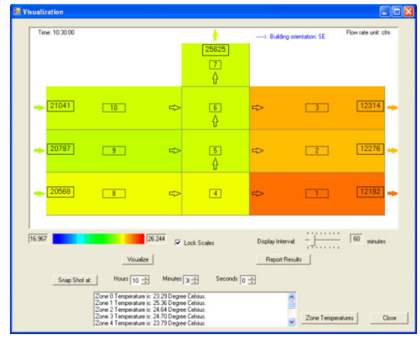

Figure 4 Visualization of results: a chromatic scale indicates the temperature of each zone and the air flow; arrows represent the direction of the flow; black rectangles show ventilation rates (cfm).

Plots

For transient simulations, it is possible to view in plots the temperature variation of the building over 24 hours. Each plot contains two curves: one representing the temperature variation of a specific zone, and the other showing the change in ambient temperature, over time (Figure 5).

Output file

Temperature and airflow results can be exported into a text file, separated by zone and time of day.

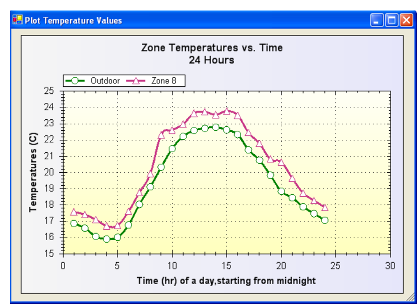

Figure 5 Plots show the variation of a zone's temperature (pink) and the outdoor temperature (green) over a 24-hour simulation.

MODEL AND CALCULATIONS

CoolVent calculations are based on a multi-zone airflow model. That is, the building is represented as network of multiple zones connected by airflow paths, to which the flow and energy equations can be applied. In each zone, temperature and pressure are assumed to be uniform (i.e., well-mixed zones).

Two equations drive the dynamics of the system: the power-law orifice equation, and energy conservation equation. Both expressions are non-linearly dependent, and must be solved simultaneously in order to obtain accurate airflow and thermal results. The following sections provide an overview of the method implemented in CoolVent to solve the system. A detailed description of the validation for such methods can be found in (Yuan 2007).

Airflow: Orifice equation

The mass airflow rate F_{ij} through an opening that connects zones *i* and *j*, is obtained by:

$$F_{ij} = C_d A \left(\frac{2\,\Delta P_{ij}}{\rho}\right)^n \qquad (1)$$

where ΔP_{ij} represents the pressure drop between *i* and *j* the zones, ρ is the density of the air going through the opening, A and C_d are the cross sectional area and the discharge coefficient of the opening respectively, and the flow exponent n is a constant, assumed to be 0.5 for large openings such as doors and windows (Walton and Dols 2006). Following the equation for mass conservation, and assuming no air sinks or sources, the sum of all flows F_{ij} must be zero.

The discharge coefficient C_d depends both on the geometrical characteristics of the opening (size, shape, depth, etc.) and on the nature of the flow. For turbulent flow going through a rectangular sharp-edged orifice, C_d is approximately constant and equal 0.6 (Etheridge and Sandberg 1996).

The pressure drop between the two sides of the opening can be calculated from the Bernoulli equation for steady flow:

$$\Delta P_{ij} = [P_i - \rho_i g(h_0 - h_i)] - [P_j - \rho_j g(h_0 - h_j)] + C_p \frac{\rho v^2}{2}\, sign(v) \qquad (2)$$

where P_x, ρ_x, and h_x are the static pressure, density and elevation (relative to the ground) of zone x, respectively, h_0 is the height of the opening (relative to the ground), g is the constant of gravity, v is the ambient free wind velocity, and C_p is the pressure coefficient of the opening. The sign of v defines the direction of the flow, and is positive if the air flows from zone *i* to zone *j*.

The pressure coefficient C_p depends on several factors, such as wind direction, wall porosity (i.e., opening-to-wall area ratio), ground roughness, height of surrounding buildings, amongst others.

Heat transfer: Energy conservation equation

Assuming the absence of any air humidification or dehumidification process, the equation of energy for an internal zone *i,* connected to one or more zones *j*, states:

$$\rho_i c_{p_{air}} V_i \frac{dT_i}{dt} = \sum F_{ji} c_{p_{air}} T_j - \sum F_{ij} C_{p_{air}} T_i + Q_{TMi} + Q_i \qquad (3)$$

where F_{ji} and F_{ij} are the incoming and outgoing mass flow rates from and into zone *i*, T_i and T_j are the temperatures in each zone, V_i is the volume of air contained in zone *i*, and $c_{p_{air}}$ is the specific heat capacity if the air. The term Q_i represents all the heat loads in zone *i* that are not related to thermal mass effects. In CoolVent these loads correspond to occupancy (people and appliances/office equipment), solar radiation (direct and diffuse), and heating (only if the corresponding window control strategy was selected –see previous section). The heat gains and losses through the thermal mass are represented by the term Q_{TMi}.

Thermal mass

Heat gains and losses in zone *i*, Q_{TMi}, due to the thermal mass of surfaces *x* (walls, ceiling, floor), are calculated by:

$$Q_{TMi} = \sum_x h_x A_x \left(T_{TM_x} - T_i\right) \qquad (4)$$

where h_x, A_x and T_{TM_x} are the convective heat transfer coefficient, the surface area and the temperature of thermal mass *x*, respectively. For these calculations, one-dimensional transient heat transfer through the thermal mass is assumed. Note that the outdoor temperature (thus the temperature gradient) in transient simulations changes with each iteration, according to the weather data.

The solution for the temperature T_{TM_x}, is obtained by dividing the thermal mass thickness into a series of "layers", each of them with a specific thermal resistance, and solving the energy equation, as will be seen in next section.

Coupling airflow and thermal models: Numerical solution

The non-linear dependence of the air temperature and airflow rate requires the use of numerical methods to obtain a solution to the system. Two methods can be used, both consisting of a series of iterations over different time steps with intervals of *Δt*. On the first method, called explicit method or "forward Euler", the term corresponding to step *t+1* is only found on the left side of the equation. On the second method (implicit or "backward Euler"), almost all terms, on the left and right side of the equation, refer to the time step *t+1*. The first method is straight forward, but lacks stability; the second method requires considerably more computational time (Yuan 2007).

The numerical method implemented in CoolVent ("Cranck-Nicholson" method) uses an average value of both the explicit and the implicit solutions, as shown in equation 5.

$$\rho_i c_{p_{air}} V_i \frac{T_{i,t+1}-T_{i,t}}{\Delta t} = \frac{1}{2}\begin{pmatrix} \sum F_{ji} c_{p_{air}} T_{j,t} - \sum F_{ij} c_{p_{air}} T_{i,t} + \\ \sum_x h_{x,i} A_{x,i} \left(T_{TM_{x,i}} - T_{i,t}\right) + Q_i \end{pmatrix}$$
$$+\frac{1}{2}\begin{pmatrix} \sum F_{ji} c_{p_{air}} T_{j,t+1} - \sum F_{ij} c_{p_{air}} T_{i,t+1} \\ + \sum_x h_{x,i} A_{x,i} \left(T_{TM_{x,i}} - T_{i,t+1}\right) + Q_i \end{pmatrix} \quad (5)$$

In a similar fashion, the term $T_{TM_{x,i}}$ is obtained by using the Crank-Nicholson method with the energy equation for the thermal mass:

$$\rho_{TM} c_{p_{TM}} \Delta x_i \frac{T_{i,t+1}-T_{i,t}}{dt} = \frac{1}{2}\left(\frac{T_{i-1,t}-T_{i,t}}{R_{i-1}/2 + R_i/2} - \frac{T_{i,t}-T_{i+1,t}}{R_i/2 + R_{i+1}/2}\right)$$
$$+\frac{1}{2}\left(\frac{T_{i-1,t+1}-T_{i,t+1}}{R_{i-1}/2 + R_i/2} - \frac{T_{i,t+1}-T_{i+1,t+1}}{R_i/2 + R_{i+1}/2}\right) \quad (6)$$

where ρ_{TM} and $c_{p_{TM}}$ are the density and thermal capacity of the thermal mass, and Δx_i, T_i, R_i are the thickness, temperature and thermal resistance of layer i. The thermal resistance is convective for the first and last layers, and conductive for all the others.

