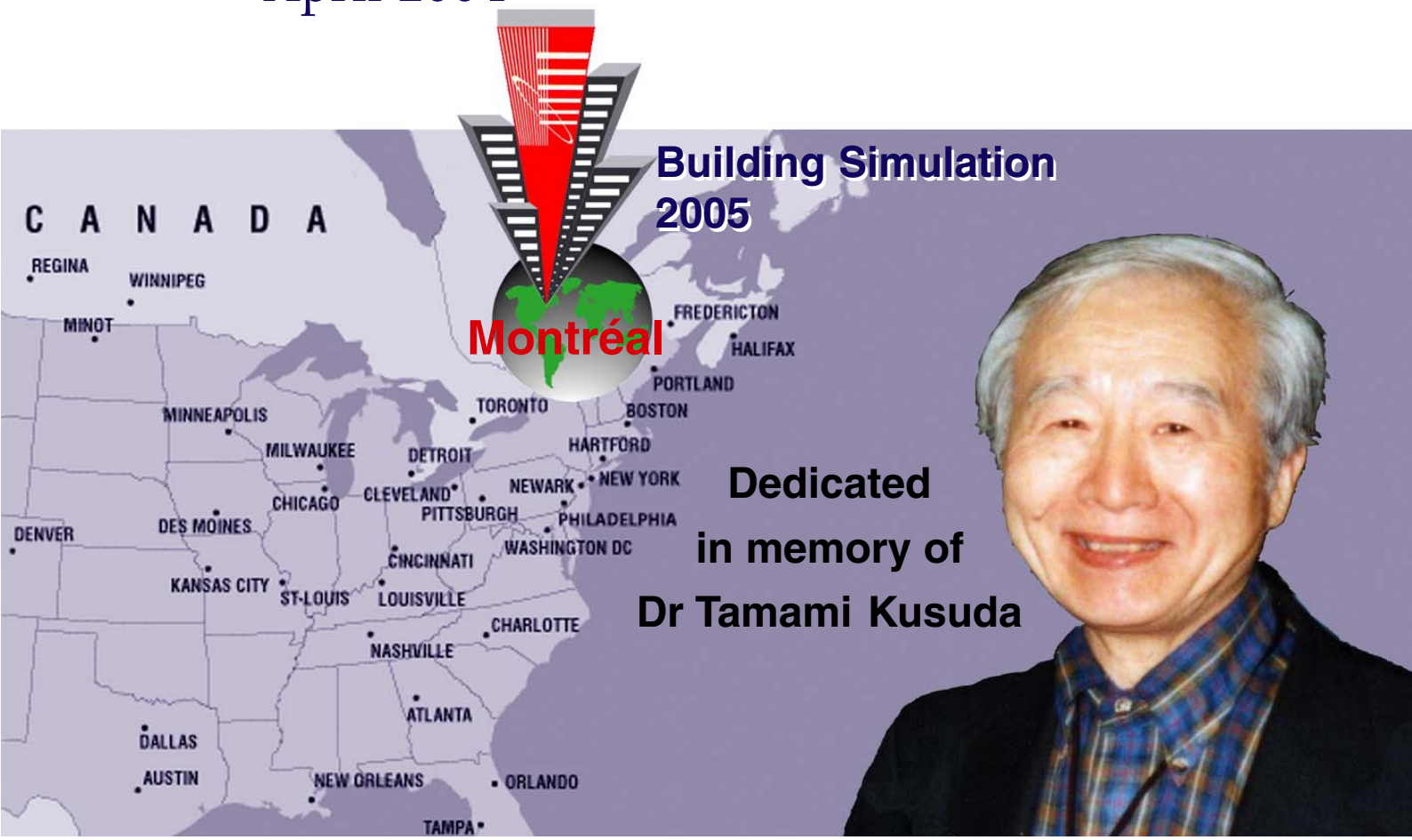
*ibpsa*NEWS

volume 14 number 1
April 2004



www.ibpsa.org

The journal of the International Building Performance Simulation Association

Contents

A Tribute to Dr Tamami Kusuda
1925 - 2003

Photo courtesy of NIST

Through a negligent, tragic and criminal act of a drunken hit-and-run driver on 17 October 2003, Tamami "Tom" Kusuda was killed while walking across Frederick Road from the Shady Grove Metro Station in Rockville, Maryland. As our sincere condolences go out to his family and close friends, we also pause to dedicate this News issue to his life and to recall his meritorious works over his professional career.

Dr. Kusuda was born in Seattle to Japanese parents and raised in Japan. He graduated from the University of Tokyo in 1947 and returned to live in Seattle in 1950. He received a master's degree in mechanical engineering at the University of Washington and, in 1955, a doctorate in mechanical engineering from the University of Minnesota. That same year (1955), he joined ASRE, the predecessor organization to ASHRAE. As

an ASHRAE member, Dr. Kusuda served on TC 4.7 (Energy Calculations), the Standards Committee, the Honors and Awards Committee, the International Activities Committee, the Research and Technical Committee, the Program Committee, TC 1.5 (Computer Applications), TC 4.2 (Weather Information), and technical committees and task groups on indoor calculations, energy requirements, survival shelters, heat transfer and psychrometrics. He received the Wolverine-ASHRAE Diamond Key Award, given for the best paper, in 1957, the Distinguished Service Award and the Crosby Field Award, given for the best paper presented at an ASHRAE meeting, in 1976. That same year he was elevated to the grade of Fellow. Later, he became a Life Member of ASHRAE and received the Louise and Bill Holladay Distinguished Fellow Award in 1987.

Dr Tamami Kusuda in Nagoya 1995 (photo courtesy of Dr Nobuo Nakahara)

Dr. Kusuda's professional career began as a staff engineer at the Worthington Air-Conditioning Company, New Jersey, during l955-1961, where he was engaged in the development of advanced heat pumps. In 1961, Dr. Kusuda joined the Center for Building Technology at NBS (now NIST). From then through the 1970s, his research laid the groundwork for thermal simulation methods and software to follow - notably his NBSLD program, which became the industry's entry point for newer generation software, like BLAST, DOE-2 and EnergyPlus, that are used throughout the industry and the design professions today. Dr. Kusuda retired from NIST in l986 as Chief of the Building Physics Division. While at NBS, he received the Silver (1972) and Gold (1980) medals of the U.S. Department of Commerce for his contribution to building energy analysis. Dr. Kusuda also taught in the department of civil, mechanical and environmental engineering at George Washington University, and he published over 100 technical papers in the area of building environmental design and energy conservation.

After retirement, Dr. Kusuda was a consultant to the Japan Technology Program (JTP) in the Technology Administration of the U.S. Department of Commerce. In this role, he assisted the director of the JTP in carrying out the mandates of the Japanese Technical Literature Act of l986 to improve the availability of Japanese science and engineering literature in the United States. He was involved in all phases of these activities from the program's inception in l987. Information thus obtained was placed into the databases at NTIS (National Technical Information Service) and the various databases of JICST (Japan Information Center for Science and Technology.) Some of the noteworthy

Dr Tamami Kusuda in Nagoya 1995
(photo courtesy of Dr Nobuo Nakahara)

Dr Kusuda with IBPSA President, Jeff Spitler at BS'99 in Kyoto (photo courtesy of Dr Jeffrey Spitler)

articles were translated and published through the Japanese Technical Literature Bulletin, a quarterly publication of which Dr. Kusuda was the editor.

Outside of his professional ties with NBS, ASHRAE, and JICST, Dr. Kusuda also committed himself to involvements with APEC (Automated Procedures for Engineering Consultants), IBPSA, and the formation of at least four international symposia (Gaithersburg, Banff, Paris, and Tokyo) on the use of computers for environmental engineering related to buildings. Most of the Charter members who hatched the idea of IBPSA in 1985 were among the participants of the well-known Gaitherburg conference in 1970, "***Use of computers for environmental engineering related to buildings***", the proceedings of which still sell for around US$99.95 (used) over the internet. The conference proceedings were a hallmark publication that many consider to be the impetus for the beginnings of IBPSA.

Dr Kusuda's creative works did not stop at retirement. IBPSA awarded him with the **Distinguished Service Award** in 1993 for his lifelong contributions to the field of simulation. He was a featured speaker at the Pan Pacific Symposium on Building and Urban Environmental Conditioning in the Asian District held at Nagoya University in 1995. He was also a keynote speaker at IBPSA's Building Simulation-1999 conference in Kyoto. His work continued into the 21st century; to wit, Kusuda, T., (2001), "Building environment simulation before desk top computers in the USA through a personal memory", ***Energy and Buildings***, Vol. 33, pp 291-302. To see his work come to an end is a big disappointment for all of us. Let me say on behalf of IBPSA, our colleagues and friends that we will surely miss the presence of Tom Kusuda at our conference gatherings. He always had valuable and noteworthy contributions to make and a friendly smile to go along with them. Truly, we will always regard him as an outstanding pioneer in the use of computer methods for analysis, simulation and design for energy efficiency in buildings.

from Larry Degelman, IBPSA Newsletter Chairperson

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IBPSA Website

For full information on how to order IBPSA's publications, or to look at Proceedings of past IBPSA Building Simulation conferences or past IBPSA Newsletters, please look on the IBPSA Website at: **www.ibpsa.org**.

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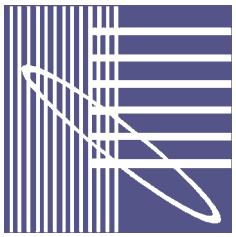

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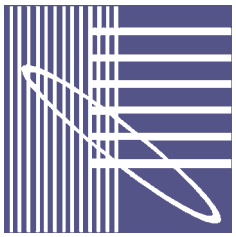

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Building Simulation 2005

www.ibpsa.ca/bs2005

August 15-18, 2005
École Polytechnique de Montréal

Deadline for abstracts 15 September 2004 - see next page

CALL FOR PAPERS
Building Simulation 2005
9th IBPSA CONFERENCE + EXHIBITION
15 - 18 August, 2005
Montréal, Canada

The Building Simulation 2005 conference and exhibition will be held at École Polytechnique de Montréal. The conference will consist of keynote speeches, presentations of high quality papers, software demonstrations, and plenary sessions. There will be several social events, including a banquet, an accompanying persons program, and post-conference tours. Details of these and of the conference programme will be available on the conference website: **www.ibpsa.ca/bs2005**.

The conference will be of interest to architects, designers, researchers, environmental engineers, city planners, simulation software producers, and all academics, professionals and practitioners involved in the wide range of disciplines associated with building performance simulation.

Conference fees are:

Early registration (before June 15, 2005):	**450 CAN $**
Late registration (after June 15, 2005):	**550 CAN $**
Full time students:	**200 CAN $**
Accompanying persons:	**100 CAN $**
Printed proceedings:	**70 CAN $**
Fee for additional paper:	**150 CAN $**
Discount for IBPSA members:	**50 CAN $**

The registration fee includes conference attendance, proceedings on CD-ROM, lunches, coffee breaks, banquet and welcome party. The accompanying persons' registration fee excludes conference attendance and proceedings.

Registration information will be posted on the conference website; in the meantime, for further information about the conference contact one of the following:

Organizing Committee :
Chair, Michel Bernier (**michel.bernier@polymtl.ca**)
Co-Chairs, Stanislaw Kajl (**skajl@mec.etsmtl.ca**) and Radu Zmeureanu (**zmeur@cbs-engr.concordia.ca**)
Scientific Committee:
Chair, Ian Beausoleil-Morrison (**ibeausol@NRCan.gc.ca**)

Montréal

Conference themes will include all aspects of modelling and simulation of the built environment including building service systems. A list of specific topics is given on the conference website.

The important dates are:

Abstracts due:	**September 15, 2004**
Abstract acceptance:	**November 15, 2004**
Manuscripts due:	**February 15, 2005**
Review results:	**April 15, 2005**
Final manuscripts due:	**May 15, 2005**
Final acceptance notification:	**May 31, 2005**

Only original papers related to the conference topics and not published elsewhere will be accepted. All papers will be peer reviewed. Detailed information about abstract and paper submission will be available at **www.ibpsa.ca/bs2005**.

Accepted papers will be presented in oral parallel sessions or in poster sessions and will be published in the conference proceedings. The presentation format will depend on the preference of the author, reviewer's recommendation, registration status and the opinion of the scientific executive committee. Each registration entitles the author to submit a single paper. One additional paper per registration is allowed for an additional fee.

The organizing committee is chaired by Michel Bernier (**michel.bernier@polymtl.ca**) and the scientific committee is chaired by Ian Beausoleil-Morrison (**ibeausol@NRCan.gc.ca**).

Montréal is framed by Mount Royal (230m) and the St-Laurence River. It was founded in 1642 by Paul Chomedey de Maisonneuve. It is the world's second-largest French-speaking city, with approximately 3 millions habitants, and a metropolis of international repute. It is the perfect marriage of North American modernity and European elegance. This multicultural mix has fostered a fertile and vibrant cultural life with art exhibitions, shows, museums, theatre, music … and nightlife that just goes on and on. Montréal is also recognized as having the finest cuisine on the continent.

Montréal is without a doubt a high-tech hub. There are around 1500 companies who invest 2 billion dollars annually in R&D activities. Aeronautical, telecommunication, and biopharmaceutical companies are the cornerstone of Montreal's economy. It is estimated that there are around 40,000 engineers working in the city.

The École Polytechnique de Montréal is one of the largest engineering schools in Canada both in terms of enrolment and research activities, with approximately 5000 students, 220 faculty members and 150 researchers.

The main conference hotels are located downtown approximately 7-8 km away from École Polytechnique de Montréal. Shuttle buses will be available to transport participants from/to the main hotels.

Other forthcoming events

Calendar

Date		Event	Venue
2004			
April	21-22	EnergyPlus Overview and Workshop	Glasgow, Scotland, UK
May	17-18	EnergyPlus Workshop (for experienced modelers)	San Francisco, CA, USA
May	17-18	TRNSYS training course	Glasgow, Scotland, UK
June	7-9	ISC'2004: Industrial Simulation Conference 2004	Malaga, Spain
June	9-11	IBPSA-Canada: eSim2004	Vancouver, Canada
June	21-24	HEFAT 2004	Cape Town, South Africa
June	26-30	ASHRAE meeting	Nashville, TN, USA
July	5-7	TRNSYS Users' Day/training course	Liege, Belgium
August	2-3	EnergyPlus Workshop (for experienced modelers)	Boulder, CO, USA
August	4-6	SimBuild 2004 (First IBPSA-USA conference)	Boulder, CO, USA
October	7-8	IBPSA France Conference, at AICVF Congress	Toulouse, France
October	10-14	CTBUH 2004	Seoule, Korea
October	11-12	Third annual Radiance Workshop	Fribourg, Switzerland
October	18-19	ICEBO 2004	Paris, France
2005			
August	***15-18***	***BS 2005***	***Montreal, Canada***

21-22 April 2004
Glasgow, Scotland, UK
www.sesg.strath.ac.uk
(appears as 'International developments and Building regulations' in Events for April 2004)

EnergyPlus - Introduction and Workshop

Scottish Energy Systems Group (IBPSA-Scotland)

IBPSA-Scotland, also known as the Scottish Energy Systems Group, are organizing an overview and workshop on EnergyPlus, the energy simulation program developed by the US Department of Energy which is under discussion for use as a UK compliance tool for the European Energy Performance of Buildings Directive. Both the overview (9:00 - 12:00 21st April, followed by a light lunch) and the workshop (1:30 - 5:30 21st April and 9:30 - 5:00 22nd April) will be presented by Dru Crawley, the programme manager and prime motive force for EnergyPlus at the DoE.

The overview is free to all (but seating is limited); the workshop, which is intended for those who are already familiar with the basic concepts of energy simulation, is limited to 15 participants and costs £250 (pounds sterling) for non-members of SESG and £175 for SESG members.

21-22 April 2004
Glasgow, Scotland, UK
www.sesg.strath.ac.uk
(appears as 'International developments and Building regulations' in Events for April 2004)

Scottish Energy Systems Group

In the **overview**, Dru Crawley will describe the facilities and capabilities of EnergyPlus, including those of Version 1.2 which is due for release in mid-April 2004 (see the **Software News section, page 21**). This session will be of interest to those who are in professional practice and are curious about EnergyPlus and how its possible adoption might impact upon your company, the way you do business and how you interact with your clients. It will also be of interest to policy makers and planners in local and regional governmental bodies who will be involved in the Energy Performance Directive and who need to find out the underlying capabilities of EnergyPlus to be in a better position to influence the details of the implementation of the directive if EnergyPlus is selected, and to those who have already begun to explore EnergyPlus and who are curious about features of Version 1.2.

The **workshop** will cover the mechanics of using EnergyPlus, with an emphasis on aspects such as multiple time-step approach, integrated simulation of loads, systems and plant, and defining fluid and air flow loops. It will discuss the basic techniques involved in applying simulation tools appropriately during the building design process, for example, comparing two or more alternative systems. Time will be set aside to allow participants to model basic building envelopes and systems using the latest version of EnergyPlus. There will be nine sessions in all, and each session will include time for questions and answers.

EnergyPlus

A laptop computer will be required for all participants for use during the workshops. SESG will provide five machines (be sure to indicate whether you require one of these). Participants are expected to have the latest version of EnergyPlus (Version 1.1) installed on their laptop prior to arriving at the workshop. This is available for download from **http://www.energyplus.gov/**. Participants will be informed of the availability of Version 1.2 prior to the course. Other software requirements include: Adobe Acrobat 5.0 or later to view PDF files, a text editor such as WordPad or Notepad to view example input files, a spreadsheet program to view CSV formatted output files, and Autodesk VoloView Express for viewing DXF files. If you require assistance in downloading any of the above please contact SESG prior to the event.

For more information visit **http://www.sesg.strath.ac.uk**, or to book your place at the overview and/or workshop, email Kathleen Whyte at: **kathleen@sesg.strath.ac.uk**

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17 -18 May 2004
San Francisco, California, USA
www.gard.com/training.htm

EnergyPlus Workshops - for experienced modelers

GARD Analytics, Inc.

2-3 August 2004
Boulder, Colorado, USA
www.gard.com/training.htm

These workshops will introduce EnergyPlus to experienced modelers who are familiar with the basic concepts of energy simulation. The course will cover the mechanics of using EnergyPlus with an emphasis on aspects of EnergyPlus that differ substantially from other common modeling tools (e.g., DOE-2 and BLAST), such as the use of a multiple time-step approach, the integrated simulation of loads, systems and plant, and defining fluid and air loops.

