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Overview of Building Simulation in Europe

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Contents

- National and EU background
- Increased use of building simulation: drivers and barriers
- Relevant EC-funded projects
- Research themes
- Technology transfer
- Conclusions

EU Policy

Following Kyoto agreement:

- All cost effective measures add up to a 5-10% CO_2 reduction over the period 2005-2010
- Aim is security of supply and competitiveness, with some environmental considerations added
- Funds redirected from fossil fuel and nuclear power programmes to renewable energy and energy efficiency

Selected EU Programmes

Joule – non-nuclear RD&D

Thermie – promotion and market introduction of energy efficient and environment-protecting technologies in industrial and private sectors

Altener – promoting the use of renewable energy by:

- Harmonised standards for RE products/equipment
- Improved information dissemination

Save - promoting rational use of energy

Growth - competitive and sustainable growth

EU 5th framework budget (Million Euros) 1998-2002

Quality of life/management of living resources	2413
User-friendly information society	3600
Competitive and sustainable growth	2705
Energy (non-nuclear)	1042
Environment and sustainable development	1083
Horizontal programmes	2857
Framework total	**13700**

Other governmental factors - UK example

Kyoto Agreement (1997)	Heads of Government commitment to reduce key greenhouse gas emissions in EU by at least 8% by 2008-2012 relative to 1990. This would result in 2010 emission levels that are ~29% below what would have been in the absence of the protocol.
Local Agenda 21	Commitment to reduce CO_2 emissions at the local level.
UK Home Energy Conservation Act (1995)	Local authorities responsible for preparing practical energy conservation plans to achieve 30% reduction over 10 year period.
UK SAP Ratings Initiative	Introduction to the Building Regulations of a Standard Assessment Procedure (SAP) for domestic buildings
UK Clean Technologies Programme	Promotion of waste minimisation, sustainable cities and new technologies (e.g. fuel cells, photovoltaics, efficiency measures).
Electricity market deregulation	Open market puts pressure on all sectors to change current practices, especially in relation to complementary demand- and supply-side partnerships.
Climate change levy	Pressure on industry to reduce energy consumption.
Energy Action Planning	Requires elaboration of a range of appropriate sustainability indicators.

Drivers for increased use of building simulation

- Organisations (IBPSA and national affiliates, CIBSE - Applications Manual)
- Software enhancements (interface and capabilities)
- “Green” clients
- Technology transfer initiatives
- Standards and building regulations

CEN Standards

Standards being developed that may include simulation

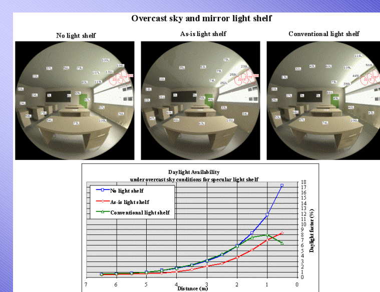
1. **Estimation of Summer Overheating**
   - General criteria and validation procedure
   - Annex contains numerical method based on implicit finite volume approach; also simplified calculation methods.
   - Almost complete – likely to be formally approved in 2002
2. **Calculation of peak cooling load**
   - Public enquiry stage: likely to be 2/3 years before approval
   - Numerical method not defined; benchmark tests.
3. **Calculation of annual cooling requirements**
   - Public enquiry stage: likely to be 2/3 years before approval

Selected EU Projects with Modelling Component

Integrated Performance	Daylight-Europe	Lighting/Thermal Exploitation of daylight to reduce artificial lighting
	Advanced glazing (IMAGE)	Lighting/thermal Managed systems, insulated glazing, multiple coatings/gas fill, improved framing systems
	IntDesign	Thermal/ CFD Local indoor comfort
	FOG	Thermal/moisture Stable fog generation and control
Renewable Energy Integration	PV-Hybrid-PAS	PV hybrid components
	HYPRI	Roof-mounted hybrid components
Design Exemplars	Solar House	Designer-led incorporation of low-energy components within European exemplary building designs
Passive Cooling	PASCOOL	Experimental and modelling study of solar control, thermal mass and natural ventilation
Validation	PASSYS	Validation methodology and application; empirical validation using outdoor test cells
Design Tool Integration	COMBINE	Development of integrated data model and design process models
Support databases	WIS	Thermal and optical properties of window systems
	CPCALC	Pressure coefficients

