Annex 23 Multizone Air Flow Modelling - A New IEA Annex

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As improvements to the thermal efficiency of buildings continue, ventilation and air flow will eventually become the dominant source of heat or cooling loss. Furthermore, in addition to direct energy considerations, the pattern and magnitude of air flow also have important consequences in relation to indoor air quality and comfort. Thus modern design must take into account the provision and distribution of air. However, the diversity of building type, combined with uncertainties over the interaction of behaviour of individual components or systems, means that faults in design can easily occur. Problems including inappropriate tightness of the building shell, duct leakage and insufficient consideration of the internal flow network will all contribute to increased energy use and/or unhealthy buildings. While standards and guidelines addressing such needs would be helpful, very few exist. Even when standards do cover the performance of individual components, the net benefit can be lost by poor building construction or incompatibility between components. It is possibly lack of knowledge in this area, combined with an obvious concern that inadequate ventilation will result in potentially serious indoor air quality problems, that has done much to limit success in controlling the indoor environment and in achieving substantial further reductions in energy use. A clear understanding of the relationships between ventilation rates, air flow patterns and consequential energy and environmental impact would do much to improve the potential for energy efficiency in buildings.

It is this background that motivates much of the air flow related research of the International Energy Agency's Executive Committee on Energy Conservation in Buildings and Community Systems. While considerable effort is being devoted to ensure the full transfer of existing knowledge to both designers and regulators, many uncertainties still exist and hence further work is still needed. One such area relates to numerical models which are not only essential as design tools but are also invaluable in providing an insight into the interaction of different components within a system. Unfortunately, however, although air flow related models have become more widely available over recent years, their reliability and range of applicability have not been adequately evaluated and hence there has to be a doubt over the reliability of results. These types of models are also generally difficult to use, with the result that their application is largely restricted to specialists rather than being available to the general practitioner. In addition, much is often left to the judgment and skills of the user to interpret or understand the results.

IEA Annex 23 has been established in order to attempt to resolve these difficulties in relation to multizone air flow modelling. These models are used to evaluate the air flow between individual rooms or zones as well as the rate of inflow and outflow of air from buildings. This approach is especially important for evaluating the adequacy of ventilation, predicting pollutant transport and evaluating airborne heat transfer between zones. Such models therfore have vital applications in both energy and air quality related analysis.

Initially multizone simulation techniques were confined to mainframe computer systems, Now, however, they are available for operation on "PC" based systems on which quite complex networks can be investigated. This has resulted in wider availability but many still tend to lack "user friendliness". Other problems include lack of suitable input data (eg leakage characteristics of openings and wind pressure values) and inadequate validation through lack of sufficient supporting measurement data. The purpose of Annex 23 is to address all of these points in order to provide a method which may be reliably used for both research and design applications. The annex is divided into three subtasks, these being:-

- Subtask 1: Model Development with User Friendly Front-End
- Subtask 2: Data Acquisition for Model Evaluation
- Subtask 3: Model Evaluation

Subtask 1 is seen as an extension to the COMIS initiative (AIVC Technical Note 29) in which an "Intelligent Simulation Environment" (ISE) is to be developed to assist a user in setting model parameters and developing a flow network. Additional tasks include the incorporation of pollutant transport and demonstrating the coupling of a multizone model with a thermal building simulation model. An outline of the ISE is illustrated in Figure 1. Its essential feature is to couple the user to a model via a series of graphic data input screens. Data is then provided by the user or taken from internal databases. An expert system is also available in order to assist the user in selecting the best information. This task therefore represents an attempt to provide the user with the necessary knowledge and tools to use a model. Essential to this subtask is also the selection or development of an appropriate algorithm for the simulation of multizone air flow.

Modules for incorporation in this algorithm include flow through large openings, single sided flow, and crack flow.

