VENTILATION TECHNOLOGIES IN URBAN AREAS

19TH ANNUAL AIVC CONFERENCE
OSLO, NORWAY, 28-30 SEPTEMBER, 1998

Perceived Barriers to Natural Ventilation in Offices

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Synopsis

The paper describes the results of a Pan-European survey carried out on identifying the barriers that restrict the implementation of natural or simple fan-assisted ventilation systems in the design of new office-type buildings and in the refurbishment of existing such buildings. The survey was part of the ***NatVent***™ project carried out in seven central and northern European countries with moderate and cold climates.

The barriers were identified through an in-depth study with structured interviews based on questionnaires among leading designers and decision makers: architects, consultant engineers, contractors, developers, owners and governmental decision makers responsible for regulations and standards.

On average the interviewees expect an increase in the future use of natural ventilation in office buildings. The survey also identified a lack of knowledge and experience on specially designed natural ventilation. In addition, the results showed that there is currently, a lack of information on natural ventilation in standards and guidelines and also a lack of case studies of the performance of office buildings with natural ventilation. Furthermore, there is a significant requirement for simple tools, which can be used to design for natural ventilation, in particular, calculation rules, and easy-to-use computer programs.

1. Introduction

Mechanical ventilation systems are often installed in office buildings where good natural ventilation would have been sufficient to obtain comfortable indoor climate and good indoor air quality. It is thus important to identify the barriers seen by designers and decision makers which restrict the implementation of natural ventilation systems and lead to the decision to install mechanical ventilation plants in office buildings where it is not strictly necessary. Knowing the barriers is the first step in providing solutions to overcome them.

2. Interviews

A total number of 107 designers and decision makers were interviewed, see table 1. The interviewees were selected with the intention of also identifying the variety in opinions and viewpoints on natural ventilation in office buildings among people with the same profession.

Table 1. Number of interviewees in each country, by profession.

		Architects	Consultant engineers	Contractors	Developers	Owners	Government dec. makers	Total
Belgium	B	7	3	1	1	1	1	14
Denmark	DK	5	3	2	2	2	1	15
Switzerland	CH	5	3	2	2	2	1	15
Norway	N	5	3	2	2	2	1	15
Netherlands	NL	5	2	-	-	2	-	9
Sweden	S	5	3	2	-	2	1	13
Great Britain	UK	10	7	2	2	3	2	26
Total		42	24	11	9	14	7	107

The interviews were based on two questionnaires as follows:

- General view on natural ventilation in office buildings.
  General knowledge, viewpoints, experience and perceived problems with natural ventilation systems in office type buildings.
- Specific building project.
  Decisions actually made during the design or refurbishment of an office type building.

A specific 5 point scale was used where possible. The questionnaires were not too tight and there was ample space for additional comments, remarks and viewpoints not included in the questions. The questionnaires were completed by the interviewee and the interviewer together. In general both parts of the interview were performed with all interviewees. The only exception is the governmental decision makers, where only the general view was relevant.

3 Main results

The main results from the interviews are given in this paper. Details can be found in the references. The results in the figures are given as the average for each group. *All* is the average of all profession groups except the governmental decision makers.

3.1 Knowledge on ventilation

Nearly all the interviewees have less knowledge on special designed natural ventilation compared to their knowledge on mechanical ventilation in offices, see figure 1. Especially in Belgium, Denmark, Switzerland and Norway the knowledge on special designed natural ventilation is very low compared to the knowledge on mechanical ventilation, see figure 2.