The boundary conditions are: the temperature of the zones connected by the thermal mass, and a direct heat flow term (assumed to be zero, since in the current version of CoolVent the heat gains from direct solar incidence on the walls are not taken into account).

Results in transient simulations correspond to the last 24 hours of a 96-hour calculation.

Limitations of the model

Well mixed air assumption. One of the major assumptions of this model is well mixed air in each zone. For most buildings this fact is far from reality: air is usually stratified within a zone. Consequently, buoyancy forces appear even in cross-ventilation designs, and affect the airflow dynamics of the system. For instance, except for single-sided ventilation, the simulation will not show any difference between a building with two vertically-spaced openings of area A/2, and one with a single opening of area A. In reality, the first configuration leads to better ventilated zones than the second one.

Open plan assumption. The current simulation assumes a "perfect" open plan configuration: it does not account for any airflow resistance within each zone. This condition is not applicable for closed plan designs, where walls and doors may reduce the airflow rate considerably. Furthermore, if such internal divisions have a large thermal mass, the solution provided by the current simulation may differ greatly from the real case.

Radiative heat sources. The model does not account for radiative heat transfer between the internal zonal surfaces. This assumption may have an important effect on the temperature calculation.

Solar radiation through roof openings Although the current model incorporates the effects of solar radiation through the side windows, it does not account for such effects through the roof openings. As a consequence, the temperatures in the upper north-facing zones may be underestimated. Furthermore, not including such heat gains prevents the current version of CoolVent from modeling solar towers –a widely-used natural ventilation strategy.

RESULTS

This section presents four cases of how CoolVent may be used to define the basic dimensions and orientation of a building, so that the indoor conditions remain within comfort standards. The cases are divided into steady and transient simulations.

All the simulations assume an urban terrain type and a surrounding height of buildings of 5m.

Steady simulations

Steady simulations may be performed when the user wants to understand the basics of natural ventilation (e.g., what is the impact of increasing the area of an opening on temperature/airflow? or that of separating two openings vertically? how does wind affect a specific natural ventilation strategy?) without the need to simulate a 24-hour period.

The results in this section show the impact of vertical separation between single-sided openings, and of wind speed in cross ventilation on indoor conditions. For both cases ambient temperature is set at 20ºC.

Single-sided ventilation: Impact of vertical separation between two openings

A classroom (floor area: 56m^2, height: 5m, heat load: 40W/m^2) has two equally-sized openings of 1m^2 each. Both openings are equidistant to the vertical center of the room. Two vertical separations between the openings are analyzed: 1m and 4m.

Figure 6a and Figure 6b show results for the simulations with small and large separation, respectively. Note that to compensate for the assumption of fully mixed zonal air, CoolVent divides single-sided ventilated rooms into two horizontal zones.

The average internal room temperature is 24.6 ºC and 23ºC and the air flow rate corresponds to 0.30 and 0.48 m^3/s (637 and 1013 cfm), for the small and large opening separation, respectively. Thus, a larger vertical separation between two openings results in higher airflow rates (consistent with eq. 2) and, consequently, in lower indoor temperatures.

Note that if the area of the opening is relatively small, a large ventilation rate will translate into a high speed of the air jet coming into the room. According to ASHRAE, if such speed exceeds about 1m/s the occupants will feel uncomfortable (and the sheets of paper will begin flying off from desks).

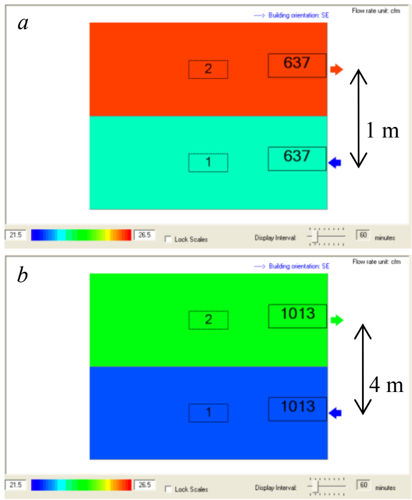

Figure 6 Temperature (ºC) and air flow rate(cfm) difference for a) 1m, and b) 4m vertical separations between openings in single-sided ventilation. The bounds of the chromatic scale are 21.5ºC (dark blue) and 26.5 ºC (bright red).

While obtaining the internal air speed requires modeling the jet –a calculation not implemented into CoolVent yet--, upper and lower bounds can be estimated by calculating the speed of the air at the smallest and largest openings, respectively. In this particular case, with openings of $1m^2$, the air speed through the windows is about 0.3 m/s and 0.5m/s, for the first and second simulations respectively.

In conclusion, while both classroom configurations provide the occupants with comfortable indoor conditions, a larger vertical separation between the openings will guarantee lower temperatures, without exceeding the internal air speed limits.

Cross ventilation: Effect of wind speed

A single-floor office building (width: 10m wide, height: 4m, heat load: $30W/m^2$) is divided into four zones of 5m long (each), connected in series (Figure 7). The area of the openings linking each zone internally (doors) is $2.5m^2$, and the total opening area of the windows connecting zones 1 and 4 with the exterior is $2m^2$. Two wind speed conditions are analyzed: 1m/s and 3m/s (Figure 7a and Figure 7b, respectively). The building has an East-West orientation, and the wind blows from West to East.

As results show, the temperature between external and internal temperatures ranges from 21.2ºC to 25ºC for low wind speed conditions, and from 20.4ºC to 21.7ºC for high wind speeds. Also, the air flow rate triples from the first case to the second, from 1.0 to 3.0 m^3/s (2132 to 6414 cfm). The airspeeds at the windows and

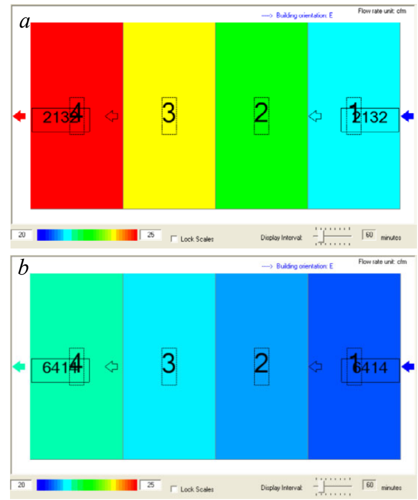

Figure 7 Temperature (ºC) and air flow rate (cfm) difference for a) 1m/s, and b) 3m/s stream air speeds in cross ventilation. The bounds of the chromatic scale are 20ºC (dark blue) and 25 ºC (bright red).

doors rise from 0.5 to 1.5 m/s, and from 0.4 to 1.2 m/s, respectively.

The effect of wind speed is clear: higher wind speeds contribute to higher ventilation rates, and thus to lower indoor temperatures. Once again, however, a wind speed of 3m/s for this particular case results in an internal airspeed that may be excessive close to the window. Several modifications in the building design –aside from the option of partially closing the windows– can help to reducing the internal airspeed and ensuring the occupants' comfort: decreasing the area of the window openings (which would increase the temperature gradient); increasing the area of the window openings (to keep or reduce the temperature gradient); or even changing the building orientation.

Transient simulations

These simulations provide an overview of the airflow and thermal dynamics of a building behave over a 24-hour period, given real weather data. In this unsteady case, changing factors such as thermal mass and building orientation have important effects on the indoor conditions of a building. Such effects will be studied in this section.