For more details on the course outline, registration fees, and accommodations see: **http://www.gard.com/training.htm**

Details about future workshops will be posted on this website as plans are finalized.

Support for these workshops is provided by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, Building Technologies Program (**http://www.eere.energy.gov/buildings**).

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17 -18 May 2004
Glasgow, Scotland, UK
http://sel.me.wisc.edu/trnsys/announcements/

TRNSYS introductory training course

IBPSA-Scotland in conjunction with SEL, University of Wisconsin-Madison

IBPSA-Scotland (SESG), in conjunction with the Solar Energy Laboratory of the University of Wisconsin-Madison, are organizing a TRNSYS introductory course in Glasgow, Scotland on May 17-18, 2004. The training course will use TRNSYS version 16, which is expected to be publicly released in early summer 2004. TRNSYS 16 is described in an article on **page 19 in the Software News** section.

The course will be taught by Michaël Kummert of SEL. Michael is coordinator of the TRNSYS developers team; he is also personally involved in TRNSYS development and user support and is an experienced teacher of TRNSYS courses in the US, France, Belgium, Spain and Korea.

Practitioners who are considering TRNSYS use will have ample opportunities to evaluate its facilities and ask questions. Those who have recently acquired TRNSYS will be avoiding the hassles and pitfalls of self instruction and users at all levels will learn how to use some of the new features in TRNSYS 16: improvements to the visual interface, better integration of the different tools, drop-in DLL's to add new components, etc.

The course venue will provide a limited number of computers with relevant software. Participants will have the option to bring their own computers and a time-limited version of TRNSYS will be made available for use during the course. If you have a design you want to test, bring along details to support your explorations on the second day.

The course fee (excluding accommodation) will be £400 (pounds sterling). If the course if fully subscribed the first six SESG members will get a discounted fee of £275. If there are fewer participants then fewer discounts will be offered. The number of participants is limited to a dozen so you are encouraged to register early.

A PDF brochure of the course details can be downloaded at:
http://sel.me.wisc.edu/trnsys/announcements/trnsys-course-sesg-2004.pdf

7-9 June 2004
Malaga, Spain
www.eurosis.org

ISC '2004: Industrial Simulation Conference 2004

European Technology Institute/European Simulation Society (EUROSIS)

ISC '2004 aims to give a complete overview of industrial simulation-related research and provide an annual status report on present-day industrial simulation research for the European Community and the rest of the world. The Call for Papers for this annual international industrial simulation conference was included in the previous edition (Vol 13 No 2) of IBPSA News, which gave detailed information on the planned topics.

Early registration deadline 15 May!

The conference is hosted by the University of Malaga and will be chaired by Javier Marin of the University's Department of Electronics. It is co-sponsored by ENSAIT, UPV, KFKI and Ghent University. The deadline for early registration is 15 May 2004.

For further information see the Eurosis website at **http://www.eurosis.org** or contact **philippe.geril@ugent.be**

9-11 June 2004
Vancouver, Canada
www.esim.ca

eSim 2004

IBPSA-Canada

IBPSA-Canada will be holding its next biennial eSim conference for professionals and students interested in building energy simulation issues and applications in Vancouver, British Columbia on June 10 and 11, 2004. There will be pre-conference workshops on June 9. **eSim 2004** will be hosted at the downtown campus of the British Columbia Institute of Technology (BCIT).

Early registration deadline 14 May!

The Call for Papers was included in the previous edition of IBPSA News, which also gave details of the conference themes. The deadline for early registration is 14 May 2004.

For more information consult the conference web site **www.esim.ca**

21-24 June 2004
Cape Town, South Africa
www.hefat.com

HEFAT 2004: 3rd International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics

HEFAT 2004 is the third conference in the HEFAT series, which aims to bring together researchers engaged in the application of experimental and/or computational heat and mass transfer, and fluid flow, in all areas of science and engineering. HEFAT 2002 was held in the Kruger National Park, and attracted 200 papers from all over the world; HEFAT 2003, held at the Victoria Falls, attracted about 250. A fourth conference is planned for 2005, in Egypt.

Further details, and order forms for proceedings from the first two conferences, are available on the conference website **www.hefat.com**.

26-30 June 2004
Nashville, Tennessee, USA
www.ashrae.org

Early registration deadline 21 May!

ASHRAE Meeting

American Society of Heating, Refrigerating and Air Conditioning Engineers

This year's ASHRAE Annual Meeting will be held at Nashville, Tennessee. Registrations made online at the ASHRAE website (**www.ashrae.org**) before 21 May will attract a $100 discount. You can register online for the technical program only, or for a package including associated social events. After 21 May you will need to register in person at the meeting venue, and the package registration will not be available.

The meeting and social events will take place at the Gaylord Opryland Resort and Convention Center, which is also the main meeting hotel. Book your hotel accommodation here by 5 June to receive a discount; remember to say you are attending the ASHRAE 2004 Annual Meeting.

For full details of the technical program, social events, technical and sightseeing tours, and Opryland, see the ASHRAE website: **www.ashrae.org**.

5-7 July 2004
Liège, Belgium
www.ulg.ac.be/labothap/

TRNSYS / EES Users day and training course

Fondation Universitaire Luxembourgeoise (FUL) and University of Liège Thermodynamics Laboratory (LT)

The EES-TRNSYS Days 2004 are organized by the Fondation Universitaire Luxembourgeoise (FUL) and the Thermodynamics Laboratory of the University of Liège (LT), in close cooperation with the Solar Energy Laboratory of the University of Madison (SEL).

The first day (Monday, July 5th) will be devoted to EES and TRNSYS short courses. Basic and advanced lectures will be offered in parallel for both programs. Presentations on specific applications are being prepared by FUL, LT and SEL, but the program is still open for other contributions from participants. Broad exchanges of ideas and discussions will be encouraged on all possible uses of EES, TRNSYS and EES-TRNSYS combinations in research and teaching.

On the second and third days (Tuesday 6th and Wednesday 7th) there will be extensive training on both programs. Examples of a range of applications will be provided, but participants are also invited to bring personal problems they would like to solve in the domain of applied thermodynamics, heat transfer, combustion, thermal machinery, refrigeration, renewable energy systems and building physics.

For pre-registration (before 15 June, 150 Euros for 3 days, 75 Euros for 1 day, free to members of University of Liège Building Analysis Group) go to the LT website at **http://www.ulg.ac.be/labothap/** (click on Meetings, EES-TRNSYS 2004).

Other events related to TRNSYS are announced on the SEL website at **http://sel.me.wisc.edu/trnsys/announcements**, and TRNSYS 16 is described in an article on **page 19 in the Software News section**.

2-3 August 2004
Boulder, Colorado, USA
www.gard.com/training.htm

EnergyPlus Workshops - for experienced modelers

GARD Analytics, Inc.

See details listed for 17-18 May on page 12.

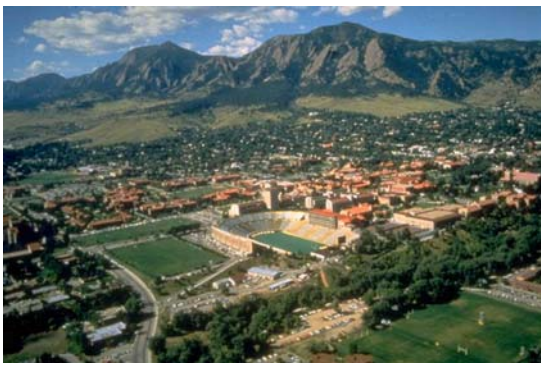
4-6 August 2004
Boulder, Colorado, USA
www.ibpsa.us/SimBuild2004

SimBuild 2004: the first National IBPSA-USA conference

IBPSA-USA

SimBuild 2004 is the first in a series of biennial conferences to improve the design and operation of buildings through advances in the modeling and simulation of building performance.

The SimBuild 2004 conference seeks to bring together the full building performance community: researchers and practitioners, software developers and users, professionals and students, public and private sectors, designers and operators, engineers and architects. Participants are also expected to span the diverse disciplines of building performance, including energy systems, acoustics, lighting and daylighting, air movement, indoor envionmental quality, controls and operations, and performance under extreme event conditions.



The program has been designed to include:

- Research presentations (peer reviewed)
- Technical presentations (not peer reviewed)
- Poster sessions (peer reviewed)
- Software demonstrations
- Simulation workshops
- Discussion forums
- Info and job fairs

There will be opportunities for researchers to present and discuss new methods, vendors to demonstrate their products and deliver workshops, and architecture and engineering firms to examine new tools and meet future employees.

Early registration deadline 15 June!

SimBuild 2004 will be held on the campus of the University of Colorado at Boulder. Conference program activities will be centered in the Engineering Center, which has auditoriums, classrooms, computer laboratories, and display areas. All presentation venues, including those for poster sessions and software demonstrations, have access to Ethernet and/or wireless network connections. Computer laboratories are available for hands-on workshops and demonstrations of building performance simulation tools.

Early registration is until 15 June 2004; abstracts for non-reviewed presentations will be accepted until 15 May. Conference details can be found at **www.ibpsa.us/SimBuild2004**

7-8 October 2004
Toulouse, France
conference2004@ibpsa-france.net

IBPSA-France conference, at AICVF Congress

IBPSA-France

IBPSA-France is now part of AICVF (the French Association of Air Conditioning, Ventilation and Cooling Engineers), and will be holding its biennial conference as part of the AICVF conference in Toulouse on 7th and 8th October 2004. The organisers recommend obtaining the Call for Papers as soon as possible, as 23 abstracts have already been received and the initial deadline has passed.

The IBPSA-France conference sessions will be held in parallel with the main AICVF sessions and those who wish to attend will also need to register with (and pay a conference fee to) the AICVF Congress Secretariat.

For a copy of the Call for Papers or to register your interest in the conference, e-mail the Conference Secretariat at: **conference2004@ibpsa-france.net**.

10-14 October 2004
Seoul, Korea
www.ctbuh2004.org

CTBUH 2004

Council on Tall Buildings and Urban Habitat

The deadline for abstracts for this conference is 30 April 2004, and the deadline for early registration is 31 August. Details of the conference are at: **www.ctbuh2004.org**.

11-12 October 2004
Fribourg, Switzerland
raphael.compagnon@eif.ch
gward@lmi.net

Third annual Radiance workshop - Call for Interest

University of Applied Sciences of Fribourg

This workshop is being planned by Raphael Compagnon and Greg Ward. Its purpose is to provide researchers with an opportunity to present their work with Radiance, and to share ideas and solutions with other attendees. Participants are invited to give a talk, which will be limited to 30 minutes (~20 minutes for the talk followed by ~10 minutes of open discussion).

Unlike last year's meeting in Berkeley, this workshop will not include a tutorial component. Radiance users of all levels are of course welcome, but if you want to take a class, the organisers refer you to John Mardaljevic's September tutorial in Leicester, UK, details of which can be found at www.iesd.dmu.ac.uk/~jm/. However, a "RADIANCE problem solving session" may be organised during the workshop.

The estimated delegate fee will be 200-300 Swiss Francs per person; there will be a discount for students. (1 Swiss Franc is approximately 0.82 US dollars or 0.65 Euros.) Some hotel rooms and some students' rooms (at lower prices) will be pre-booked for delegates' use once the organisers know how many attendees to expect.

This announcement is a preliminary call to gauge the level of interest, to determine whether the workshop will go ahead or not, so if you are interested, **please contact the organisers as soon as possible** (see overleaf). A final announcement with the agenda, workshop dates and registration fees will be sent out in late May, and registration will be due on 15 June. The venue for the workshop will be the University of Applied Sciences of Fribourg, Switzerland, whose website is at: **www.eif.ch.**

If you are interested in attending this event, please send the following information as soon as possible to **raphael.compagnon@eif.ch** and **gward@lmi.net**:

Attendee name (First M. Last, Title):
E-mail:
Address:
Telephone:
Student (Yes/No):
Title (if you plan to give a talk):
Abstract/Description:
Interested in a "problem solving session"? (Yes/No):
Other comments:

18-19 October 2004
Paris, France
http://ddd.cstb.fr/icebo2004

ICEBO 2004 - International Conference for Enhanced Building Operation

CSTB, Texas A & M University and IEA ECBCS Annex 40

The 4th International Conference for Enhanced Building Operation (ICEBO 2004) aims at being a leading place for exchanges between engineers, energy managers, state energy agencies, industrial companies, contractors and scientists interested in continuous improvement of existing building energy usage.

Organized in connection with the closing meeting of the International Energy Agency ECBCS-ANNEX 40 on "Commissioning of Building HVAC Systems for Improved Energy Performance", it will include the presentation of results from this international research project.

Addressing the question of how to transfer results from research projects to the "day-to-day" practice of building managers will be one of the main emphases of this conference.

The conference will take place at the FIAP Jean Monnet in the heart of Paris. The deadline for abstracts has just passed (19 April); the number of delegates is limited, and registration will close on 8 October 2004 at the latest. The conference fee is $400-$500 ($200 - $250 for authors). For further information see the conference website at **http:ddd.cstb.fr/icebo2004**.

Software news

TRNSYS 16 due for release in early summer 2004

http://sel.me.wisc.edu/trnsys/

Michaël Kummert, TRNSYS Coordinator, Solar Energy Laboratory, University of Wisconsin-Madison

TRNSYS (pronounced TRAN-Sys) is a modular simulation program used to model energy systems and buildings. Its main applications are: advanced buildings and HVAC systems, solar systems (thermal and photovoltaic systems), other renewable energy systems, cogeneration plants, fuel cells and Hydrogen systems.

TRNSYS has become reference software throughout the world. It is one of the listed simulation programs in the recent European Standards on solar thermal systems (ENV-12977-2). The level of detail of TRNSYS' building model, known as "Type 56", is compliant with the requirements of ANSI/ASHRAE Standard 140-2001. The level of detail of Type 56 also meets the general technical requirements of the European Directive on the Energy Performance of Buildings, which makes TRNSYS a potential candidate for compliance with the directive's implementations in various EU countries.

TRNSYS actually consists of a suite of tools, from visual interfaces that allow users to input the required data for a simulation (building + systems) in a visual, user-friendly way to programs that allow you to create stand-alone applications that can present a simplified simulation to non-expert users.

The **Forthcoming Events pages (13 and 15)** give details of TRNSYS training and users' days in May and July; other events related to TRNSYS are announced on their website at: **http://sel.me.wisc.edu/trnsys/announcements** (and see overleaf).

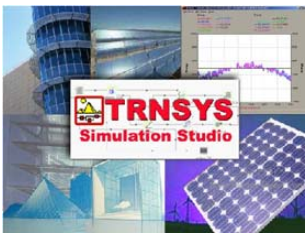
What's new in TRNSYS 16?

After four years of development work, both the TRNSYS kernel and its graphical user interface have undergone significant evolutions in the new major update, TRNSYS 16. While the TRNSYS kernel has been restructured to allow for even easier integration of new components, communication with other programs and even higher performance, the graphical user interface has evolved towards an integrated development and simulation environment : the **TRNSYS Simulation Studio.**

The TRNSYS Simulation Studio is the next generation of the well-known IISiBat program, and the other programs in the TRNSYS Suite have also been renamed to reflect the higher level of integration:

- **TRNBuild** (formerly known as Prebid) is the visual interface of the multi-zone building model (Type 56)
- **TRNEdit** is the successor of TRNSHELL. TRNEdit is used to develop stand-alone distributable TRNSYS applications.

TRNSYS 16 features at a glance:



http://sel.me.wisc.edu/trnsys/features

TRNSYS Simulation Studio

- Multiple connection port for better clarity of complex projects
- New user-friendly connection window
- Plug-ins for easy parameter input
- New user-friendly output window (to manage all outputs in one central location)

TRNSYS kernel

- Multi-DLL architecture. Adding new Types is as easy as dropping a file in a folder
- Full backwards compatibility for deck files (no change required) and Types (4 lines to add)
- Performance enhancements (time steps down to 0.01 sec, Enhanced speed for equations)
- Usability enhancements (Equations order, improved error handling, etc.)

Component library

- Combined Data reader and Solar radiation processor for easier configuration
- Full support of current TRNLIB components: HYDROGEMS library developed by IFE, links with external programs (Matlab, Excel)
- Addition of several components currently available in the TESS Libraries

TRNBuild – Type 56

- New 2-band window model
- Chilled ceilings
- Enhancements to the visual interface: improved library management (walls and windows), automatic segmentation of active layers, copy-paste of defined wall & window types, etc.

TRNEdit

- Multiple tabs to organize the input fields
- Clickable areas in pictures with links to external applications or other tabs
- More intuitive syntax, improved documentation and examples

General package enhancements

- Electronic documentation available on the CD and online
- Improved examples and templates
- Easier access to weather data

For more information, see the following websites:

TRNSYS website: **http://sel.me.wisc.edu/trnsys/**
TRNSYS 16 information: **http://sel.me.wisc.edu/trnsys/features**
TRNSYS 16 brochure: **http://sel.me.wisc.edu/trnsys/features/trnsys16-new-features-2003-12.pdf**

www.energyplus.gov

EnergyPlus Version 1.2 Now Available

Dru Crawley, US Department of Energy

The next major release, Version 1.2, of the EnergyPlus building energy simulation program with many new features is now available. Many updates and extensions have been made through the existing building envelope, daylighting, and HVAC equipment and systems portions of the program. New features include:

Input

- Dataset of measured input parameters from Sandia National Laboratory for 128 different photovoltaic modules.
- Dataset of measured input parameters from Solar Rating Coordinating Council for 96 different solar thermal (hot water) collectors.
- Datasets of environmental emissions factors for electricity (US national- and state-average) and combustion—natural gas, diesel, gasoline, LPG, propane, fuel oil (#1, #2, #4, #6), and coal.

Geometry/Windows/Walls/Shading

- User-selectable outside convection algorithm (BLAST/TARP, DOE-2, MoWiTT, or ASHRAE simple)
- Radiation-to-air component separated from detailed convection (exterior) models
- User-schedulable temperature for other side coefficient object
- Solar gain and daylighting calculations now account for beam and sky diffuse solar reflected from building sections, fins, overhangs, and neighboring buildings, including specular reflection from highly-glazed neighboring building facades.
- Improved ground-reflected solar calculations account for shadowing on ground of target building and other shadowing surfaces.
- Generalized multipliers for organizing identical groups of zones, e.g. floors in a multi-story building
- Dirt correction factor added for glass solar and visible transmittance
- Interior solar report variables added, including beam and diffuse solar incident on inside face of surfaces.
- Movable storm windows.
- Solar gain through blinds now accounts for different transmittances for sky and ground diffuse solar.
- Photovoltaic systems can be integrated with heat transfer surfaces (building integrated photovoltaic systems) to account for energy removed as electricity.

