NatVent™

#M662

EC CONTRACT: JOR3-CT95-0022 (DGXII)

'NatVent™ - a better way to work'

16 June 1998

Venue: Building Research Establishment, Garston, Watford, UK

PROCEEDINGS

Compiled by
Vina Kukadia

NatVent™
Overcoming technical barriers to low-energy natural ventilation in office type buildings in moderate and cold climates

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Research part funded by

THE EUROPEAN COMMISSION
in the framework of the JOULE
Non-Nuclear Energy Programme (1994-98)

Conference sponsored by the
Energy Efficiency Best Practice
Programme

'NatVent™ - A Better Way To Work'

16 June 1998

BRE, Garston, Watford, UK
Programme

9.00 Registration and coffee/tea.

9.30 Chairman's welcome. *Earle Perera, BRE, UK.*

9.40 Morning opening address. Buildings and energy within the framework of sustainable development. *David Vincent, Department of Environment, Transport and the Regions, DETR, UK.*

10.00 NatVent™: Its aims and vision. *Vina Kukadia, BRE, UK.*

10.20 Pan-European survey of technical barriers to natural ventilation and required solutions. *Soren Aggerholm, Danish Building Research Institute, SBI, Denmark.*

10.40 Natural ventilation at work: case studies of innovative commercial buildings in Europe. Jan Demeester, *Belgian Building Research Institute, BBRI, Belgium.*

11.00 Coffee

11.20 Air and noise pollution in urban and city centres. *Paul Ajiboye, Willan Building Group, UK.*

11.40 The application of controlled airflow inlets. *Willem de Gids, TNO, Bouw, The Netherlands.*

12.00 Recovering heat from natural ventilation systems. *Jorn Brunsell, Norwegian Building Research Institute, NBI, Norway.*

12.20 Control of summer overheating. *Dolf van Paassen, Technical University of Delft, TUD, The Netherlands.*

12.40 Practical guidelines for integrated natural ventilation design. *Johnny Kronvall, AB Jacobson & Widmark, (J&W), Sweden.*

1.00 Lunch

2.00 Afternoon opening address: Low energy buildings within the European policy framework. *Derek Hughes, BRE, UK*

2.20 Design strategies for innovative natural ventilation in office buildings. *Peter Wouters, Belgian Building Research Institute, BBRI, Belgium.*

2.40 Application of NatVent principles in European buildings. *Peter Kofoed, Sulzer Infra Lab AG, Switzerland.*

3.00 NatVent™: Accomplishments and recommendations. *Martin Liddament, Air Infiltration & Ventilation Centre, AIVC, UK.*

3.20 Panel debate: Industry response and viewpoint. *(Chair: David Warriner, BRE. Panel: Rab Bennetts, Bennetts Associates, Chris Twinn, Ove Arup and Partners and Geoff White, Grosvenor Developments).*

4.00 Open forum to discuss way forward. Chair: *Earle Perera, BRE*

4.30 Close and tea.

Foreward

Dear Colleague

It gives me much pleasure to present this selection of papers presented at the conference on 'NatVent™ - a better way to work' held at the Building Research Establishment Ltd.

NatVent™ is a European JOULE project that has studied ways of 'Overcoming technical barriers to low energy natural ventilation in office-type buildings in moderate and cold climates'. A consortium of nine partners across seven countries — Great Britain, Belgium, Denmark, the Netherlands, Sweden, Norway and Switzerland – carried out this project. It set out to:

- **Identify barriers**: through in-depth studies amongst leading designers, architects, building owners and occupants.
- **Assess current practice:** to provide case studies by monitoring the environmental performance parameters of buildings designed with low-energy ventilation strategies in mind
- **Provide solutions:** to overcome the identified barriers by developing 'smart' natural ventilation technology systems and components.

The papers and presentations given here form part of the public domain output from this project.

We hope that you will find the enclosed material useful and interesting as well as providing you with an opportunity to be aware of important findings from the NatVent™ project. If you would like to be kept informed of future developments or would like to establish a dialogue with us on this very important issue, I would be most interested to hear from you.

Earle

Earle Perera
(Co-ordinator of the EC NatVent™ Project)
July 1998

Buildings and energy within the framework of sustainable development

by

David Vincent

Department of Environment,
Transport and the Regions
UK

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME- from research to authoritative guidance

Dr. David Vincent

UK Department of the Environment, Transport and the Regions

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

ENERGY EFFICIENCY

Department of the Environment, Transport and the Regions

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

- The UK's principal energy efficiency information transfer and R&D programme
- Working in partnership with other related programmes at home, in the European Union and beyond

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

Relevant policy drivers

- Sustainable development
- Climate change
- Building Regulations

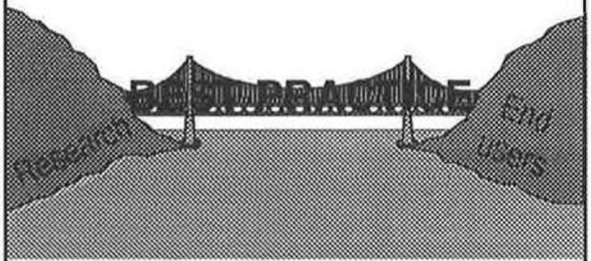
THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

Programme target

- £800m pa of energy savings by 2000
- 5 million tonnes pa of Carbon

Already stimulated about £500m pa of energy savings (about 3mt/C)

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME



The essential bridge

From research to authoritative guidance

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

Best Practice is about:

- Developing knowledge
- Independent checking
- Targeted dissemination
- Assessing impact

DETR

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

Best Practice is for:

- Energy users in industry, commerce, the public and domestic sectors
- Building professionals and their professional bodies to provide authoritative guidance

DETR

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

Housing Association new homes

- UK Housing Associations commission 30,000 new homes each year - almost one fifth of the total new starts
- Housing Associations have a good history of working to raise housing standards
- Best Practice / National Federation of Housing Associations joint project

DETR

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

Housing Association new homes

- A range of design solutions was developed drawing on Best Practice knowledge
- Guidance written for the target audience - designers, building professionals and builders
- Higher standards set and accepted by the Housing Corporation

DETR

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

Housing Association new homes

- The Finished Product

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

Client Briefing Guide - Building for Energy Efficiency

- Produced in collaboration with the Construction Industry Council
- Architects say "clients do not ask so we don't offer"
- Result: Clients get energy inefficient buildings. Occupiers are worse off.

DETR

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

Client Briefing Guide - Building for Energy Efficiency

- Partnership project with the CIC, Environment Committee, and the Best Practice programme
- Produced client briefing guide
- Publication launched last year - stimulated much interest in the building community

DETR

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

The Finished Product

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

Avoiding or minimising the use of air conditioning

- Research funded through DETR's Energy Related Environmental Issues programme
- Air conditioning on the increase, therefore an essential priority in tackling CO_2 emissions

DETR

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

Avoiding or minimising the use of air conditioning

- Results and recommendations from the study are published and promoted through the Best Practice programme

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

The European JOULE Programme *NatVent™* Project

- A major partnership project involving 7 EU Member States supported by the EU JOULE Programme and, in the UK, by DETR funding
- Designed to provide robust solutions to the wider application of energy efficient, natural ventilation in buildings

DETR

THE UK ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

The European JOULE Programme *NatVent™* Project

- The Energy Efficiency Best Practice programme involved throughout
- Information from the project is being converted into guidance material for building professionals
- Guidance will be promoted in the UK as part of the Best Practice guidance on low energy building

DETR

NatVent™:
Its aims and vision

by

Vina Kukadia

Building Research Establishment Ltd
UK

NatVent™ : Its aims and vision

by

Vina Kukadia
Building Research Establishment Ltd, BRE

Abstract

The main objectives of this seven nation pan-European project NatVent™ is to reduce primary energy consumption in buildings (and consequently CO_2 emissions) by overcoming barriers which prevent the uptake of natural ventilation for office-type buildings. It is intended for countries with low winter and moderate summer temperatures and where summer overheating from solar and internal gains can be significantly reduced by good natural ventilation. The project has investigated and developed 'smart' components to provide natural ventilation for office type building which could be naturally ventilated but, because of various technical barriers are, at present, inadequately ventilated, fully mechanically ventilated or air-conditioned.

The objectives have been addressed through three work packages. The first is aimed at **'Identifying perceived barriers to natural ventilation'**. This has been achieved by carrying out in-depth structured interviews among leading designers, architects, building owners and developers. A European-wide questionnaire was produced with input from all nine Partners within the NatVent™ consortium and interviews in all the seven countries were carried out. The responses have been analysed and national reports written. A final report giving a summary of the findings from all the countries was produced.

The second work package has evaluated the '**performance of existing ad-hoc buildings'** designed and constructed specifically as energy-efficient naturally ventilated buildings. Nineteen such buildings within the seven EU countries were monitored (details of all these buildings are available in a separate report). Parameters such as ventilation rates temperature, humidity and carbon dioxide were measured during both winter and summer periods to identify the efficacy of the different ventilation strategies used for each period. Any shortcomings and the advantages gained from such strategies have been identified. Also, overall design and construction conditions required for achieving successful natural ventilation have been specified.

The third work package has been aimed at developing **'smart' naturally ventilated technology systems and component solutions** to overcome the barriers identified. This has been done through the following five activities:

(a) Developing specifications and design solutions for natural **ventilation air supply components** (and filtration strategies) for use with high external pollution and noise levels.

(b) Identifying and specifying conditions under which newly-developed natural ventilation 'smart' **constant air inlets** can provide acceptable indoor air quality for occupants' health and comfort in offices.

(c) Developing systems which can provide **natural ventilation in cold climates and recover heat** without incurring an unacceptable high energy consumption.

(d) Developing natural ventilation systems and controls suitable for **optimal night cooling**.

(e) Addressing and defining robust specifications for **integrated performance** of 'smart' systems for optimum year-round performance.

Effective and widespread dissemination and communication of the results has been a key issue within this project. Results are being disseminated to a wide spectrum of the construction industry, to building designers, architects, researchers and services engineers through national and international conferences and workshops. A network of European architects has also been established to advise and share the findings from the project. Several products such as a CD_ROM, design tools and reports and case studies have been developed as part of the project and details of these will be given during the presentation today.

NatVent ™: Its aims and vision

by
Vina Kukadia

NatVent™ *Conference, 16 June 1998, London*

Presentation

- Background
- Objectives
- Overview of technical aspects
- Summary of final products

NatVent™

NatVent™

Overcoming technical barriers to low energy natural ventilation in office-type buildings in moderate and cold climates

NatVent™

NatVent™

- **EC JOULE PROGRAMME 1994-1998 Area 2.1: Rational use of energy in buildings**
- **Funding - part EC, part national**
- **A1 - an 'outstanding proposal supporting improved natural ventilation'**

NatVent™

Why naturally ventilate?

- **Environmentally sound**
  - *Energy usage is reduced*
  - *Minimise CO_2 emissions*
  - *Minimise ozone depletion*
- **Financial savings**
  - *Energy, capital, operating*
- **Improve productivity**
  - *SBS, occupant control, enhance comfort*

NatVent™

Impact of ventilation

- Target floor area = 500 million m^2 (EU heating season countries)
- Ventilation-related energy use = 95 to 155 PJ
- Energy necessary for adequate ventilation = 70 PJ
- Estimated total energy savings = 25 to 85 PJ = 3,000 to 11,000 kT CO_2

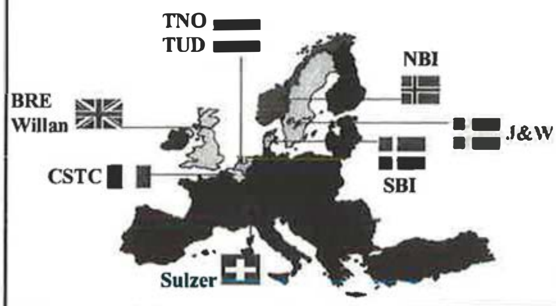
NatVent™

Ellis Survey

- UK survey of major office occupiers
- 90% of senior management preferred buildings without air-conditioning
- Use of natural ventilation and daylighting top of 'requirements'

*Nat**Vent***™

NatVent™ Consortium



*Nat**Vent***™

Vision

- ***NatVent***™ to act as the catalyst by being internationally recognised as the focal point for source of information for future low-energy design
- ***Arrived through:***
  - *technical excellence*
  - *collaborative partnership*
  - *targeted dissemination*

*Nat**Vent***™

Objective

- Reduce primary energy consumption (and CO_2 emissions) in office type buildings

  without compromising indoor air quality and comfort

*Nat**Vent***™

Specific objectives

- Identify and overcome technical barriers which restrict the implementation of natural ventilation in buildings.
- Provide solutions and encourage the use of natural ventilation.

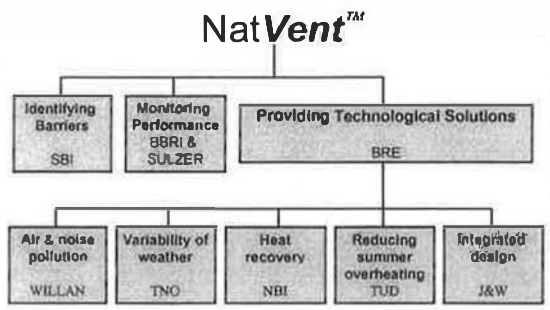
*Nat**Vent***™

Three key activities

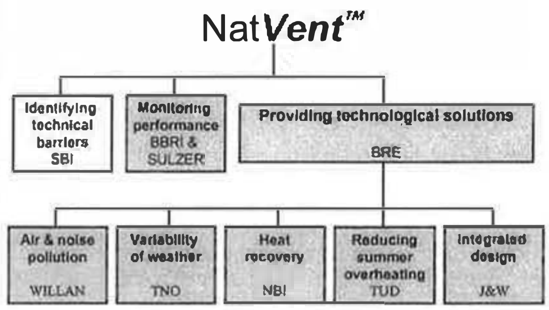
- Identify technical barriers (*Industry*)
- Establish innovative design strategies (*Leading low-energy architects*)
- Provide technological solutions (*Nat**Vent***™ *Consortium*)

*Nat**Vent***™

Overview of activities



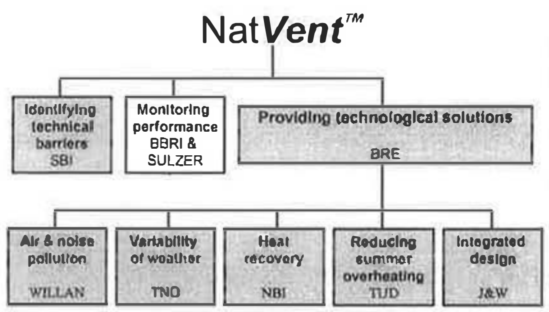
Overview of activities



Identify barriers

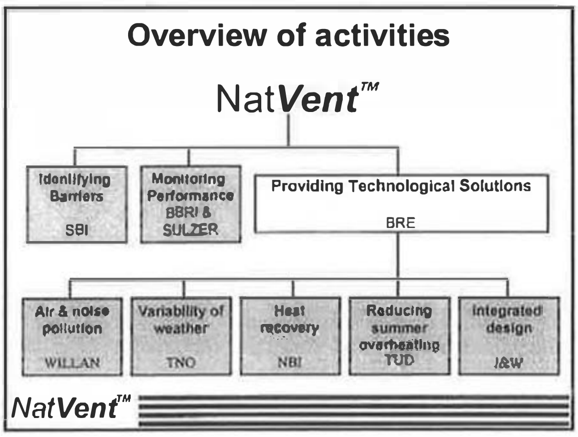
- **Led by Danish Building Research Institute**
  - Seven-nation activity
  - In-depth national studies with structured interviews
  - Targeted at industry professionals

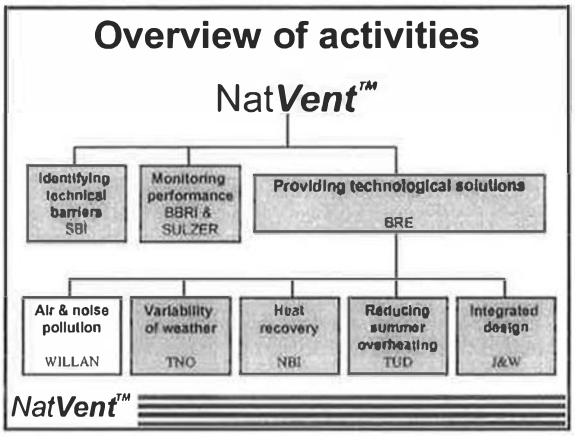
Overview of activities



Monitoring performance

- **Led by**
  - **Belgian Building Research Institute**
  - **Sulzer**
    - Seven-nation activity
    - Monitoring performance of 19 'low-energy' buildings to provide case studies