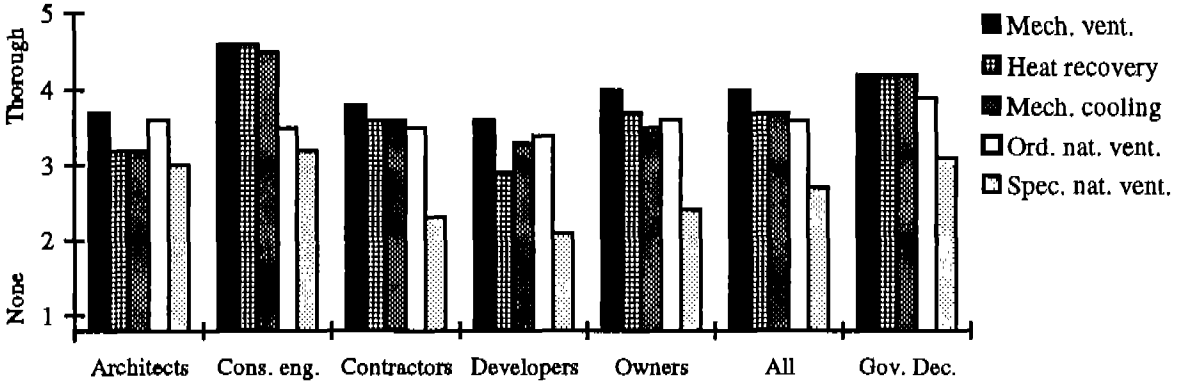

Figure 1. The interviewees' perception of own knowledge, by profession.

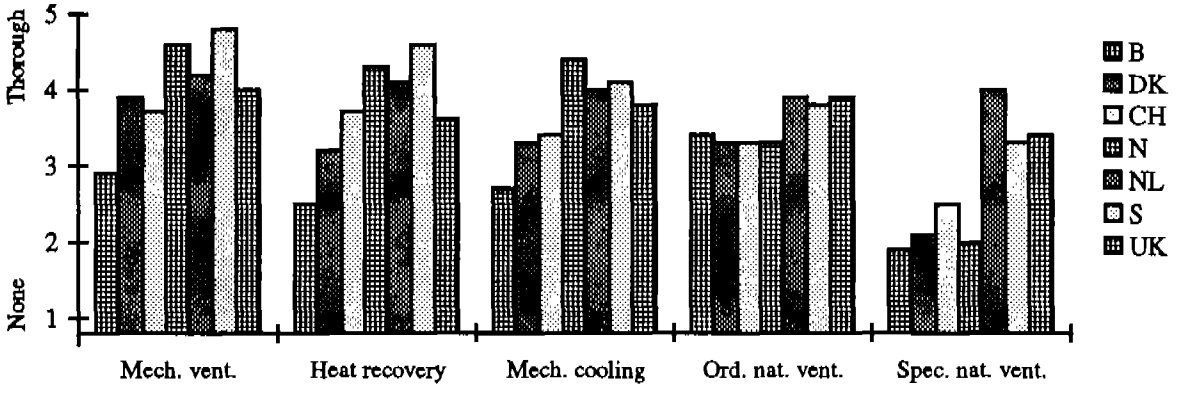

Figure 2. The interviewees' perception of own knowledge, by country

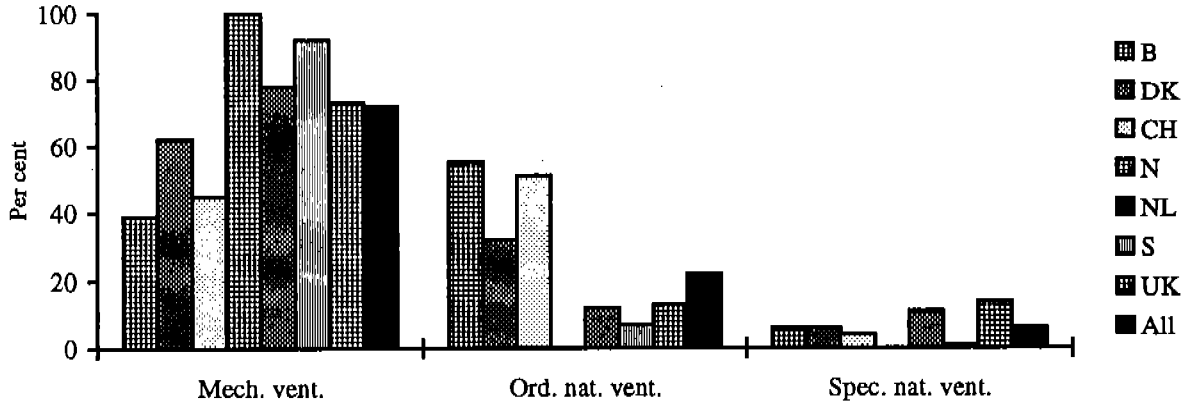

Figure 3. The interviewees' relative experience with mechanical, ordinary and special designed natural ventilation in new offices. The scale is the per cent of offices designed, constructed or owned

On average the interviewees have the same level of knowledge on ordinary natural ventilation as on mechanical ventilation. The exception is the consultant engineers who in general have less knowledge on ordinary natural ventilation compared to their knowledge on mechanical ventilation. The interviewees have indicated their level of knowledge on the five topics based on the knowledge necessary to perform their normal task in the design or decision process. It is therefore not possible to compare the absolute level of knowledge between the professions.