Side atrium configuration: Effect of thermal mass on indoor temperature

A side atrium-type residential has three floors (floor area: 200m^2, floor height: 3m, occupational heat load: 20W/m^2). Each floor has window openings of 1.8m^2 and glazing area of 6m^2. The roof is 3m high (with respect to the top of the third floor), and has openings of 20m^2. The building has an East-West orientation.

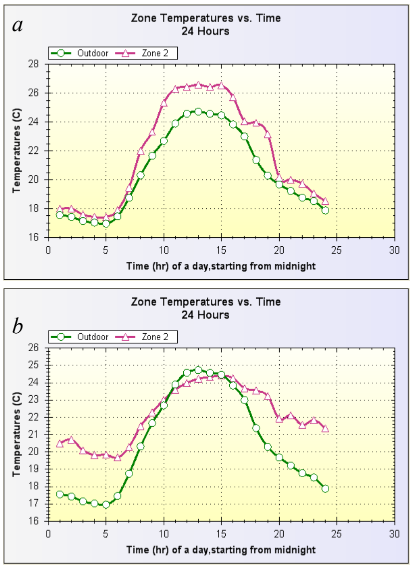

Figure 8 Resulting temperature variations of transient simulations a) without and b) with the inclusion of thermal mass in the analysis. The temperatures of a typical internal zone (pink), and that of the outdoors (green) are plotted over a 24-hour period.

Two cases are studied: one where thermal mass is neglected –an acceptable approximation when construction materials are light– and other considering 20cm-thick concrete slabs, with exposed ceiling and floor.

The weather data for this simulation corresponds to that of the month of April in Houston, TX.

The best way to visualize the effects of thermal mass is through plots. Figure 8a and Figure 8b show the variation of the temperature (triangles) in zone 2 (second floor of the building) for the simulations without and with thermal mass, respectively. Both plots show additionally the variation of ambient temperature (circles).

Note that these results are based on the assumption that windows are open at all times of the day. Any divergence from this assumption may result in a very different output.

Central atrium geometry: Effect of building orientation on air flow

The orientation of a building affects how the sun warms the different zones, and how the wind hits each façade. This, in turn, determines whether buoyancy- or wind wind-driven forces dominate the flow dynamics and internal temperatures. As wind conditions vary greatly from one location to another and throughout the year, the resulting flow behavior can be rather unpredictable without a transient simulation. For some cities, the orientation of a building could be a decisive factor on the kind of natural ventilation strategy to be implemented.

A central atrium-type office building has three floors (floor area: 2x200m^2, floor height: 3m, occupational heat loads: 30W/m^2). Each floor has 3m^2 of window openings and 30m^2 of glazing area (50% of the façade) on each side. The roof is 3m high (with respect to the top of the third floor), and has openings of 10m^2. The thermal mass properties are the same as in the previous section, but only 10 cm thick. The temperature and airflow conditions for two building orientations, North-South (NS) and East-West (EW) are compared, for the same time of day: 12:30 pm.

The simulation is set in Boston, for the month of June. A different flow regime is observed for each case: on a NS orientation (Figure 9a) wind forces dominate over buoyancy, and thus the air flows with cross ventilation. On the other hand, on an EW orientation (Figure 9b) buoyancy forces dominate and the air flows out exclusively through the roof openings. This difference in flow (relatively constant throughout the 24-hour simulation) is due to the fact that in June, Boston winds run predominantly from North to South.

During the day, air flow rates through the occupied zones reach up to 13.9 m^3/s and 7.7 m^3/s, while the maximum internal temperatures correspond to 25ºC and 28 ºC, in the NS and EW orientations, respectively. The airspeeds through the openings are closer to the comfort range in the EW building, yet still higher than 1m/s. Smaller openings or a higher thermal mass may contribute to reducing both air speed and temperature.

No cross effects of solar heat gains and building orientation can be appreciated zone by zone in these simulations. This is because of the air flow rate is high enough that the air rapidly mixes inside the building, and homogenizes the air temperature.

FUTURE WORK

- As mentioned within the current limitations of the simulation, air stratification within zones, closed plan configurations, internal radiative heat transfer, and solar heat loads through roof openings should be incorporated into the model.

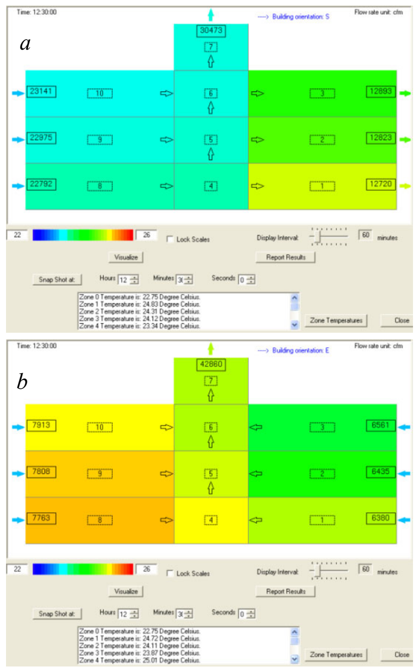

Figure 9 Indoor conditions of a central atrium building, located in Boston, during the month of April (screenshot of 12:30 pm). Two building orientations are simulated: a) North-South, b) East-West. The chromatic scale ranges from 22ºC (dark blue) to 26 ºC (bright red). Air flow rate (solid rectangles) is expressed in cfm.

- The use of thermal mass for night cooling is an important natural ventilation strategy used for climates where the daytime ambient temperature is higher than the desired comfort temperature inside a building. It is therefore important to consider incorporating this design into CoolVent.
- Usually the openings on the first floor of a building have different properties than those in the other floors (e.g., there may be several doors and no windows on the first floor, and several windows but no doors in the upper floors). Although one of the main features of CoolVent is having a simple interface, it may prove useful to distinguish the lower floor geometrical parameters from the others.
- Given that reducing energy consumption is within the main objectives of the use of natural ventilation, it would be useful to provide the user with information about the energy consumption of the building, with and without the use of natural ventilation.
- Finally, usability tests of the software's interface should be performed, to ensure that the end users (architects) will successfully adopt CoolVent as a modeling tool.

CONCLUSION

Several factors influence the performance of natural ventilation systems in buildings. CoolVent is a user-friendly tool developed to assist the architect in understanding such influence, during the early stages of a design. (Once the final design has been defined, a full CFD simulation of the building may still be needed, in order to have a detailed model of its indoor airflow and thermal dynamics.)

The program predicts the temperature and ventilation rate through the different zones of a building, using a multi-zone coupled thermal and airflow model. A visualization of the output allows the user to have an easier understanding of the flow and thermal dynamics inside the building. Steady and 24-hour simulations can be performed.

Four case studies presented in this paper show how some parameters of the building's geometry or location affect its internal temperature and air flow. An adequate design of natural ventilation systems can lead to considerable savings in the energy consumption of a building, while maintaining the indoor comfort levels within acceptable limits.

ACKNOWLEDGMENT

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REFERENCES

Etheridge, D., and M. Sandberg. 1996. *Building Ventilation: Theory and Measurement*. John Wiley & Sons.

Loftness, V. 2004. Improving Building Energy Efficiency in the US: Technologies and Policies for 2010 to 2050. prepared for the PEW Center on Global Climate Change, http://www.house.gov/science/hearings/energyO4.

Tan, Gang. 2005. Study of Natural Ventilation Design by Integrating the Multi-Zone Model with CFD Simulation. Massachusetts Institute of Technology.

Walton, G. N., and W. S. Dols. 2006. CONTAM 2.4 User Guide and Program Documentation. NISTIR-7251. National Institute of Standards and Technology. Technology Administration, US Department of Commerce. Web site: http://www.bfrl.nist.gov/IAQanalysis/CONTAM/userguide. htm.