Overview of activities
NatVent™
Identifying Barriers SBI
Monitoring Performance BBRI & SULZER
Providing Technological Solutions BRE
Air & noise pollution WILLAN
Variability of weather TNO
Heat recovery NBI
Reducing summer overheating TUD
Integrated design J&W
NatVent™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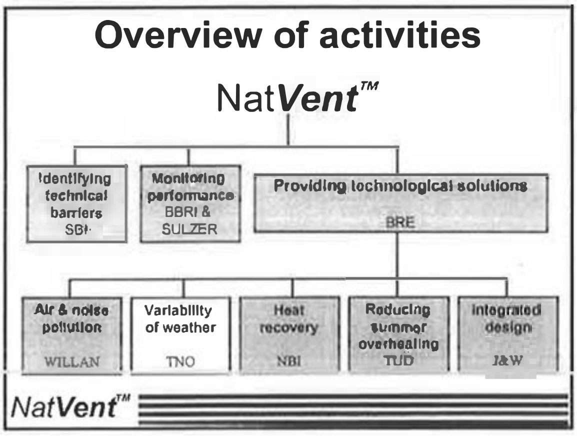
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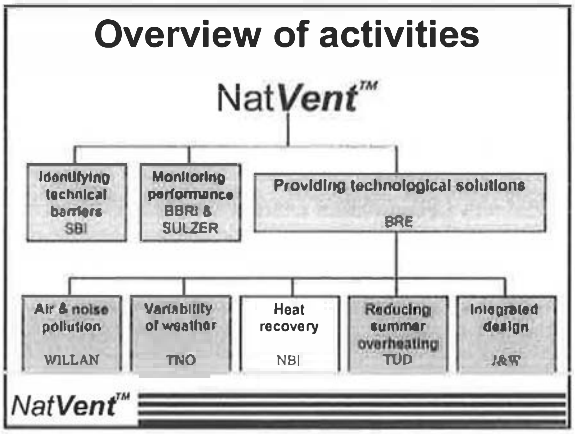
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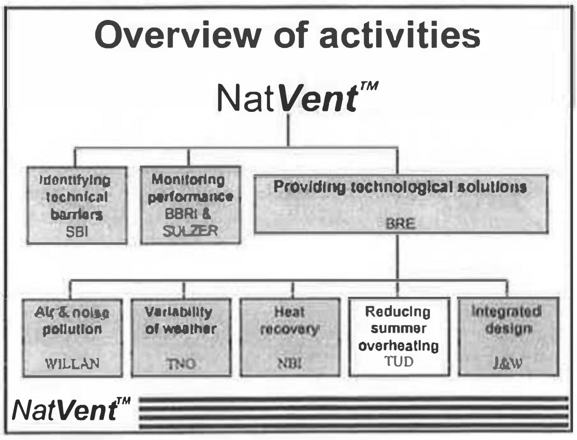
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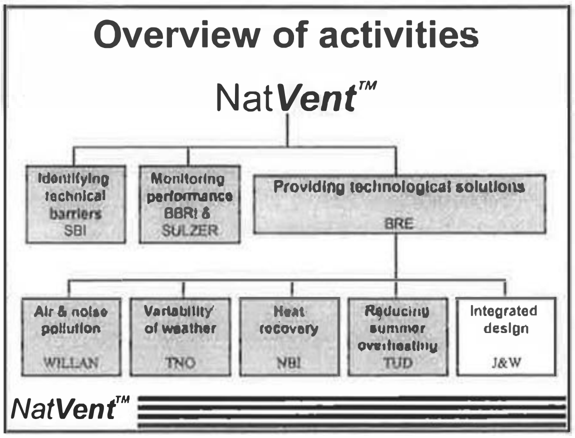
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Monitoring performance BBRI & SULZER
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Air & noise pollution WILLAN
Variability of weather TNO
Heat recovery NBI
Reducing summer overheating TUD
Integrated design J&W
NatVent™

Effective dissemination

- Network of European Architects
- Workshops
- Conferences
- Publications

NatVent™

NatVent™ Products

- Reports on technical barriers
- Case studies of low-energy buildings
- Design tools, components
- Guidebook
- CD_ROM

NatVent™

Final overall aim

- To combine 19th and 20th Century 'Strategies'
- With late 20th Century 'Technologies'
- To provide Low-energy Ventilation for the 21st Century

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Pan-European survey of technical barriers to natural ventilation and required solutions

by

Soren Aggerholm

Danish Building Research Institute
Denmark

Pan-European survey of technical barriers to natural ventilation and required solutions

by

Soren Aggerholm
Danish Building Research Institute, SBI, Denmark

Abstract

The objective of the study described in the paper is to identify perceived barriers restricting the implementation of natural or simple fan assisted ventilation systems in the design of new office buildings and in the refurbishment of existing buildings. The perceived barriers are identified in an in-depth study with structured interviews based on questionnaires among leading designers and decision makers. The interviews have focused on general knowledge, viewpoints, experience and perceived problems with natural ventilation in office buildings and on the decisions actually taken in specific building projects. To our knowledge this is the first time a study of this type has been carried out in Europe.

The identification of perceived barriers to natural ventilation design of office buildings is the first phase (work package) of the NatVent project being carried out under the EU-JOULE programme. Knowing the barriers is the first step in providing solutions to overcome them. The two other work packages in the NatVent project are:

- Performance of naturally ventilated buildings: evaluating the performance of twenty existing buildings designed specifically for natural ventilation.
- 'Smart' technology systems and components: developing systems, components and solutions to the barriers and shortcomings identified in the first two work packages.

The interviews identifies significant lack of knowledge and experience on special designed natural ventilation in office buildings compared to the knowledge and experience on mechanical ventilation. In addition there is a lack of sources to natural ventilation knowledge in standards, guidelines and building studies and a desire for new design tools on natural ventilation including also calculation rules and easy to use, simple and advanced computer programmes.

In general the interviewees expects an increase in the future use of natural ventilation in office buildings. In the interviewees perception mechanical ventilation have several advantages compared to natural ventilation, Nevertheless the interviewees do not expect a higher user satisfaction in mechanical ventilated offices. In fact they expect the highest user satisfaction in natural ventilated cellular offices, where also the highest individual controllability is expected.

Pan-European Survey of Technical Barriers to Natural Ventilation and Required Solutions

Søren Aggerholm
Danish Building Research Institute, SBI

NatVent™ *Conference, 16 June 1998, London*

Objective and Method

- The objective was to identify barriers restricting the implementation of natural or simple fan assisted ventilation systems in the design of office buildings (new and refurbished).
- The barriers were identified in an in-depth study with structured interviews based on questionnaires among leading designers and decision makers.

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Interviews

- 7 countries
- 107 designers and decision makers:
  - 42 architects
  - 24 consultant engineers
  - 11 contractors
  - 9 developers
  - 14 owners
  - 7 governmental decision makers

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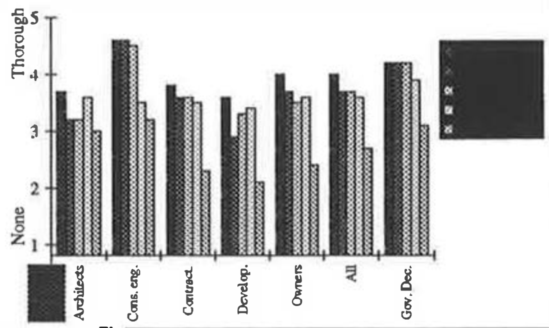
Knowledge, by profession



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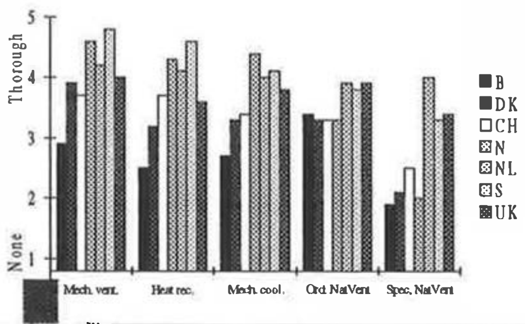
Knowledge, by country



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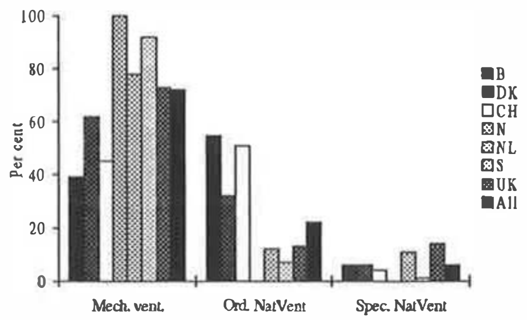
Experience



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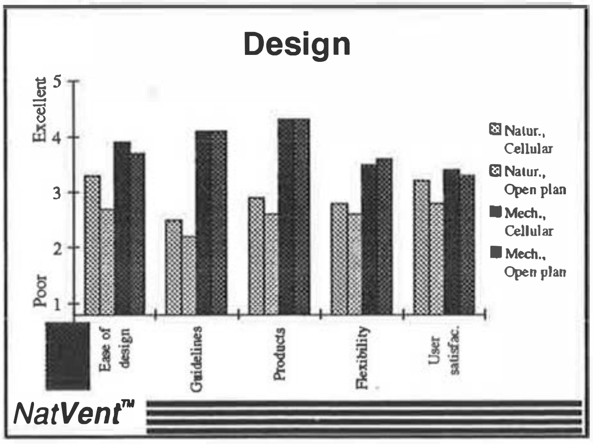
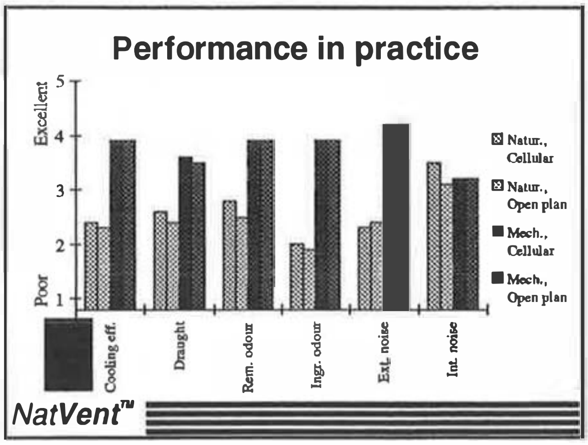
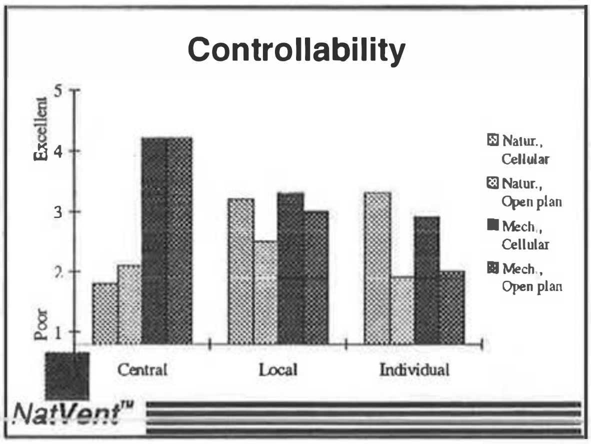
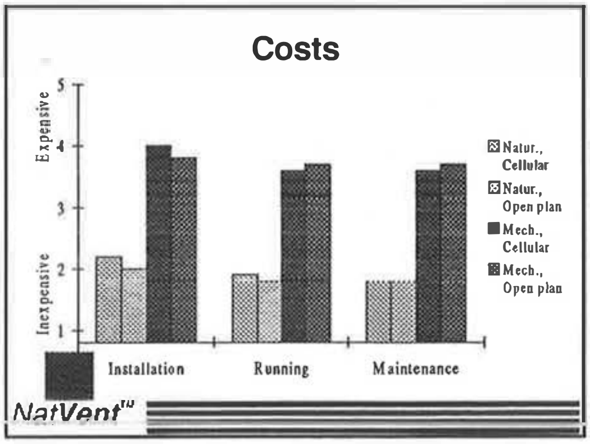
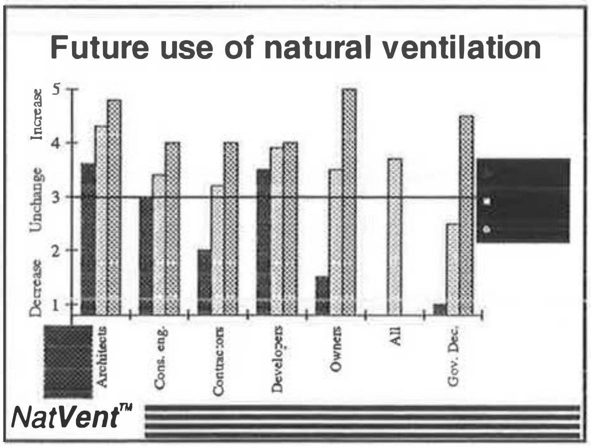
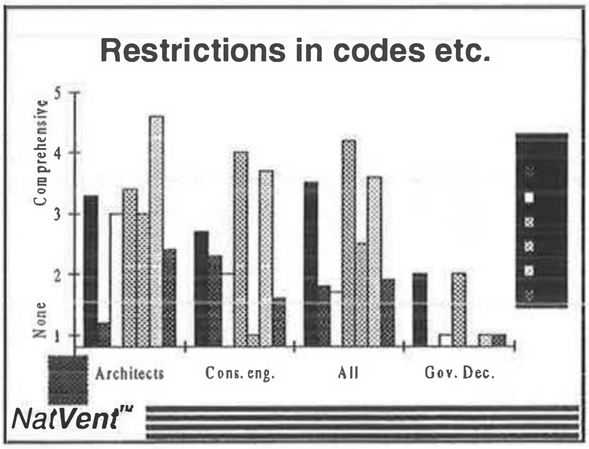

Design
Excellent
Poor
5
4
3
2
1
Natur., Cellular
Natur., Open plan
Mech., Cellular
Mech., Open plan
Ease of design
Guidelines
Products
Flexibility
User satisfac.
NatVent™


Performance in practice
Excellent
Poor
5
4
3
2
1
Natur., Cellular
Natur., Open plan
Mech., Cellular
Mech., Open plan
Cooling eff.
Draught
Rem. odour
Ingr. odour
Ext. noise
Int. noise
NatVent™

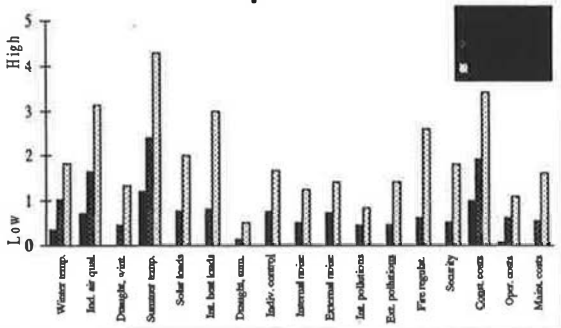

Controllability
Excellent
Poor
5
4
3
2
1
Natur., Cellular
Natur., Open plan
Mech., Cellular
Mech., Open plan
Central
Local
Individual
NatVent™


Costs
Expensive
Inexpensive
5
4
3
2
1
Natur., Cellular
Natur., Open plan
Mech., Cellular
Mech., Open plan
Installation
Running
Maintenance
NatVent™


Future use of natural ventilation
Increase
Unchange
Decrease
5
4
3
2
1
Architects
Cons. eng.
Contractors
Developers
Owners
All
Gov. Dec.
NatVent™

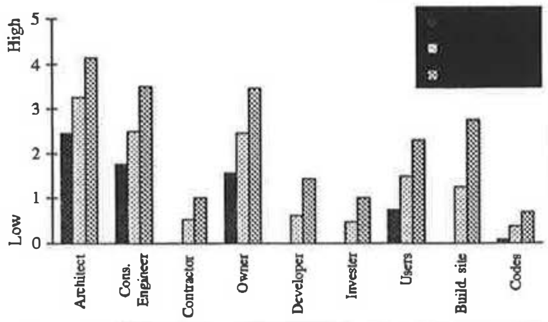

Restrictions in codes etc.
Comprehensive
None
5
4
3
2
1
Architects
Cons. eng.
All
Gov. Dec.
NatVent™

Critical parameters



NatVent™

Influence on design



NatVent™

Conclusions

Further improvement of natural ventilation system concepts, components, controls and design tools:

- Simple, efficient, low cost system concepts
- Standards and guidelines on natural ventilation
- Simple design tools
- Better components and control systems
- Improved knowledge on natural ventilation

NatVent™

Natural ventilation at work: case studies of innovative commercial buildings in Europe

by

Jan Demeester

Belgian Building Research Institute
Belgium

Natural ventilation at work: case studies of innovative commercial buildings in Europe

by

Jan Demeester
Belgian Building Research Institute, BBRI, Belgium

Abstract

Since the beginning of this decennium natural ventilation in office type buildings is receiving specific interest in several countries. The driving forces are multiple: not always satisfying experiences with mechanical systems, increased interest for 'natural' approaches, progress in natural ventilation technology etc.