Daylight Europe

- 20 research institutions
- 80 case study buildings
- 21 selected for detailed monitoring
- 12 of these evaluated by modelling

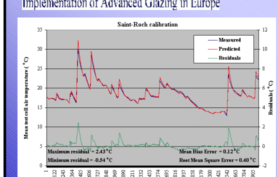


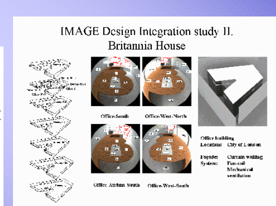
Ref: Daylight Performance of Buildings, ed M Fontoynont, James & James, 1999

Image - Advanced Glazing

Implementation of Advanced Glazing in Europe

- 3 major European glass manufacturers
- Involved laboratory tests, outdoor tests, model calibration and ‘live’ design studies.





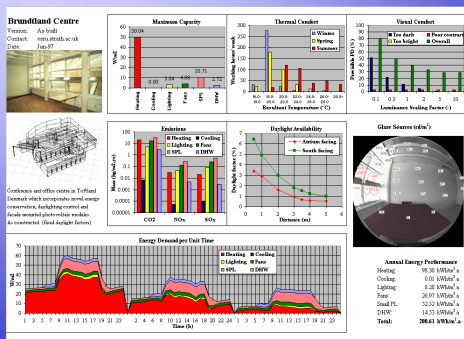
Ref: Clarke J A and Janak M, Assessing the overall performance of advanced glazing systems, Solar Energy, Vol63, No4, pp231-41, 1998.

Solar House

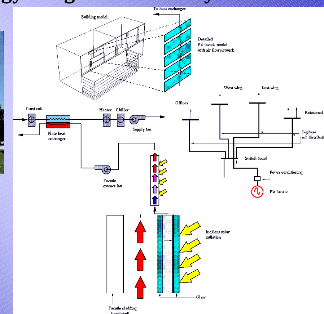
- 33 case study buildings involving solar energy integration
- Large range of projects (Solar Reichstag in Berlin, new museum in Athens, Brundtland exhibition centre in Denmark, teaching hospital in Thessaloniki)
- Modelling support offered to projects to appraise building overall energy and environmental performance

Ref: European Solar Architecture, ed E Fitzgerald and J O Lewis EC DGXII, 1995

Integrated Performance View



Renewable energy integration - PV-Hybrid-PAS

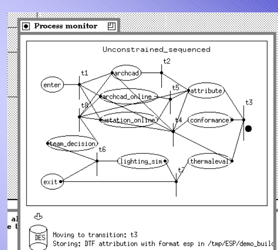


- Outdoor testing, model calibration, scaling and replication to full scale

Ref: Clarke J A et al, PV-Hybrid-PAS: Calibration, Scaling and Replication by Modelling, 14th European Photovoltaic Solar Energy Conf, Barcelona July 1997.

Design Tool Integration - COMBINE

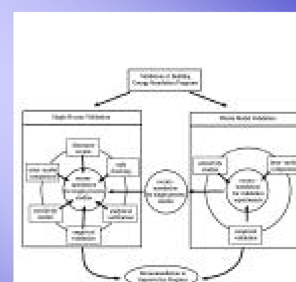
- Development of an Integrated Data Model (IDM)
- Development of Intelligent Integrated Building Design System, providing control of design tool interaction using Petri-nets



Ref: Augenbroe, ed, COMBINE Final Report, EC DGXII, Brussels, 1995
Augenbroe G, COMBINE Project: An Overview, Proc 1st ECPPM Conf, Dresden, 1994

Validation - PASSYS

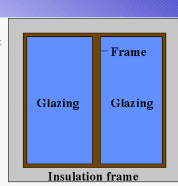
- Development of validation methodology
- 12 teams throughout Europe



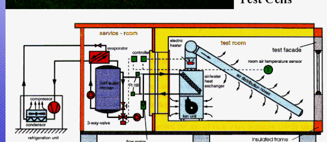
Ref: ed Jensen S O, Validation of Building Energy Simulation Programs, Research Report PASSYS Subgroup Model Validation and Development, EUR 15115 EN, 1993.