3.2 Experience

Most of the interviewees have much experience on mechanical ventilation in offices, whereas the experience with special designed naturally ventilated offices is very limited, see figure 3. Many of the interviewees have worked with ordinary natural ventilation in office buildings, but the actual number of buildings designed, constructed or owned varies significantly. The exception is Norway where none of the interviewees had designed, constructed or owned an office building with natural ventilation. The experience with ventilation in refurbished offices was about the same as in new offices.

3.3 Source to natural ventilation knowledge

The general opinion among the interviewees is that there is huge lack of good sources to natural ventilation knowledge. The mentioned sources are very sporadic and nearly no specific sources were mentioned by more than one or two of the interviewees.

3.4 Project fee

In many of the countries most architects and consultant engineers are normally paid according to design fee rules of the national Counsel of Practising Architects or Counsel of Consultant Engineers, and with the fee for the detailed design fixed based on a percentage of the estimated construction costs.

3.5 Design

There is no significant difference in the interviewees' perception of the *ease of design* in the four cases: natural ventilation in cellular offices, natural ventilation in open plan offices, mechanical ventilation in cellular offices and mechanical ventilation in open plan offices, see figure 4. Many of the interviewees emphasised that the ease of design also depends on the demands of the indoor climate and on the complexity of the ventilation system.

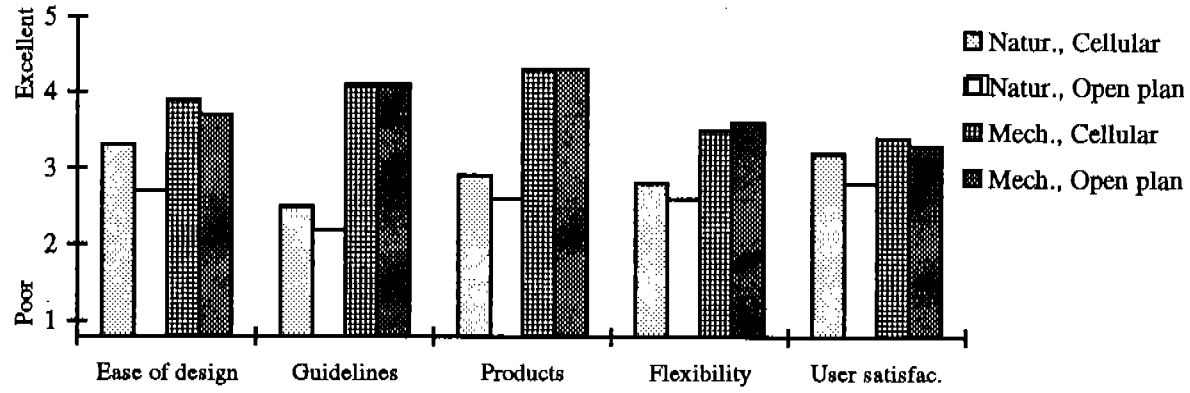

Figure 4. The interviewees' perception of the design of ventilation offices.

Nearly all interviewees found that the availability of design *guidelines* and *products* were better on mechanical ventilation when compared with natural ventilation. The interviewees also expected a higher *flexibility* in mechanical ventilated offices than in natural ventilated offices.

The interviewees expect about the same *user satisfaction* in natural and mechanical ventilated cellular offices. They also expect higher user satisfaction in natural ventilated cellular offices than in natural ventilated open plan offices. If mechanical ventilated the expected user satisfaction is the same in cellular and in open plan offices. It was mentioned that user satisfaction also depends on the expectations, which are normally higher in mechanical ventilated offices.