Daylighting

- More daylighting reporting variables added, including daylight illuminance from individual windows.
- An alternative daylighting analysis method has been added, called DElight, which is similar to the detailed method with two key differences:
- DElight can analyze geometrically and optically complex fenestration systems that have been characterized using bi-directional light transmittance data.
- DElight uses a radiosity method for calculation of interior interreflection of light.

www.energyplus.gov

COMIS Air Flow Calculation

- Venting through interior windows and doors now has same control options as venting through exterior windows and doors.

Zone Model

- Mundt room air model
- Displacement ventilation model (UCSD)
- Example files to illustrate modeling of UFAD system.

HVAC

- New latent capacity degradation model for DX cooling coil, constant supply air flow with cycling coil/compressor to meet zone load
- Cooling coils (DX or chilled water) can now be modeled in combination with an air-to-air heat exchanger to improve dehumidification performance.
- New crankcase heater power modeling for DX cooling coil
- Autosizing of gas turbine driven chiller
- Outside air economizer implemented for cycling systems
- Economizer lockout for packaged systems
- Added a condensation cut-off to the radiant cooling systems to avoid cases when the radiant cooling surface temperature is so low that it results in condensation
- New evaporative condenser option for DX cooling coils
- Based on simple effectiveness model.
- Water usage and water pump power can be calculated and metered.
- New air distribution system model for calculated energy losses due to conduction and air leakage for constant volume systems.
- Water-to-air heat pumps
- Extended the wet bulb and saturation pressure functions to cover temperatures from -100C to 200C (up from -60 to 100C).
- Autosizing of multiple hot water, cold water, and condenser water loops.
- Added new algorithms for the electric chillers to calculate heat recovery and to simulate a double bundled condenser
- Improved water heater to operate by itself (does not require plant loop).
- Added a plant loop component to allow scheduling domestic hot water demand and cold water supply from mains
- Added a load profile object for simulating plant loops without defining a building.
- Added stratified hot water tank model.
- Allow multiyear simulation for heat pump simulation startup
- Allow 'Design Week' and 'Design Month' simulation
- Delta temperature plant loop operating controls allows loop control based on environmental and loop temperature differences.
- Added ability to allow multiple supply plenums
- Upgraded the simplified demand-controlled ventilation model
- Ventilation now composed of rate per occupant and rate per unit floor area
- Added availability schedule to allow ventilation air flow to be stopped while the remainder of the HVAC system can continue to operate

www.energyplus.gov

- Plant system availability managers added: differential thermostat, high temperature cutoff, and low temperature cutoff.
- Changed the temperature schedule to a setpoint manager for the plant and condenser loop to allow use of scheduled temperature setpoint manager on the loop setpoint, or the outside air temperature reset temperature setpoint manager.
- Changes to evaporative condenser option for DX coils
- Changed "approach temperature" to effectiveness.
- Added field for evaporative condenser air flow to allow water usage to be calculated and metered.
- Added field for evaporative condenser water pump power.

On-Site Energy Supply

- Added new flat plate solar thermal collectors for domestic hot water that can also be connected to HVAC plant loops for space heating systems.
- Added two new options for photovoltaic power calculations—simple and Sandia.
- Allow solar panels to use and be shading surfaces.
- Electric power generators now determine electric utility purchases and surplus.
- Net Site and Source Energy Use Intensities calculated to account for on-site production.

Environmental Impacts

- Extended the pollution calculations to include all major greenhouse gases, precursors and criteria pollutants as well as water and nuclear waste. Environmental emissions calculated include: CO2, CO, CH4, NOx, N2O, SO2, PM, NH3, NMVOC, Hg, and Pb as well as water consumed by electricity generation and high- and low-level nuclear waste from nuclear electricity generation.

Output

- Added new Annual Building Utility Performance report (similar to DOE-2 BEPS) with reporting of energy, water, and on-site generation.
- Meters can now be reported to eplusout.mtr to reduce file size
- Added reporting of schedule values
- Added reporting of specific enthalpy, volumetric flow rate and wet-bulb temperature for all HVAC nodes

Utilities

- New HVAC diagramming tool

Operating Systems Supported

- Mac OSX version (planned for release soon after the Windows and Linux versions)

Documentation and Guides

- Input/Output Reference and Engineering Reference Updated and Extended for all new features and updates.
- Revised Module Developers Guide
- Revised Programming Guide

More information on these and other new features in this version is available on the EnergyPlus web site: **www.energyplus.gov.**

www.energytoolsdirectory.gov

Building Energy Tools Directory

Dru Crawley, US Department of Energy

The web-based Building Energy Tools Directory at **www.energytoolsdirectory.gov** contains information on more than 280 building-related software tools from around the world. Haven't visited lately? Many new tools have been added over the last several months including: ModEn, Rehab Advisor, ION Enterprise, ISE, WISE, LoopDA, SenseDat Analyzer, TREAT, DAYSIM, Hydronics Design Studio, and Prophet Load Profiler.

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.

Know of a tool (yours?) that isn't in the directory, visit **http://www.eere.energy.gov/buildings/tools_directory/your_software_here.html** or contact Dru Crawley at **Drury.Crawley@ee.doe.gov**.

http://SimulationResearch.lbl.gov

GenOpt® 2.0 released

Michael Wetter, Simulation Research Group, EETD, LBNL

GenOpt® 2.0 has been released. GenOpt is a general purpose numerical optimization software that integrates with any of your preferred simulation programs as long as the simulation program can use text files for input and output. GenOpt can be used to solve a wide variety of engineering optimization problems to reduce the cost, enhance the comfort, or improve the controls of complex systems. GenOpt has been specifically designed for situations where the cost function is computationally expensive and its derivatives are not available or may not even exist.

Any simulation program that can use text files for input and output (such as EnergyPlus, TRNSYS, DOE-2, SPARK, or any user-written program) can be coupled to GenOpt without any code modifications.

GenOpt has a library with several algorithms that can be used to solve local and global optimization problems with continuous and/or discrete independent variables. The algorithm library contains Generalized Pattern Search algorithms (Hooke-Jeeves and Coordinate Search algorithm), various Particle Swarm Optimization algorithms, hybrid optimization algorithms for global and local optimization, a Discrete Armijo Gradient algorithm, and Nelder and Mead's Simplex algorithm, as well as algorithms for one-dimensional optimization and parametric studies.

Additional optimization algorithms can be added with little effort by using GenOpt's algorithm interface.

GenOpt runs on any operating system that supports Java, such as Windows, Unix, and Linux.

For a free download and more information, visit **http://SimulationResearch.lbl.gov**

Announcements

http://buildingscience.tuwien.ac.at

New graduate program at Vienna University of Technology, Austria

A new two-year graduate program will start in fall 2004 at the Vienna University of Technology:

Building Science and Technology (MSc)

The graduate program has a strong interdisciplinary character. It is open to candidates from a variety of educational and professional backgrounds, such as architecture, civil engineering, mechanical engineering, and computer science, who wish to achieve leadership positions in industry or academia. Successful and qualified graduates of the program may subsequently join the Doctoral Program.

The "Building Science and Technology" graduate program covers a wide spectrum of competence in the areas of building performance, information technology, design science, and building ecology. Based on sound fundamentals in building science, the program's curriculum encourages students to develop their scholarly strengths and technical skills according to their individual talents and interests.

Deadline for applications 11 June!

Deadline for applications: June 11th 2004

For further information see:

web: **http://buildingscience.tuwien.ac.at**
or
email: **buildingscience@tuwien.ac.at**

DEVELOPMENT OF DISTRICT ENERGY SYSTEM SIMULATION MODEL BASE ON DETAILED ENERGY DEMAND MODEL

Yohei Yamaguchi, Yoshiyuki Shimoda, and Minoru Mizuno
Department of Environmental Engineering, Graduate School of Engineering,
Osaka University
2-1 Yamada-oka, Suita, Osaka 565-0871, JAPAN

ABSTRACT

This paper presents a district energy system simulation model in which the energy flow of a district is modeled as the sum of total energy flow in each building. By using this model, various kinds of energy supply systems can be evaluated taking into account the relationship among performance of energy supply systems, available technologies, and conditions of targeted districts, such as characteristics of energy demand, size and arrangement of buildings. In the last part of this paper, results of a case study, which evaluates two types of energy supply systems utilizing CGS are presented.

INTRODUCTION

Recently, there has been growing interest in energy saving technologies in the building industry. Various energy saving measures that could considerably reduce energy consumption of a building have been proposed. In total, however, the net energy consumption at city/district level is still increasing. In order to curb this upward trend and to reduce energy consumption, strategies to improve energy system should be better imposed.

Figure 1 shows the characteristics of a typical building energy supply system with two axes. The vertical axis represents grid electricity dependency. Advancement in the distributed generation technologies allows an energy system to be partially or completely independent from grid electricity (Mathew et al, 1999). Due to the fact that these technologies could considerably change the energy flow of a district, grid electricity dependency is a vital factor for the evaluation of a district energy system.

The other axis shows different combination of buildings in the installation of energy supply systems. Advancement in distributed generation technologies could contribute not only to self-sustenance in electricity but also realize various types of heat and electricity supply systems in a district. For example, a small scale Waste Heat Network (WHN), which is at the right-hand side of the horizontal axis, may be a flexible and effective system. In this system, a number of closely located buildings share the heat and power generated from one or more cogeneration

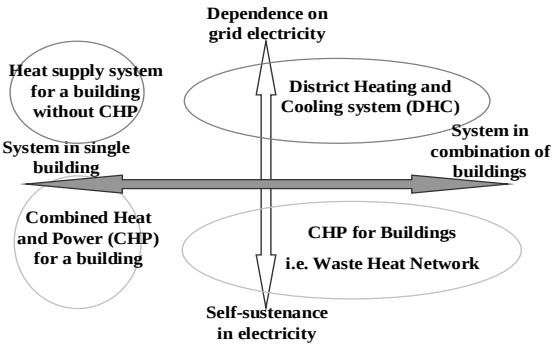


Figure 1 Characteristics of energy supply systems

systems installed in one or more buildings. This system will be realized when the distributed generation technologies achieve sufficient advancement. Further development of these technologies, however, could lead to complete self-sustenance of each building by decrease in heat power ratio of cogeneration systems. If this situation occurs, cooperation with neighboring buildings would be unnecessary. As combination of building energy demand profile alters the heat and electrical load of energy supply systems in pattern and scale, combination of buildings in sharing an energy supply system is also a significant factor in evaluating the effectiveness of a district energy system.

As can be seen in the example of distributed generation technologies given earlier, the development of technologies utilized in energy supply systems could change the choice of energy supply system and affect the energy flow of a district. Similarly, the circumstances of buildings' renewal are also significant in choosing suitable energy supply systems. For example, if a number of neighboring buildings are renewed simultaneously, an energy supply system with combination of buildings could be relatively easily installed. On the contrary, if the renewal of each building occurs separately, a system with combination of buildings could not be implemented simultaneously; thus, its installation is uneconomical due to the longer pay back period. Therefore, in order to employ effective strategies to improve a district energy system, a framework that is able to evaluate various energy supply systems by taking into account uncertainties

Editor's note: This and the following two papers were presented at BS2003 in Eindhoven; they are also available in the BS2003 proceedings available from IBPSA Member Services (jhaberl@esl.tamu.edu).

such as technology development and buildings' renewal is required.

During investigations on the performance of energy supply systems in the commercial sector, energy demand profiles of buildings have been traditionally assumed as a fixed demand per unit floor area (IBEC 1985 etc.). Although this is very convenient, it shows limited ability to achieve accurate estimation. Huang et al. (1991) and some other researchers have provided prototypical input information of various commercial buildings for energy demand simulation. The output of this simulation allows users to estimate the effectiveness of energy supply system considering the effect of energy saving measures and climatic conditions. Both methods generalize energy demand profiles to acquire generalized effectiveness of energy supply systems. In reality, however, the performance of energy supply systems utilizing distributed generators varies with the changing pattern of building energy demand profiles (Yanagi et al, 2002). The performance of systems connecting a small number of buildings such as a WHN system could also be affected by differences of energy demand in each building. For this reason, in order to evaluate various energy supply systems at a district level, the relationship between the performance of energy supply systems and energy demand profiles of buildings should be taken into account even if the buildings are of the same function.

Thus, in order to evaluate various energy supply systems considering the relationship among the performance of energy supply systems, characteristics of energy demand of buildings, and available technologies, we developed a district energy system simulation model which contains a detailed energy demand model. This model adopted the bottom up approach in which the energy flow of a district is modeled as the sum of total energy input and output of each building. In this model, heat and power demands of each building are simultaneously calculated considering climatic conditions, occupant behaviors, use of appliances, adoption of energy saving measures, and etc. In this paper, we present the structure of the simulation model and the result of evaluation of the two systems, which are CHP for a single building and WHN for two buildings.

MODELING DISTRICT ENERGY SYSTEMS

Figure 2 illustrates the calculation procedure of the district energy system simulation model. This model consists of three basic components, an occupant behavior model, a building energy demand model and district energy supply system model. Firstly, based on occupant behavior, the heat and electrical load generated from the use of energy consuming appliances by each occupant are simulated in the occupant behavior model. Then, heat and electrical

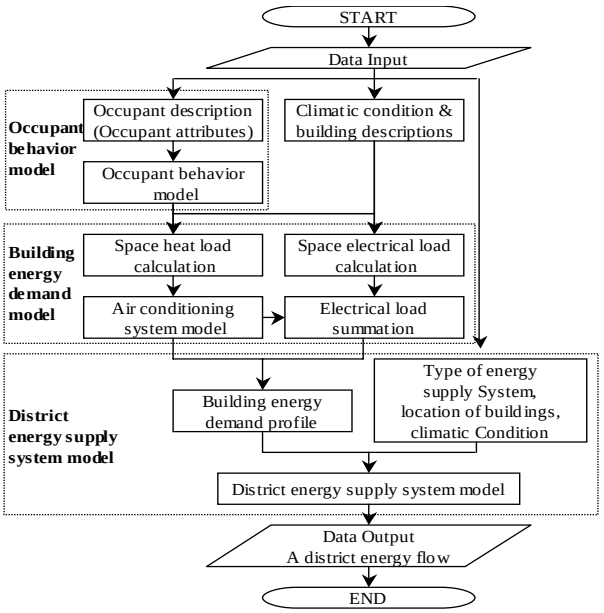


Figure 2 Flow chart of the district energy system simulation model

demand profiles of each building are calculated. Finally, the total energy flow of a district is quantified.

The remaining part of this section presents descriptions of each sub-model.

Occupant behavior model

The purpose of this model is to reflect the practical operational condition of a building and also energy consuming appliances in energy demand profiles. These operational conditions of many prototypical buildings have been modeled as fixed conditions as stated previously. In reality, however, there are differences in those conditions among buildings. Particularly, energy-consuming appliances vary in number, specification and operational conditions. These real conditions could change the energy demand profiles and also the energy saving potential of active energy saving measures such as the adoption of low-power consuming appliances and improvement of these operational conditions. Then, it could further affect the performance of energy supply systems. Thus, to account for these influences, we developed the occupant behavior model stochastically simulating the practical operational condition of energy consuming appliances and occupant schedule, resembling as much as possible the real world condition.

Stochastic model for occupant behavior

Figure 3 illustrates the flow chart of the occupant behavior model. The model adopted a transaction approach in which the behavior of each occupant is simulated.

Firstly, working hours of each occupant are decided base on the distribution functions of T_1~T_4 as defined in Table 1.

Then, the working state of each occupant during working hours are decided. There are limited kinds of working states for office building occupants that can be roughly divided as in Table 2. Firstly, we assume random mobility among working states. Secondly, the duration in each working state is assumed to be occupant's attribute-dependent. Based on the first assumption, the transition of states can be modeled as a Markovian process. In a Markovian process, the next state will depend only on the present state. Additionally, the second assumption allows transition probabilities to depend only on occupant attributes. The occupant attributes are data that can be easily obtained for each building, such as type of job and ages. In this paper, only the type of job is considered as occupant attributes.

In Markovian process, Markov matrices define the transition of states, which its elements are transition probabilities from a present state to another. Markov matrices are generated corresponding to the occupant attributes. To generate these matrices, two kinds of data are required. One is the average duration of each occupant in a state i (=1, 2,.., n where n is the number of states). From this information, the probability (r_i) of transition occurrence from a state i to other states is decided. The other data required is the percentage distribution (s_j) of working states j (=1, 2,.., n) for building occupants with different attribution. From these data, the transition probabilities from the present state i to another state j (p_{ij}) of Markov matrices for each occupant attribute are decided by formula (1).

$$p_{ij} = 1 - r_i + r_i \cdot s_j \quad (i = j) \qquad (1a)$$

$$p_{ij} = r_i \cdot s_j \quad (i \neq j) \qquad (1b)$$

Using the inverse function method (R. Fritsch et at, 1990) with these Markov matrices, the working states of occupant can be simulated. Although probabilities r_i and s_j should be given by measured data, we assumed the values of r_i as given in Table 3 and each s_j can be decided at a constant 6.25% for all states and all attributes, which means that the expectation of state transitions is 1.5h base on a 5-minute time step used in the occupant behavior model.

Finally, the calculation results of working states of each occupant are translated into occupant schedule and power consumption and heat release from appliances controlled by each occupant. By inputting these data into the building energy demand model, occupant behaviors are thus integrated into the energy demand profiles of a building.

Building energy demand model

The building energy demand model calculates the hourly heat and electrical demand profiles of each building simultaneously.

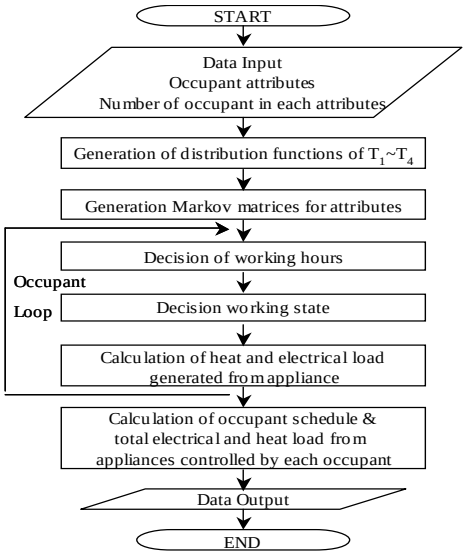


Figure 3 Flow chart for the occupant behavior model

The space heat load is calculated using the weighting factor method. Then, the air conditioning system model translates the space heat loads into the cold and hot water coil loads. It is assumed that an air conditioning system is installed in each story. The load of the heat supply system is then defined as the sum of all cold and hot water coil loads.