Natural ventilation devices (trickle ventilators, ventilation grilles etc.), as part of a strategy for indoor air quality control are already common in several countries. Another possible application is night ventilation during warm or hot periods. In this latter case, the aim is to cool down the building mass at nighttime in order to obtain a better thermal comfort at daytime and/or to reduce the cooling energy.

In the framework of the NatVent™ project 19 naturally ventilated office buildings in seven countries - Belgium, Denmark, The Netherlands, Norway, Sweden, Switzerland, and the UK - were selected for detailed monitoring. The selected buildings are very diverse. Both existing buildings as well as renovated and new buildings were studied. The objective of the monitoring campaigns was to identify the advantages and shortcomings of natural ventilation strategies in ad-hoc buildings.
The buildings were monitored during the winter and summer. Parameters such as temperature, humidity and ventilation rates were measured to identify the efficacy of the ventilation strategies.

The results and the major findings will be presented by showing the results of three naturally ventilated buildings: an existing building, a renovated building and a new building. For each building the ventilation strategy, the ventilation technology and the performance of the ventilation system will be explained.

All results of the monitoring activities will be collected in several final products: the NatVent™ Source Book, the NatVent™ Monitoring Report and the NatVent™ CD_ROM. A draft version of the NatVent™ CD_ROM will be presented.

Natural Ventilation at work

Case studies of innovative commercial buildings in Europe

Jan Demeester
Belgian Building Research Institute

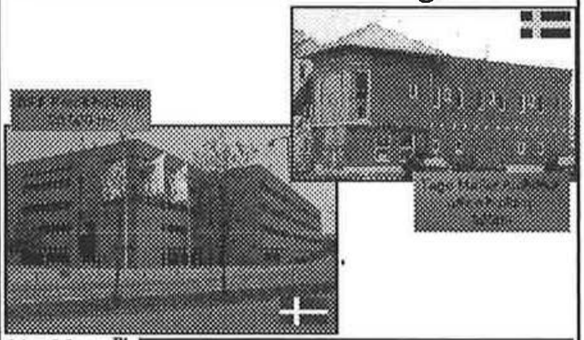
Task 2: the objectives

- To evaluate the **performance** of **existing** buildings **naturally ventilated buildings**:
  - To identify the **shortcomings** & **advantages**
  - To identify the required **boundary conditions** for achieving successful natural ventilation

19 selected office buildings

- The selected buildings are very diverse:
  - new buildings, older buildings, renovated buildings
  - in urban/rural environment
  - moderate/cold climate
  - countries with/without natural ventilation experience
  - different ventilation strategies...

19 selected office buildings



List of the 19 selected buildings

- BE1: PROBE building
- [illegible]
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Monitoring campaign

- Winter & Summer monitoring
- Several parameters
  - basic:
    - temperature / IAQ (CO_2) / Ventilation rate (active tracer gas measurements) / Indoor air velocity / Wind (velocity and direction) / Energy consumption
  - extra:
    - noise / heat fluxes / ...
- ➔ Report: Monitoring protocol

Monitoring results
Use of natural ventilation

- For Indoor Air Quality

- Objective: removal of pollutants
- During office hours (winter & summer)
- Characteristics:
  - relatively small air changes (0-1,5 ACH)
  - many requirements
    - noise, draught, IAQ, ...

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Monitoring results
Use of natural ventilation

- For thermal summer comfort

- Objective: cool down the thermal mass.
- During warm periods in summer at night
- Characteristics
  - relatively large air changes (5 - 10ACH)
  - no special requirements to noise and air quality
  - other measures necessary !

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Monitoring results

- 19 different stories....
- As an illustration: 2 case-studies
  - **The Canning Crescent Centre (UK)**
    - urban environment
    - new purpose-built naturally ventilated building
    - natural ventilation for IAQ & intensive night ventilation
  - **The PROBE-building (BE)**
    - rural environment
    - renovated office building
    - natural ventilation only for intensive night ventilation

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The Canning Crescent Centre
Building presentation

- Health care centre
- 1.350m²
- Building with high internal thermal mass: exposed walls & ceilings
- **Along very busy road**

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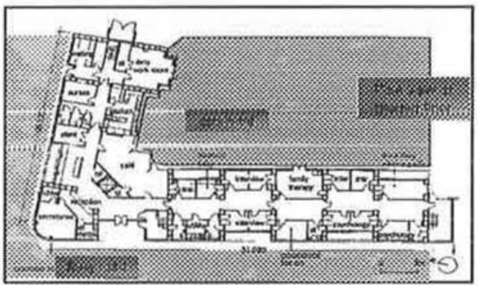
The Canning Crescent Centre
Building presentation

- Rooms around central corridor & courtyard at rear side



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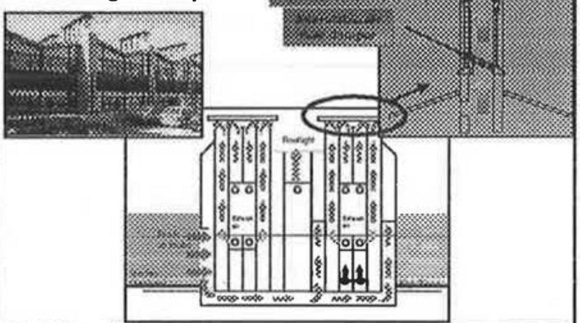
The Canning Crescent Centre
Building concept



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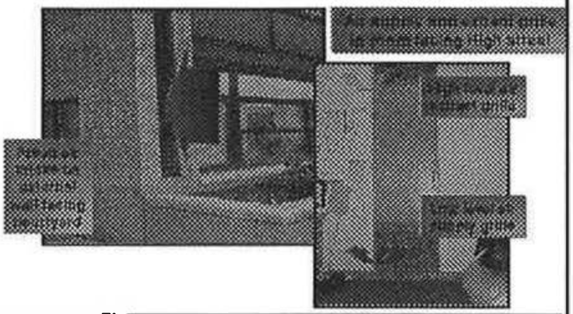
The Canning Crescent Centre
Building concept



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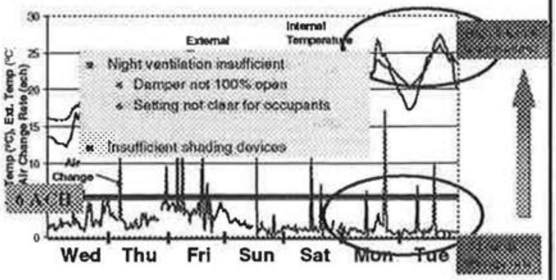
The Canning Crescent Centre Summer



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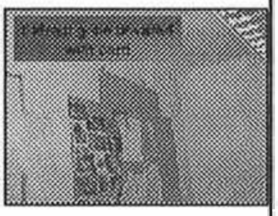
The Canning Crescent Centre Winter

- Occupants reactions in WINTER:
  - Cold down draughts from the high level
  - Sealed extract grilles



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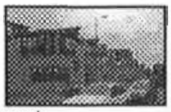
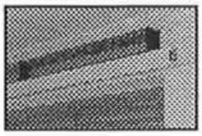
The Canning Crescent Centre
Conclusion & suggested improvements



- Conclusions
  - Not enough shading devices
  - Problems with dampers:
    - (summer) Setting of damper not clear to occupants
    - (winter) Dampers too leaky or even left open



- Possible solution:
  - Remove dampers →
    - slide control inlet & outlet grilles....
  - ...with clearly marked settings
    - (closed/half open/totally open)

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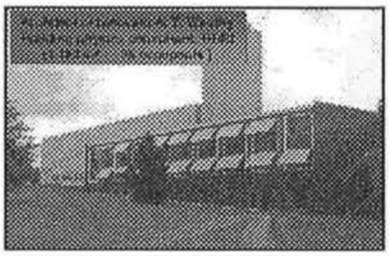
The PROBE-building
building presentation

- Built in 1975
- Situated in rural environment
- Comfort problems:
  - overheating in summer
  - bad air quality in winter



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The PROBE-building
renovation project

- Pragmatic Renovation of Office Buildings for a Better Environment
- Renovation project 1996-1997: several relatively small-scale measures:
  - New fuel boiler, thermostatic valves and improvement regulation system
  - Addition of thermal insulation to flat roof
  - **Installation of mechanical ventilation with IR presence detection**
  - Replacement of single glazing by low-e gas filled double glazing
  - External solar shading with automatic control
  - **Large grilles for night ventilation**
  - Low-energy lighting with luminance control and electronic ballast

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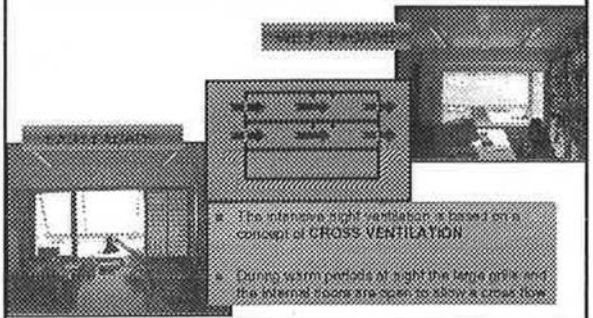
The PROBE-building
building concept - night ventilation



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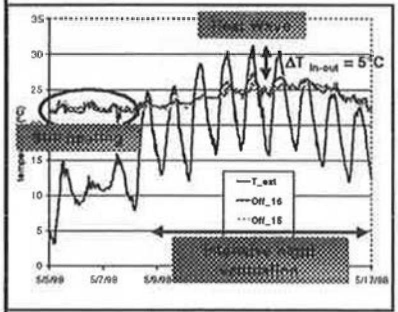
The PROBE-building
SUMMER



Conclusion:

Global concept of
- shading &
- night ventilation

leads to an acceptable summer comfort

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- General conclusions: presentation P.Wouters

The final products of Task 2

- 19 stories are described in...
  - The Summary Reports: 19 global reports (4p.)
  - The Monitoring Report: 19 detailed reports (20p.) of the monitoring campaigns
  - The NatVent CD-rom: 19 interactive slide-presentations + all NatVent final products
- and now its time for...

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Air and noise pollution in urban and city centres

by

Paul Ajiboye

Willan Building Services
UK

Air and noise pollution in urban and city centres

By

Paul Ajiboye and Mark Hesketh
Willan Building Services Ltd, UK

Abstract

The aim of this paper is to suggest ways of overcoming barriers to natural ventilation. The study forms part of the Pan-European project titled NatVent™ involving seven countries; the UK Building Research Establishment (BRE) is the co-ordinator.

A major barrier to the adoption of natural ventilation in urban environment is the perception that outdoor pollution levels are too high. The traditional approach of supplying 'clean' outdoor air is to draw external air pass filter media. However this precludes the use of naturally driven ventilation because of high airflow resistance generated. Consequently mechanically driven air conditioning is often specific, but at the cost of increased building energy consumption and subsequent CO_2 emissions.

A solution to the problem above is to intelligently apply natural ventilation concepts so that indoor air quality (IAQ) is not adversely affected by outdoor pollution levels. The paper reviews current issues of concern and presents a summary of an interactive tool based on 'best practice guidance' for successful application of natural ventilation. The outputs of the design tool include an assessment of the impact of all pollution sources on IAQ, advise on where to locate air intakes to avoid problems, realistic air filtration options in relation to exposure risk, as well as sizing of air intakes to ensure adequate ventilation during all seasons.

The main pollutants identified are particles (PM_{10}) and noise. Flow diagrams have been constructed summarising when these pollutants may adversely affect the quality air for ventilation. These include issues such as the proximity of buildings to busy roads, impact of local industries and airports, and periods during a day when pollutant concentrations are significantly higher. Increased height of air intakes from roads, and sheltered building facades are potential design solutions discussed. Wind flow patterns around buildings are another essential factor considered when locating air intakes in relation to pollution emissions from building exhaust vents and industry. A model is included within the design tool that evaluates pollutant concentrations entering air intakes, in relation to distance from source and wind speed.

The aim of interactive design tool is to encourage the use of natural ventilation by resolving pollution problems that might arise from urban locations. Air inlet options are suggested with different levels of pollution control. A model is also provided that calculates size of air inlets for adequate ventilation during winter and summer periods.

Air supply components suitable for high pollution and noise loads

Paul Ajiboye
Environmental Research Scientist
Willan Building Group

NatVent™ *Conference, 16 June 1998, London*

Background

Work package 1 identified key barriers to the wider adoption of natural ventilation in commercial buildings located in urban areas. Of these exposure to external pollution featured highly.

Tasks

1. evaluate the extent of the problem in urban environments.
2. develop guidelines for avoiding exposure to outdoor pollution.
3. design products to attenuate levels whenever necessary.

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1. Evaluation of urban pollution problems

- analysis of pollution data revealed that levels of particles (PM_{10}) were a frequent cause of concern. Noise from traffic was also a considerable problem.

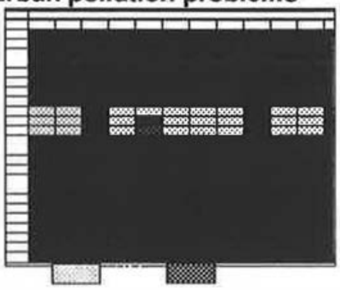

Chart 1.
Suitable and unsuitable periods for natural ventilation in urban environments, assuming excess outdoor pollution periods of up to 5%.

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1. Evaluation of urban pollution problems

- problems occurred if buildings were close to busy roads, railway stations, airports and the exhaust from other buildings as well as industry.
- wind flows around buildings greatly influenced the potential exposure to high pollution loads.
- air quality adjacent to sheltered building facades and at increased height from road level, is often better than would otherwise be.

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2. Guidelines for ventilating in urban environments

The NatVent™ CD-ROM includes guidelines on how to ventilate buildings in urban locations whilst minimising the effects of external pollutants.

These guidelines are accessible in three ways depending on the level of information required. Two approaches are summary schematics, and the third a comprehensive list of tables that considers all relevant issues.

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Sequence of tables identifying all pollution issues

Table A:	Location of facade relative to transport generated pollutants.
Table B(1):	Height of air intakes.
Table B(2):	Alternative pollution sources
Table C(1):	Building exhaust vent problems.
Table C(2):	Dilution of exhaust gases.
Table D(1):	Proximity to other buildings.
Table D(2):	Noise associated with environment.
Table D(3):	Proximity to industrial emissions.
Table E(1):	Air inlet design features
Table E(2):	Office use in relation to noise attenuation requirements.

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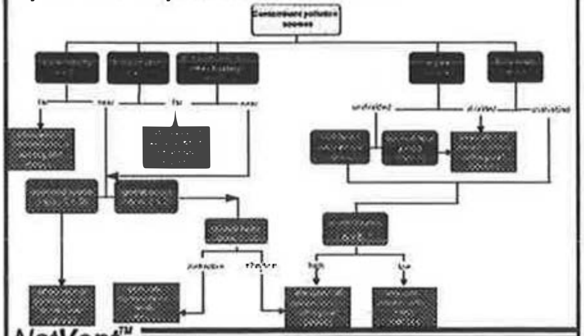
A simplified schematic summarising particulate pollution concerns



A simplified schematic summarising noise pollution concerns

3. Air inlets that attenuate noise and particle levels

A large capacity air inlet device, suitable for naturally ventilating buildings, has been designed to achieve three purposes;

- provide adequate ventilation in summer months.
- limit the penetration of external noise entering the building.
- reduce the amount of particles entering the building.