Yuan, Jinchao. 2007. Transition Dynamics Between the Multiple Steady States in Natural Ventilation Systems: From Theories to Applications in Optimal Controls. Massachusetts Institute of Technology.

A SCALABLE LIGHTING SIMULATION TOOL FOR INTEGRATED BUILDING DESIGN

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ABSTRACT

Integrated building design processes involve multiple disciplines and synthesize building designs in an adaptive-iterative manner. To achieve a high quality design, considerations from the various domains occur concurrently and are used collectively to ensure holistic design decisions. However, differing semantics in the disparate disciplines, non-interoperable tools and datasets, as well as the difficulty in accessing tacit expert knowledge across domains pose significant challenges to the integration of cross-domain collaborations. This paper documents our experience in conducting lighting simulation in actual building projects and our development of a scalable lighting simulation tool that demonstrates effective support for integrated design processes.

INTRODUCTION

The use of detailed simulations in architecture design has typically been associated with high costs in terms of time, manpower, training and computational resources (Bazjanac, 2001, Wong et al, 1999, Lam et al., 2004). With the mentioned information and interoperability issues in integrated design, the substantial resource requirements associated with simulations pose significant challenges to their pervasive use. By capitalizing on concepts of Shared Object Models (SOM) and plain-text markup languages (XML), this paper presents how much of the effort in conducting simulations can be automated and typical errors avoided. By using typical scenarios of concurrent energy and lighting considerations in a building project, this paper demonstrates how the preparation of input models for lighting simulations that traditionally take hours or even days can now be completed within seconds.

While simulations are excellent at evaluating the performance of building designs, the varying levels of detail (LOD) and ambiguity as a design develops limit the usefulness of traditional simulation tools and metrics from providing operative information for design decisions. As an example, the progressive availability of various building parameters results in the use of different simulation techniques and consequently not useful to performance tracking and review. This paper shows, by analogy of typical lighting design development that entails energy concerns, how the new design support tool scales effectively and provides operative information for decision making throughout the design process.

Through recounting our experience in conducting lighting simulation in actual building projects, obstacles to using lighting simulation tools are identified. A list of pertinent features is then suggested that may alleviate the low usage in practice. This list is checked against findings in contemporary research and used to guide the development of a new scalable lighting simulation tool. The same use-cases are used to demonstrate the effectiveness of the new tool.

LIGHTING SIMULATION IN INTEGRATED CONCURRENT DESIGN

The Center for Building Performance and Diagnostics, in conjuntion with United Technologies Research Center, developed integrated solutions for a quick service restaurant. To achieve a high performance holistic design solution, the multidisciplinary team collaborated in an integrated concurrent design process. The benefits and challenges of integrated design have been well discussed and documented (NIBS, Lindsey, 2003, Deru, 2004). Concurrent design attempts to reduce the turn-around time and improve the efficiency of such multidisciplinary effort by conducting the various domain tasks in parallel.

From an initial set of design documents including digital 2D CAD drawings and specifications, a series of performance mandates in the various domians were formed. The quantification of desired lighting perfomance led to the identification of appropriate benchmarks and metrics that can be used to evaluate, meaure and compare the appropriateness of various

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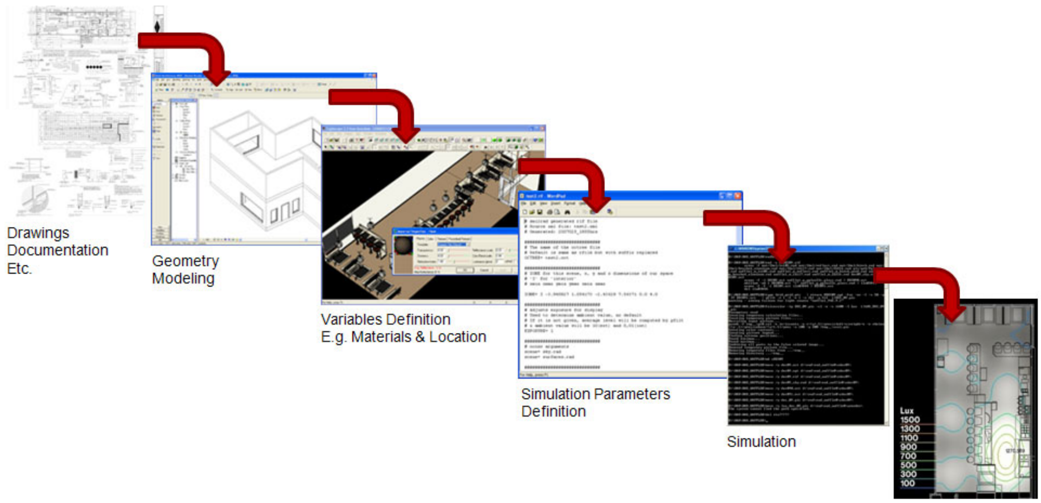

Figure 1 Multiple tools and duplicate entry of data

design strategies. By decomposing the benchmarks and metrics into fundamental radiance and irradiance levels, lighting simulation tools can be used to compute the latter efficiently. However, such results would then require further analysis and processing to become *operative* information; information that is relevant to and allows design decisions to be made. This remains largely a manual and repetitive task. It is noted that this process of problem formulation and analysis of simulation output requires much user expertise and tacit knowledge.

Even when the objectives for lighting simulation are well-defined, there remains much manual work that requires user expertise. The design information, essentially a building model, has to be remodeled with appropriate semantics for lighting simulation. Additional assumptions, such as geometric abstraction and material properties, have to be made. Often, part of this information is related to or duplicated by concurrent work in other domains. The sharing and checking of such information is done manually, error-prone and time consuming. Following the completion of the remodeling, much expertise is required to conduct the simulation and process the results. The entire process is thus time consuming, involves multiple tools and the problem of redundant data-entry and information exchange is further compounded by the non-interoperability of these tools (Figure 1).

Additional impediments to the efficient use of simulation tools in concurrent deign arise from the progressive nature of design development. First, the varying levels of detail (LOD) a design solution possesses as it develops and evolves limit the consistent use of lighting simulation tools and metrics through the stages of design. Since different facets of information are only available or refined at different stages of design, this entails the inevitable use of different performance metrics and corresponding tools at the various stages depending on what information is available. This hinders effective performance comparisons and progress tracking central to implementing integrated processes.

Second, some parameters in each domain task may be dependent on other domains or that information necessary for the tasks may not yet be available at that stage of design. Assumptions made in each domain may be conflicting with related assumptions in other domains, but the level of detail of the design may not yet be high enough for effective conflict resolutions, leading to consequences downstream.

From our experience, lighting simulation tools have shown to be potentially useful in supporting integrated concurrent design, though currently falling short by being too time-consuming and requiring significant expertise and resources to use. The varying LODs a design undergoes throughout the design process also pose significant challenges to effective simulation tool usage. The pertinent points within these two issues are summarized as follows:

Too time consuming

- Semantic differences – redundant effort in remodeling
- Interoperability – difficulty in information exchange between tools
- Operative information – repetitive and difficulty in processing results

Varying LOD

- Consistent metrics – difficulty in implementing consistent technical method
- Information availability – missing information and difficulty in error-checking

In this exercise, we used three tools: EnergyPlus and Desktop Radiance from Lawrence Berkeley National Labs, and Lightscape Visualization System from Autodesk. Identical tasks were performed on all three tools. To model the effects of daylighting, EnergyPlus uses an enhanced split-flux which is based on a series of averaged values that approximate the effects of geometry and material properties in contributing to interior illumination. Desktop Radiance employs backward ray-tracing where virtual paths from each pixel of the final image are traced backwards into the scene following the behavior of reflections and refractions geometrically. In Lightscape, the radiosity model follows the principles of radiative heat transfer theory and solves an equation where each surface in the scene emit, receives and transfers light energy with all the other surfaces, but with equilibrium within the scene.