The electrical demand of a building is calculated by summing the electrical loads shown in Table 4. Table 4 also shows the calculation method of each electrical load. The capacity of each appliance is calculated considering its number and specifications. Electrical load for conveyance, emergency, sanitary, security and etc. are also calculated by the total capacity of 31.2W/m^2 and the schedule showed in Figure 4. The value of total capacity is taken from statistical data (Japan Building Mechanical and

Table 1 Definition of T_1~T_4

Time	Definition
T_1	Time when occupant starts work
T_2	Time when occupant finishes work
T_3	Time when occupant leaves for lunch break
T_4	Time when occupant comes back from lunch break

Table 2 Working states of building occupants

State	Definition	Location	Load source of appliances
A	Using PC	Seat	1 PC + 1 monitor
B	Not using PC	Seat	Stand-by power of 1 PC and monitor
C	Being out	Outside of office	Stand-by power of 1 PC and monitor
D	Using two PC	Seat	2 PCs + 2 monitors

Table 3 Percentage distribution of working states for building occupants at different positions

State	Position			
	Manager	Clerk	Sales	Engineer
A	30	60	20	30
B	30	20	20	20
C	40	20	60	20
D	0	0	0	30

Table 4 Electrical load

Term	Example	Load calculation mothod
Lighting	-	Capacity * Schedule
Appliance controlled by single occupant	PC, Moniter	Input from occupant behavior model
Appliance controlled by ocupants group	Copy machines	Capacity * Schedule
Appliance always switched on	Network servers	Capacity * Schedule
Fan for ventilation	-	Input from secondary system model
Fan for air supply	-	Input from secondary system model
Other Electrical loads	Conveyance Emergency Sanitary Security	Capacity (31.2W/m^2)* Schedule (Schedule is shown in Figure 4)

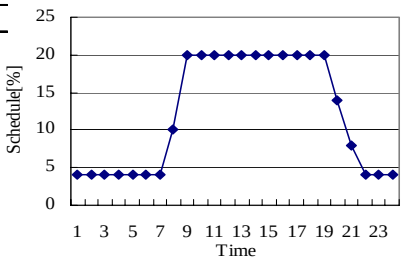


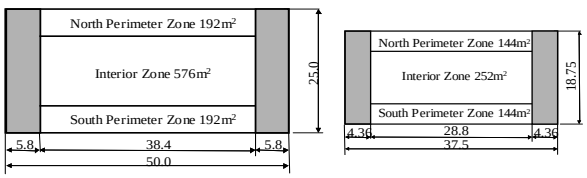
Figure 4 Schedule for other electrical load in Table 4

Electrical Engineers Association 1994). The schedule pattern is decided with reference to the IBEC electrical demand profiles (IBEC 1986).

District Energy supply system model

The district energy supply system model calculates the total energy flow of a targeted district. The input information is the energy demand profiles of all buildings, climatic conditions, types of energy supply system, and location of the buildings, which is required for the design of heat supply pipelines

The district energy supply system model is able to deal with systems for a single building and for a number of buildings. The inner and outer diameters of pipelines and its insulator are designed from the peak heating or cooling demand of each building. The part-load characteristic is assumed in the calculation for all components of the energy supply system. For refrigerators, in addition to the part-load characteristics, the COP modeled from its rated COP and its regression with chilled water temperature as well as condenser water temperature.



Large office building
16,250m^2 (1,250m^2/story)
12 stories 1 basement

Medium office building
6,327m^2 (703m^2/story)
9 stories

Location	Osaka
Percentage of glass in wall	40%
Occupancy rate	0.1 person/m^2
Light	20 W/m^2
Appliances	19 W/m^2

Figure 5 Illustration and description of buildings in case study

Table 5 Definition of the combination of buildings

Combination	Description of building combination
C1	Two large office buildings
C2	One large office building and One medium size office building

CASE STUDY

In this case study, the effectiveness of two types of energy supply systems utilizing cogeneration systems (CGS) is evaluated for two different combinations of closely located buildings shown in Table 5. One combination (C1) is of two large office buildings with a total floor area of 16,250m^2 (1,250m^2 per story). The other (C2) is the combination of a large building and the medium office building with a total floor area of 6,325m^2 (about 703m^2 per story). The illustrations of these buildings are shown in Figure 5. In addition, distance between the two buildings is assumed to be 50m for calculations of the heat supply pipelines.

Description of Energy Supply Systems Utilizing CGS

Three types of energy supply systems were assumed in this case study. Figure 6 illustrates the basic energy supply system to be compared with systems utilizing CGS.

Figure 7 illustrates the first type of energy supply system utilizing CGS for a single building. In this system, all generated electricity and exhaust-heat are used only in the building itself. In this system, utilization of gas engine cogenerations is assumed. Exhaust-heat is recovered in hot water and steam. The hot water and steam are converted into heating energy using heat exchangers, then to cooling energy using exhaust-heat gas absorption chiller/heaters (EGAR). Finally, the surplus of the recovered hot water is discharged from cooling towers. However, it should be noted that there is an upper limit of the exhaust-heat utilization. A maximum of 30% of EGAR cooling capacity could be supplied by exhaust-heat utilization.

Figure 8 illustrates the second type of energy supply system, the Waste Heat Network (WHN) for two buildings. In this system, CGS is installed in one building (the CGS building). This system also adopts gas engine cogenerations. In the CGS building, the recovered hot water and steam are used similarly as those in CHP for a single building. Then, the surplus electricity and steam are supplied to the neighboring building (the demand side building). In the demand side building, the supplied steam is used for heating, then for cooling using double effect absorption

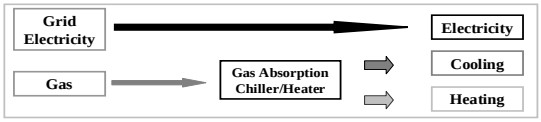


Figure 6 Schematic of the basic energy supply system

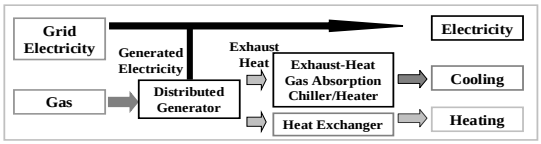


Figure 7 Schematic of CHP for a single building

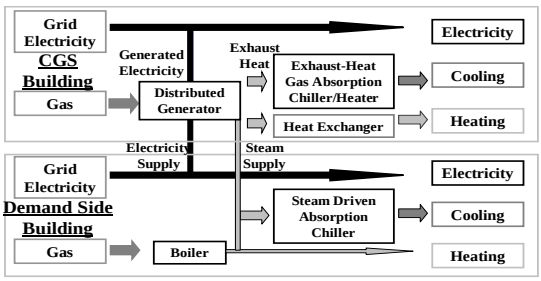


Figure 8 Schematic of WHN for two buildings

chillers (AR). The steam supplied to the demand side building enhances the utilization ratio of exhausted heat. The electricity supply to demand side building contributes to increase the full-load operating hours of CGS.

The power generation efficiency, steam and water recovery efficiencies of gas engine cogeneration utilized in these two systems are shown in Figure 9 considering part-load operating condition. Basically, the efficiency in Figure 9 will be used in this case study. We describe this CGS as high efficiency CGS. In the last part of this case study, we examined a different efficiency of CGS, the medium efficiency CGS. The respective efficiencies of the medium efficiency CGS are shown in Figure 10. Values in Figure 9 and Figure 10 are based on lower heating value of fuel (city gas).

We would like to point out that any heat storage facilities are not considered in this case study. Thus,

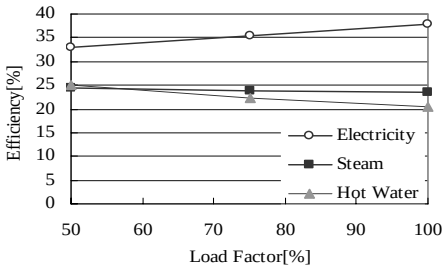


Figure 9 Efficiency of the high efficiency CGS

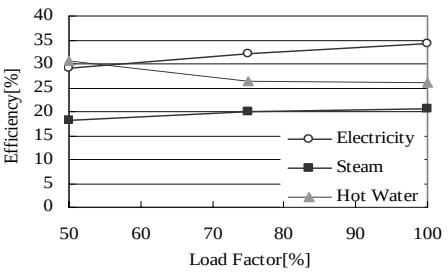


Figure 10 Efficiency of the medium efficiency CGS

the performance of the energy supply systems could be heavily depending on energy demand patterns. In order to better understand the performance of energy supply systems utilizing CGS, further study considering energy storage facilities will be carried out.

Alternatives of energy saving measures

Table 6 shows the alternatives of energy saving measures for two buildings. These alternatives are combinations of two types of energy supply systems utilizing CGS described above and energy saving measures shown in Table 7.

Energy consumption, cost and amount of waste heat produced will be focused in this study. We defined these values as the summation of these of two buildings in the targeted building combinations.

Simulation Result

Impact of operational condition of CGS

For each system utilizing CGS, two operational

Table 6 Alternatives for energy saving systems

Alternative	Description
Case 1	No measures
Case 2	Energy saving measures in Table 7
Case 3	One CHP for each building
Case 4	WHN shared by two buildings
Case 5	Energy saving measures in Table 7 + One CHP for each building
Case 6	Energy saving measures in Table 7 + WHN shared by two buildings

Table 7 Energy saving measures

Item	Standard condition	With energy saving measure
Window	Solar reflecting glass	Pair glass
Light	20[W/m2]	15[W/m2]
Set point of room temperature	Cooling:26[^{o}C], Heating:22[^{o}C]	Cooling:28[^{o}C], Heating:20[^{o}C]
Total heat exchanger	Assume unused	Use, and efficiency 30[%]

conditions for CGS are defined as follows.

1) Energy minimum operation

With this operational condition, CGS is operated to minimize the primary energy consumption for each time step. The optimum capacity for energy minimum operation of CGS is calculated from the value of minimum primary energy consumption of two buildings.

2) Cost minimum operation

With this operational condition, CGS is operated to minimize the operational cost each time step. The optimum capacity for cost minimum operation of CGS is calculated from the value of minimum annual depreciation and operation expenses. The operation expenses include standing charge and unit commodity charge for electricity and city gas.

Usually, energy supply systems are operated to minimize total cost. This operational condition may differ with the operational condition in which systems achieve the maximum energy conservation potential. Thus, clarifying the degree of the difference is important to improve the effectiveness of energy supply systems. Figure 11 shows the annual primary energy consumption at optimum capacity of CGS for energy minimum operation. Figure 12 shows these values at cost minimum operation. Both figures show the total energy consumption of two buildings in the building combination C1 as defined in Table 5. Percentage at the end of bar graph shows the energy saving ratio of each case.

At the energy minimum operation, the energy saving ratio of Case 2 is 19.3%. This value is larger than those of Case 3 and Case 4 where energy saving measures are not implemented. As can be seen in Figure 11, the energy saving ratios in Case 5 and Case 6 are about 25% with the difference of 0.7%. At the cost minimum operation, however, a greater difference, which reaches 3.5% in the energy saving ratios between Case 5 and Case 6 are obtained. Figure 13 and Figure 14 can account for this difference. Figure 13 shows the transition of energy saving ratio of Case 5 and Case 6 at cost minimum operation for different CGS capacities. Figure 14 shows the annual depreciation and operation expenses in the same condition. In Case 6, the optimum capacities of CGS for the maximum energy saving ratio (Figure 13) and for the smallest annual depreciation and operation expenses (Figure 14) almost conform. On the contrary in Case 5, there is discrepancy between these capacities of CGS. The difference in degree of reduction of energy conservation efficiency between Case 5 and Case 6 is the consequence of this discrepancy.

In addition to this, Figure 13 and 14 shows higher energy and economical performance of Case 6. In Case 6, the demand side building utilizes exhaust-heat without limitation. This means that a larger amount of exhaust-heat utilization can be achieved, thus leading to higher energy saving ratio compared to Case 5. Furthermore, the energy saving

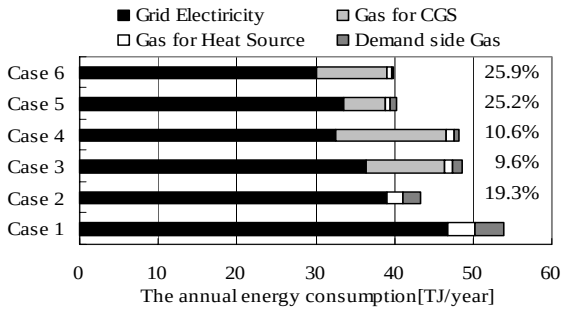


Figure 11 Annual primary energy consumption and energy saving ratio [%] at energy minimum operation

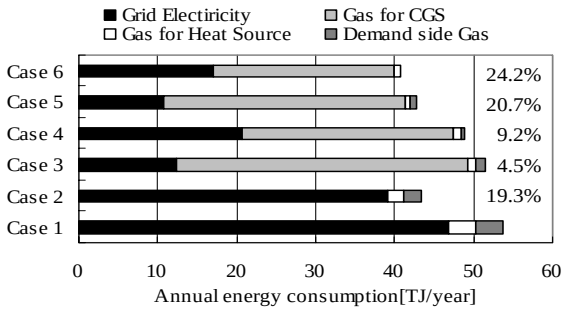


Figure 12 Annual primary energy consumption and energy saving ratio [%] at cost minimum operation

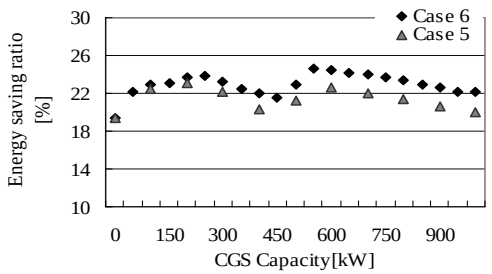


Figure 13 Transition of energy saving ratio of Case 5 and Case 6 at cost minimum operation

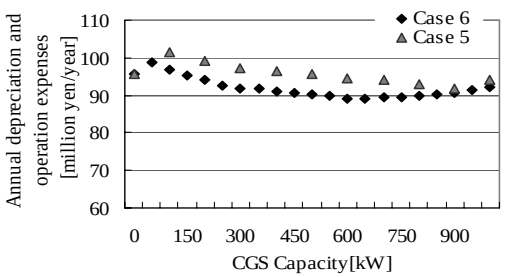


Figure 14 Transition of the annual depreciation and operation expenses of Case 5 and Case6 at cost minimum operation

ratio in Figure 13 shows two maxima. The energy saving ratio declines after the first peak as CGS operates without exhaust-heat utilization during unconditioned hours. During these hours, with low CGS capacity, the electricity is supplied by CGS operation thus resulting in energy cost reduction. However, with larger CGS capacity after the local dip in Figure 13, the CGS operation during unconditioned hours (low load factors) becomes uneconomical due to the fall in CGS power generation efficiency. Thus, the CGS operation during these hours is ceased; resulting in the rise to the second peak of the energy saving ratio. Furthermore, the scale merit of the CGS initial cost with the lower standing charge and unit commodity charge for gas utilization together account for the economical merit shown in Figure 14.

Impact of type of energy supply system utilizing CGS

Figure 15 shows the annual depreciation and operation expenses at optimum capacity of CGS at cost minimum operation. The numbers in Figure 15 shows simple pay back periods for each case. As can be seen in Figure 15, although Case 2 provides the shortest simple pay back period, the least annual depreciation and operation expenses occurs in Case 6 which also provides the highest energy saving ratio. These results demonstrate feasibility of Case 6.

Figure 16 shows the annual amount of waste heat produced for each case in the same operating condition. As can be seen in Figure 16, although introduction of CGS increases waste heat from these buildings, the waste heat produced in Case 6 is less than those in Case 5.

Impact of building size

In existing city centers, various types of office buildings have been densely constructed. Thus, in order to achieve sufficient energy conservation, we could not ignore various types of combinations of buildings. With regard to building size, smaller buildings have relatively more difficulties in adopting energy saving measures as it usually requires large initial investment (i.e. the introduction of CGS), though these buildings usually make up a large portion of existing city centers. In this section, the case study is executed for the building combination C2 as defined in Table 5 to study the effect of building size on the effectiveness of energy supply systems.

Figure 17 and Figure 18 shows the annual energy consumption and the annual depreciation and operation expenses at the cost minimum operation respectively. In Case 5, the CHP system for the medium size office building is unsuitable due to the higher annual depreciation and operation expenses than those without CGS. Thus, for Case 5, the most suitable installation criteria were found to be only a CHP in the larger building. On the contrary, Case 6 achieved the highest energy saving ratio of 23.3% from these two buildings without increasing the annual depreciation and operation expenses. However, the simple pay back period of Case 6 increased to 7.6 years from the 5.5 years in the building combination C1.

Impact of the efficiency of CGS

In energy supply systems using CGS, the total effectiveness of the system may be critically affected

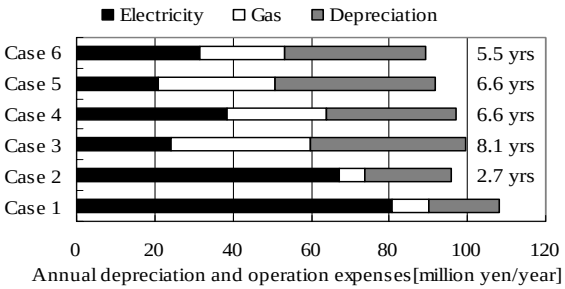


Figure 15 Annual depreciation and operation expenses and simple pay back period [yrs] at cost minimum operation

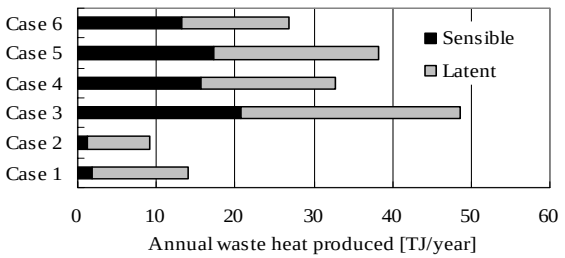


Figure 16 Annual waste heat produced at cost minimum operation

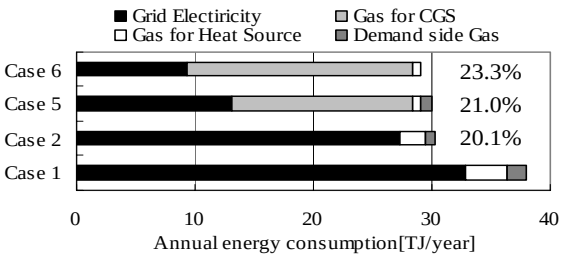


Figure 17 Annual energy consumption and energy saving ratio [%]

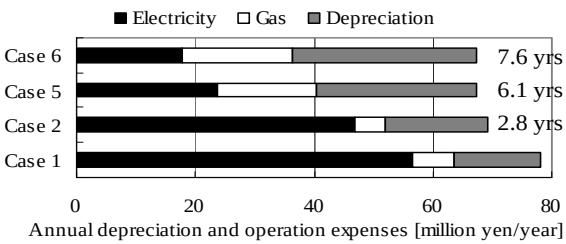


Figure 18 Annual depreciation and operation expenses and simple pay back period [yrs]

by the efficiency of CGS. In this section, in order to investigate this sensitivity, the comparison between cases utilizing high and medium efficiency CGS is presented. Figure 19 and Figure 20 shows the annual energy consumption and the annual depreciation and operation expenses respectively for both high and medium efficiency CGS. Here, the building combination C1 is assumed. Both figures show results of Case 5 and Case 6 where systems with medium efficiency CGS are indicated with an apostrophe (i.e. Case 6').