Each of these criteria has been evaluated.

Air Inlets that attenuate noise and particle levels

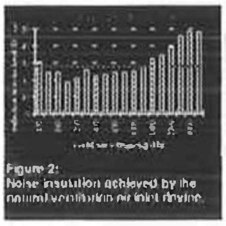
Adequate ventilation for summer months

Initial prototype testing of a large capacity air inlet has shown that the effective ventilation area is 2/3rds of the geometric open area - without filtration; when filtration is included this is reduced to approximately 1/3rd of geometric opening area. With ongoing developments this ventilation performance will be improved.

Simple models of stack, wind and combined stack & wind driven ventilation can be used to determine air inlet sizes. The models are derived from equations published in the CIBSE Guide on Natural Ventilation In Non - Domestic Buildings, by Oscar Faber.

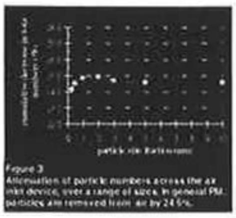
Attenuation of noise levels

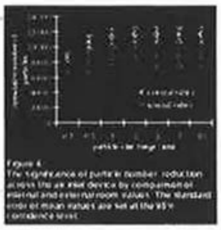
The noise insulation rating of the prototype air inlet device has been independently evaluated; a rating of 28 dB (A) was given.



Attenuation of particle numbers

Test on a prototype air inlet device, carried out at BRE, have established that up to 25 % of particles of size 0.3-10 µm are removed.





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Conclusions

- There are real concerns about naturally ventilating buildings located in urban environments, where pollution is deemed to be a problem.
- An extensive evaluation of the pollutants most frequently associated with urban locations has identified that noise and particulate levels are the major concerns.
- A passive low maintenance prototype air inlet device has been designed, capable of supplying sufficient ventilation during the summer, and attenuating levels of noise and particles entering buildings.

NatVent™

The application of controlled airflow inlets

by

Willem de Gids

TNO
The Netherlands

The application of controlled airflow inlets

by

Willem de Gids
TNO Bouw, The Netherlands

Abstract

In the EU Joule project NatVent one of the work packages was dealing with controlled airflow inlets. During the last conference in Greece an overview was presented on availability, performances and application of controlled airflow inlets. At the presented poster an interactive IAQ computer tool was demonstrated. This tool has been improved and is now available.

Some participating countries in the NatVent project have carried out special tests with the NatVent IAQ tool. The NatVent Participants were asked to design a natural ventilation system according to their national requirements. A second run was asked for a ventilation system which could reach the 1000 ppm CO_2 requirement. The tests of the various countries will be shown. The results of this exercise are very interesting. It shows the positive effect of controlled inlets on IAQ in case of natural ventilation in offices.

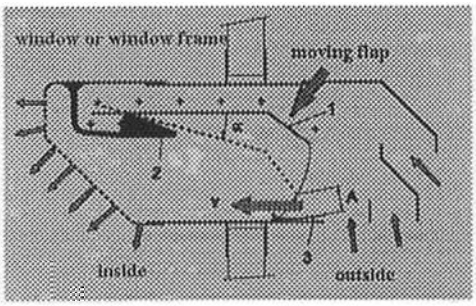
Controlled Airflow Inlets

Willem De Gids
TNO Building and Construction Research
The Netherlands

Type of Inlets Available

- Humidity Controlled Inlets
- Pollutants Controlled Inlets
- Temperature Controlled Inlets
- Pressure Controlled Inlets

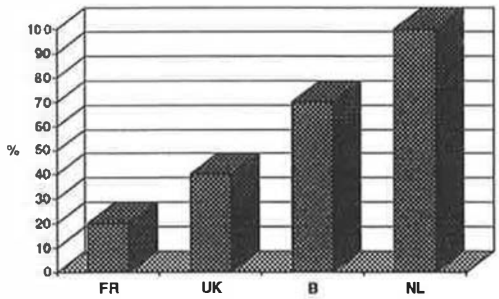
Example of a pressure controlled airflow inlet



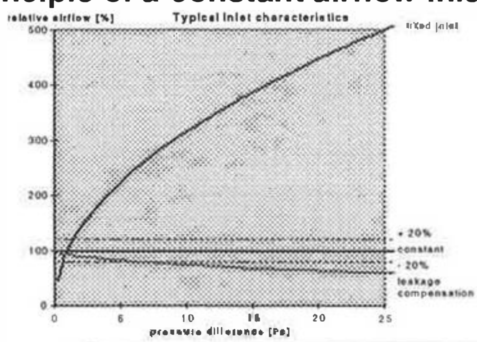
Performance of Pressure Controlled Inlets

- Big differences
  - flowrate/capacity or size
  - respons pressure level
    - 1, 5 , 20 Pa or even peak shaving closing only in stormy weather
  - response time
  - control possibilities
  - passive/active

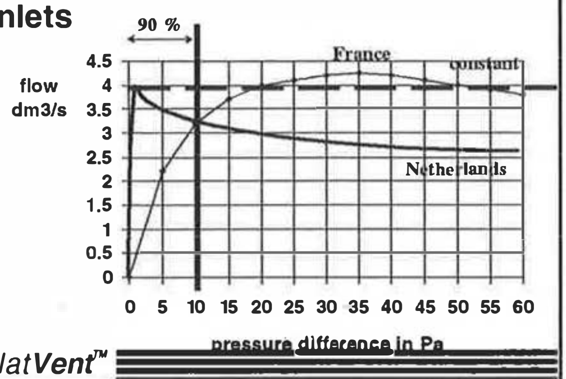
Comparison of sizes of inlets



Principle of a constant airflow inlet



Examples of pressure controlled inlets



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Application of Pressure Controlled Inlets

- Mainly in dwellings (minority of the buildingstock)
- Some new developed inlets are planned to be used in offices (price is a problem)
- No obligatory regulations or standards to use them
  - **mostly used in problem dwellings or the more expensive dwellings**
- Future applications:
  - **a big increase is expected in office type buildings**

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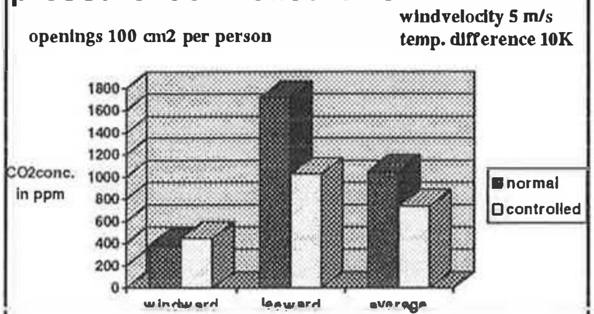
Indoor Air Quality pressure controlled inlet



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Energy Use

- Controlled air inlets can
  - increase indoor air quality
  - decrease the energy use for ventilation
- Energy saving depends on;
  - assumed use of non controlled (normal) inlets
  - If people leave their inlets open for instance during nighttime
- Energy saving may be in the order of
  - **15 to 30 m3 natural gas per person**

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Possible Improvements Pressure Controlled Inlets

- Presence control
- Interaction with BEMS
- Sound attenuation
- Integration with ventilation system

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NatVent™

Recovering heat from natural ventilation systems

by

Jorn Brunsell

Norwegian Building Research Institute
Norway

Recovering heat from natural ventilation systems

by

Jorn T Brunsell, Trygve Hestad
Peter Blom and Eimund Skaaret
Norwegian Building Research Institute, NBI, Norway.

Abstract

This paper deals with energy consumption and heat recovery in office buildings with natural ventilation. In the framework of the EU-project "NatVent" we have built a natural ventilation system in our laboratory. This system has been used to measure pressure differences, volume flows, heat recovery efficiency, filter efficiency, stack and wind effect on the system. Results from the measurements will be compared with calculations in this paper.

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Energy recovering from natural ventilation systems

Because of two reasons in moderate and cold climate:

1. To recover energy
2. To supply preheated air

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Work content w.p. 3.3 Natural ventilation with heat recovery

- Requirements of a system with heat recovery for an office building.
- Evaluate the energy saving potential.
- Develop advanced systems with heat recovery
- Laboratory testing of system.

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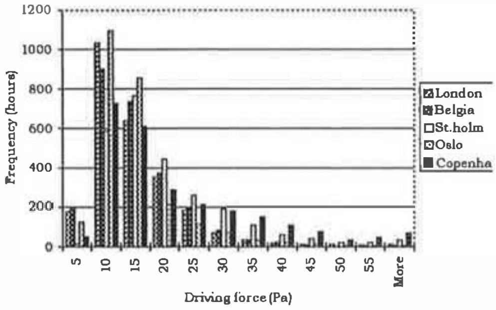
Distribution of natural driving forces



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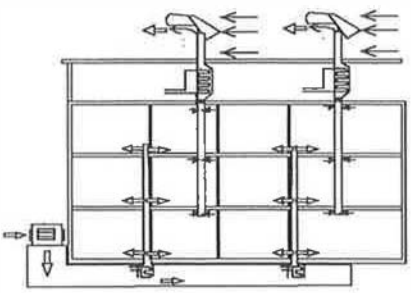
Internal air supply



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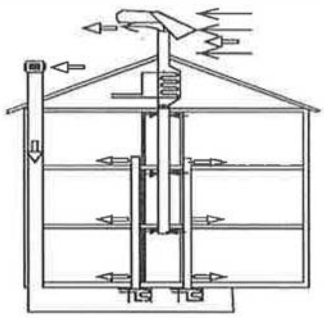
Internal air supply



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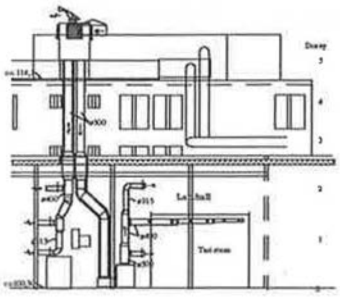
NBI's NatVent system with heat recovery



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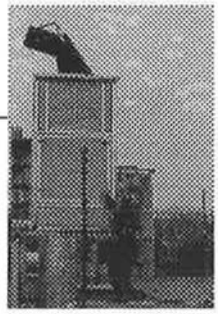
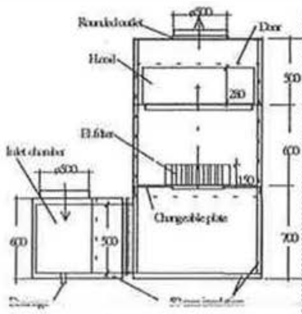
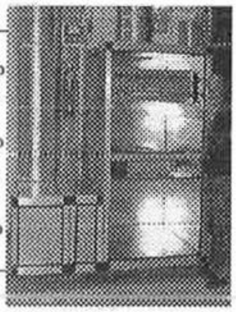
System outdoors



NatVent

System Indoors





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Measurements

- Temperatures
  - Outdoor
  - Indoor
  - Outgoing air
  - Incoming air
- Pressure drops
  - Across the filter
  - Across both sides of the heat recovery
  - Total for the system including ducts and terminals
- Velocity
  - In the ducts, gives the air flow
  - Wind
- Driving forces
  - Natural
    - Temp. dif.
    - Wind
  - Assisting fan
- Filter efficiency
- Heat recovery efficiency

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Pressure loss - extract side at design value: 400 l/s

Component	Pa
Outlet to atmosphere	1,2
Heat exchanger	3,1
Extract duct and terminals	7
Total sum	12,7

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Pressure loss - supply side at design value: 400 l/s

Component	Pa
Intake and vertical duct	11,3
Filter	1
Heat exchanger	6,5
Supply ducting and terminals	19,4
Total sum	38,2

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Measurement modes

- Without any fans
- With extract fan (most of the time)
- With both extract and supply fan

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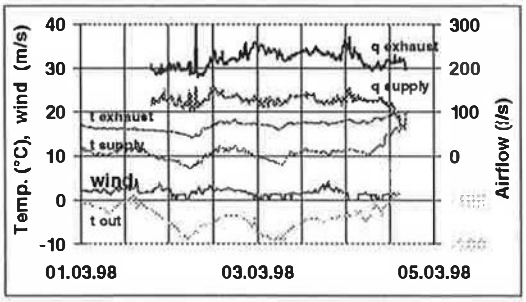
Temperatures and air flow Without fans



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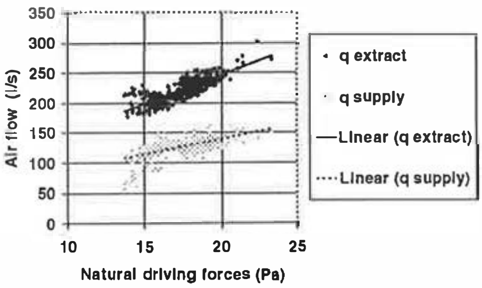
Air Flow vs Natural Driving forces



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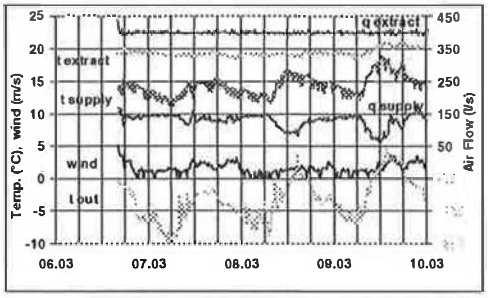
Temperatures and air flow Extract fan running



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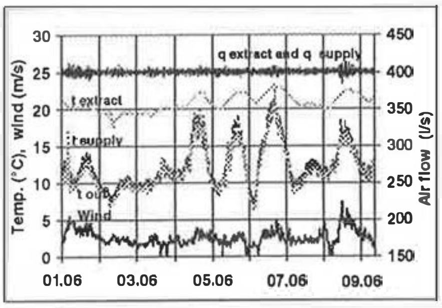
Extract and supply fan (without pump running)



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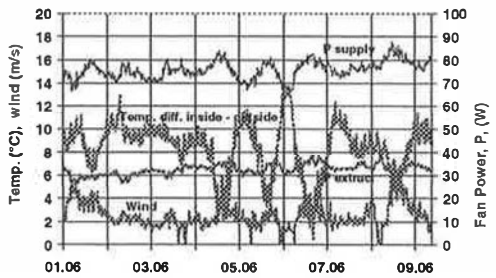
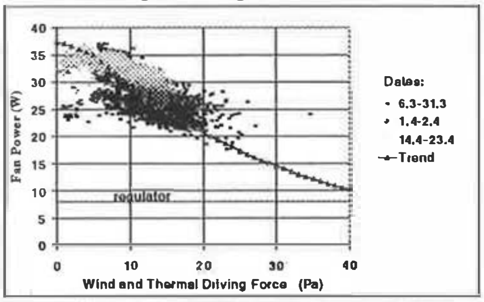
Fan power and natural driving forces (pump turned off)



NatVent

Extract fan power vs nat. driving force Regulating at 400 l/s



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Conclusions (1)

- Heat recovery should be considered in natural ventilated office buildings in cold climates
- Practical concepts existed and have been further developed
- Concepts must involve a close integration with the building design
- Heat recovery require assisting fans for stabilising air flows. Available natural driving forces are not sufficient

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Conclusions (2)

- Assisting energy efficient fans may act as efficient flow controllers
- Measured heat recovery efficiency: 0.5
- Natural ventilation with heat recovery is economic and technical competitive with traditional systems today

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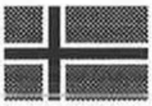
Outcome of NatVent in Norway

- Fast growing interest in the topic
- Big discussion in Norway about natural ventilation in general
- Interest for natural ventilation in other kinds of buildings



(Norway vs Scotland: 3-1)

NatVent

Control of summer overheating

by

Dolf van Paassen

Technical University of Delft
The Netherlands

Control of summer overheating

by

A.H.C. van Paassen, S.H. Liem, and B.P.Groninger
Delft University of Technology, TUD, The Netherlands

Abstract

To study the effects of night cooling with natural ventilation, a dynamic simulation of an office building has been developed. This simulation consists of models of the thermal and ventilation processes, the control system and weather. At each time step the indoor temperatures, control actions and the ventilation flows are determined simultaneously.