3.6 Performance in practice

In general the interviewees expect a better performance of mechanical ventilation systems than of natural ventilation systems regarding cooling effectiveness, draught minimisation, ability to remove odours and pollutants, ability to prevent ingress of odours and pollutants and insulation against external noise, see figure 5. Regarding generation or transmission of internal noise the same performance level is expected by natural and mechanical ventilation. Several of the interviewees emphasised that the performance also depends on the design.

3.7 Controllability

In general the interviewees expected a high degree of central controllability of mechanical ventilation systems and a low degree of central controllability of natural ventilation systems especially in cellular offices, see figure 6. The expected degree of local and individual controllability of the ventilation is a little higher in cellular offices than in open plan offices.

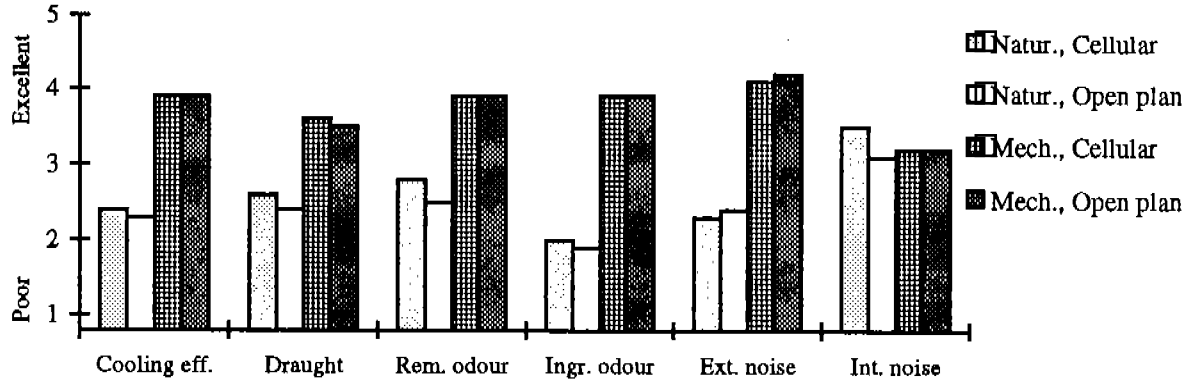

Figure 5. The interviewees' perception of the performance in practice of office ventilation.

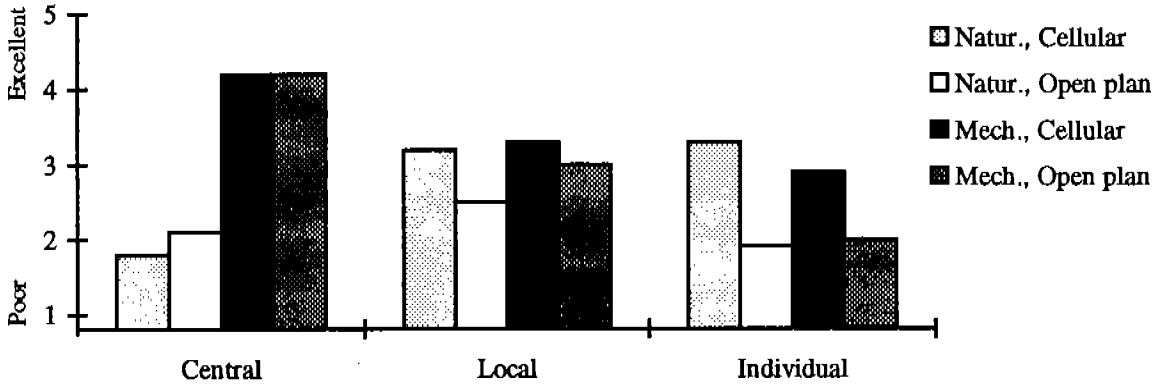

Figure 6. The interviewees' perception of the controllability of office ventilation.