As can be seen in Figure 19, the deterioration of efficiency of CGS leads to the increment of total energy consumption, though the cost performance changes slightly for both cases. From this, the largest energy saving rate occurs in Case 2 when the lower efficiency CGS is utilized. Thus, in order to achieve adequate energy conservation by utilizing CGS, sufficient development of CGS is essential as well as the adoption of high efficiency equipments and suitable maintenance.

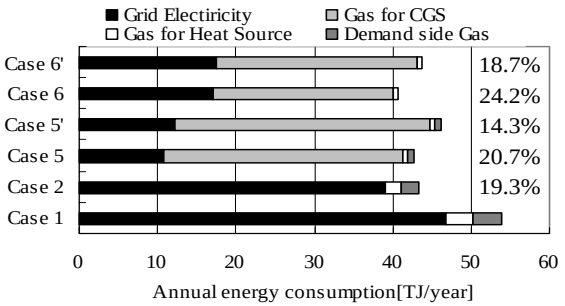


Figure 19 Annual energy consumption and energy saving ratio [%]

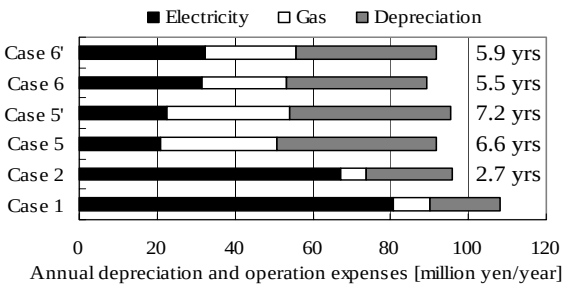


Figure 20 Annual depreciation and operation expenses and simple pay back period [yrs]

CONCLUSION

This paper described a district energy system simulation model that adopted a bottom up approach. In this model, the energy flow of a district is modeled as the sum of total energy input and output of each building. By using this model, six alternatives comprising various energy saving measures and utilization of CGS were examined in the case study. The combination of energy saving options and WHN achieved the highest energy saving ratio and the lowest annual depreciation and operation expenses for the examined two combinations of office buildings. Particularly important was the finding that WHN was more effective than CHP for a single building in energy conservation, cost, and waste heat produced. This result implies that utilizing CGS in a combination of buildings is more appropriate to achieve energy saving potential than installing CGS for every building respectively. Additionally, for medium size buildings where it is usually not economical to install a CGS, the WHN proves to be a solution with lesser cost. Thus, WHN is an effective energy supply system to reduce energy consumption of a district. On top of that, as the efficiency of CGS critically influences the effectiveness of energy supply systems, adoption of high efficiency equipment and suitable maintenance are essential.

In our future work, combination of various case studies in actual districts with higher variability of building combinations will be carried out, taking into account the uncertainties in technology development of distributed generation systems. Other improvements of the model will include shorter time-step, consideration of facilities maintenance cost and etc.

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SIMULATION FOR FAÇADE OPTIONS AND IMPACT ON HVAC SYSTEM DESIGN

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ABSTRACT

This paper presents a simulation study employed for the optimization of the building envelope for a new university building located in Montreal (latitude 45^0N). The study involved simulation of façade design options, taking into account maximization of daylight, reduction in electricity consumption for lighting and optimal control of solar gains. Combinations of motorized shading devices in conjunction with controllable electric lighting systems are investigated in detail. Transient simulations also considered the impact of motorized shading and light dimming on HVAC system sizing and energy consumption for heating/cooling. The resulting energy savings and thermal comfort using an optimum design strategy are discussed.

INTRODUCTION

The area of fenestration in buildings is continuously increasing, driven by two factors- first the higher demand for buildings with much daylight, and second the development of advanced windows with predictable or controlled solar transmittance characteristics (e.g. electrochromic coatings, motorized shading) and high thermal resistance. The increased fenestration areas often result in highly varying heating and cooling loads throughout the year, especially when inadequate amounts of thermal mass are employed. The fragmented nature of the building process, in which no member of the design team considers the overall optimization of the indoor environment, further compounds the problem.

Different types of dynamic building envelope systems have recently been studied and employed in buildings in order to achieve a better performance. The main purpose of these devices is to optimally control solar gains and create a high quality indoor environment. The design of such systems is a complex task; daylighting, shading, peak heating and cooling loads and electric lighting together with their control strategies should all be taken into account when designing a façade. Since the above parameters are interrelated, an integrated approach must be followed in order to attain an optimal solution. The situation is more complex for facades with high solar gains. In this case, shading provision should be considered as an integral part of fenestration system design. One solution is the use of advanced windows with innovative fenestration systems and motorized shading devices (*Rosenfeld et al 2001, Athienitis & Tzempelikos 2002*). They can block direct sunlight and allow diffuse light into the room, thereby eliminating glare and creating a pleasant luminous environment if they operate optimally.

Dynamic control of shading devices, daylighting systems, electric lighting and HVAC system components may lead to minimization of energy consumption for lighting, heating and cooling (*Lee et al, 1998*). At the same time, good thermal and visual comfort can be achieved under continuously varying outside conditions. The objective of this paper is to investigate different façade design options for a new building to reach an optimum solution, based on all factors mentioned above. The effects of each parameter on energy efficiency and human comfort are studied simultaneously. Human control of some of the components is also discussed.

SIMULATION METHODOLOGY

The 17-storey-high building has two main unobstructed facades facing southwest and southeast. The total floor area is about 53000 m^2 while the floor area covered by perimeter spaces is 5000 m^2. The first decision is the fraction of glazing area of the façade. This should be decided in conjunction with the thermal properties of the curtain wall and the type of glazing. The thermal resistance of the curtain wall was set to 3 RSI, to meet energy code recommendations for Montreal. Then a typical floor was selected for energy

analysis. For perimeter offices, maximization of daylight utilization is important. Also, these offices usually require perimeter heating. Integrated thermal studies were performed for three glazing R-values (0.52, 0.67, 0.85 RSI) and three fractions of vision area (50%, 65% and 75%). The purpose of this simulation was to determine a combination of glazing thermal resistance and vision (glazing) area fraction so as to minimize the need for perimeter heating and maximize daylight. The mean radiant temperature, operative temperature and radiant temperature asymmetry were calculated 1m from the window for winter conditions. It was found that a glazing with at least 0.67 R-value may eliminate the need for perimeter heating for all cases. This leads to significant capital cost savings and increases the usable area of the perimeter offices. Daylighting calculations (next section) also showed that, by choosing two-thirds of the façade to be clear glass, the amount of daylight is sufficient most of the time. Moreover, the effect of the glazing R-value on the peak loads together with the effect of shading is shown in Fig.8. Thus the combination of 2/3 glass-to-wall area and glazing R-value 0.67 was selected as optimum.

Daylighting and shading analysis

The two facades (SE and SW) receive high amounts of solar radiation during the year and shading provision is necessary to control solar gains, prevent from overheating and eliminate glare. The types of shading devices considered in the simulation are: (i) motorized reflective venetian blinds integrated in the double-glazed window, (ii) internal roller blinds with transmittance in the range 10%-30%, (iii) a translucent glazing unit with honeycomb insulation between glazings and (iv) combinations of the above. The critical choice of the optimum type and transmittance of shading devices is an optimization problem. It has an impact on heating/cooling energy consumption, peak loads and visual comfort. The major parameters considered in the decision analysis are: visual and solar transmittance, thermal resistance, visual comfort, reduction of glare and cooling load, privacy, control issues, reflectivity, appearance and cost.

Detailed hourly simulations were performed in order to calculate the illuminance distribution in typical 4m x 4m x 3.5m perimeter offices for all the above shading options and for both clear and overcast sky. First, the incident daylight (*E*) on each façade was calculated hourly during the year, based on CIE overcast and clear sky models (*CIE, 1989*). The transmitted daylight into the room is calculated next. The amount of transmitted daylight depends on the type of shading device used. For all cases, it is assumed that direct (beam) sunlight is not allowed to enter the room; shading devices block direct light and reflect it, re-direct it or diffuse it into the space. In the case of motorized venetian blinds, their transmission characteristics were determined as a function of day number (*n)* and solar time (*t)* (*Athienitis & Tzempelikos, 2001*). They are optimally operated by the building automation system to block all direct sunlight during clear days, while allowing the maximum possible amount of daylight during overcast days. For the case of the interior roller blind, the transmittances of the window and the roller blind have to be calculated separately. The diffuse transmittance of the window is assumed fixed. The roller blind transmittance (τ_b) is assumed constant. Values from 10% to 30% were considered. The transmittance of the translucent glazing is approximately constant (50%). The transmitted daylight is equal to:

$$G(n,t) = E(n,t) \cdot \tau(n,t) \quad (1)$$

where $\tau(n,t)$ is the effective transmittance of the window and shading device together. Fig. 1 shows the beam effective transmittance for the different shading options during a clear summer day (SW façade). As shown, the motorized venetian blinds allow a lot of daylight during the morning -when the sun is high- but after 2pm they close to prevent direct daylight transmission.

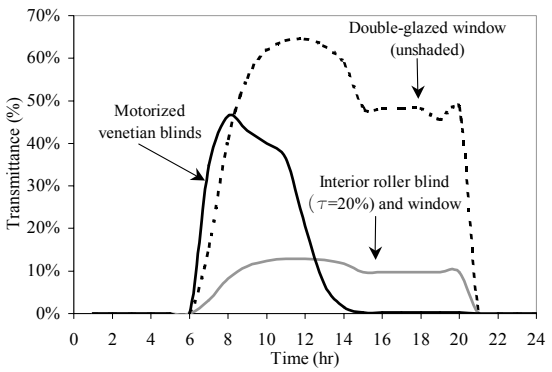

Fig. 1. Transmittance of window/shading device as a function of time (clear summer day).

The illuminance distribution on the work plane after multiple reflections in the room is calculated next, based on a radiosity-based analysis (*Athienitis & Tzempelikos, 2002*). Depending on the type of shading device used, the transmitted daylight calculated in (1) will be the initial interior luminous

exitance of the window. If only one shading device is used, the room interior is modeled as a seven-surface enclosure (six walls and one window). The six walls are simulated as perfectly diffuse sources, with the following reflectances: 30% (floor), 70% (walls) and 5% (window). The roller blind is also modeled as a diffuse surface. In this case, the roller blind is the only initial luminous source and diffuse light is reflected multiple times between all room interior surfaces. The final illuminance on the work plane is computed (*Athienitis & Tzempelikos, 2002*), after calculating view factors, final luminous exitance of all surfaces (*Murdoch, 1985*), and configuration factors for representative points on the work plane. The same approach is followed for the translucent glazing.

However, for the case of the motorized venetian blinds, it was found that this kind of system does not transmit daylight uniformly into the room as a diffuse luminous source. Instead, there are directional effects due to the blinds' inclination (to block sunlight) and their high reflectivity (85%). Experimental measurements showed that almost 35% of the transmitted daylight is reflected horizontally ($\pm 10^0$ deviation), 25% is reflected downwards (mainly towards floor) and at least 35% is reflected towards the ceiling, as shown in Fig. 2.

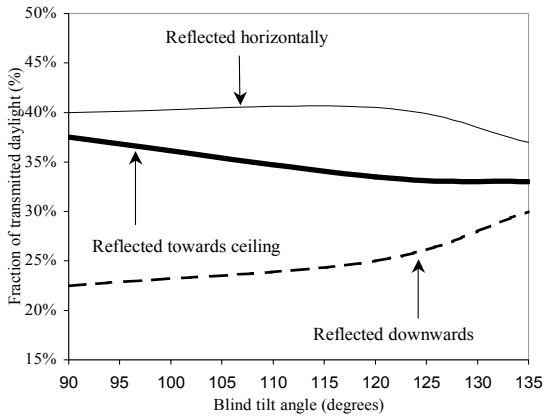

Fig. 2. Directional distribution of transmitted daylight through motorized venetian blinds, for different blind tilt angles (90^0 is horizontal).

This directional distribution of transmitted daylight can change the illuminance distribution on the work plane significantly. Therefore, it was taken into account when calculating the illuminance in the room by increasing the luminous exitances of the floor, the back wall and the ceiling by the appropriate amount. For the case where more than one shading device is used (combinations), the room is modeled as an eight-surface enclosure (six walls and two windows) with two initial luminous sources. The top part of the window can be either motorized venetian blinds or the honeycomb translucent glazing (1.3m high) and the bottom part of the window (1.4m high) is always shaded by a roller blind. The same approach as before is followed and all the surfaces are assumed diffuse, except for the window with the venetian blinds. Illuminance distributions were determined for daytime hours in the year, considering all the above shading options, for all perimeter spaces, for both clear and overcast days.

Roller blinds may ensure privacy and can be open during overcast days to allow maximum daylight in the room. On clear days, they may diffuse daylight and their transmittance can be low in the bottom half and higher in its upper part. Motorized reflective venetian blinds block direct sunlight, reduce cooling loads (as shown below) and allow some view to the outside. Moreover, they reflect daylight towards the ceiling by adjusting the blind tilt angle in order to block direct sunlight, and improve the daylight uniformity deep in the room. The honeycomb translucent glazing has good thermal resistance, but it may create glare on clear days and can lead to overheating. For most cases, the motorized venetian blinds perform better than the roller blind. Fig. 3 shows the best case; in the summer the sun is high and the venetian blinds allow plenty of diffuse daylight in the room. Fig. 4 shows the worst case; during December and January, the sun is low and the venetian blinds close at a high angle to block direct sunlight. The performance of translucent glazing is not included in the figures, because of very high illuminance values (glare).

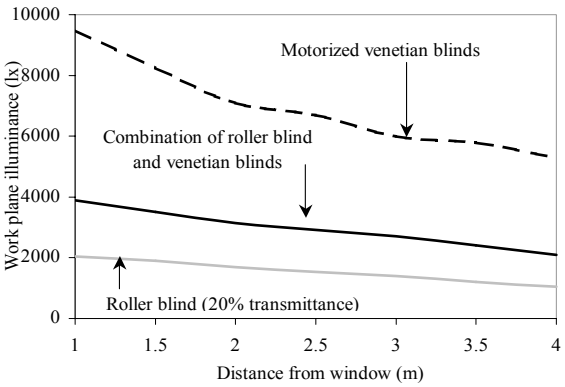

Fig. 3. Illuminance distribution in a typical office on SW façade (clear summer day, noon).

The thermal transmittance and the control of the shading device are also important when deciding for the best system because they affect significantly the heating and cooling loads as discussed below. The window with integrated venetian blinds has a variable thermal resistance (depending on the blind tilt angle and the outside temperature), which is quite high (around 0.65 RSI).

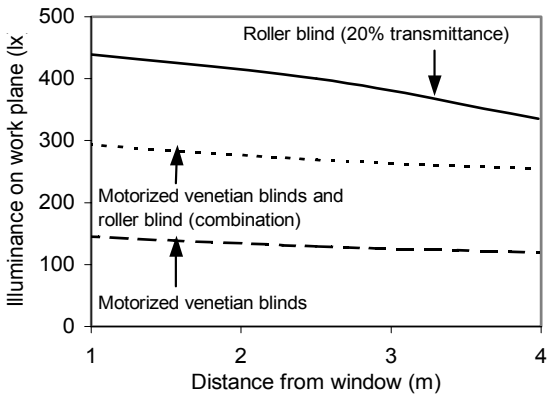

Fig. 4. Illuminance distribution in a typical office on SW façade (clear winter day, afternoon).

Based on the above, and at the same time considering that people would like to have some control on their luminous environment, the optimal solution was found to be that of Fig. 5. This is a combination of motorized venetian blinds (top half of the window) and manually controlled roller blind (bottom half of the window). The roller blind has a smaller resistance but in this case, it is not important since the glazing R-value has been selected as 0.67 RSI. However, their control is very important, and this is shown in Figs 8-10. Nevertheless, in the determination of the best shading/daylighting system the daylighting performance plays a dominant role and overall, the motorized venetian blinds perform better.