With this simulation two items are investigated: the control strategies and the required ventilation opening areas. The following is used as comfort criterion: less than 100 overheating hours (resultant indoor temperature above 25.5C during working hours) per annum, of which not more than 15 hours above 28C. Surprisingly all control strategies show more or less the same performance. What really matters is the tuning of the night cooling control strategy. So, only one system, the Cooling Day Control, is used to determine the required ventilation openings under different situations.

An optimal solution shows to be cross ventilation with 2% (of net floor area) effective vent opening. For that situation the allowable internal gain for a high inertia (HI)-building is 33 [W/m^2] for NS- and 27 [W/m^2]for WE-orientation. For a medium inertia (MI)-building this is respectively 26 and 22 [W/m^2]. A low inertia (LI) building is not suitable, it is less than 20 [W/m^2] for both orientations.

Based on the outputs of a large series of simulation runs, two user friendly design tools are developed. The first design tool consists of simplified equations and can be used in a spreadsheet. The second one is a graphical design tool in the form of a chart with which it is possible to determine quickly the limitations of night cooling with natural ventilation. These tools can be used to determine the requirements of the ventilation openings and control strategy at an early stage of the building design.

Intelligent Night Cooling

NatVent project,WP3/A3.4

A.H.C. van Paassen and S.H. Liem

TUDelft WbMT Delft University of Technology
Subfaculty:
Mechanical Engineering and
Marine Technology

NatVent™ *Conference, 16 June 1998, London*

Intelligent Night Cooling

- How to cool with Natural Ventilation?
- How to Design ?
- How to Control ?
- Benefits and Limitations

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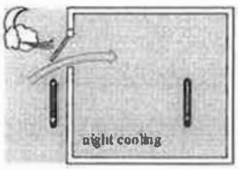
How to cool with natural ventilation?



- Natural driving forces are used for cooling:
  - Wind pressure around the building.
  - Stack effect by temperature difference between the in- and outside air.

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Single sided Ventilation

- Single sided ventilation: outside air enters and leaves the room through openings on one side of the façade.

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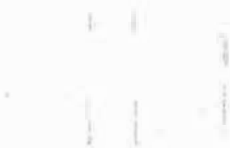
Cross Ventilation



- Outside air enters the building from one side and leaves the building on the other side.
- Cross ventilation gives higher ventilation rates than single sided.

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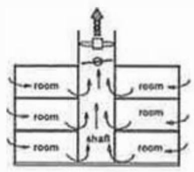
Fan assisted ventilation



Fan assisted cross ventilation with a chimney or a shaft

- Cooling effect can be increased with an chimney or fan.
- The fan will be switched at low windspeed.

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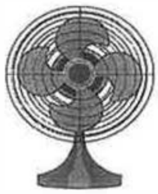
Aim is comfort during office time



- General accepted criterion:
  - During a year not more than 100 hours with too high indoor temperatures (> 25.5 °C)
  - Only 25 hours with temperatures higher than 28 °C.

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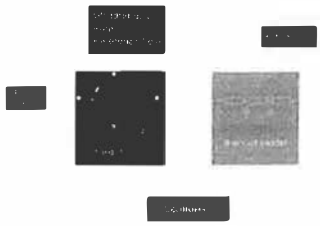
Simulation



- Design rules are based on simulation of thermal and ventilation processes.
- Input weather: Dutch Reference Year.

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How to design vent openings? General Design Rules

- Use an effective outdoor solar shading device. Without that, natural ventilation cooling is out of the question.
- Only medium to high inertia buildings are appropriate.
- Use of open ceilings and interior walls of bricks to get sufficient heat accumulation.
- For a standard room of 20 m^2 an effective vent opening of 0.4 m^2 is necessary.
- Single sided ventilation requires much larger openings (2X).
- The internal gains should not exceed 30 W per m^2 floor area.

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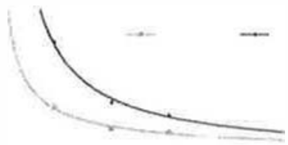
Effective Vent Opening



- Comfort with 2.0 % effective opening (internal heat gain < 30/m^2).
- 1% opening will lead at 30 W/m^2 to discomfort (200 hours).

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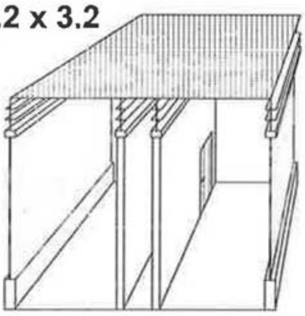
vent opening 2% of floor area: louvers :0.13 x 3.2 [m] window:0.2 x 3.2



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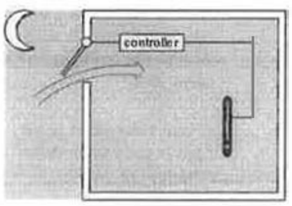
How to control ventilation openings?



- During night the building is cooled in a proper way.
- No overheating will occur during the next day.

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Effect of Control Strategies

- Night cooling is very effective.
- No difference between various predictive control strategies.

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Cooling Day Predictive Control

- Rule :
  - If during the day cooling was needed than the night setpoint is decreased with 2 K. (22 ->20-> 18°C).
- During office time the temperature setpoint is 22 °C.

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Limitations

- Cooling capacity of natural ventilation is limited.
  - Room with 2 persons, 2 PC's and lighting switched on is the limit (30 W per m² floor area).
- Well designed building is required:
  - - windows glass area less then 40% of the facade
  - - outside solar shading -
  - open ceiling and interior walls.

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Design tools derived from simulation runs

- For engineers simple equations, giving the area of the effective openings.
- For architects a graphical tool.

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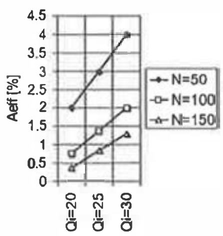
Equations put in a spread sheet can be used for fast analyses



- Effective opening in % floor area as function of internal heat gain Q_i at various comfort:
  - Temperature exceedings N(>25.5) = 50, 100, 150
  - Outside shading
  - 40% window
  - Medium M=75

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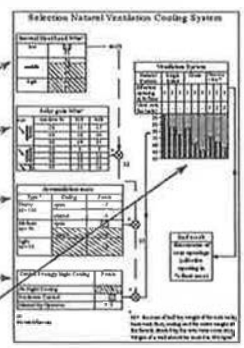
Graphical Design

Select:

- Internal heat gain
- Shading
- Mass
- Control
- Find system and effective opening in green area



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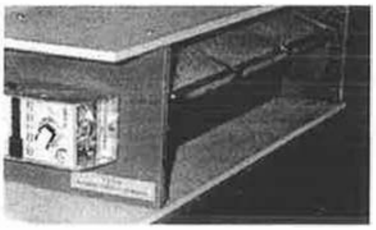
Conclusions

- Two user friendly tools are derived from simulation runs:
  - based on equations for engineers (spread sheet)
  - based on graphic for architects
- For cooling : cross ventilation is best

Conclusions

- Effective vent openings of 2% of the net floor area give comfort provided:
  - building is medium to heavy
  - outside shading
  - internal load 25 to 30 W per m2 floor area.
- Control strategy is not critical as long as some kind of prediction rule is applied

Prototype



Thank you for your attention.

Practical guidelines for integrated natural ventilation design

by

Johnny Kronvall

AB Jacobson and Widmark
Sweden

Practical guidelines for integrated natural ventilation design

by

Johnny Kronvall, Charlotte Svensson and Karin Adalberth, J&W BYGG and Anlaggning AB, Sweden
Soren Aggerholm, SBI, Denmark

Abstract

In many countries there is a turn towards natural ventilation as an alternative to energy and cost demanding mechanical ventilation systems. The objective is to save money and energy while maintaining an acceptable indoor air quality and thermal climate, or even to improve the indoor environment by reducing noise levels, giving the user more control over the indoor climate etc. The aim of the EC-JOULE project NatVent is to investigate, develop and integrate "smart" components to provide good natural ventilation for office-type buildings. Hitherto, simple design tools and guidelines for integrated natural ventilation design have not been available for practitioners. Therefore, as a part of the NatVent project, a robust and easy-to-use computer simulation program has been developed, coupling an airflow calculation model with a thermal model. One of the most important objectives while developing the program has been to create a robust underlying theoretical model and an easy-to-use interface. The aim for the user interface is to facilitate the use of the program by any building designer, architect or engineer at an early design stage. Therefore the interface uses input that are simple to quantify and so the simulation tool can be used at an early design stage giving an indication of the suitability of natural ventilation in a specific building.

In addition to the development of the simulation tool, a large number of test-runs have been performed in order to identify the most significant parameters that influence the indoor air temperature and the outdoor air flow rates.

The test-runs have been statistically processed and thus a detailed picture of which parameters have the largest influence on the indoor environment can be presented. These are consequently generalised as guidelines for integrated natural ventilation design. The proposed paper will focus on these guidelines.

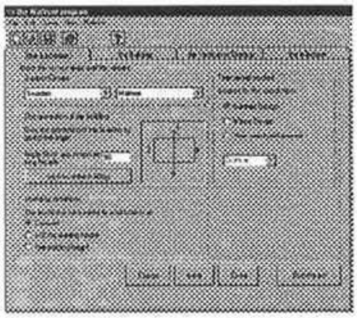
Practical Guidelines for Integrated Natural Ventilation Design

Johnny Kronvall
Charlotte Svensson
Karin Adalberth
J&W Consulting Engineers, SE

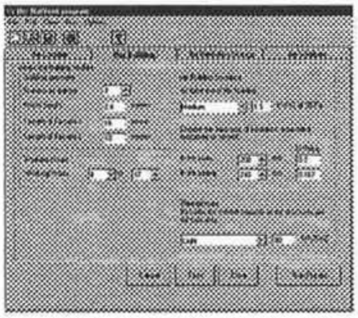
The NatVent program

- Pre-design simulation tool to predict natural ventilation performance
- Users: architects, engineers, developers
- Typical Windows environment
- Single zone model
- Coupled thermal and air flow model

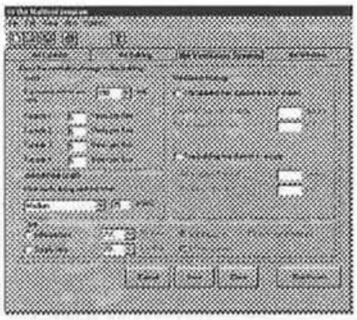
"The Location" form



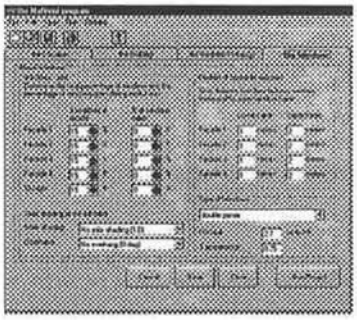
"The Building" form



"The Ventilation Strategy" form



"The Windows" form



Simulation Options

- Different European climates
- Typical summer period (1 week)
  - Ventilation air flows
  - Indoor temperatures
- Typical winter period (1 week)
  - Ventilation air flows
- Year-round performance
  - Durability graphs - ventilation and temperatures

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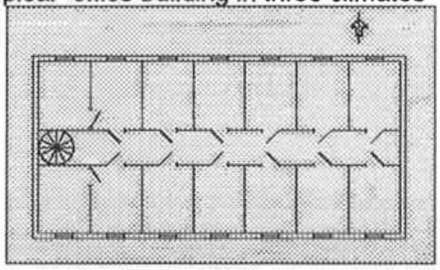
Parametric Study

"Typical" office building in three climates



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Parametric Study

Five different ventilation strategies:

- Passive stacks + Ducted air supply
- Passive stacks
- Ducted air supply + Skylight
- Skylight
- No ventilation devices except facade vents

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Parametric Study

Influencing parameters (number of levels)

- Climate (3)
- Number of storeys (3)
- Air leakage (3)
- Thermal insulation level (3)
- Thermal mass (3)
- Vent size (3)
- Internal heat loads (3)
- Night ventilation (2)
- Fenestration (3)
- Windows open (3)
- Solar shading (3)
- Type of windows (3)

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Parametric Study

Criteria of Critical Performance:

- Ventilation air flow rate< 0.7 l/s per m^2
- Indoor Air Temperature > 25 degC
- Indoor Air Temperature > 28 degC

Response Parameters:

- Number of work hours per year when performance is critical as above

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Parametric Study

Statistical Analysis

- 1 771 470 possible combinations
- Reduced to 450 by means of fractional factorial design
- Results analysed by a partial least square model
- Format for results:

$N_{hours}=10^{(a_0+a_1*par1+a_2*par2+......)}$

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Practical Guidelines for Integrated Natural Ventilation Design (1)

- Higher buildings
- Airtight (Build tight - Ventilate right!)
- Well insulated envelopes
- High thermal mass
- Large area of (adjustable) facade vents

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Practical Guidelines for Integrated Natural Ventilation Design (2)

- Limited internal heat loads
- Providing for night ventilation
- Limited solar loads by limited window area and/or solar shading devices
- Providing for user-controlled window airing

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Integrated Natural Ventilation Design

Conclusions

- Demand specifications
- Preliminary ideas / sketches etc
- Simulate! NatVent program
- Assessment; is it feasible?
- Specifications for detailed design
- Build as intended!
- User information / education

NatVent™

Low energy buildings within the European policy framework

by

Derek Hughes

Building Research Establishment Ltd
UK

Low Energy Buildings Within the European Policy Framework

Derek Hughes, Head International Marketing, BRE, UK

The paper considers the impact of European Policy issues on low energy building design. The paper considers four thrusts helping to shape and direct policy. These are probably the most important amongst a wide range of issues. The paper then goes on to consider how the European Commission is establishing actions to provide underpinning information (both technical and non-technical) to support these policies.

Factors Affecting Policy

Four thrusts directing energy related policy issues at European level are considered (although it is recognised that there are others). These are the response to the signing of the Kyoto Protocol, Renewable Energy, Sustainability, and the Fifth Framework Programme for R&D.

Kyoto Protocol – The Protocol was signed by the European Environment Commissioner in December 1997. The Protocol has legally binding targets for CO2 emission reductions. For the EU the agreed reduction by 2010 for a basket of CO2 emissions is 8% compared to 1990 emissions. As a result of Kyoto the Commission has prepared a "communication" on energy efficiency (essentially a precursor to an Action Plan) whose prime aim is to promote a higher profile and increased commitment to energy efficiency at both Member State and European level. The communication includes proposals to give special priority to energy efficiency in the building sector, an extension of EU schemes for labelling domestic appliances, strengthening efforts to remove financial barriers to energy efficiency and focusing on energy efficiency in other policy areas such as regional and international co-operation policy.

Renewable Energy – The Commission recently published a White Paper on Renewable energy. Amongst one of its proposed policy actions was a reorientation of building regulations to reflect the opportunities offered by renewable energy in buildings. Within suggestions for inclusion were the promotion of high efficiency windows and solar facades, natural ventilation and window blinds in both new buildings and retrofits, promotion of passive solar heating and cooling, integrated PV systems and use of construction materials with low energy content.

Sustainability – One of the major driving forces acting currently. In European terms the focus is particularly on sustainable cities. The European Commission (DGXI) set up an Expert Group on the Urban Environment who produced a report called *European Sustainable Cities*. In policy terms the report suggested a number of local policy options. Those relating to buildings include promoting sustainable design principles, provide financial incentives to support energy efficiency, support energy audits, and promote energy management.

Fifth Framework Programme – Increasingly the European research programmes are reflecting and underpinning European policy aims. This is as a result of the increasing power of the European Parliament in approving the activities (and funding) of the programmes. In the next strategic R&D programme – the Fifth Framework programme (which will probably start in early 1999) – the main focus for activity related to energy efficiency in buildings will be in two areas – Economic and Efficient Energy for a Competitive Europe and City of Tomorrow and Cultural Heritage. In the former policy themes include the provision of a reliable, clean, efficient, safe and economic energy supply and development of sustainable energy systems. In the latter they include the sustainable development of European cities to include energy efficiency and conservation.

Action Lines for Policy

In addition to other more general actions the Commission is promoting a number of R&D and associated actions which will help underpin, at a technical level, a number of the policy lines discussed above. These are the Fifth Framework programme (as outlined above), the SAVE II programme and the ALTENER II programme.