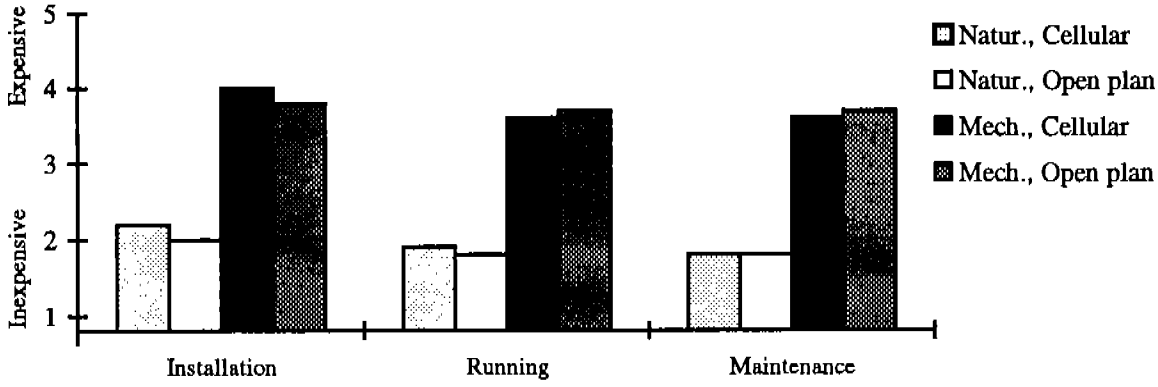

Figure 7. The interviewees' perception of the costs for office ventilation.

3.8 Costs

Most interviewees expect higher installation, higher running and higher maintenance costs for mechanical ventilation systems than for natural ventilation systems, see figure 7. Several of the interviewees emphasised that if mechanical ventilation is installed a perceptible percentage of the total construction costs would be for the mechanical ventilation systems. It was also mentioned that the costs for natural ventilation is high if additional space is required.

3.9 Expected future use of natural ventilation

The architects in general have the highest expectations of an increase in the use of natural ventilation in offices, see figure 8. On average only the governmental decision makers expect a decrease in the use of natural ventilation.

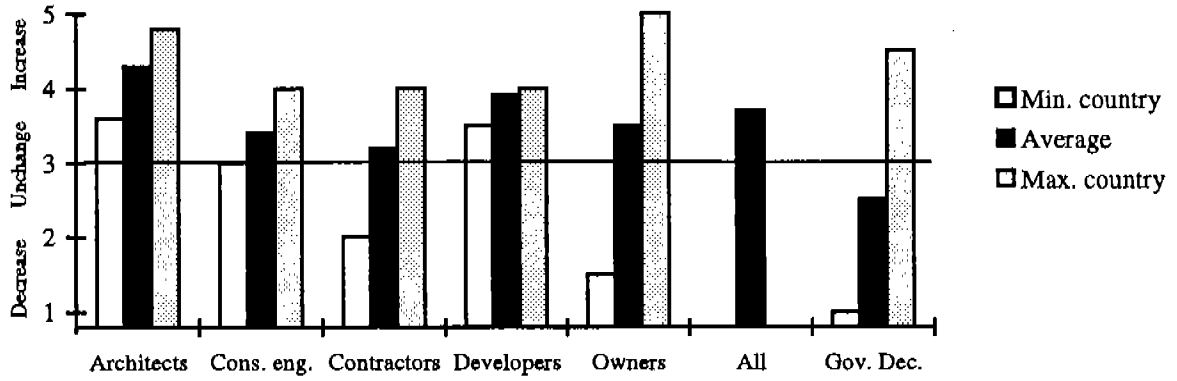

Figure 8. The interviewees' expectations on the future use of natural ventilation in offices.