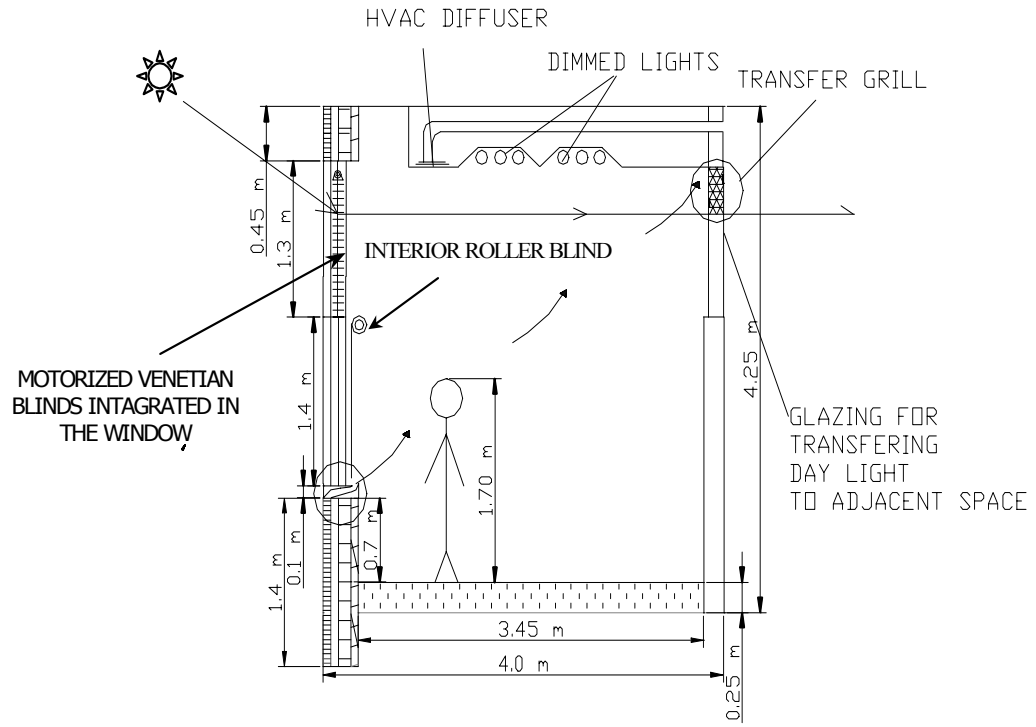

Fig. 5. A multifunctional façade with optimum shading and daylighting options for a typical perimeter office. The top part of the window consists of motorized venetian blinds and the bottom half is a manually controlled interior roller blind.

The venetian blinds block sunlight and improve daylight uniformity in the room, while the manually controlled roller blind gives the occupants the choice of changing -to a certain extend- their visual environment and can provide privacy. Under normal circumstances, the roller blind should be open during overcast days and closed during clear days. Moreover, by using this configuration, the control points are dramatically reduced (1-2 points on each façade).

Electric lighting options and energy savings

Utilization of daylight in perimeter spaces can lead to significant energy savings due to reduction in electricity consumption for lighting if dimmable electric lighting systems are used (*Tzempelikos & Athienitis, 2002, Lee et al, 1998*). In the simulations, the electric lights are dimmed based on a control algorithm developed at the Centre for Building Studies in Concordia University, to always ensure more than 500 lx on the work plane (target illuminance). For a typical perimeter office, three 60W T8 type fluorescent lamps with their 10W ballasts were assumed (12W/m^2 power). Two options were considered for the electric lighting control: (i) continuous dimming of all lamps (0-100%) and (ii) three-level switching based on on/off operation of one, two and three lamps. The difference between the two control strategies is that, for the three-level switching, the lights are not dimmed, but they are 100% on when there is not sufficient daylight (less than 500 lx) on the work plane -which is assumed to be 0.8m above the floor. The advantages of dimming the lamps continuously are first, a better visual environment (occupants cannot easily realize the changes in the intensity of lights) and second, the energy savings are higher because all the lamps operate at the minimum necessary level, to ensure 500 lx on the work plane. The three-level switching also results in significant energy savings, but the lights turn suddenly on when there is insufficient amount of daylight on the work plane. However, this option is more cost-effective.

The simulations produce the dimming levels and the operation times of all lamps for every work-hour in the year, for the configuration of Fig. 5. The motorized blinds operate automatically based on outside illuminance and sky conditions. The roller blind is assumed to be closed during clear days and open during overcast days. The algorithm computes the illuminance in pre-selected representative points on the work plane and the electric lights are dimmed/ turn on, starting from deep in the room-lower illuminance- and proceeding towards the window. If it is necessary (very cloudy days or at night), all three lamps are operating. For all the other cases, only one or two lamps are operating at the optimum level, to ensure at least 500 lx on the work plane. The daily electricity consumption using the two lighting control strategies is also found for all days in the year. Clear and overcast average days are taken into account in the simulations, based on the clearness index values for each month for the region of Montreal. The results are shown in Fig. 6.

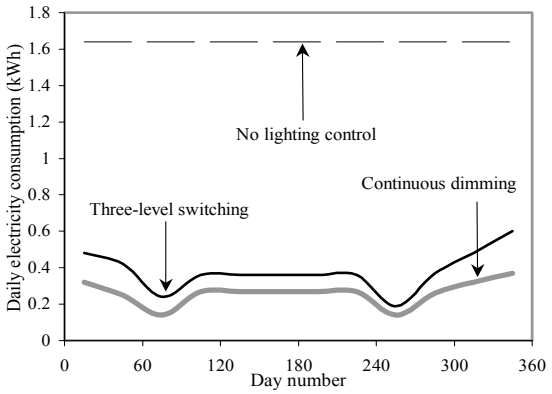

Fig. 6. Comparison of mean daily electricity consumption for lighting using continuous dimming, three-level switching and no lighting control in a typical office on SW façade.

As expected, continuous dimming is more energy-efficient than three-level switching. The two curves are compared with the case when there are no lighting/daylighting controls. These simulations were performed for all facades and perimeter spaces, for every hour in the year, to estimate the total energy savings due to reduction in electricity consumption for lighting in perimeter spaces. The annual energy savings using continuous dimming reach 334300 kWh or 67 kWh/m^2 (83%), whereas using three-level switching they reach 275000 kWh or 55 kWh/m^2 (71%). The 8% difference (59300 kWh) is noticeable, but when compared with the difference in the cost of the two systems it seems that the three-level switching is the most cost-effective option. The illuminance distribution in perimeter spaces using the optimum shading configuration of Fig. 5 and the three-level switching for lighting control is significantly improved. Daylight uniformity and sufficient amount of light are ensured during the year. A typical result is shown in Fig. 7, for December 15th, 3pm, which is the worst case for the southwest façade. The venetian blinds close at a high angle and the roller blind is also closed, to reduce glare, because the sun is low. The illuminance on the work plane is less

than 500lx and two of the lamps are on, resulting in a relatively uniform distribution (around 700 lx) on the work plane. For most clear days in the year, only one lamp is operating for a few hours and the work plane illuminance varies between 500lx and 600lx. In Fig. 7, two roller blind transmittance values are also compared. From simulations throughout the year, it seems that 20% transmittance is better than 10%. More than 20% transmittance may lead to overheating in the summer and increase of cooling loads. The final uniform light distribution is shown, when the electric lights are operating based on the three-level switching control.

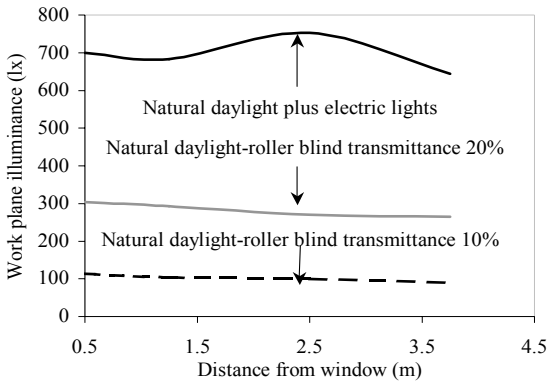

Fig. 7. Illuminance distribution on the work plane in a typical office on SW façade (December 15th, afternoon).

Reduction in heating and cooling loads and energy consumption

Detailed transient thermal studies were performed to investigate possible reduction in peak cooling/heating loads and reduction in energy consumption for heating and cooling. The simulations were done for heating design days (cold cloudy and sunny) and for cooling design days (hot sunny) using software based on a Mathcad electronic book (*Athienitis, 1999*). Solar gains, conduction gains, lighting and other internal gains are all taken into account and the results are based on detailed transient analysis (*Athienitis & Santamouris, 2002*). The most important thing in this analysis is to consider building envelope parameters together with the shading devices and their control, as well as light dimming, in order to find their effect on the loads and energy consumption.

Simulation results show that the motorized shading devices reduce dramatically the peak cooling loads and energy consumption. Cooling loads are further reduced because the lights are dimmed. Figure 8 shows the impact of different options on peak heating and cooling loads. The heating analysis is for a cold January day, while the cooling analysis is for a hot sunny summer day. This figure presents all the major findings of this part of the simulation. The peak heating load is of course highly dependent on the glazing R-value. A glazing with R-value=0.52 is not suggested also for this reason. The maximum reduction in peak cooling load is due to motorized control of shading devices (last group of bars), but there is also a significant reduction due to light dimming using three-level switching (second group of bars). Also, there is no noticeable reduction in the peak cooling load due to increasing window (or wall) R-value because most of the cooling load is due to solar gains, lighting and other internal gains. The reduction in cooling capacity due to motorization of shading devices and light dimming reaches 513 kW for both cases (R=0.67 RSI and R=0.85 RSI). In terms of cooling performance, they are both equal. These results together with the elimination of perimeter heating and the big difference in the cost of the glazing, justifies the choice of R=0.67 versus R=0.85 for the glazing. Fig. 9 shows the effect of light dimming and shading device motorization on daily cooling load (for all perimeter spaces).

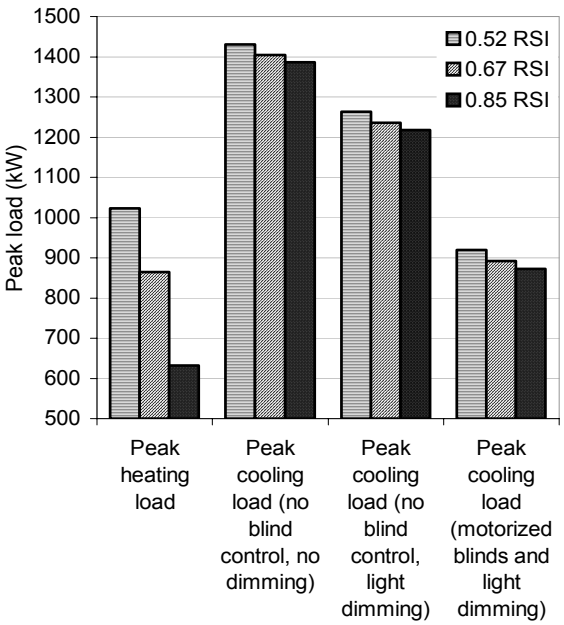

Fig. 8. Peak heating and cooling loads for different glazing R-values and the effect of blinds control and light dimming (perimeter floor area is 5000 m2).

The above parameters have similar effects on the energy consumption for heating and cooling (except for the loads). Fig. 10 summarizes the annual energy consumption for heating and cooling for the

parameters of Fig. 8. These results correspond only to perimeter spaces (interior zones are not considered here). The reduction in cooling electricity consumption is 740 MWh (148 kWh/m^2) due to light dimming and 1540 MWh (308kWh/m^2) due to blinds control. As shown in Fig. 10, the operation of motorized shading devices in conjunction with three-level switching of the lights reduces dramatically the energy consumption for cooling. The total energy savings calculated above pay for the cost of motorized shading devices and glazings in less than three years.

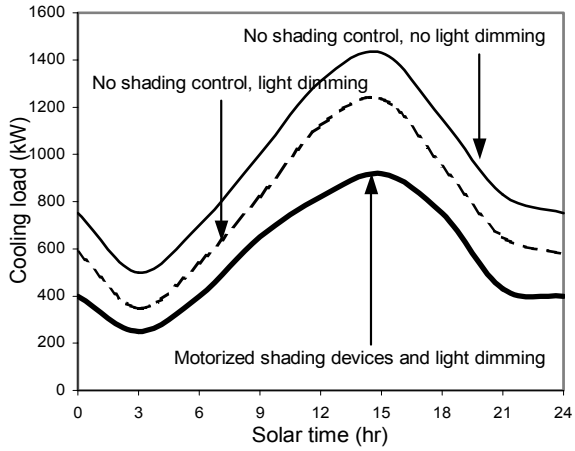

Fig. 9. Impact of light dimming and motorized shading on cooling load during a hot summer day.

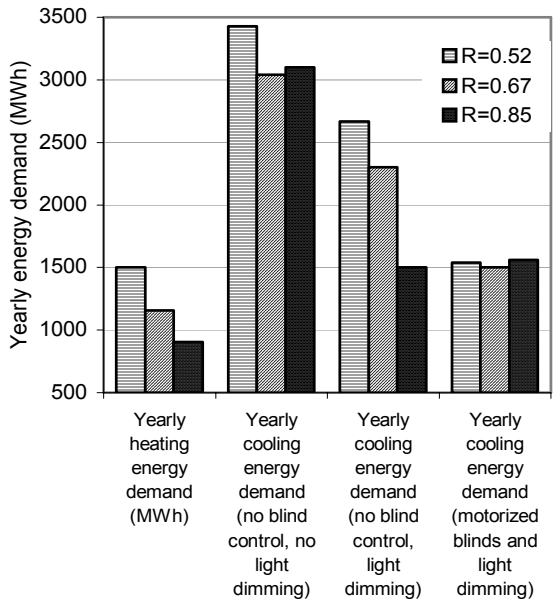

Fig. 10. Impact of glazing thermal resistance, blind control and light dimming on annual heating and cooling energy consumption (perimeter floor area is 5000 m^2).

CONCLUSIONS

The major objectives of this simulation design study were to maximize daylight utilization, control solar gains optimally, reduce energy consumption for heating, cooling and lighting and peak loads, while maintaining good thermal and visual comfort. By choosing two thirds of the façade area to be glass with R-value of approximately 0.67 RSI for the particular building considered, perimeter heating could be eliminated. Maximization of daylight is achieved by selecting clear glass for the facades. The selection of shading devices and their control is critical. Thermal and visual comfort are strongly affected by the type and control of the shading device used. The daylighting performance of three shading devices and their combinations was estimated by detailed hourly daylighting simulations. The combination of motorized venetian blinds integrated in the windows and operated by the building automation system with manually controlled interior roller blinds in the lower portion of the window was found to be an optimal solution. The occupants have some control on the luminous environment, without affecting the performance of the motorized venetian blinds.

Two lighting control strategies were compared and the three-level switching seems the most cost-effective option. The operation of the motorized blinds in conjunction with the controllable electric lighting system ensures adequate illuminance all the time and uniformity on the work plane (500lx). Peak cooling loads and cooling energy consumption are dramatically reduced -by 40%- if the proposed strategy is used (not considering ventilation loads). When calculating heating and cooling energy consumption and peak loads, it is very important that the shading devices and their control are taken into account, since the impact of these factors in the results is strong. Further research is underway in order to develop a general methodology that allows integrated design of shading devices/fenestration systems, electric lighting systems considering their impact on heating, cooling and lighting energy consumption.

NOMENCLATURE

E	illuminance [lx]
n	day number
τ	transmittance
G	transmitted daylight [lx]
t	solar time [hr]

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EXPERIENCE OF USING BUILDING SIMULATION WITHIN THE DESIGN PROCESS OF AN ARCHITECTURAL PRACTICE

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ABSTRACT

This paper documents work that follows on from a previous study [Morbitzer et al 2001] on the implementation of a simulation-tool into an architectural practice at outline design stage. The use of simulation is now pervasively and routinely undertaken by designers within the company to evaluate energy and environmental performance of their design concepts.

The paper documents the changes to the interface, based on the feedback from designers. It includes a case study of how these improvements have impacted on the degree-of-use of the simulation-tool by designers, the impact of the tool on the design process and the design outcome, a discussion on the development of the simulation-tool, and the issues facing the architectural practice with use of simulation.

INTRODUCTION

Historically, the use of simulation on practical problems is undertaken, predominantly, by specialised environmental systems engineers or research groups (commercial, government funded or academic), usually focused on specific problems [McElroy et al 1999]. This situation gives rise to simulation exercises being undertaken, generally, later on within the design process (scheme or detail design stages [RIBA 1995]) with the purpose of validating design decisions. This situation is due to the limited availability of resources for simulation work at early design stages and limited understanding of the benefits of using simulation by design team members. However, changes in procurement methods and legislation have provided strong incentives for the use of simulation within architectural practice.

The use of simulation facilitates better understanding of the design problem with respect to energy performance, often highlighting poor performance of design concepts: the need to change designs to mitigate this under-performance at the later design stages can be costly.

In order to address these problems, an Outline Design Stage (ODS) interface was developed [Morbitzer et al 2001] with ESP-r [ESRU 2003] as the core simulator. The interface was introduced and used within an architectural practice, with the intention of using the tool routinely on projects at the outline design stage when it can have the greatest influence on energy and environmental aspects of the design.

The adapted software is currently in its final phase of development as described by [Maver and Ellis 1982]: *where commercial exploitation and development of user training and support procedures* is being undertaken.

Providing the analysis software is only part of the requirement. In order for the use of simulation to be exploited, significant investment of resources [Clarke 2001] in some crucial areas is required:

- obtaining an appropriate level of knowledge of the issues of computer modelling within practice;
- development of a robust understanding of how, where and when simulation can be used; and
- development of collaboration between key individuals within practice.

In this particular case (within the architectural practice) the requirement for increased resources has been facilitated through the UK government's TCS project. Funding from this provided the additional resources required for development of software.

The paper focuses on three core issues relating to the use of simulation in practice:

- Potential drivers for the increased use of simulation.
- Interface/software development to increase functionality and ease of use.

- Business control for quality assurance and user training

These issues have been highlighted through practical application of the ODS Interface within an architectural practice.

The ODS Interface is a bespoke interface to an advanced simulation tool. The interface facilitates straightforward creation of the geometry model through links with the existing CAD tool within the practice and enables easy attribution of the geometry model through support databases which hold construction, operation, and control files.

Currently the software is capable of determining the annual energy consumption and thermal comfort conditions.

It is the belief within the architectural practice that significant benefits are available to clients in using simulation at the earliest design stages, predominantly in explicit evaluation and quantification of the design parameters. This improved design concept evaluation methodology is believed to facilitate better design-decision making, leading to improved design entities and an improved service to clients.

Information and knowledge increase as the project progresses. At the earliest design stages, information and knowledge pertaining to the design problem may be significantly restricted which emphasizes the importance of understanding the assumptions made within the simulation model. This requires a high level of control by management.

It has been found through the application of the ODS interface by architects within the practice that control of any simulation exercise, particularly those undertaken by non-specialists, is of vital importance in limiting the liability of the architectural practice: clients often assume that the predicted annual energy consumption for example, indicates how the actual building will perform. It is therefore necessary to highlight the assumptions made within the simulation model to demonstrate that simulation is not infallible.

The following sections of the paper discuss:

a) the barriers to the use of simulation that have been addressed and those remaining;

b) the issues facing the construction industry with respect to sustainability and associated legislative changes, how simulation will play a crucial role in demonstrating sustainability, and how this has been interpreted by the architectural practice in its strategy for sustainable building design utilising simulation;

c) changes to the interface to improve architect take-up of the software; and

d) the issues of quality assurance and training.