Fifth Framework Programme – In the Key Action *Economic and Efficient Energy for a Competitive Europe* R&D construction related activity is focused on the development of energy efficient lighting, space heating and cooling systems for buildings, renewable energy in buildings and improving the efficiency and reducing the costs of PV systems. In the Key Action *City of Tomorrow and Cultural Heritage* the construction-related activity is focused on amongst other issues research to ensure safety and security of the supply of essential resources (including energy) at an urban level. It is important to note that in this latter programme the emphasis is placed on planning, management and technical issues at urban level, not at individual building level.

SAVE II – This is a non-technical programme for promoting energy efficiency in the EU. It will run until the end of 2000. Themes of interest include acceleration of energy efficiency investments, increased energy efficiency management cohesion and improving energy efficiency at urban level.

ALTENER II - This is a non-technical programme for renewable energy in the EU. It will run until the end of 2000. Themes of interest include legislation to promote renewable energy investment, consideration of renewable energy in local and regional planning and developing new financial products to stimulate investment in renewable energy.

Summary

In summary here can be seen to be a number of overarching thrusts concerning energy policy and low energy building design. However a number of common threads emerge. These can be summarised as:

- A focus on sustainable development and how energy efficiency can contribute to this.
- Development of financial and fiscal measures – both to encourage energy efficiency and to punish energy profligacy.
- A focus on issues at an urban level.
- A recognition that energy efficiency in buildings is an essential component for success.

Low Energy Buildings Within the European Policy Framework

Derek Hughes

Head, International Marketing, BRE

NATVENT Conference - BRE, 23 June 1998

Energy Consumption in Europe

Buildings - 46%
Transport - 33% (delivered energy)
Industry - 20%
Agriculture - 1%

Energy intensity in EU as a whole is being reduced by only 0.6% per year

Thrusts Directing Energy Policy

- Kyoto Protocol
- Renewable Energy
- Sustainable Cities
- Fifth Framework Programme

Kyoto Protocol

- Agreed December 1997
- Signed by EU Environment Commissioner
- Legally binding reduction targets
- Legally binding CO_2 reduction target for EU is 8% by 2010 (compared to 1990)

Kyoto Protocol

- As a follow-up to Kyoto EC produced a "Communication" on Energy Efficiency.
- Main purpose to promote renewed commitment and higher profile at EU and Member State level.
- First step for EU strategy on energy efficiency, basis for a future "Action Plan for Energy Efficiency"

Kyoto Protocol

Communication proposals include:

- special priority to energy efficiency in building sector
- amend and improve Council Directive (93/76/EEC) to limit CO2 emissions
- extension of EU labelling scheme for household appliances
- strengthen effort to remove financial barriers to energy efficiency
- focus on energy efficiency in other policy areas such as regional development and international co-operation

Renewable Energy

Publication of second European Renewable Energy Study (TERES II) shows:

- renewable energies account for 5.3% of EU's primary energy needs
- renewable energies account for 1.7% of Eastern Europe's primary energy needs
- renewable market in the EU growing by 4.3 BECU annually
- prediction that renewable energy may contribute 14% of primary energy by 2020

Renewable Energy

Publication of a White Paper from the Commission on "Energy for the Future: Renewable Sources of Energy", key activities:

- Improving building regulations
- Improving access for renewables to electricity market
- Introducing fiscal and financial measures
- Supporting bioenergy for transport, heat and electricity

Renewable Energy

White Paper - Improving Building Reg's:

Total energy consumption in building sector could be reduced by 50% by 2010, of which half could be achieved by introduction of active and passive solar measures. Proposed actions:

- Incorporation of requirements on the use of solar energy for heating and cooling in building approvals
- promotion of high efficiency windows and solar facades, natural ventilation and window blinds in new build and retrofit.

Renewable Energy

White Paper - Improving Building Reg's:

- Promotion of active solar energy systems for space heating and cooling and warm water.
- Promotion of passive solar energy for heating and cooling
- encouragement of integrated PV systems (facades, roofs etc)
- PV electricity sales from private customers to utilities priced to allow direct reversible metering
- encourage use of construction materials with low energy content (eg timber)

Sustainable Cities

- Initiative from DGXI (Environment)
- Focus on sustainable urban development
- Provides framework for local action, principles:
  - > urban management
  - > policy integration
  - > ecosystems thinking

Sustainable Cities

Proposed local policy options:

- energy management as a basic aim
- local energy management systems (at city level)
- promote local energy production
- promote least cost planning
- replace non-renewable energy with renewable energy

Sustainable Cities

Proposed local policy options (cont.):
- promote co-generation
- recover waste industrial heat/produce energy from waste
- promote sustainable design principles
- energy audit
- financial incentives/environmental taxes

Fifth Framework Programme

- Five Year strategic R&D programme
- Likely start in early 1999
- Programmes 1-4 have had high energy focused funding
- Increased reflection of European policy issues

Fifth Framework Programme

Energy and buildings focus in two areas:

- Economic and efficient energy for a competitive Europe
- City of Tomorrow and cultural heritage

Fifth Framework Programme

Economic and efficient energy for a competitive Europe

Underpinning policy themes:
- provide Europe with reliable, clean, efficient safe and economic energy supply
- secure energy for the benefit of European citizens via the better functioning of society and industrial competitiveness
- development of sustainable energy systems

Fifth Framework Programme

City of Tomorrow and cultural heritage

Underpinning policy themes:
- sustainable development of European cities to include energy efficiency and conservation
- improve quality of life for European city citizens
- stimulation of economic competitiveness within cities

Action Lines

- Fifth Framework Programme
  Key Actions:
  > Economic and Efficient Energy
  > City of Tomorrow and Cultural Heritage
- SAVE II
- ALTENER II

Action Lines

Fifth Framework Programme
- Economic and Efficient Energy

RTD Actions include:

- develop energy efficient lighting, space heating and cooling systems for buildings
- integrate renewable energy into buildings
- improve energy efficiency of transport infrastructure
- improve efficiency and reduce costs of PV systems

Action Lines

Fifth Framework Programme
- City of Tomorrow and Cultural Heritage

RTD Actions include:

- development of demand management tools for energy at an urban level
- RTD to secure safety and security of supply for essential resources (inc. energy) at an urban level
- more efficient management of resources (including energy) in the construction and maintenance of buildings.

Action Lines

SAVE II: Non-technological programme to promote energy efficiency in EU

Duration: December 1996 - 31 December 2000

Actions:

- labelling and standardisation of equipment
- acceleration of energy efficiency investments
- dissemination of information

Action Lines

SAVE II: Non-technological programme to promote energy efficiency in EU

Actions (cont)

- monitoring of energy efficiency progress at national and EU level
- increased energy efficient management cohesion
- improving energy efficiency at regional and urban level
- establishing energy efficiency as a criterion in other existing EU programmes

Action Lines

ALTENER II - Programme designed to promote the use of renewable energy in the EU

Duration: June 1998 - 31 December 2000

Actions (include):

- sectoral and market strategies
- norms and certification
- legislation to promote renewable energy investment
- evaluation of non-market costs and benefits
- Improved dissemination of renewable energy know-how

Action Lines

ALTENER II - Programme designed to promote the use of renewable energy in the EU

Actions (cont.):

- consideration of renewable resources in:
  - > local and regional planning
  - > tools for planning design and evaluation
  - > new financial products and market instruments
- evaluation of the impact and cost-effectiveness of the programme

The End

Design strategies for innovative natural ventilation in office buildings

by

Peter Wouters

Belgian Building Research Institute
Belgium

Design strategies for innovative natural ventilation in office buildings

by

Peter Wouters
Belgian Building Research Institute, BBRI, Belgium

Abstract

When people speak about a 'naturally ventilated office building', it is often not evident to have a good understanding of what they really mean. In a number of countries and/or for a number of people, the meaning of natural ventilation is that the air supply and exhaust is assumed to happen through cracks and leakages in the facades as well as by opening the windows and doors. It is clear that such approach may work for not too airtight buildings in very mild climates with good outdoor conditions (no noise problems and good outdoor air quality) but it is clear that in most circumstances such strategy can not guarantee good indoor air quality conditions. This kind of uncontrolled ventilation is in the context of the NatVent™ project as unwanted.

Some understand by 'natural ventilation design' that the required supply air for indoor air quality (IAQ) control is guaranteed by specifically designed supply and exhaust openings allowing to meet the IAQ needs and at the same time to keep the energy demand within reasonable limits. This strategy can be described as ***'natural ventilation for IAQ control'.***

Others understand by 'natural ventilation design' that ventilation plays a crucial role for keeping thermal comfort conditions in summer. In general, night ventilation is used for cooling down the building structure at night in order to limit the indoor temperatures at daytime. This strategy can be described as ***'natural ventilation for thermal comfort control'.***

The presentation focuses on both strategies and tries to highlight the specific challenges and possibilities. By using several case studies, a critical analysis is made of the use of natural ventilation in comparison with other strategies.

Design Strategies
for
Innovative Natural Ventilation
in
Office Buildings

A synthesis
by 5 statements...

*Nat***Vent**

1

The key challenge is to achieve comfortable buildings which are moreover energy efficient

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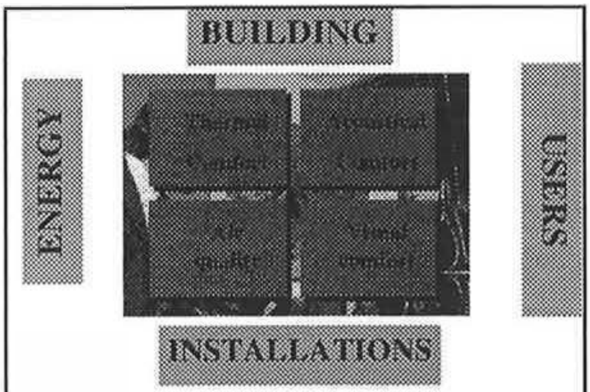

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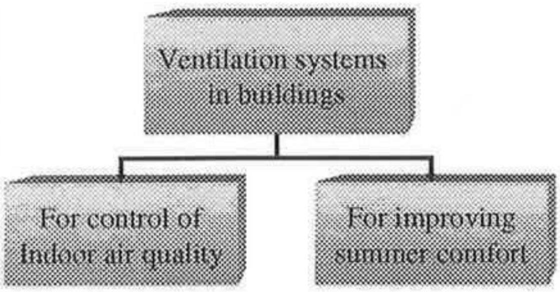
2

It is essential to understand that "natural ventilation" can have different meanings

*Nat***Vent**

The role of ventilation...



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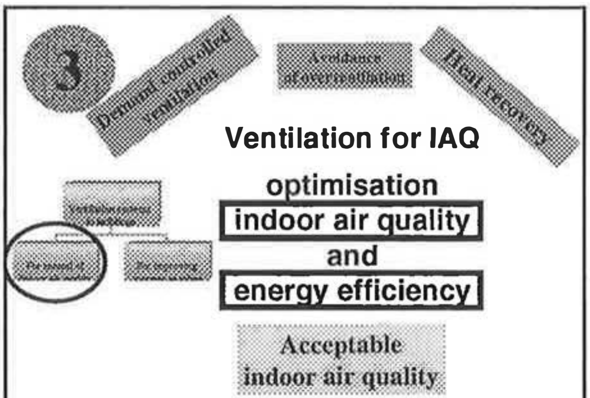

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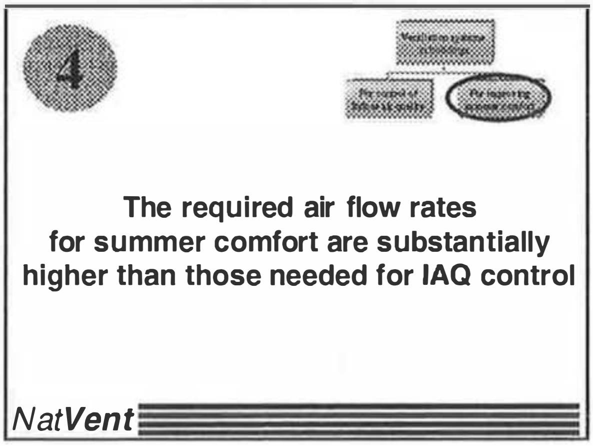
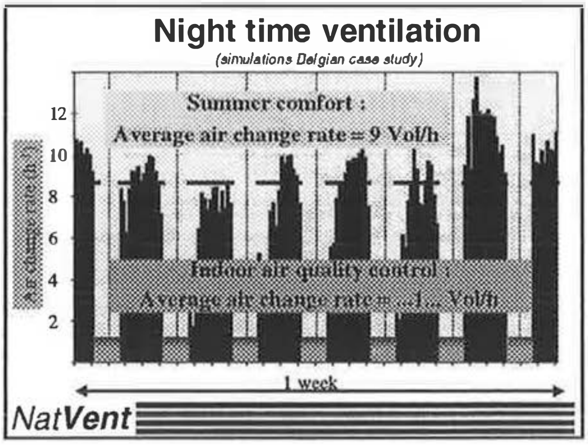
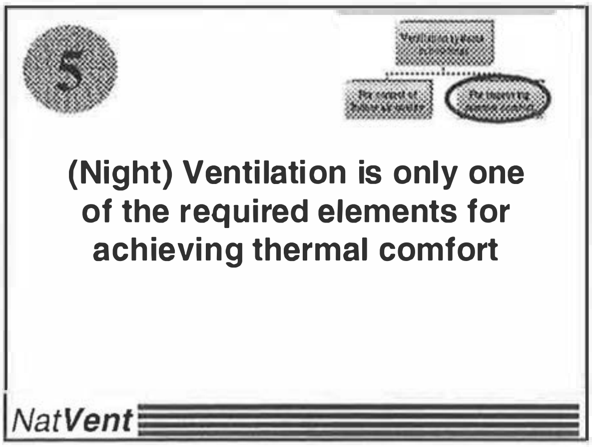
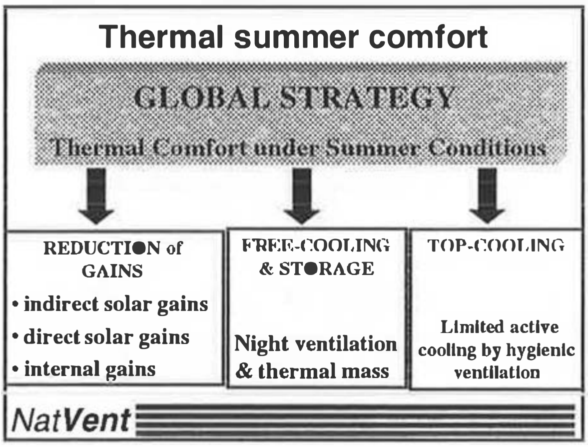
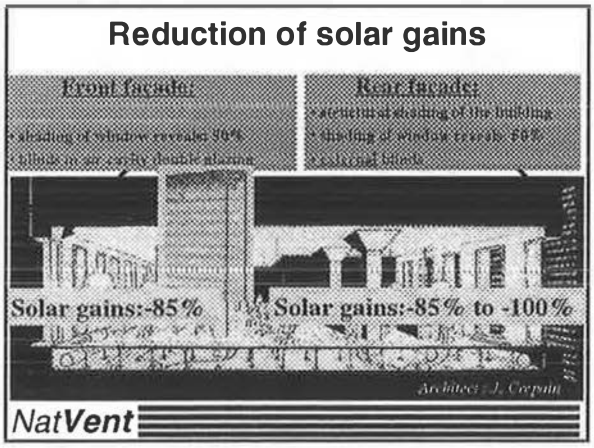
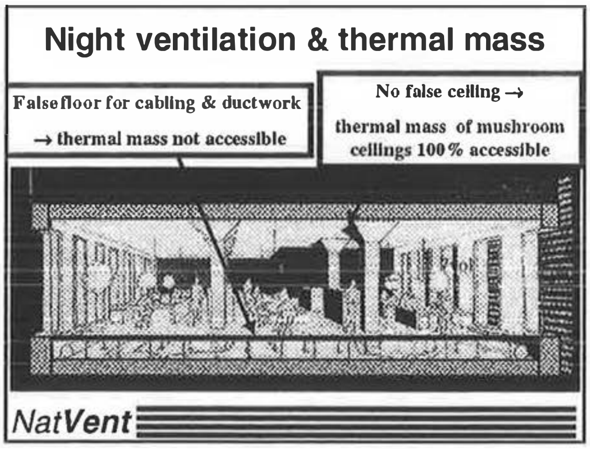