While the above mentioned findings (too time consuming and difficulty in handling LOD) were consistent for all tools, the different technical approaches, implementations and interfaces however, were noted to present varying opportunities and constraints in conducting lighting simulations within the integrated concurrent design context. A summary of the comparison between the three tools is presented in Table 1.

Table 1 Comparison of three tools

	EnergyPlus	**Desktop Radiance**	**Lightscape**
GUI	Limited, 3rd Party	Yes	Yes
CAD Import	No	Yes	Yes
Additional Modeling	Yes	Yes	Yes
Technical Method	Enhanced Split-flux	Global Illumination	Global Illumination
Simulation Time	3 min to simulate 1 year (8760 time-steps)	60 min to simulate 1 scene (1 time-step)	60 min to simulate 1 scene (1 time-step)
Graphical Post-process	No	Limited[1]	Yes
Results Output	Yes	Yes	No
Model Output	Open-source code and input/ output formats	Open-source code and input/ output formats	Proprietary code and input/ output formats
Batch Processing	Yes	Yes	Limited[2]

[1]Simulations produce either illuminance or luminance values, not both. Static analysis renders only of false color and iso-contour plots. No numerical value grids, averages nor interactive sampling.

[2]Proprietary formats inhibit batch processing input files for the similar scenes but different times or locations. Similar output format restricts batch processing results for analyzes.

LITERATURE REVIEW

Using modeling tools (Bazjanac, 2001) was found to be a difficult, time-consuming and error prone process. The effort to prepare for simulation and analysis of results was noted to be mostly manual and tedious, and accounted for almost all the effort and time spent; computational effort and time was insignificant by comparison. Geometry acquisition was particularly noted to be difficult, accounting for up to 80% of the effort in input preparation. While the findings were based on energy modeling, the similar nature of tasks and functionalities of tools available for lighting allow the findings to be applicable to the lighting domain.

Correspondingly, research (Augenbroe 1991, 2001) and industry surveys (Wong et al, 1999, Lam et al., 2004) have revealed a low usage of modeling tools in industry. The reasons for such included:

- Large amounts of data inputs were difficult and time consuming to prepare
- Outputs difficult to interpret and apply in design decision making, requires expert knowledge to translate to design information
- Difficult to ascertain level of accuracy

Contemporary lighting simulation tools (Ubbelohde, 1998, Kopylov, 1998, Roy, 2000, Bryan, 2002, Estes, 2004) were found to have the following shortcomings:

Difficult to use

- Hard to learn, frustrating to learn many tools
- Geometric input tedious and error prone

- Required inputs difficult to obtain
- Modeling limitations
- No feedback on accuracy
- Output difficult to interpret

Does not support integrated, concurrent design processes

- Difficult to transfer data between domains
- Does not validate assumptions
- Difficult to conduct parametric analysis
- Difficult to transfer findings between domains

For physically accurate tools, only Radiance, Lightscape Visualization System (since then acquired and discontinued by Autodesk, Inc), and Inspirer from Integra Inc. (not distributed in United States) were mentioned. All the tools require significant effort in remodeling building geometry. "Simplistic" tools such as Lumen Micro from Lighting Technologies Inc. often achieve user-friendliness at the expense of accuracy, often to the extent of being unsuitable for use in architecture design. At the other extreme, the highly accurate Radiance tool was difficult to use, requiring much training and time to use well.

A recent survey (McGraw-Hill, 2007) shows that 28% of building firms in the United States use Building Information Models (BIM) and estimates this figure to grow to 49% by 2009. The main motivation cited by the respondents to adopt BIM is the ability to reduce costs by spending less time reentering data manually and other repetitive tasks, and improving communication among stakeholders. The survey also notes an average of 49 hours spent per project on building codes checking and a significant industry interest in automated code checking technology.

A NEW LIGHTING SIMULATION TOOL

Based on the findings from the use of lighting simulation tools and literature review, a new lighting simulation tool is developed with the objective of reducing the time and effort required to use lighting simultaion tools in integrated concurrent design. This is achieved by making the tool 1) interoperable with other tools so that it can exchange and reuse information modeled in other tools regardless of semantics, 2) scable such that valid assumptions are used and that consistent metrics can be used notwithstanding the availability of information in various LOD, 3) provide funtionalities to process simultion results into operative information automatically, and 4) easy to learn and use throughout all stages of design.

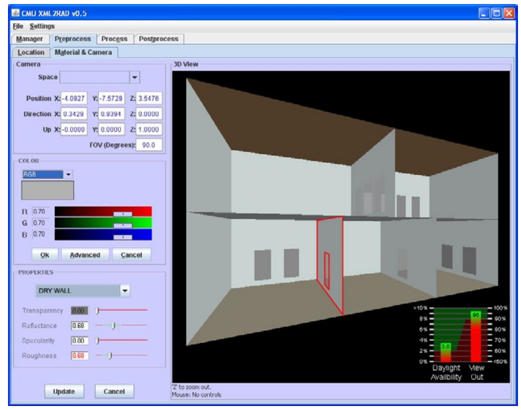

Figure 2 A new lighting simulation tool

Interoperability

Efficient information exchange and reuse is achieved by capitalizing on developments in Shared Object Models (SOM) and plain-text markup languages (XML). A model schema that is comprehensive enough to include all necessary information and semantically compatible with the diverse domain views, yet lightweight enough for efficient query and use, is developed by extending the gbXML schema (GBS, 2002) to include lighting information. This XML-based schema is used to construct a holistic BIM that is implemented across the design team as a SOM. The SOM can then be can be parsed into several lightweight domain specific Domain Object Models (DOM) by the different tools.

The new tool implements a semantic translator that parses the SOM automatically to form a DOM suitable for use by lighting simulation. There is now a seamless sharing and reuse of building information between the design tool (Revit), the energy tool (EnergyPlus via GreenBuildingStudio), and the new lighting tool (Figure 3). By eliminating the need for manual remodeling, error- and consistency checking, the single largest obstacle and time/effort-cost of using lighting simulation as mentioned in the earlier discussions is avoided.

Following the principles and benefits of utilizing a SOM, similar project-wide, application-independent datasets of construction types, materials, location and sky information are developed. The same extended XML-based schema is used to organize this information to ensure portability and ease of parsing.

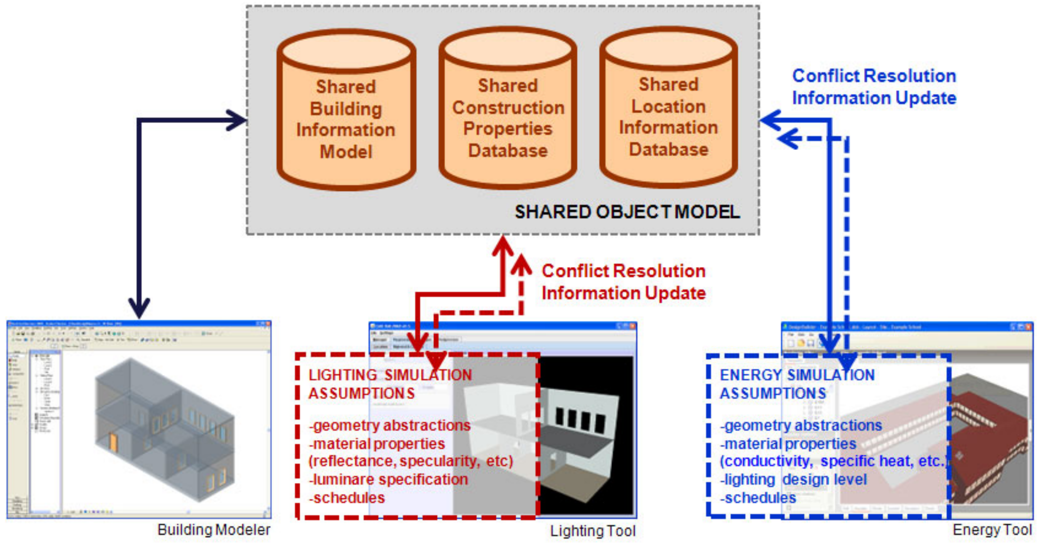

Figure 3 Error and consistency checking across domains via SOM

Together with the SOM, these data sets are shared across the project team. The use of common datasets across the design team can then ensure consistency in assumptions made in each domain. Specific user definition of variables and parameters can also be validated against these datasets automatically without the need for user intervention.