BARRIERS TO THE USE OF SIMULATION IN PRACTICE

Initially the barriers to the use of simulation were attributed to:

- complexity in creation of the simulation model;
- poor understanding of simulation by architects.

These barriers were addressed in the development of the ODS Interface and its implementation in the company.

Through the experience of using simulation within an architectural practice further barriers to its use have been identified through user surveys and feedback as:

- increased risk of liability of the architectural practice;
- unfamiliar working methods;
- lack of knowledge of energy modelling;
- perceived increase in workload.

These barriers have been addressed in the following ways:

Firstly, in the development of comprehensive management procedures to control the risks associated with architects undertaking simulation.

Secondly, in appropriate communication through training to ensure that the architects have an appropriate level of understanding to undertake simulation.

Finally, the significant barrier of the 'perceived increase in work load' has been mitigated through recent developments of the software interface to incorporate a Building Regulations Compliance checker and other additional functionality. The hypothesis was that the provision of additional functionality, specific to the way an architect works, would give an added incentive for building the geometry model to check compliance to Building Regulations. Having built the geometry model for the Building Regulations check, the attribution stage is achieved in a straightforward manner enabling energy and comfort performance results to be obtained for the design concept.

Since the initial implementation phase of the ODS Interface within the architectural practice, a variety of external factors have been highlighted by the architectural practice as important drivers for increased use of simulation within the design process. These are highlighted in the following section.

THE DRIVERS FOR INCREASED USE OF SIMULATION

Since the architectural practice first started implementing thermal simulation into its design process, there have been several developments that have resulted in increased need for its use, and also additional requirements to its capabilities.

The root of many of the drivers for increased use of simulation in practice comes from the drive for energy efficiency, and in the broader context, the drive for sustainability. The impact of sustainability on governmental policy and legislation is significant. The drivers towards sustainability include:

- International/National/Organisational policy, such as Rio and Kyoto agreements, the UK government's *Building a better quality of life*, and the NHS Estates and Defence Estates Policies for sustainable development; [DETR 2000, NHS Estates 2001]
- Planning policy (Local Agenda 21) - this has led to changes in the Structure and Local Plans by Local Authorities;
- Legislative changes such as the recent update to the Building Regulations in the UK and the EU Directive on energy performance of buildings [CEC 2001];
- Changing types of procurement such as PFI/PPP (Private Finance Initiative/Public Private Partnership) where the focus is on the life cycle of the building and on improvements to public services.

The *triple-bottom line* [EEA 1997, CIRIA 2001] of sustainability or sustainable development can be seen as the integration or optimisation of social, economic, and environmental objectives in Figure 1.

The circles represent the domains in which the aspects of sustainable development exist. The use of simulation could help in quantification of the impact of the operational energy and the impact of the building components within the environmental domain at the building scale. It could also be useful in quantification of the degree of comfort within spaces within the societal domain.

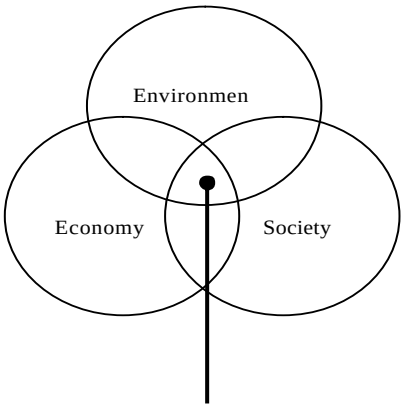

Figure 1 – Triple-bottom line model of sustainability

Changes to the UK Building Regulations Part L (Conservation of Fuel and Power)

Recently in the UK the Building Regulations Part L [DTLR 2002] have undergone significant changes. The Building Regulations in the UK now allow the designer to carry out an energy performance assessment in three different ways.

- Elemental Method
- Whole Building Method
- Carbon Emissions Method

The *Elemental Method* compliance is achieved when components of the building such as window sizes, insulation level, plant efficiencies and ventilation performance specification comply with the specification set out in the Regulations.

The *Whole-building Method* of compliance is achieved when the proposed building is simulated and its performance is compared with benchmarks.

The *Carbon Emission Calculation Method* of compliance is achieved when the proposed building is simulated and the carbon emissions are calculated and assessed against a notional building of the same size and shape as the proposed building designed to comply with the Elemental Method.

The introduction of the Whole-building Method and Carbon Emission Calculation Method is a significant change in the way the Building Regulations address energy efficiency. Firstly, they remove the design restrictions that the Elemental Method imposes on the design, such as the construction used or window sizes. Secondly, the methods embrace all the energy consumers in the building. This allows a trade-off approach between

different energy consumers, hence further increasing the flexibility of the designer (e.g. lighting energy consumption vs. heating energy consumption). This trade-off also includes an assessment of the energy type used (hence the use of electricity rather than gas as an energy source would be penalised).

The case study described later highlights the use of simulation to assess compliance to the new building regulations of a building that fails to achieve compliance when using the Elemental method.

The European Directive on the energy performance of buildings

The European Directive on energy performance of buildings is likely to be a significant driver towards the increased use of simulation in two main ways:

- In the establishment of a general framework for calculating the integrated building performance:
- The certification of buildings means that new building performance will need to be evaluated and guarantees given that the predicted and actual performance of the building will be the same within an acceptable boundary. The most sensible way of achieving this would be in the use of integrated simulation.

The directive's main objective is stated as:

The basic objective underlying this draft Directive is to promote the improvement of the energy performance of buildings within the EU, ensuring in so far as possible that only such measures are the most cost-effective are undertaken.

Although this objective doesn't explicitly indicate how costs are determined, it remains to be seen whether only energy costs are considered or whether other considerations of the triple-bottom line approach are included in the accounting procedure.

Changing Procurement Routes

Under PFI/PPP procurement methods employed by the UK government there usually exists a situation where the occupier of the building pays for the energy use of that building, and therefore a reduction in energy consumption is a tangible benefit. This may not be the case in the situation of speculative building development facilitated through more traditional procurement routes (e.g. Design and Build). In this situation the focus is more likely to on the minimisation of the capital cost of the development. Energy savings may not be perceived as important in this situation as the developer will not be responsible for the energy cost. Admittedly, reduced running costs may enhance the chances of leasing any speculatively developed space; however, there exists no framework, as yet, for demonstrating energy performance to potential tenants/buyers. [Hobbs 2003].

Currently the ODS Interface enables quantification of annual energy consumption and comfort conditions. The architectural practice is focused on developing the evaluation capabilities of the software to increase the use of the tool in practice in direct response to the external drivers.

The following section describes the framework for enhancements to the ODS Interface to improve degree of use, to respond to the external drivers and to ensure that the associated risks of using simulation are kept to minimum within the architectural practice.

DEVELOPMENT OF A SUSTAINABLE DESIGN ENVIRONMENT (SDE)

[Clarke 2001] introduced the concept of the Computer Supported Design Environment (CSDE), as a way in which the use of simulation could be developed to aid in the design process. To address the long-term requirements of the architectural practice, a framework (Figure 2.) for such an environment has been constructed in order to guide the gradual change in design approach to incorporate explicit design concept evaluation, facilitated to provide *feedback on all aspects of performance and cost in terms meaningful to the designer*. [Clarke 2001]

It is believed this approach within the practice will aid in the production of sustainable design outcomes, by allowing designers to quantify their design decisions with respect to sustainability at the pre-design and concept design stages, where the impact of the design-decisions is greatest.

The Sustainable Design Environment includes:

- Qualitative Sustainability Assessments [BREEAM 2003, LEED 2003, SEAM 1996]
- Window Designer (daylight level calculator)
- Thermal analysis for thermal comfort and energy consumption.
- Environmental Impact Assessment (Life Cycle Analysis tool)
- Whole Life Costing Tool
- QA/Training Material

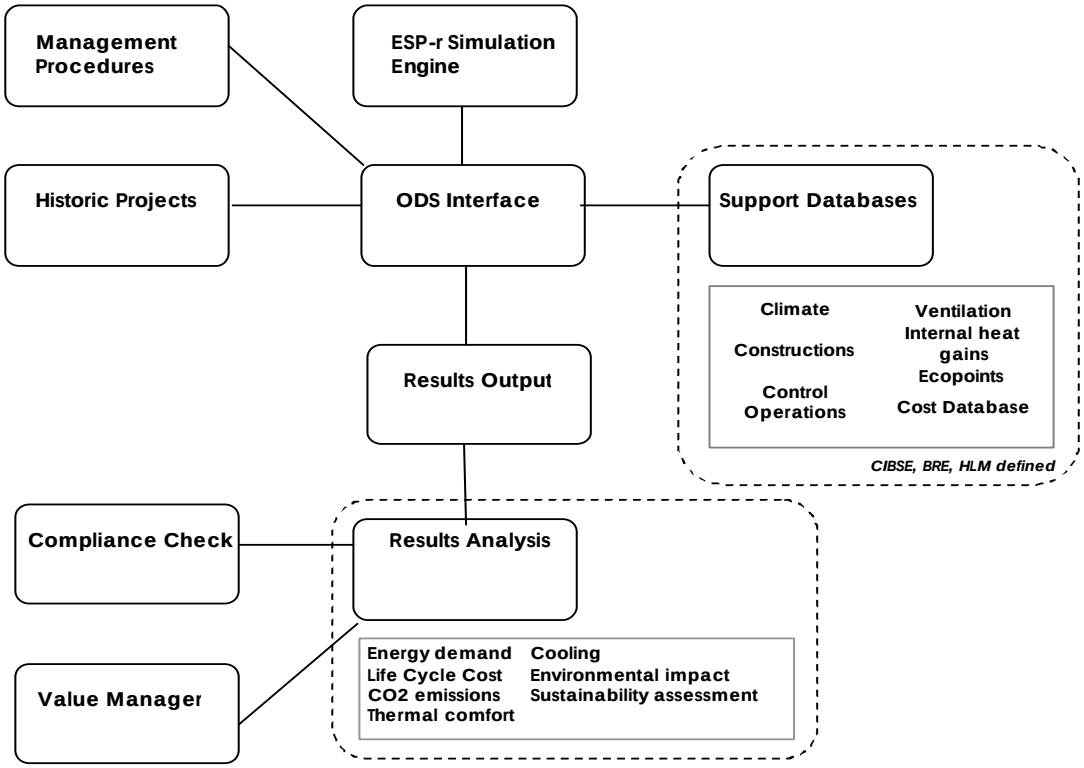

Figure 2 – Sustainable Design Environment

INTERFACE DEVELOPMENTS

The ODS interface described in [Morbitzer et al 2001] has been developed in a number of ways to extend capabilities and embed it within the framework described in the previous section.

The developments that have been achieved so far to the interface are as follows:

- Window Designer (daylight level calculator)
- Building Regulations compliance checker
- Operations and control specifier

The developments to the support databases are underway to include cost and environmental impact fields. The qualitative sustainability assessment tools are still to be incorporated along with the value management tool.

Probably the most significant adaptation to date is the Building Regulations compliance checker that has enabled designers to check compliance of their design concepts early within the design process and enabled them to change things when compliance was not achieved.

QA AND TRAINING

The use of simulation by architects within the design process requires a level of control for a variety of reasons. This has led to the development of management procedures in order to:

- Provide a checking mechanism as to whether or not a simulation exercise is necessary – a simulation exercise should only be carried out if it provides an answer to a design consideration that cannot be answered in an easier and quicker way (e.g. by contacting a building services engineer).
- Ensure that financial and human resources required for the exercise are available.
- Agree deadlines that can be met by all parties and provide performance predictions in the time frame required by the design team.
- Ensure that either an external or internal party approves data used for the model creation and that data sources (as well as the person(s) who approved the data) are documented.
- Ensure that verification and validation of the simulation model are applied.
- Ensure that performance predictions are reported in an understandable way and that the report with the performance predictions explains the basis on which

they were produced (e.g. input data used, model accuracy applied).

These procedures have been developed to limit the risks associated with using simulation by architects at early design stages.

The procurement and design processes are complex processes involving varied and often disparate individuals/organisations. The information available at the early design stages is limited and therefore contains a significant degree of uncertainty; the procedures limit the effects of that uncertainty.

QA checks of the simulation model form a vital part of every simulation exercise to ensure that the information produced is reliable. Performance predictions need to correspond to the actual behaviour of the building. This check should be carried out as a combined verification and validation exercise. Verification and validation is defined as follows [Robinson 1994]:

Verification: ensuring that the designer is solving the *problem correctly*. This deals with the accuracy of transforming a problem formulation into a model.

Validation: ensuring that the designer is solving the *correct problem*. This deals with the model behaving with satisfactory accuracy consistent with the study objectives.

Generally the use of management procedures can slow down the speed with which a simulation model is created (additional work required to fulfil the tasks involved, waiting for response from person carrying out a QA check), but it has to be ensured that they are always applied. One way to ensure this is by linking them to the simulation tool (management procedures open up automatically in a text document when a designer starts the simulation interface). This feature is currently under development for the ODS Interface.

The situation where simulations are routinely undertaken by non-specialists will occur only with substantial training being implemented: an appropriate level of training of the architect carrying out a simulation exercise is required to ensure the efficient use of the tool and the creation of an appropriate simulation model. From experience with architects within the company, it was found that basic training in the operation of the CAD tool for the specification of a model geometry as well as the model attribution in the ODS can be carried out within a day. Training is currently carried out by in-house training, support during project work as well as through an extensive user manual.

CASE STUDY

A case study is given to demonstrate how the adapted ODS interface has been used in early stage design by architects. The interface has been used on many projects ranging from prison and hospital design to commercial and residential building design. The example given here focuses on how it has been used to check compliance against the new UK building regulations and reflects the impact of the QA procedures developed.

The case study describes a simulation exercise that assessed whether or not a proposed building design could achieve compliance under the Carbon Emission Calculation Method of the British Building Regulations Part L.

Simulation model

The simulated building comprised 13 floors. The bottom floor was used as a retail area. The floor above was used as the lobby of the building. On top of this were 11 floors that were used as office spaces. Each floor comprises of an occupied space with a height of 2.75m and a void space 1.1 m high. For the model representing the proposed building the glazing area of the occupied space was specified as 90% and for the notional building as 61.1% (equivalent to 40% overall façade area). The windows in the proposed building were attributed as double-glazing, in the notional building as glass with a U-value of 2.2 W/m^2K (required by the Building Regulations). Fresh air was supplied at 16 l/s per person, assuming a 50% heat recovery. Internal heat gains were specified as typical for an office building [CIBSE 1998].

Results

The study was carried out in two steps. First the building was simulated with the ODS Interface to determine the heating and cooling energy requirements as seen by the building plant as well as the required capacities. Table 1 shows this data for the notional and the proposed building design.

It can be seen that the notional building has a lower heating energy consumption than the proposed building but a higher cooling energy consumption. This was a surprising finding because it was initially assumed that the higher solar gains caused by the larger glazing areas of the proposed building would result in higher cooling energy consumption.

Table 1: Heating and cooling energy requirement as seen by the building plant and required plant capacities

	Notional Building	Proposed Building
Heating Energy Consumption [kWh/m^{2}a]	7.5	11.1
Cooling Energy Consumption [kWh/m^{2}a]	63.2	60.5
Heating Capacity [kW/m^2]	30.5	35.5
Cooling Capacity [kW/m^2]	61.8	70

Figure 3 displays a first finding from this analysis. The graph displays the heating and cooling loads in the zones on the level that was simulated as representative for most of the office spaces within the building. It can be seen the building has a significant cooling load throughout the year, whereas the heating load is generally low. The glazed areas with their lower thermal resistance are an important heat flow path. In this particular case the large glazing area therefore reduced the cooling load of the building. This finding was also confirmed by a detailed analysis of the energy breakdowns that occur in the different zones during various climatic conditions.

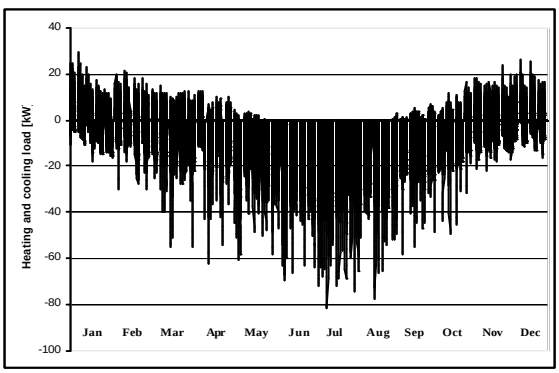

Figure 3: Heating and cooling loads in selected office spaces (perimeter and core location) of the proposed building over an annual period

Although the building envelope did not negatively influence the energy performance of the proposed building the notional building still had marginally lower energy consumption. This was a result of the plant system that was specified for this particular building (See Table 2). In consequence the proposed building failed to achieve compliance through the carbon emissions method. However, the building achieved compliance through the *Whole-building Method* because its overall carbon emissions were lower than the benchmarks specified in the Building Regulations.

Table 2: Annual delivered energy consumption (kWh/m^{2}a) and capacity (kWh/m^2)

Building type	Heating	Hot water	Cooling	Auxiliary plant	ACMV[1] fans	Lighting	Office equipment (small power)	Total
Notional	7	4	33	11	47	43	30	176
Proposed	11	4	38	38	60	39	30	220

Discussion of case study

The case study showed how the integration of simulation into an early building design stage resulted in a more informed decision process. It was shown that for this particular building large glazing areas did not cause higher energy consumption than a notional building with smaller glazing areas. This was a finding that contradicts best practice advice as well as the design approach that the Building Regulations try to encourage with the elemental method. Using simulation thus informed the designer that in this particular case it is possible to make the preferred aesthetic design choice and still comply with the Building Regulations.

CONCLUSIONS

- Policy for Sustainability, Changing Legislation (UK Building Regulations, EU Directive on the performance of buildings), and use of the PFI/PPP procurement route is likely to increase the use of simulation within the construction industry.
- It is important to have appropriate control of any simulation exercise undertaken in practice, particularly by non-specialists.
- Quantification of the design parameters is an important aspect: simulation is utilised to facilitate this quantification within practice in order to improve design-decision making.
- The adoption of comprehensive Quality Assurance has reduced the risks associated with the use of simulation in practice.
- Training has improved understanding within the architectural practice of when and how the use of simulation should be undertaken

1. Air Conditioning and Mechanical Ventilation

- Training and the interface developments have led to an increase in use of simulation within the architectural practice.
- The use of simulation by architects at the early design stage has facilitated improved understanding of the design problem and improved design outcomes.
- The political drivers for sustainability are likely to encourage the take up of other tools within the design process for quantification of other important design parameters.
- There is need for additional appropriate tools to be made available for designers in order to improve design concept appraisal.