4
The required air flow rates
for summer comfort are substantially
higher than those needed for IAQ control
NatVent

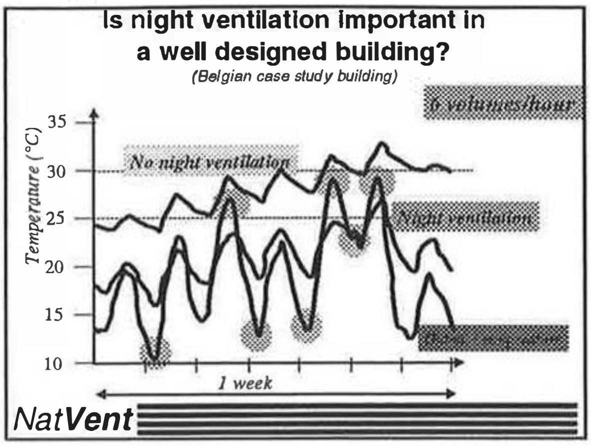

Night time ventilation
(simulations Belgian case study)
Summer comfort :
Average air change rate = 9 Vol/h
Indoor air quality control :
Average air change rate = ...1... Vol/h
12
10
8
6
4
2
1 week
NatVent

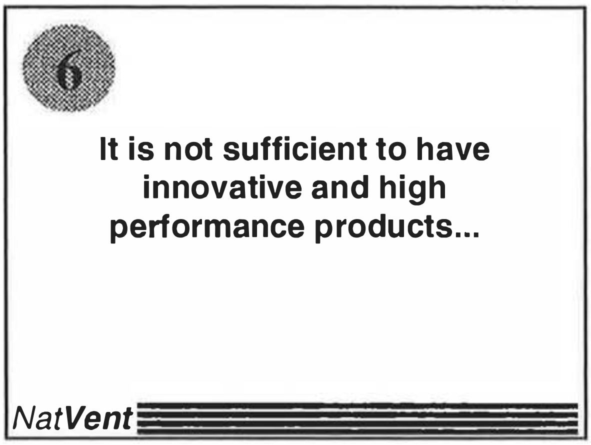

5
(Night) Ventilation is only one
of the required elements for
achieving thermal comfort
NatVent

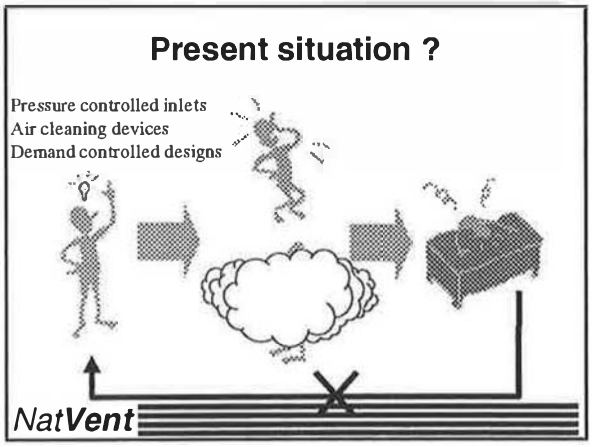

Thermal summer comfort
GLOBAL STRATEGY
Thermal Comfort under Summer Conditions
REDUCTION of GAINS
• indirect solar gains
• direct solar gains
• internal gains
FREE-COOLING & STORAGE
Night ventilation & thermal mass
TOP-COOLING
Limited active cooling by hygienic ventilation
NatVent

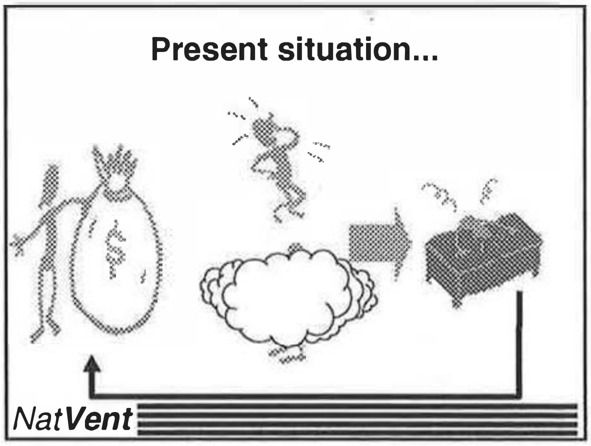

Reduction of solar gains
Front facade:
Rear facade:
Solar gains:-85%
Solar gains:-85% to -100%
Architect : J. Crepain
NatVent

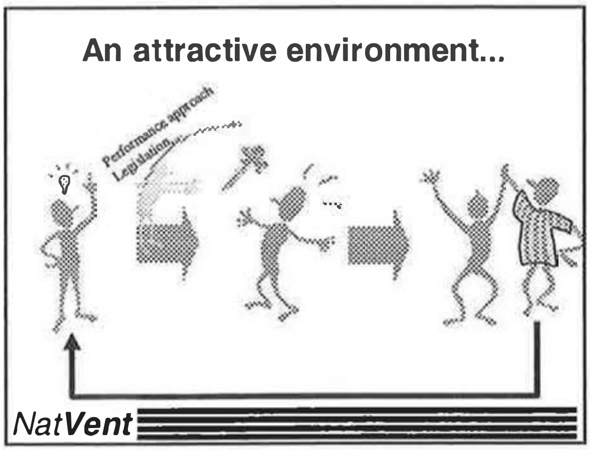

Night ventilation & thermal mass
False floor for cabling & ductwork → thermal mass not accessible
No false ceiling → thermal mass of mushroom ceilings 100% accessible
NatVent

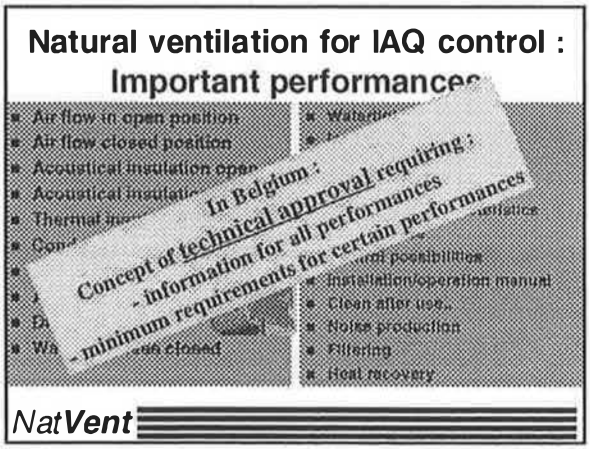

Is night ventilation important in a well designed building?
(Belgian case study building)
6 volumes/hour
No night ventilation
Night ventilation
Temperature (°C)
35
30
25
20
15
10
1 week
NatVent


6
It is not sufficient to have innovative and high performance products...
NatVent


Present situation ?
Pressure controlled inlets
Air cleaning devices
Demand controlled designs
NatVent


Present situation...
NatVent


An attractive environment...
Performance approach
Legislation
NatVent


Natural ventilation for IAQ control :
Important performances
Air flow in open position
Air flow closed position
Installation/operation manual
Clean after use..
Noise production
Filtering
Heat recovery
In Belgium :
Concept of technical approval requiring :
- information for all performances
- minimum requirements for certain performances
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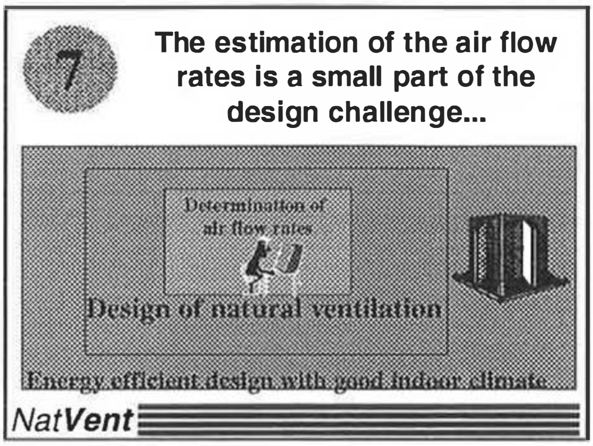
7
The estimation of the air flow rates is a small part of the design challenge...
Determination of air flow rates
Design of natural ventilation
Energy efficient design with good indoor climate
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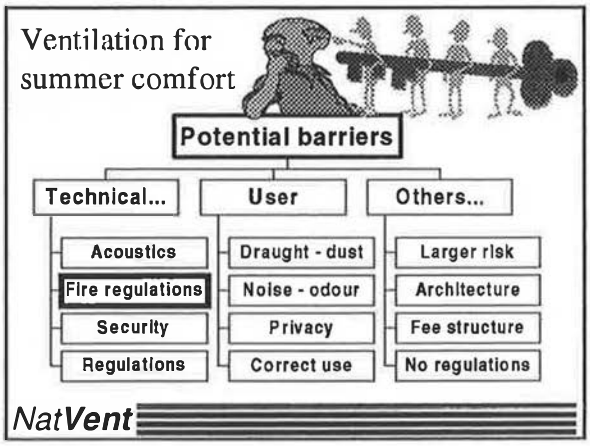
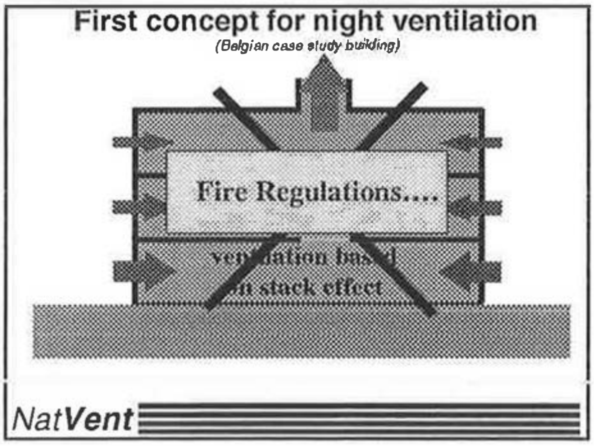
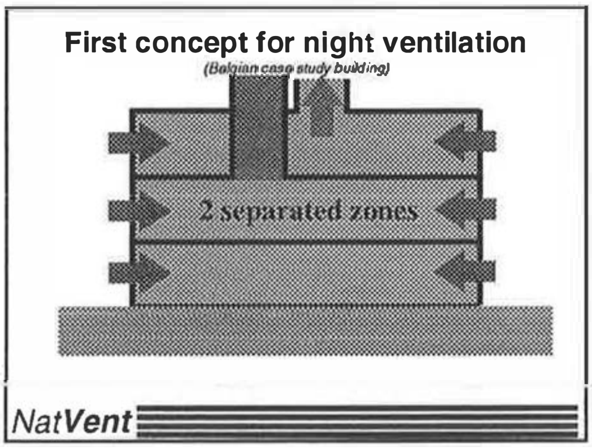
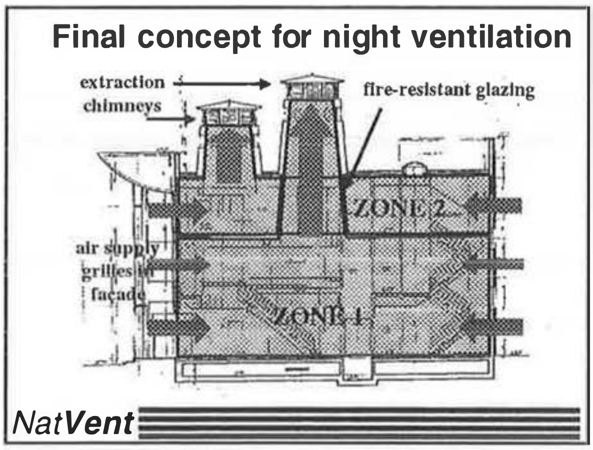

Ventilation for summer comfort
Potential barriers
Technical...
User
Others...
Acoustics
Fire regulations
Security
Regulations
Draught - dust
Noise - odour
Privacy
Correct use
Larger risk
Architecture
Fee structure
No regulations
NatVent


First concept for night ventilation
(Belgian case study building)
Fire Regulations....
ventilation based on stack effect
NatVent


First concept for night ventilation
(Belgian case study building)
2 separated zones
NatVent


Final concept for night ventilation
extraction chimneys
fire-resistant glazing
ZONE 2
ZONE 1
air supply grilles in façade
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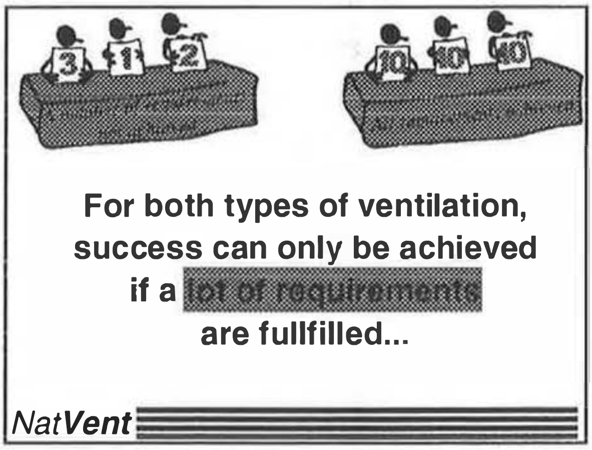
3
1
2
10
10
10
For both types of ventilation, success can only be achieved if a lot of requirements are fullfilled...
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8 Natural ventilation

is

one of the options

for

achieving an energy efficient building with good indoor climate

but

NOT the only solution

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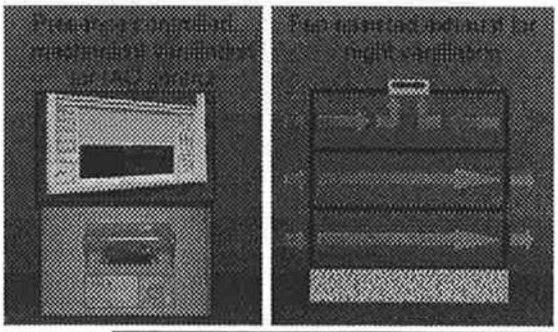
Examples of 'hybrid' concepts



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Synthesis of conclusions...

- Key challenge is to achieve comfortable buildings which are moreover energy efficient
  - energy efficiency without comfort no sense
- It is essential to understand that natural ventilation can have different meanings
- Ventilation for IAQ : optimisation of indoor air quality and energy efficiency
  - summer ventilation less critical

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Synthesis of conclusions...

- Required air flow rates for summer comfort much higher than for IAQ control
- Summer comfort requires much more than intensive (natural) ventilation
  - solar control, internal gains, thermal mass, active cooling...
- Estimating air flow rates is a (small) part of the achievement of a succesfull design

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Synthesis of conclusions...

- The creation of an attractive environment for innovation is extremely important
  - good standards, technical approval,...
- Natural ventilation can be an attractive option, NOT the only option...
  - mechanical ventilation, hybrid concepts, innovative cooling,...
- I'm running out of time...

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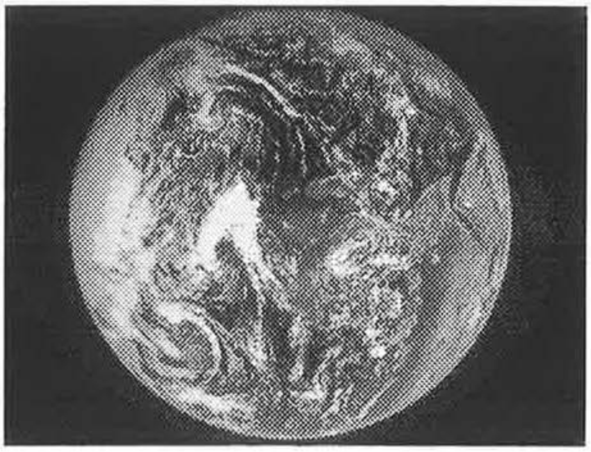

Application of NatVent™ principles in European buildings

by

Peter Kofoed

Sulzer Infra Lab AG
Switzerland

Application of NatVent™ principles in European buildings

by

Peter Kofoed
Sulzer Infra Lab. AG, Switzerland

Abstract

In this presentation, a brief history of the NatVent™ project from the Swiss point of view will be given. Since natural ventilation has always been used with success in the past with very interesting concepts, various natural ventilation concepts will be described.