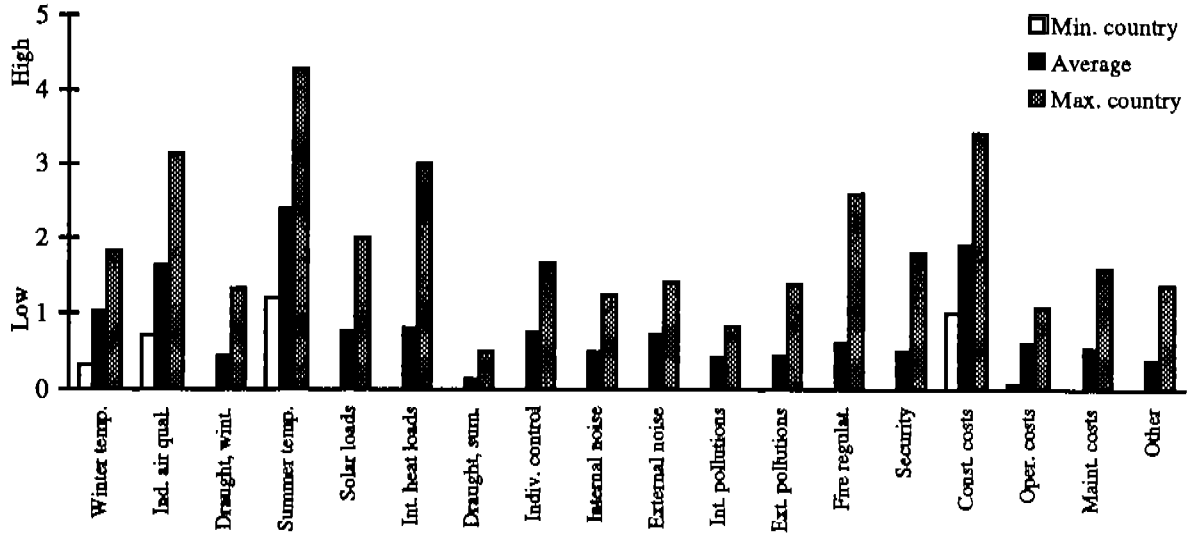

Figure 9. Critical parameters in the design of the buildings.

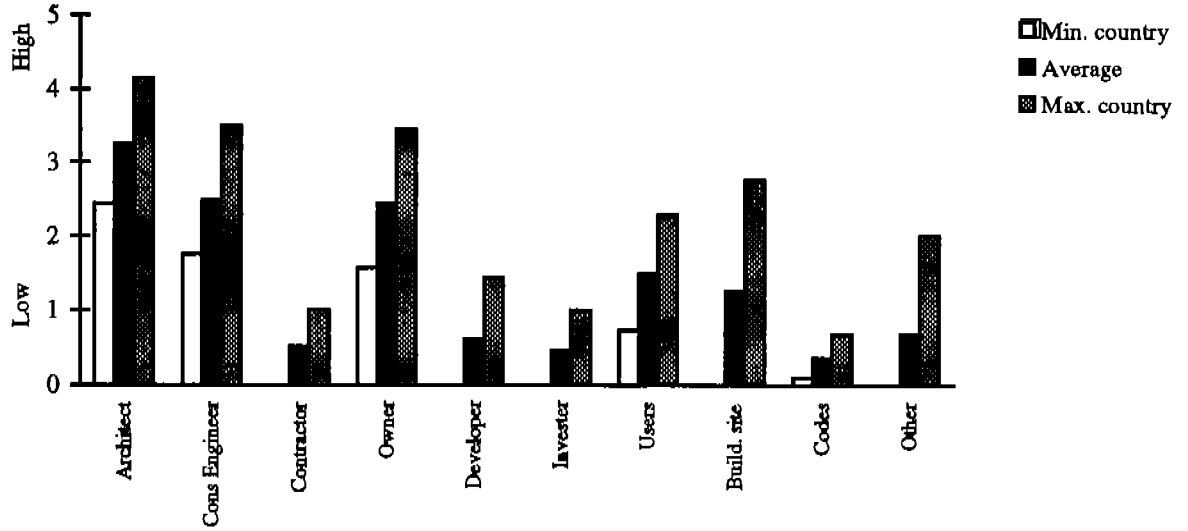

Figure 10. Influence on the design of the buildings.

3.10 Restricting requirements in codes

In Belgium, Norway and Sweden the interviewees perceived significant restrictions in building regulations and standards to the use of natural ventilation. In the other countries restrictions exist but they are perceived to be more limited. The governmental decision makers perceived the restrictions to be much more limited than the rest of the interviewees in a country.

3.11 Critical parameters

The interviewees perceived summer temperature, construction costs and indoor air quality to be the most critical design parameters in specific building projects including buildings with natural ventilation and buildings with mechanical ventilation in the offices, see figure 9.

3.12 Influence

The architects, the consultant engineers and the owners were the ones with the highest influence on the chosen design in the specific building projects, see figure 10.