Scalability

To overcome the problem of incomplete or missing information due to the LOD of design, the idea of using appropriate placeholders is used to ensure a well-formed model at all times. This allows the use of a consistent benchmarks and metrics throught the design process. By completeing the SOM with information from the implemented external datasets, consistency between the various DOMs is ensured. This enhances concurreny since dependency between tasks is reduced, and the potential downstream problem of impossible specifications and products is avoided.

Given the fact that the building industry typically employs a relatively limited variety of standard practices, the preparation of this shared data set is relatively straightforward. A rule-based algorithm is used to populate the SOM by querying the shared datasets according to available information and the context of such information. In cases where the required information is absent from the dataset, a nearest-neighbor search allows the selection of appropriate values. The entire process is automatic and instantaneous; there is no need for user intervention to review the SOM or search for appropriate and consistent assumptions, the time and effort to prepare a well-formed lighting model is greatly reduced.

The problem of LOD, where information in the DOM is missing due to the stage of design, is essentially reframed as that of level of confidence (LOC), where the BIM is used keeping in mind that certain assumptions have been made. Scalability is achieved since a consistent methodology is used regardless of the level of information availability and precision. The use of LOC may also be more consistent with professional practice considerations such as due diligence and consistent with the progressive nature of design.

Operative Information

Besides the fundamental radiance and irradiance values, the new tool identifies common useful lighting codes and benchmarks to better provide operative information for design decisions. The additional benefit of using codes and benchmarks is that they eventually have to be evaluated during design submissions. Currently, codes and benchmarks are seldom used as performance metrics during design development because their calculation is often time consuming, both in terms of computation as well as documentation. The LEED rating system is a popular benchmark for high performance green buildings and includes two credits for lighting performance: daylight availability (EQ 8.1) and external view availability (EQ 8.2) in building spaces.

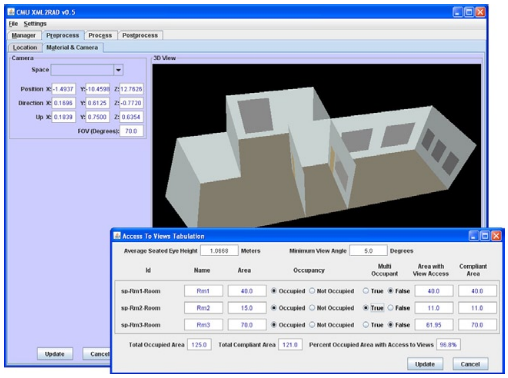

Figure 4 Automatic calculation of LEED EQ 8.2

To provide operative information in a timely fashion, the new tool formulates the two LEED credit procedures as computable problems, and optimize them for fast automatic evaluation. The typical LOD problem where nescessary information is only available in the later stages of design development is avoided by the LOC approach discussed earlier. The new tool calculates both credits in a matter of seconds and this information is available throughout all desgin stages (Figure 4).

The new tool also supports parametric studies and provides post-processing features including false-color, luminance and contrast ratio visualizations, various tone mapping functions, as well as results comparisons to provide metrics and analyses supporting typical lighting design decisions.

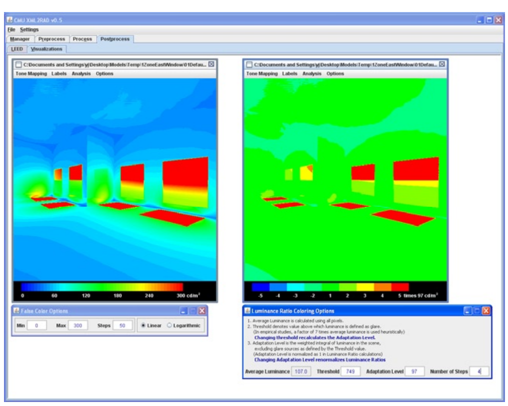

Figure 5 False-color (left) and luminance ratio (right) analyses. Corresponding feature options GUI below each image

User Interface

The design (Figure 2) of the graphical user interface (GUI) reinforces the workflow of simulations and the display of parameters is flexible to reflect the changing LOD along different stages of design. In keeping with the notion of LOC, the GUI employs color coding to cognitively distinguish between user specified values and those that are populated automatically by querying the datasets. Similarly, the recommended ranges of values for various parameters are presented in the same manner.

To facilitate faster cognition of the context of various attributes, the new tool uses an interactive 3D model viewer to let users inspect and edit the information. The tabulation of the LEED benchmarks are also dynamically linked to this viewer; changes made to the model results in an instantaneous update of the LEED evaluations. The tabulation format of these benchmarks is also consistent with submission requirements. This contributes to the reduction of common time consuming manual activities.

To improve the ease of use of the tool, help menus and documentation within the GUI makes explicit some of the tacit knowledge in conducting simulation. Together with the mentioned recommended value ranges and color-coding, the inspection of parameters and use of appropriate values is made easier; there is no need for additional research or depend on user expertise. Another objective of the documentation is to avoid the inappropriate use of metrics by highlighting the underlying methodologies in a succinct manner (Figure 6).

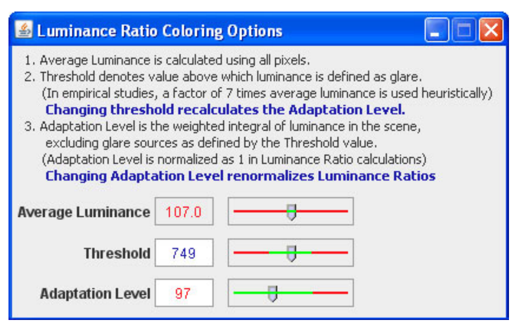

Figure 6 Luminance Ratio GUI

DEMONSTRATIVE USE

Two use-cases demonstrate the use of the new tool and the drastic reduction in time and effort required to use lighting simultaion tools in integrated concurrent design. In the first case, a lighting simulation is performed on a preliminary sketch design to assess the suitability of particular design strategies. In traditional practice, a lighting model would first have to be built from the design model, and missing attributes in the model researched and populated. Depending on the simulation tool to be used, appropriate input files will then have to be prepared from the lighting model. After successful simulation, the results will then be analyzed to provide information in suitable performance metric. The entire process would typically take hours if not days, even when excluding simulation computation time. The user is also expected to be highly trained with much domain expertise and knowledge.

When using the new tool (Figure 7), the building model that serves as the project SOM is exported from the design CAD tool in a XML-based format. This is parsed by the new tool automatically to build a lighting DOM. The necessary geometry processing and population of missing information based on the externalized data and contextual rule sets are performed instantaneously and without any user intervention. The user can inspect and edit all parameters if desired. In the case where LEED performance benchmarks are used, the results are available within seconds. In the case that a detailed simulation is desired, all necessary input files are prepared automatically. Once simulation computation finishes, the tool provides a host of analysis and visualization features to aid the generation of operative information from the simulation output. The entire process, excluding simulation computing time, takes only seconds, and is almost completely automatic. In comparison, there is no need for special training or expertise requirement when the new tool is used.