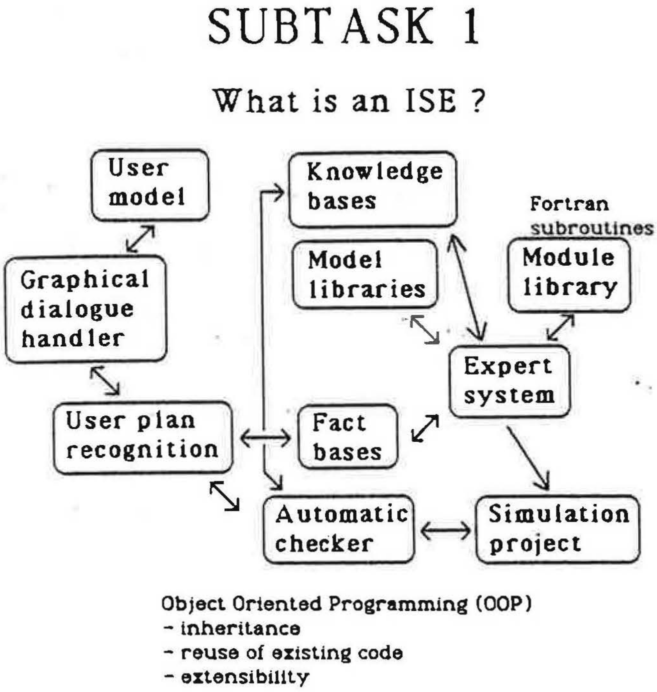

Figure 1: Outline of ISE

Subtask 2 is fundamental for the independent evaluation of multizone models. Its objectives are to identify input requirements, assess the quality or accuracy needed for input data and to obtain appropriate datasets based on these needs. Much data are already available but do not necessarily reflect all the requirements of existing models. Where existing data are used, emphasis will be placed on quality assessment, dealing with missing data items, establishing rules for any interpolation requirements and carefully discriminating between actual measured data and derived values. To support existing data, an extensive measurement programme is envisaged in which clearly defined examples will be selected for analysis. In providing new datasets, emphasis will be directed at clearly defining the objectives of each measurement in the context of evaluation needs, standardising the format of data collection and standardising procedures for estimating errors. It is intended that the experimental programme should include measurements on isolated systems within the laboratory, the use of test cells, field measurements on "simple" buildings of different constructional techniques and field measurements on more complex buildings such as multi-storey office buildings. It is also intended that as wide a range of climatic and exposure conditions as possible be applied. A particular advantage of fulfilling this task by international collaboration is that as well as the sharing of cost, this type of approach enables the widest range of construction, ventilation and climatic conditions to be included within the study.

Subtask 3 is concerned with establishing a protocol for model evaluation. This would be applicable to the evaluation of any multizone technique and hence has applications outside the existing annex by providing usable datasets for general validation purposes. It hence has important value within the AIVC's own Numerical Database for application in future validation studies. The goals of this subtask are to ensure that the model performs according to benchmark criteria, to determine the domain of application and, by means of feedback from the results, improve model performance. Still to be established are the criteria against which a model will be judged. Also, when comparing a model against measurement data, the deviation of the measurement from the physical quantity being measured must be understood. These aspects will therefore form an early part of the subtask. Some of these issues are also currently being addressed by IEA Annex 21 "Thermal Modelling" and consequently it is hoped that valuable input for the benefit of this subtask will be obtained from this particular Annex.

The first formal meeting to discuss the necessary tasks and to set a schedule for undertaking and completing this work was hosted by France in October. An approximate timescale of 12-18 months preparation phase and 24-30 months operational phase was established within an overall 3.5 year time frame. During the forthcoming 6 month period, an operating agent and subtask leaders are to be appointed. It is then hoped that a full start on the project can begin early next year. Initial tasks include establishing the availability of existing algorithms (eg COMIS) and determining the need for additional codes (eg for incorporating special flow mechanisms, pollutant and thermal transport etc). This would take the form of a state of the art review and a survey of public domain simulation codes. Once a general multizone algorithm incorporating the desired features has been compiled, then work can commence on adding the user interface or "Intelligent Simulation Environment". The proposed knowledge or input database will, in part, be based on the comprehensive numerical database being compiled by the AIVC (Air Infiltration Review, Vol. 11, No. 3, June 1990, pp7-8).

This new annex will also draw upon the results of IEA Annex 20 "Air Flow Within Buildings" which has devoted an entire subtask to developing and analysing techniques for the measurement of multizone air flow. These validated techniques will form the basis of future experimental work within Annex 23. In addition, data sets derived from multizone measurements in Annex 20 will provide initial input to the validation exercise.

Organisations interested in contributing to this Annex should contact their IEA Executive Committee Member or, alternatively, contact Martin Liddament at the AIVC who would be pleased to provide further information. The next meeting of this group will take place in April 1991.