4. Conclusions

On average the interviewees expect an increase in the future use of natural ventilation in office buildings. In general, the architects have the highest expectation of increasing use of natural ventilation. The interviews also identify significant lack of knowledge and experience of specially designed natural ventilation in office buildings compared to the knowledge and experience of mechanical ventilation. In addition there is a lack of source and information to natural ventilation knowledge in standards, guidelines and building studies. There is also a desire for new design tools on natural ventilation, including also calculation rules and easy to use, simple and advanced computer programmes.

- There is a need for good, standardised and generally acceptable natural ventilation system solutions and for more advanced solutions including heat recovery. In addition, there is a moderate need for new components regarding windows and vents with better air flow and draught performance, better controllability and better design.
- In the interviewees' perception, mechanical ventilation has several advantages compared to natural ventilation with regard to cooling effectiveness, draught minimisation, ability to remove odours and pollutants, ability to prevent ingress of odours and pollutants, insulation against external noise and central controllability, especially if the mechanical ventilation systems are well designed. Nevertheless the interviewees do not expect a higher user satisfaction in mechanical ventilated offices.
- Many interviewees expect higher installation, higher running and higher maintenance costs for mechanical ventilation in offices than for natural ventilation.
- Room temperatures in summer, indoor air quality and construction costs are the most important and critical design parameter. The architects, consultant engineers and owners have the biggest influence on the design of a building.
- Fee structures for design, and the liability of natural ventilation design in relation to lack of calculation rules, standards and guidelines causes problems for the use of natural ventilation in office buildings.
- Restrictions in the use of natural ventilation in office buildings placed by national building regulations and standards are limited, but problems can be caused by fire division requirements, and by guidelines about the need for mechanical ventilation in certain instants.

5. Recommendations

It is possibly, with further and continuing improvement of natural ventilation system concepts, components, controls and design tools, to encourage the wider uptake of natural ventilation in office buildings. This will also accelerate natural ventilation as a main design option in new and refurbished office buildings where good natural ventilation is sufficient to obtain comfortable indoor climate and good air quality with both high user satisfaction and low energy consumption, installation and maintenance costs.

- Simple, energy efficient, low cost natural ventilation system concepts for new and refurbished office buildings have to continue be developed and tested so that the use of natural ventilation in the majority of ordinary office buildings is not a technical and architectural challenge but a simple and well approved design solution.

- Standards and guidelines have to be improved for a better technical and legal background for the design of natural ventilated office buildings. The standards and guidelines should also include generally acceptable, simple and easy to use calculation rules for the design of natural ventilation.
- Simple design tools: diagrams or easy to use computer programmes have to continue to be developed that can be used in the early design process by architects, consultant engineers or design teams to analyse the advantages and disadvantages of different ventilation systems.
- The general knowledge on natural ventilation has to continue to be improved. Among architects, consultant engineers and possibly also contractors, the improved knowledge must come from basic education, post education, source books and building studies. For developers and owners the improved knowledge must be supplied by way of simple, easy to understand descriptions and examples.
- It may also be necessary to adjust the fee structure for the design of office buildings to reward the designers for the energy, indoor climate and total cost advantages of their design solutions and not for the amount of equipment installed in the building.

6. Acknowledgements

This paper is an output from the ***NatVent™*** project which is part funded by the European Commission DGXII within the JOULE programme 1994-1998 and under contract: JOR3-CT95-0022. The work in the project is also funded by national sources in the countries.

7. References

Aggerholm, S.; Bergsøe , N.C..and Tolstrup, A.B. "*NATVENT - Identifying Perceived Barriers to Low-Energy Ventilation Design*" CIBSE/ASHRAE Joint National Conference '96, Harrogate, September 1996.

Aggerholm, S. "*Barriers to Natural Ventilation Design of Office Buildings*" 18th annual AIVC conference: Ventilation and Cooling. Athens, Greece, September 1997.

Aggerholm, S. "*Perceived Barriers to Natural Ventilation Design of Office Buildings. NatVent™ European Report*" Danish Building Research Institute, 1998.

Aggerholm, S. "*Barriers to Natural Ventilation Design of Office Buildings. National Report: Denmark*". Danish Building Research Institute, 1998 (similar national reports from the other participating countries)