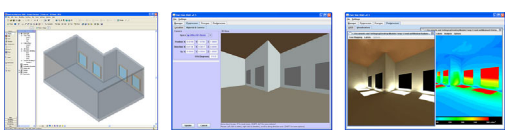

Figure 7 Existing design model from external CAD software (left). Automatic processing and population of missing values instantaneously and without user intervention (middle). Simulation results and analysis (right).

In the second use-case, lighting simulation is performed on developing design; simulation is used to guide decisions on optimal strategies. Multiple domian considerations are undertaken concurrently following the tenets of integrated design. In this case, the user is forming a better understanding of the design problem and exisiting (partial) solution. By making minor changes in the model, the user might test his theories inductively and perhaps arrive at new ideas for improving performance. In this case, updates in the performance metrics should be fast, ideally in real-time. In traditional practice, the time-constraint is a major obstacle given the multiple manual tasks described in the first use-case. Since contemporary lighting simulation tools do not explictily support parametric studies, the entire process has to be duplicated for each design iteration. The time consuming process of analyzing lighting performance also impedes the workflow of comparative design investigations.

When using the new tool, the lighting model is prepared effortlessly as demonstrated in the first use-case. In the case that the SOM is repeatedly changed, the same workflow in the previous use-case applies. For parametric studies on lighting related parameters on the same SOM such as time and material properties, the new lighting tool includes a parametric files generator that automatically generates a sequence of simulation input files and a single batch file to execute the sequence of simulation runs.

The provision of fast LEED rating calculations (Figure 4) supports comparative studies by providing performance metrics dynamically and continuously. As an example, both LEED calculations and tabulations are updated within seconds when changes, such as material properties, are made to the model. Such metrics are available regardless of the stage of design and LOD of the SOM. Post-processing features such as comparison of simulation outputs are also available in the new tool to facilitate and reduce the time and effort in parametric studies.

CONCLUSION

The implementation of a project-wide SOM and data sets allows the new tool to achieve unprecedented interoperability for lighting tools. By automating previously manual modeling and conflict resolution tasks, the new tool drastically reduces the time and effort required to prepare lighting simulations.

The concept of LOC and innovation in formulating the LEED benchmarks as computable within seconds make consistent performance metrics available throughout all design stages. The list of post-processing features is similarly geared towards providing operative information that enables design decisions within time-frames suitable for design processes.

While the Radiance rendering engine is currently used for radiance and irradiace calculations, the benefits from the LEED benchmark algorithms suggest advantages in developing a new simulation engine.

The new engine should model lighting physics more comprehensively and allow performance metrics to be calculated more effectively; the metrics should be computed in time frames complementary to design processes and presented dynamically like what has been done for the LEED benchmarks.

ACKNOWLEDGMENT

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REFERENCES

Augenbroe, Godfried and Frederick Winkelmann. 1991. Integration of simulations into the design process. *Proceedings of Building Simulation '91*, pp. 367 – 734.

Augenbroe, Godfried. 2001. Building simulation trends going into the new millennium. *Proceedings of Building Simulation '01*, Rio de Janeiro, pp. 15-27.

Bazjanac, Vladimir. 2001. Acquisition of building geometry in the simulation of energy performance. *Proceedings of Building Simulation '01*, Rio de Janeiro, pp. 305 – 312.

Bryan, Harvey and Sayyed Mohammed Autif. 2002. Lighting/daylighting analysis: a Comparison. *Proceedings of the Solar Conference 2002*, Reno, Nevada.

Deru, M. and P. Torcellini. 2004. *Improving Sustainability of Buildings Through a Performance-based Design Approach*. Colorado: National Renewable Energy Laboratory.

Estes, James M., Susan Schreppler, and Tonya Newsom. 2004. Daylighting prediction software: comparative analysis and application. *Proceedings of Fourteenth Symposium on Improving Building Systems in Hot and Humid Climates*, Texas, pp. 259 – 267.

Green Building Studio. 2002. *gbXML Schema*. *Available at http://www.gbxml.org/. Last Accessed 31 January 2008.*

Kopylov, E. A. and A. B. Khodulev. 1996. *Physically Accurate Lighting Simulation in Computer Graphics Software*, presented at the Sixth International Conference on Computer Graphics and Visualization, St. Petersburg, Russia, 1-5 July 1996.

Lam, Khee Poh, Yi Chun Huang and Chaoqin Zhai. 2004. Energy Modeling Tools Assessment for Early Conceptual Design. Final Report to Northwest Energy Efficiency Alliance (Contract 10026). Pittsburgh, Carnegie Mellon University.

Lindsey, Gail, Joel A. Todd and Sheila J. Hayter. 2003. *A Handbook for Planning and Conducting Charrettes for High-Performance Projects*. Colorado: National Renewable Energy Laboratory.

McGraw-Hill Construction. 2007. Interoperability in the Construction Industry, SmartMarket Report. *Available online at http://construction.ecnext.com/coms2/summary_0249-259123_ITM. Published 24 Oct 2007. Last Accessed 30 Nov 2007.*

National Institute of Building Sciences. *Whole Building Design Guide. Available at* www.wbdg.org. *Last accessed 31 Jan 2008.*

Roy, Geoffrey. 2000. *A Comparative Study of Lighting Simulation Packages Suitable for use in Architecture Design*. Perth, Murdoch University.

Ubbelohde, M Susan. 1998. Comparative evaluation of four daylighting software programs. *Proceedings of ACEE Summer Study on Energy Efficiency in Buildings.*

US Green Building Council. 2005. *Green Building Rating System for New Construction and Major Renovations (LEED-NC)*, version 2.5.

Wong, Nyuk Hien, Khee Poh Lam, and Henry Feriadi. 1999. The use of performance based simulation tools for building and evaluation - a Singapore perspective. *Building and Environment* 35 (8), pp. 709 – 736.

News from IBPSA affiliates

IBPSA affiliates are asked to submit a report to the IBPSA Board each year to keep Board members informed about their activities and membership. These are too detailed to include in *ibpsa*NEWS, so affiliates have been asked to make their latest annual report available through their web sites, and this section includes only selected, recent news — in this issue, from Germany, China, Slovakia and a prospective new affiliate, India. Other news from affiliates is available from their websites:

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BauSIM
2008

IBPSA Germany: BauSIM2008

The second German-Austrian IBPSA conference BauSIM2008 was held at the University of Kassel in September 2008, chaired by Anton Maas. The main focus was on "Sustainable Building", and about 60 papers were presented, the majority of them from Germany, Austria and Switzerland. The three key note sessions were given by Hans-Dieter Hegner (Federal Ministry of Transport, Building and Urban Affairs, Germany), Ardeshir Mahdavi (University of Technology of Vienna, Austria) and Darren Robinson (École Polytechnique de Lausanne, Switzerland).

The conference included a specialized exhibition to provide institutions and companies with the opportunity to demonstrate their products and services available for building simulation purposes.

Clockwise from top left: the conference venue, the University of Kassel (two photographs); dinner at the Zentrum fur Umweltbewusstes (two photographs); the conference chairman, Anton Maas. (All photographs by Nils Klinger.)

IBPSA China: Global Building Energy Data Benchmarking

To address the issue of inconsistency in the investigation of global building energy consumption data, IBPSA China has organised a series of workshops on "Global building energy data benchmarking". The first was held at Tsinghua University, Beijing, in March 2007, organized by Prof. Yi Jiang from Tsinghua University and Prof. N. Vojislav from NTNU, Norway, and attended by 15 participants from 7 countries. The second was held in Sendai, Japan on 29 Oct. 2007, organized by Prof. Hiroshi Yoshino from Tohoku University and Prof. Yi Jiang from Tsinghua University. This was attended by 13 Participants from 6 countries. The discussion centred on the need to develop a standardized methodology for acquiring building energy use data, and concluded with a recommendation that a new Annex should be added to the International Energy Agency's ECBCS programme.