FUTURE DEVELOPMENTS

Future developments will include the further development of the SDE. Post Occupancy Evaluation (POE) should also be undertaken to compare predicted and actual performance against key parameters such as client and user satisfaction, energy consumption, efficacy of control systems and comfort conditions. POE has the capacity to:

- improve benchmarking of new design concepts; and
- improve understanding of design of sustainable buildings.

Post occupancy evaluations are considered by the company as crucial to their provision of an unrivalled service. However, it is understood that the development of a framework for POE will occur in the mid to longer term.

It is envisaged that the in-house training will aid further implementation and expand the possibilities for the use of simulation throughout the architectural practice.

Finally, the issues of procurement and contractual arrangements within any design process impacts significantly on whether simulation is used and how it used within the design process; these issues need to be investigated. For example, an important use for simulation is in quantification of energy consumption; however, in situations where the client is not the owner or occupier this has little relevance. Suitable assessment of the need for simulation and the degree of quantification of the design parameters is likely to be required.

ACKNOWLEDGEMENTS

Scottish Energy Systems Group (SESG, www.sesg.strath.ac.uk) for access to knowledge, techniques and tools for the deployment of simulation based technologies.

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News from Affiliates

IBPSA-Australasia

Veronica Soebarto, University of Adelaide

IBPSA Ausalasia held its annual seminar in 2003 in conjuction with the ANZAScA (Australia and New Zealand Architectural Science Association) Conference, at the University of Sydney, on October 31st, 2003. The seminar included presentations by:

- Paul Bannister, from Exergy Australia, ACT, with a presentation titled "Lies, damned lies and simulations: Use and abuse of simulation in the marketplace"
- PC Thomas from Arup, Sydney, "A Dynamic Simulated Reality!?"
- Quentin Jackson from Building Workshop, Wellington, NZ, "The use of simulation in architectural practices"
- Dirk Schwede, University of Sydney, "Integrated Simulation of Physical Processes to Predict the Occupants' Comfort Perception in and Energy Efficiency of Buildings - A computational Model to Support Architectural Design in its Early and Advanced Stages".

Full contact information for IBPSA-Australasia is on page 6

IBPSA Australasia is planning to hold the 2004 seminar in conjuction with the ANZAScA conference to be held in the University of Tasmania, in November 2004.

IBPSA-Brazil

Fernando Simon Westphal and Roberto Lamberts, Federal University of Santa Catarina

2nd IBPSA-Brazil Workshop

The second IBPSA-Brazil Workshop took place in Curitiba, Paraná, on November 6th, 2003, during the VII National Conference on Comfort in the Built Environment (ENCAC) and the Latin American Conference on Comfort and Energy Performance of Buildings (COTEDI) (**www.labeee.ufsc.br/encac-cotedi**).

During this event, 25 papers and 3 posters were presented, covering research activities in building simulation developed across Brazil and in other Latin American countries. Most research groups are using third-party software, developed abroad; only one software program is being fully developed in Brazil (Domus).

Full contact information for IBPSA-Brazil is on page 6

In the concluding discussion, the participants agreed that the use of simulation tools in Brazil is still restricted to universities, applied to scientific works, with a little

participation in some design projects with focus on energy efficiency and sustainability issues.

A lack of national simulation tools, adapted to the local culture, was detected and some groups are working to change this situation, developing new tools or adapting existing code.

The number of IBPSA-Brazil members has increased to 44, covering the main national research groups in this area. It is expected that there will be an increase in the exchange of information and experiences after this Workshop.

IBPSA-France

Gilles Lefebvre, Université Paris-XII Val de Marne

IBPSA France has modified its status. It is now a component of AICVF (the French Association of Air Conditioning, Ventilation and Cooling Engineers, **www.aicvf.org**). A meeting is planned soon to organise the future head of the component and to initiate projects.

One of the early initiatives of the reorganised group will be the IBPSA France Conference, which will take place in the framework of the annual AICVF Congress in Toulouse on the 7th and 8th of October 2004 (see the announcement on **page 17**, in the Forthcoming Events section). A joint call for papers has been issued and can be obtained by sending an e-mail to the Conference Secretariat at **conference2004@ibpsa-france.net**. Readers should obtain this announcement at their earliest convenience, as around 23 communication proposals have already been received.

Full contact information for IBPSA-France is on page 6

Further information about IBPSA-France and its activities can be found on their web site at: **http://www.ibpsa-france.net** or the English site at: **http://www.ibpsa-france.net/English**.

IBPSA-Netherlands+Flanders

Wim Plokker, TNO Building and Construction Research

2003 was focused on the organization of BS2003 in Eindhoven. A special issue about BS2003 was produced for the magazine of the Dutch Society for Building Services, TVVL (**www.tvvl.nl**), which is a cooperating association of IBPSA-NVL.

In addition to the organization of this major event a lot of effort was directed to the following topics:

- Setting up a new web site with automated membership registration (**www.ibpsa-nvl.org**).
- Organizing a mini symposium "Design of large glass covered spaces" with approximately 50 participants
- A workshop on model validation by the "Quality assurance of models" work group
- Publication of three newsletters.
- Two workshops on CFD.
- Two workshops, on "User-friendliness" and "HVAC toolbox", by the Matlab & Building simulation group.

IBPSA-NVL (Nederland + Vlaanderen) is an incorporated association. The second official annual meeting took place on 11 December 2003. We were able to welcome Dirk Saelens as a member of the board, representing Flanders. The officers and members of the board are:

- Jan Hensen (chair),
- Wim Maassen (secretary),
- Wim Plokker (treasurer, IBPSA board representative)
- Hans Buitenhuis (co-operating associations),
- Klaas Visscher (research),
- Kees Arkesteijn (education),
- Ed Rooijakkers (practice),
- Laura Itard (public relations),
- Dirk Saelens (Flanders).

Full contact information for IBPSA-NVL is on page 7

Currently IBPSA-NVL has the following work groups: coupling of models (Buitenhuis), Newsletter (Loomans), CFD (Loomans), matlab/simulink (Southout), quality assurance (Visscher).

The board members are a mix of academics, researchers from large research institutes (TNO, ECN, etc), branch organisations (such as ISSO and VABI) and practitioners.

IBPSA-NVL works together with a number of other associations (building services, building physics, acoustics, etc). Any member of those associations may join IBPSA-NVL without paying any fee.

IBPSA-NVL is financed by sponsors (at the moment mostly in kind through the board member institutes) and profits from activities such as our annual conference series (Delft 1999, Eindhoven 2000, Petten 2001).

As implied above, our main activities are the annual conference series. The focus of effort in 2004 will be on:

- Increasing cooperation with other associated organizations.
- Continuing to increase the professionalism of the website.
- The organization of workshops and symposia, especially the yearly symposium, this time in Flanders.

IBPSA Membership Information Sheet and Application:

The following information is for membership and orders for IBPSA proceedings. You may order directly from the forms below, or you can request by e-mail a hard copy of the request sheet. Conference proceedings are not part of the membership fee, though they are significantly discounted for members. We are not able to process credit card orders at this time.

IBPSA is comprised of International Regional Affiliates. If you are located within one of the affiliated regions listed on the IBPSA website at http://www.ibpsa.org/regional.htm , please contact the appropriate representative regarding membership in IBPSA. If you are not within any of the affiliated regions, you may join IBPSA central by using the attached form.

Members of the affiliate organization are automatically considered full members of IBPSA-Central. If you are joining IBPSA, please inquire as to the affiliate organization in your region. Additional affiliates may be forming soon.

The IBPSA Newsletter is published twice annually. It contains instructions on how to create an IBPSA affiliate in your region (start-up grants are available from IBPSA), as well as announcements for Building Simulation Conferences. All members of IBPSA's Regional Affiliations receive the newsletter.

TO LEARN MORE ABOUT IBPSA in general, look at the World Wide Web page at "http://www.ibpsa.org"

Thank you for your interest in IBPSA. Join to get more news from the Newsletter.

Jeff Haberl, IBPSA Publications
jhaberl@esl.tamu.edu

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IBPSA MEMBERSHIP INFORMATION

"The professional association devoted to improve the built environment through computer simulation and analysis"

Mission

The International Building Performance Simulation Association (IBPSA) was founded to advance and promote the science of building performance simulation in order to improve the design, construction, operation and maintenance of new and existing buildings worldwide.

Goals:

Along with building designers, owners, operators and developers,

* Identify problems with the built environment that may be solved by improved simulation tools and techniques
* Identify the performance characteristics of buildings on which simulation should be focused
* Identify building performance simulation R & D needs and transfer new developments to the user
* Promote standardization of the building simulation industry
* Inform and educate its members and the public regarding the value and the state-of-the-art of building performance simulation.

Activities:

* Biannual International Building Simulation Conference.
* Resource publication on simulation tools (under development)
* Newsletter announcing upcoming events and software tools.
* Sponsorship of regional workshops and seminars on simulation.

MEMBERSHIP APPLICATION …….. For IBPSA Central……...

Membership Classification Desired (check one): Effective date: Sept. through Aug.

__ Sustaining member.. US$ 500/year
An individual, company, or institution in related practice.

__ Member.. US$ 75/year
A graduate from a college or university, or a registered professional engineer or architect.

__ Student Member.. US$ 25/year
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www.ibpsa.org

Proceedings of IBPSA's Building Simulation conferences as long as stocks last. Prices follow:

Item	#Papers/pp	Price (US$)	Conf. Location	Dates
BS'85	59 / 416	$40	Seattle, WA (USA)	12 Aug. '85
BS'89	54 / 300	$40	Vancouver, Canada	23-24 June '89
BS'91	85 / 675	$40	Nice, France	20-22 Aug. '91
BS'93	71 / 570	$40	Adelaide, Aus.	16-18 Aug. '93
BS'95	81 / 717	$40	Madison, WI (USA)	14-16 Aug. '95
BS'97	119 / 976	$25 (CD-ROM)	Prague, Czech Republic	08-10 Sep. '97
BS'99	183 / 1470	$50 (3 vol.)	Kyoto, Japan	13-15 Sep. '99
BS'99	183 / 1470	$35 (CD-ROM)	Kyoto, Japan	13-15 Sep. '99
BS'85 – BS'95		$40 (CD-ROM)	5 conferences	'85 '89 '91 '93 '95
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BS'01	174 /1404	$60 (2 vol.)	Rio de Janeiro, Brazil	13-15 Aug. '01
BS'03	195 / 1512	$60 (3 vol.)	Eindhoven, Netherlands	11-14 Aug. '03
BS'85 – BS'03		$100 (CD-ROM)	9 conferences (> 1000 papers)	'85 '89 '91 '93 '95 '97 '99 '01 '03

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International Building Performance Simulation Association

The regionalization of IBPSA

To whom it may concern

Dear Colleague:

You may be aware of the International Building Performance Simulation Association (IBPSA) which has existed since the late 80s to represent and promote the application of computer-based design and management techniques in the construction industry worldwide.

To further the goals of the organization, we have embarked on a regional development program by which we plan to stimulate the establishment of regionally based, autonomous organizations who are affiliated to IBPSA. In this way we hope to achieve the correct balance between the servicing of practitioner needs at the local level and the provision of information flow at the international level.

I am writing to you to ask whether you might be interested in exploring further the possibility of establishing an IBPSA affiliated organization in your part of the world. To help you reach a decision, there follows details on the regionalization proposal. A copy of IBPSA's Strategy Plan, IBPSA's By-Laws and more general information about IBPSA's activities, biannual Building Simulation conferences, etc. is available from its web site at: http://www.ibpsa.org/

IBPSA very much hopes that you will see merit in this idea and is looking forward to receiving your reply in the near future.

Yours sincerely

The IBPSA President

IBPSA Regionalization Guidelines

IBPSA's Mission
The International Building Performance Simulation Association (IBPSA) is a non-profit making organization that was first incorporated in January 1987. The Association's principal mission is to promote and advance the practice of building performance simulation in order to improve the energy and environmental performance of new and existing buildings worldwide.

IBPSA seeks to achieve its goals through the establishment of a range of products and services aimed at informing and equipping those who are involved in the construction industry and who seek to utilize computer-based tools to good effect. To this end, the **IBPSA Strategic Plan** identifies nine specific areas that encompass the organization's activities. These are:

1. ***Strategic Alliances*** with professional organization such as the engineering and architectural societies. The intention is to engender a better understanding of the profession's requirements and the technology's potential.

2. ***International Conference Series*** to periodically collate and preserve those developments that comprise the current state-of-the-art.

3. ***Technical Development Program*** aimed at influencing the direction the technology of building simulation might take at any given point in time.

4. ***Educational Initiatives*** concerned with the teaching of building simulation in the higher education institutions and in the context of continuing professional development.

5. ***Harmonization Activities*** in an attempt to regularize the application of the different modeling systems through the definition of standard methods for performance assessment and the provision of standard support data.

6. ***Member Recruitment*** aimed at extending the IBPSA products and services to those practitioners who can most benefit from the new technology.

7. ***Products and Services*** devised in response to the profession's evolving needs.

8. ***Technology Transfer*** concerned with the delivery of training in all aspects of computer-based performance assessment at all stages of the building life cycle.

9. ***Regional Development*** to subject the foregoing activities to appropriate regional influences and enable their effective delivery.

This document addresses the last area concerned with regional development in order to more effectively address local needs and create a mechanism for an international exchange of know-how and best practice.

Rationale
IBPSA has achieved significant success at the international level - largely through its biannual conference program (Vancouver '89, Nice '91, Adelaide '93, Wisconsin '95 and Prague '97) and worldwide electronic mailing facility. IBPSA has also recognized the difficulties surrounding the development of products and services that are appropriate to the day-to-day needs of its members.

The underlying causes of these difficulties are twofold. Firstly, the geographical spread of IBPSA members is wide and gives rise to a requirement to cover disparate work practices, technologies and professional needs. Secondly, IBPSA's organizational structure is such that the coordination of activities at the local (regional) level is problematic. At the same time like-minded, but regional, organizations are making significant progress at the local level through their seminar, workshop, publications, training and software development activities.

If the construction industry were to be well supported in its attempts to harness effectively the emerging IT and simulation technologies then the establishment of regionally based support organizations was essential. Equally essential was the creation of a structure by which these organizations could affiliate in order to disseminate their know-how and promote their local best practice. Only in this way could the benefits of the new technology be understood and future standardization enabled. It was with the view of a network of autonomous regional organizations that IBPSA has turned to regionalization and is encouraging existing or newly formed groups to become IBPSA affiliates.

Structure and Operation

Under the existing structure, IBPSA affiliates are financially and administratively independent. In practice, this means that they raise and deploy their funds as long as these funds are under the control of elected officers and are used in pursuit of aims and objectives that are consistent with those of IBPSA. IBPSA-Central concentrates its resources on issues such as inter-region communication, international conferences and product standardization. In this way IBPSA complements and empowers the regional affiliates in their attempts to inform and support their members in the context of local design issues and concerns. The entire IBPSA network is represented by a 15-member Board comprised of an executive and regionally elected officers.

The following guidelines have been devised to assist with the establishment and operation of an IBPSA regional affiliate.

1. Organizers of a new regional affiliate should prepare a brief proposal for the IBPSA Board of Directors. This should outline the proposed name, geographic territory, organizational structure and goals and objectives (if different from those included in the IBPSA charter statement). Affiliation depends only on the organization having a purpose and mission consistent with those of IBPSA. The Affiliate and IBPSA then enters into a specific agreement by defining their working relationship based on regional considerations prevalent at the time.
2. Regional affiliates may be named **"IBPSA <region>"** or they may use any other appropriate name. Their letterhead and other publicity material should indicate that they are "an affiliate of IBPSA".
3. For regions with limited financial resources, IBPSA can provide a limited amount of **matching start-up funds** (see below) to aid the initial set-up of the affiliated organization. A case for support should be submitted to the IBPSA Secretary for consideration by the Board. (See attached proposal guidelines.)
4. The financial structure of a regional affiliate is independent from IBPSA. This means that affiliates will retain all member dues or other funds raised by their activities.
5. IBPSA will provide affiliates with a list of operational guidelines (see attached by-laws), contact information for persons available to assist the local organizer and electronic images of the IBPSA logo.
6. The regional affiliate will provide membership data to IBPSA for use in mailing IBPSA materials.

7. Members of the regional affiliates will automatically be full members of IBPSA. Any given individual or organization will pay dues directly to IBPSA only if there is no regional affiliate operating in their area.
8. IBPSA will make newsletters and other IBPSA materials available to all members of the regional affiliates either in printed form or in downloadable electronic format from the IBPSA web page. This will be at no cost or at a nominal cost depending on the circumstances. Other services may be provided by IBPSA to the regional affiliates for a fee.

Start-up Proposal Guidelines:
It has been the IBPSA Board's policy to grant start-up funds to regions that are in need of matching funds to get the organization officially registered and/or to purchase initial office support equipment. The proposal should be submitted to the IBPSA board and should contain the following elements:

1. Name of Affiliate: i.e., **IBPSA-<region>.**
2. Geographic territory covered.
3. Organizational structure – The IBPSA Charter is founded on a set of board- and member-approved by-laws (see attached). Each Affiliate's organizational structure is therefore expected to adhere to the same or similar principles of operation.
4. Officers -- i.e., Specify the officers that will be constitute the board (e.g., Chairperson, secretary, treasurer, etc. – see IBPSA by-laws)
5. List of goals and objectives – Must be consistent with the mission statement and objectives of the IBPSA Charter.
6. Minutes of the first organizational meeting, indicating organizational business transacted.
7. List of initial members and their affiliations (can be those attending the first meeting).
8. Proposed activities of the affiliate.
9. Proposed amount of annual membership dues.
10. Breakdown of costs associated with set-up of the Affiliate organization.
11. Amount of matching funds provided by the Affiliate.
12. Amount of the requested support from IBPSA. *

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* Please note that IBPSA's policy is to provide start-up funds with the expectation that the Affiliate will return the granted amount once the region reaches financial stability. The Affiliate is therefore asked to return the funds on a voluntary basis, so other regions can be assisted in the same fashion.

Becoming an IBPSA Affiliated Organization

If you would like to become an affiliated organization then please write to the IBPSA Secretary at the address given at http://www.ibpsa.org . Alternatively, you may wish to discuss the matter further with one of the IBPSA office bearers or a representative of one of the existing affiliates whose addresses can also be found at http://www.ibpsa.org.