Validation - PASSYS

Tested Component



PASSYS Test Cells



High quality data acquisition:
- Short term climate data
- Longwave sky radiation
- Mean cell air temperature
- PAS temperature
- Net heating - cooling injection

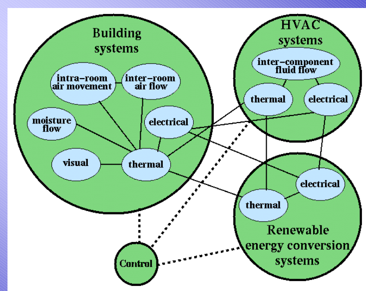
Research Directions

- Little direct national or EU funding for model development – exclusively focused on application
- Model development undertaken by companies/universities/utilities, but varies from country to country
- Main theme is integration
- Focus on technology transfer
- Research topics: IAQ, local comfort, productivity, health, life cycle analysis

Integration of design tool functionality

Two routes:

- Pragmatic approach: increasing functionality of individual programs
- Formal approach – e.g. COMBINE, IAI

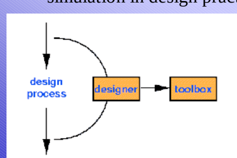


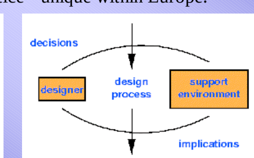
Mapping of Description to Behaviour

Cumulative model description	Typical behaviour enabled
pre-existing databases	simple performance indicators (e.g. material hygrothermal and embodied energy data etc)
+ geometry	visualisation, photomontage, shading, insolation etc
+ constructional attribution	embodied energy, material quantities, time constants etc
+ operational attribution	casual gains, electricity demands etc
+ boundary conditions	photo-realistic imaging, illuminance distribution, no-systems thermal and visual comfort levels etc
+ special materials	electricity generation (photovoltaics), daylight levels (switchable glazings) etc
+ control system	daylight utilisation, energy performance, system response etc
+ flow network	natural/mechanical ventilation, system performance, heat recovery etc
+ HVAC network	psychrometric analysis, component sizing etc
+ CFD domain	indoor air quality
+ electrical power network	renewable energy integration, load control etc
+ enhanced geometrical resolution	thermal bridging
+ moisture network	local condensation, mould growth and health

Technology transfer

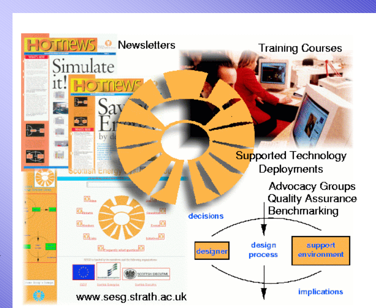
- In the UK, the Energy Design Advice Scheme provided design advice to architects and engineers through the use of consultants. The Scottish Energy Systems Group is attempting to progress the work by helping to embed simulation in design practice - unique within Europe.





Technology transfer

SESG aims to transfer simulation to energy sector companies particularly through specialist staff secondments. The intention is to demonstrate that simulation-based design can yield results, quicker, cheaper and better than conventional methods. The SESG is a joint Scottish Office, Industry, Scottish Enterprise venture.



Conclusions

What building simulation software tools are commonly used by design professionals (architects/engineers)?

- Use of simulation increasing, particularly for prestige projects, but a long way to go for routine use.
- Biggest factor is move towards performance-based standards.
- Tools:
  - highly variable within Europe
  - more advanced applications

Conclusions

What are the major barriers to further adoption of simulation by designers?

- Capital cost driven design
- Cost of modelling
- Lack of awareness of capabilities by managers
- Poor ease of use/ need for training
- Need to set up QA procedures
- Skills shortage

Conclusions

Who is doing software development: universities, government agencies or private companies?

- Diverse in Europe:
  - utilities
  - companies
  - universities
- Proprietary software in most cases

Conclusions

What government and energy utility initiatives encourage the use of building simulation?

- Explicit:
  - technology transfer initiatives
- Implicit:
  - stricter building codes
  - performance-based standards
  - Kyoto etc.…