The general activities and projects relating to natural ventilation in the German speaking part of Europe will be presented. In particular, four main projects showing two different approaches: natural window ventilation and natural hybrid ventilation with the help of atria - will be described in detail. There are:

1. Natural window ventilation

- UBS Suglio
- Swiss Pavilion Expo 2000

2. Natural hybrid ventilation

- IFZ Gissen
- GVB Gaudeversicherung

Application of NatVent™ principles in European buildings

Peter Kofoed, Sulzer Infra Lab Ltd, Switzerland

NatVent™ *Conference, 16 June 1998, London*

The Idea of the Project

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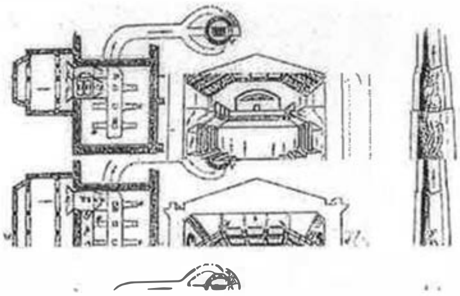
Natural Ventilation: An old idea



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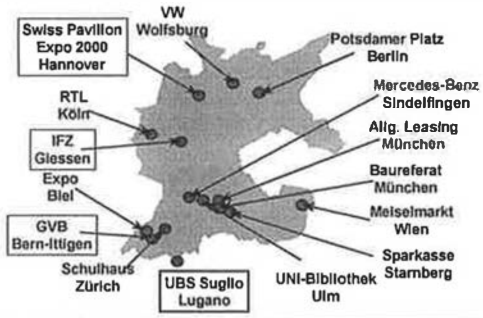
Activity in the German speaking part of Europe



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Natural Window Ventilation

- UBS Suglio
- Swiss Pavillion Expo 2000

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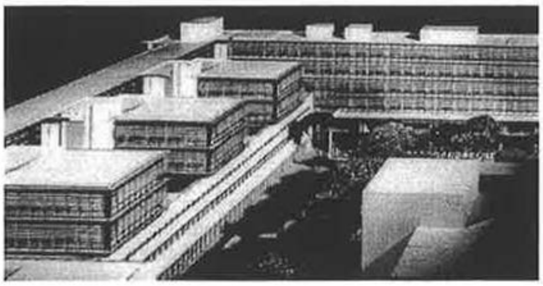
UBS Suglio



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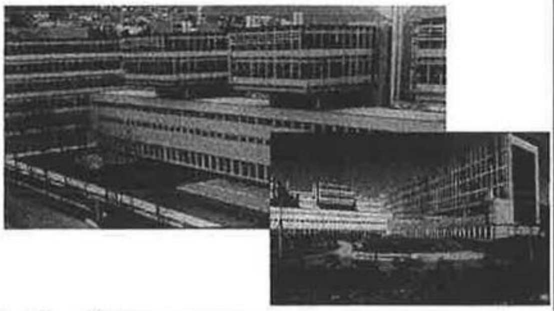
UBS Suglio



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UBS Suglio

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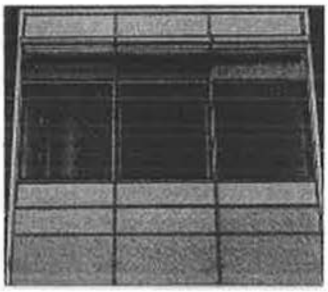
UBS Suglio



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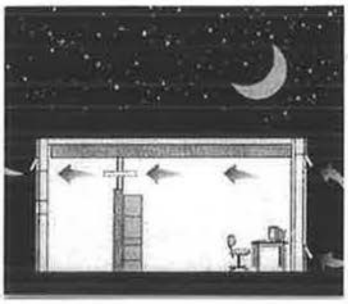
UBS Suglio



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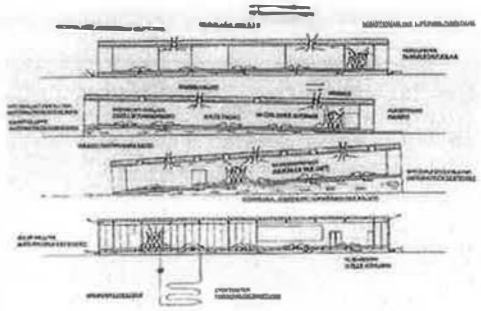
Swiss Pavillon Expo 2000



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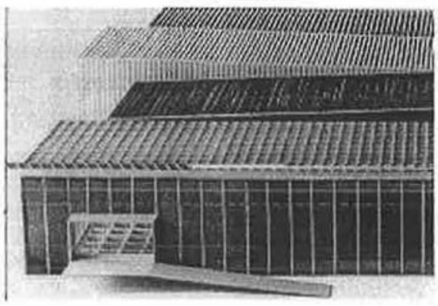
Swiss Pavillon Expo 2000



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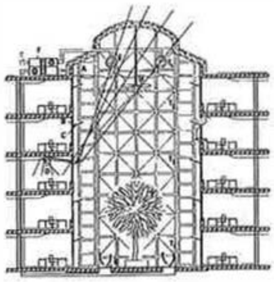
Hybrid Ventilation



- IFZ Giessen
- GVB Gebäude-versicherung

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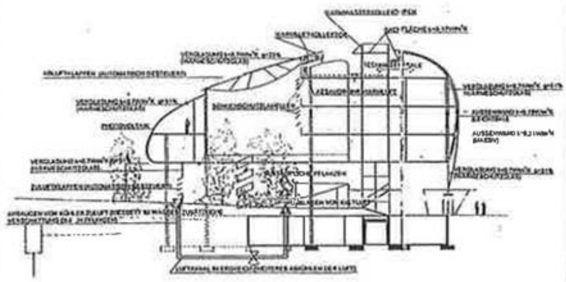
IFZ Giessen



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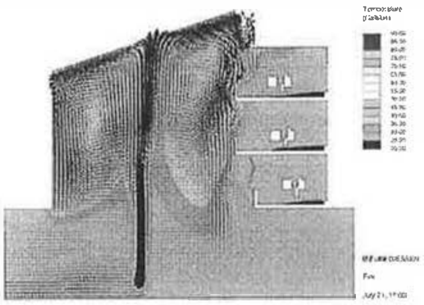
IFZ Giessen



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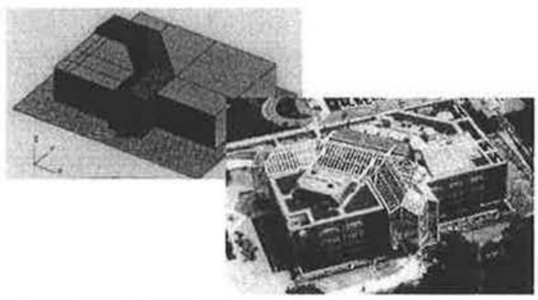
GVB Gebäudeversicherung



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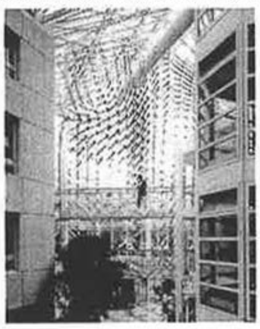
GVB Gebäudeversicherung



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NatVent: A better way to work

"It is the task of our generation to replace energy with information."

Niels Postman

NatVent™

NatVent™: Accomplishments and recommendations

by

Martin Liddament

Air Infiltration and Ventilation Centre
UK

NatVent™ : Accomplishments and recommendations

By

Martin W. Liddament
Air Infiltration and Ventilation Centre

Abstract

Through an extensive programme of development work, combined with a detailed analysis of case study buildings, much has been learnt about the performance and range of applicability of natural ventilation in commercial and public sector buildings. New technology including night cooling, heat recovery, control systems, acoustic damping, filtration and constant flow air vents has been developed and demonstrated. Similarly, a variety of new tools for design and operational prediction has been developed.

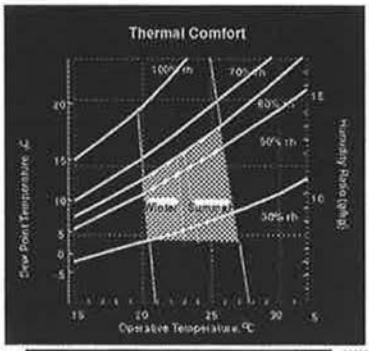
Analysis of existing buildings has indicated that ventilation and cooling needs can be satisfied for much of time in central and northern European climates. Where 'top up' cooling is needed, good natural ventilation design can reduce the cooling load considerably. Occupant surveys have shown that control systems must be easy to use and be responsive to the needs of occupants. Above all designers should be aware of the lessons learnt and suggested improvements, arising from the case study analysis. Architects and designers must also take responsibility for monitoring and rectifying problems that may arise.

NatVent - Accomplishments and Recommendations

Martin W. Liddament
Air Infiltration and Ventilation Centre

NatVent[TM] *Conference, 16 June 1998, London*

Ventilation and Comfort



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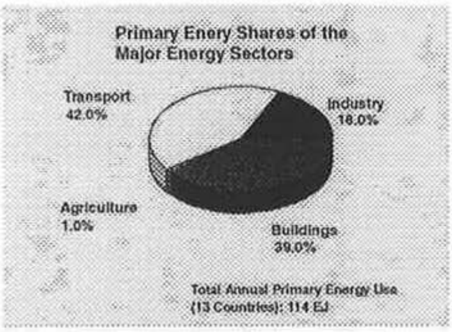
Energy Use



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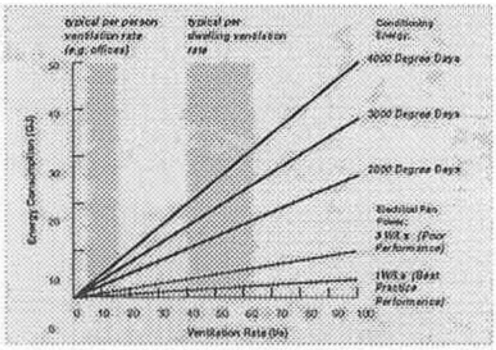
Ventilation and Energy



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Compulsory (Mechanical) Ventilation Checks - Sweden

From 8,000 inspections, 63% failed.

Common faults included:

•Wrong Air Flow Rates	61 %
•Deposits on Fans	40 %
•Deposits in Ducts	37 %
•Defects in Ducts	30 %
•Controls	27 %

(over 2/3rds of hospitals and daycare centres failed)

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Reasons for Ventilation

- To provide sufficient 'fresh' air to achieve optimum indoor air quality.
- To provide for thermal cooling.

Winter Ventilation - *minimise ventilation*
Summer (Passive) Cooling - *maximise ventilation*

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Some General Conclusions

•Ventilation for good air quality can be achieved using natural ventilation.

•Many demonstrated solutions for the supply of air, mixing and thermal conditioning (i.e. avoidance of cold draughts).

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The Issue of 'Cooling'

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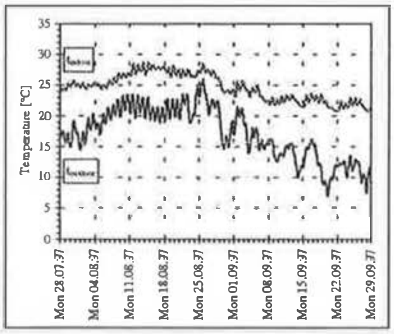
Indoor/Outdoor Temperatures - No Measures



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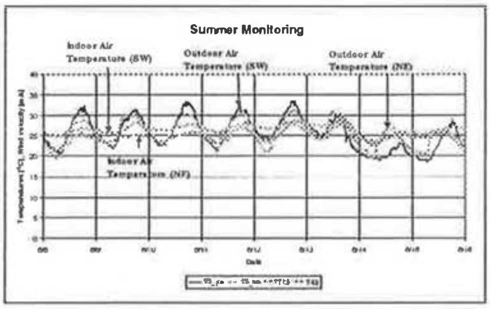
Shading, Night Cooling, Reduced Internal Heat Gains



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General Conclusion

Natural ventilation combined with passive cooling measures can go a long way to meeting the cooling needs of many buildings.

It is essential to understand the physics and to design (and construct) correctly.

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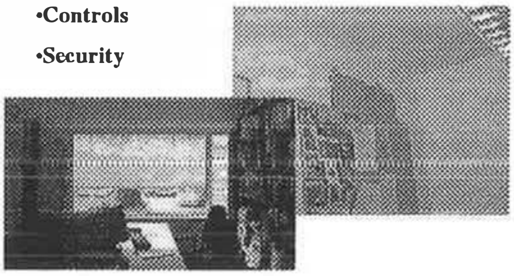
Overcoming Problems/Barriers

•Controls

•Security



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Products

- Vents (Pressure Sensitive, Acoustic, Filtration)
- 'Priming' Fans
- Low Energy Heat Recovery

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Tools

- Cooling
- Heat Loss/Gains
- Air Change Rate
- Coupled

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The Future

- Dissemination of key Information:
  - Innovative
  - Demonstration

(Demonstrated technology must be clearly presented, indicating how to apply and what can be expected)

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The Future

- New European Projects:
  - TIP-VENT
  - AIRLIT-PV

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Panel Debate:
Industry response and viewpoint

by

Geoff White and Chris Twinn

UK

Summary of Views

by

Geoff White BSC ARICS
Grosvenor Estate Holdings

- The conference and the research is a tremendous help to industry by sighting examples and showing where it was done before.

- There is an increasing need for publicity on exemplar buildings and user feedback.

- It should be stressed that low energy buildings are good places to work and may be more stress placed on "healthy building syndrome".

- The tax regime in this country does not promote alternative methods of air conditioning but tend to favour capital intensive methods.

- The Kyoto protocol requirements are highly optimistic as the emphasis appears to be of use of building regulations which will only affect 1% of the building stock.

- There needs to be emphasis on changing existing buildings and reducing their CO_2 omissions.

- Services consultants appointments should be based on the building cost not the amount of plant.

- The decision makers within the property market also include agents and more especially funds and their advisors. There are none at this conference and they should be targeted with information and education to assist them in understanding the principal.

- More emphasis should be placed on user satisfaction with naturally ventilated buildings and demonstrating how more easily they can accommodate tenant requirements.

- It is necessary to establish consistent definitions and descriptions to enable comparisons to be made between naturally ventilated and traditional air conditioning buildings.

- Air conditioned buildings should also be explained thoroughly to make sure that their weak points are identified.

- Government should take a strong line in encouraging sensible use of energy in its own buildings and spread the word to a wider audience.

Industry Response

by

Chris Twinn
Ove Arup and Partners

- There are apparent overlaps between proposed analytical tools - could these be combined as part of a single tool.

- Based on real building feedback the proposed analytical tools appear to under-estimate the cooling potential of thermal inertia with night ventilation. The tools should be validated against real buildings before they are presented as modelling representations of real life.

- The effectiveness of fabric thermal storage and the usefulness of the depth of mass is closely related to the thermal mass core temperature and its pre-conditioning over the days and weeks before the design heat wave. Until we can model realistic peak internal temperatures we will have major problems selling natural ventilation. Room temperatures of 27°C or more (2.5% of hottest month) do not generally sell in the UK market.

- Consider comfort methods which allow direct comparison with air conditions, eg Fanger PPD. This allows natural ventilation with good fabric design to compete directly with air conditioning with poor fabric design (ie radiant temperature with air temperature = comfort temperature) .

- Consider using the same peak weather day as used for air conditioning design (eg 1% annual or 2.5% hottest month exceeded design day) to allow direct comparison (albeit part of a longer lower temperature pre-peak weather sequence).

- Issues of perception of control are significant in occupant satisfaction terms (ie as identified by PROBE studies) how can we start to define this? - eg number of degrees of freedom
- Beware of total control by BMS. Occupants do not like motorised controls in their immediate space without local override ability

- Most night cooling algorithms are too complicated for the industry to deliver fault free

- Beware of too high a rate of trickle ventilation as this creates room winter RH levels which are too low. Consider 24 hour average trickle ventilation rates and the room reservoir effect over night. This avoids the 'large' trickle vents sized to meet 'instantaneous ventilation rates.

- Most natural ventilation is cross ventilation driven by wind pressure. Just as there should be standardised peak design temperature recommendations, there is a need for standardised wind pressures recommendations used for natural ventilation design.

- There should be standardised corrections given for height, urban/open, simple adjacent obstructions.

NatVent ™ Consortium Particpants

(Lead contact is in bold text)

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