The 3rd workshop was held on 24-25 Aug. 2008 in VTT, Finland, hosted by Mr. Jorma Pietilianen, and attended by 20 participants from 12 countries. Proposals to form IEA ECBCS new annex and ISO/TC163 new standard were developed during this workshop.

IBPSA Slovakia

On 5 June 2008 IBPSA Slovakia hosted the Central European Regional IBPSA Conference in Bratislava. The Conference, attended by professionals from five countries — Austria, Czech Republic, Germany, Hungary and Slovakia — was held with two main aims: (1) to contribute to better understanding between designers and architect on one hand and the community of building physicists on the other, and (2) to provide a forum for information exchanges among the professionals active in this area in the Central European Region.

More information about the Conference is available at **www.cab.sk/cerc/index.html**. The conference proceedings can be obtained from:

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Update from India — a prospective IBPSA affiliate

The Centre for Environment Planning and Technology (CEPT), Ahmedabad, and the Alliance to Save Energy (ASE), USA, have launched a collaborative effort in India to train architects and professionals working within the building construction industry in the design of energy efficient buildings. The *Building Energy Simulation Capacity Development* project aims to equip relevant professionals with the skills and knowledge to conduct comprehensive building energy simulation exercises at an initial stage of building design, both for design optimization and for compliance with the recently-introduced Energy Conservation Building Codes (ECBC) which require whole-building energy simulation and rating.

The project has four key activity areas: holding Awareness and Training Workshops, conducting a Pilot Simulation Project, developing a *Getting Started — Guide to Energy Simulation* manual, and establishing an Indian Chapter of the International Building Performance Simulation Association (IBPSA). It is funded by the US Department of Energy, supported by USAID ECO III, and receives technical cooperation from the Malaviya Institute of Technology (MNIT) in Jaipur, as well as the International Institute of Information Technology (IIIT) in Hyderabad.

Two Awareness Workshops and two Training Workshops have already been held. The Awareness programmes are mainly intended for building developers, architects and government officials to give them a basic idea of energy simulation and highlight its role in building design processes. The Training workshops are intended for working professionals and take a hands-on approach with participants having to carry out simulation exercises and discussing the analysis with experts. More than 100 professionals are expected to complete both workshops in the next few months.

The Pilot Simulation demonstration project, the only one of its kind in India, is expected to be completed by the end of November 2008. To complement this, a *Getting Started — Guide to Energy Simulation* manual is under development as a resource tool for educators. This will combine a self-explanatory manual and an interactive tutorial and is expected to be available by the end of January 2009. It will cover the fundamentals of simulation and explain some of the more advanced capabilities of whole building simulation tools, with some relevant Indian-specific contextual aspects. Together, these two publications should give simulation enthusiasts a detailed insight into simulation processes.

Finally, the formation of IBPSA India is under way. This will take the form of an interactive portal where professionals can discuss relevant issues and collectively build simulation capacity in India.

IBPSA Sustaining Members

Sustaining members of IBPSA are those individuals or organizations that provide financial support to IBPSA at the level of US$500 or more per year. To learn about sustaining membership, please contact one of the IBPSA officers shown in this newsletter.

	US - DOE United States Department of Energy 1985-2009
	American Society of Heating, Refrigerating & Air-Conditioning Engineers 2003-2009
	REHVA Federation of European Heating & Air-Conditioning Associations 2003-2009
	IEA - ECBDS International Energy Agency - Energy Conservation in Buildings & Community Systems 2005-2009
	Tsinghua University 2007-2009
	China HVAC&R Society 2007-2009

IBPSA Central contacts

Newsletter Submissions

To submit Newsletter articles and announcements:
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Newsletter Editor

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Conferences sub-committee

Ian Beausoleil-Morrison chair and contact for information about IBPSA Building Simulation conferences
Members: Michel Bernier, Jan Hensen, Roberto Lamberts, Jeff Spitler (future conference location coordinator), Yingxin Zhu

Honors and Awards sub-committee

Lori McElroy chair
Members: Ian Beausoleil-Morrison, Wim Plokker, Jonathan Wright, Gerhard Zweifel

Membership Development sub-committee

Jonathan Wright chair
Members: Chip Barnaby, Dru Crawley, Karel Kabele (Affiliate Developments), Roberto Lamberts, Lori McElroy, Jeff Spitler, Christoph van Treeck

Public Relations sub-committee

Larry Degelman chair
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Website sub-committee

Roberto Lamberts chair
Members: Chip Barnaby, Dru Crawley, Karel Kabele, Christoph van Treeck

IBPSA Website (www.ibpsa.org)

For full information about IBPSA activities and organisation:
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For additional information about IBPSA, please visit the Association's web site at **www.ibpsa.org**. For information on joining, contact your nearest regional affiliate.

IBPSA's mailing list has recently been consolidated into another listserver known as BLDG-SIM, which is a mailing list for users of building energy simulation programs worldwide, including weather data and other software support resources.

To **subscribe** to BLDG-SIM, to unsubscribe or to change your subscriber details, use the online forms at **http://lists.onebuilding.org/listinfo.cgi/bldg-sim-onebuilding.org**.

To post a message to all members, send email to **bldg-sim@lists.onebuilding.org**.

The BLDG-SIM list is provided by GARD Analytics. If you have any questions, please contact the list owner Jason Glazer at jglazer@gard.com or +1 847 698 5686.

IBPSA Board of Directors

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Past Presidents of IBPSA:
1987-1991 (5 years) Ed Sowell, USA

1992-1993 (2 years) Dan Seth, Canada

1994-1997 (4 years) Joe Clarke, Scotland

1998-1999 (2 years) Larry Degelman, USA

2000-2001 (2 years) Roger Pelletret, France

2002-2005 (4 years) Jeff Spitler, USA

Privileges and Obligations of IBPSA Members and Affiliates

All members are encouraged and entitled to take part in the activities of IBPSA, subject to constitutional or special provisions by the management of IBPSA. The aims of the activities are to disseminate information and aid the progress of IBPSA's efforts and image.

All members have the right to participate in meetings of IBPSA, but the right to vote is subject to the provisions for voting as contained in the present By-Laws. Members holding their membership through an Affiliate are not eligible to vote if the Affiliate has not submitted its membership roster to the Secretary of IBPSA. Affiliates, therefore, need to keep their membership rosters up to date and communicate them to the Secretary.

All members joining IBPSA must undertake to observe the IBPSA constitution and By-Laws and all obligations arising from them. They must also accept the obligation to contribute to the accomplishment of the activities of IBPSA according to their particular competence.

Any member may submit any communication for consideration at a General or Special Meeting of IBPSA or the Board of Directors. The Board will indicate its decision on the proposals within a reasonable timeframe that allows for an IBPSA Board meeting, either in person or by e-mail.

Affiliates are entitled to appoint one representative to the Board and take part in activities of IBPSA. Affiliates, upon joining IBPSA, must undertake to observe the IBPSA constitution and By-Laws and all obligations arising from them. Special obligations of Affiliates include annual notification to the Secretary of IBPSA of the following items:

1. the name of the Affiliate's board representative
2. the Affiliate's membership roster
3. reports of meetings and/or conferences held by the Affiliate, and
4. other information or reports requested by the Board.

Resignation and Termination

Affiliates wishing to terminate their affiliation may do so at any time subject to 90 days notice. Notice of termination must be transmitted in writing to the Secretary. If all communications from an Affiliate to the Board have ceased for a period of two years prior to any Board meeting, that Affiliate will be considered to have resigned.