BEPAC
Building Environmental Performance Analysis Club

by

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ABSTRACT
This paper summarises the objectives and initial achievements of BEPAC, a recently formed club based in the UK which in many respects parallels the stated goals of IBPSA. The mission of BEPAC is "to improve the quality of building performance by encouraging the use and development of environmental prediction methods for buildings". The intention is to promote an inter-disciplinary approach to the use of prediction methods, and to bring together in one forum all groupings within the construction industry, from academic research, through software developers to designers and building owners and operators.

INTRODUCTION

Modern buildings are becoming increasingly complex, and designed to increasingly tight time and cost constraints. These constraints are imposing additional burdens on designers to come up with solutions which are both energy efficient and provide good environmental quality. It is the BEPAC view that environmental models can make substantial contributions to both the efficiency and the quality of the design process. A number of guiding principles governing the BEPAC mission are worth stating.

(a) The primary concern is with improving the quality of the built environment. Elegant and sophisticated software is of no value in itself. Its only benefit is in making a positive contribution to the quality and cost effectiveness of our buildings. To achieve this, designers need advice on the range of validity of models, and on appropriate data and assumptions for particular applications.

(b) BEPAC is about environmental modelling for buildings in the widest sense of the word. Traditionally, greatest emphasis has been on thermal and energy performance models, but these aspects of a building's behaviour must interact with many other physical processes - lighting, ventilation and air movement, acoustics etc. Consequently, BEPAC is keen to promote the inter-disciplinary nature of building design by bringing together experts from each speciality area to debate common issues.

(c) BEPAC is concerned about promoting the use of appropriate models in the design process. This means that it should not be assumed that the only developments should be in the direction of increasingly detailed and sophisticated simulation models. Complex finite difference models requiring substantial amounts of input data may not be appropriate at the very early stages of design. Equally, steady state methods are not appropriate when the designer is trying to evaluate alternative HVAC control strategies, where the dynamics of the interactions between plant and building response are all important.

(d) BEPAC is very much about building bridges for communication between various groups within the industry. A common experience in the UK is for the designer engrossed in the commercial pressures of putting up buildings to be unaware of the capability of the tools which exist and are available to him. In contrast, the research community can be blissfully ignorant of the real problems which are facing designers on a daily basis. This exchange of information promoted by BEPAC will accelerate the uptake of new technology, and help direct future research efforts.

(e) One of the major problems in the use of environmental models is ensuring that the data input is appropriate to the task in hand. Experience from many fields indicates that model users need as much validation as program codes themselves. Good modellers need to acquire their skill, and one aim of BEPAC is to assist its members develop their expertise by learning from previous experience.

To that end, BEPAC has a major effort on Standards, both in terms of defining benchmark data sets and in collating fundamental data such as thermo-physical properties. The benchmark data sets will contain full

details of typical problems, along with the expected range of answers that might be expected for that particular analysis. This will enable new users of models (or users of new models) to build up confidence in the techniques before applying the tools to real design activities.

BEPAC TASK GROUPS

In order to facilitate the work of BEPAC, a number of task groups have been established. Currently 4 are operational, and a fifth is in the process of being set up. The majority of the task groups have a particular technical focus, but the Standards Task Group aims to address wider issues which cut across all the BEPAC activities. In order to ensure proper communication between the various activities, each Task Group reports to the full BEPAC Steering Committee, which in turn is formally represented on each Task Group. The various Task Groups are now described in turn.

TG 1 - Air Movement

This area has been perceived by BEPAC as being of great importance. Although thermal simulation techniques have progressed significantly over the last 15 years or so, convective heat exchanges around and within the building are often modelled very crudely. This heat transfer mechanism is also becoming increasingly dominant, with the moves to increased insulation standards, and the wide scale adoption of such features as atria in commercial buildings. Of equal importance is the great impact effective ventilation has on air quality and occupant health and comfort.

In keeping with BEPAC's aims of identifying different categories of model for different applications tasks, TG1 has sub-divided air movement models into 3 main classes -

(a) Simplified models such as air change rate and regression models based on overall leakage and climate parameters.

(b) Zonal (or multi-cell) methods which solve the mass balance equations for a network of inter-connected flow paths subject to the combined influence of wind, stack and mechanical ventilation.

(c) Field methods based on the numerical solution of the fundamental Navier-Stokes equations.

The task group's aim is to try and bring coherence to a field of endeavour which is relatively new to building physicists. As in all modelling work, there is a need to give insights into the balance between accuracy and economy of the alternative approaches. This will be achieved by attempting to catalogue existing algorithms/models, and to identify their perceived strengths and weaknesses. This will be supported by a number of state-of-the-art reviews, which will also draw on the experience of the wider computational fluid dynamics community.

TG2 - Controls

It is increasingly being recognised that controls are perhaps the key feature in determining the way in which a building will behave in terms of both energy efficiency and occupant comfort. The best designed building with the most efficient HVAC components will not perform well if the controls are poorly specified or installed incorrectly. Further, to many engineers, controls are black boxes which are incorporated into a design without proper understanding of their function. TG2 will therefore promote an increasing dialogue between the building services engineers and the control specialists to ensure that controls become an integral part of the building design.

Another important role for the Task Group is to promote a standardization of control algorithms at different levels of accuracy for control performance prediction. Such developments may well provide the basis for the control algorithms for the BEMS systems of the future.

TG3 - Lighting

Lighting is another area in which there are very strong impacts on both energy and user acceptance of building designs. In energy terms, lighting can have a double impact in electrical costs, firstly for the lighting itself, and then the knock-on effect of fridge plant to remove excess heat. This combined effect is further exacerbated by the combination of high prices for the energy source (electricity) and the cost implications of maximum demand tariffs.

The other major problem with lighting is to find a means to translate visual performance into terms which can be quantified for design analysis methods. This highlights the inter-disciplinary nature of BEPAC's aspirations; to help promote the development of design tools which use quantifiable and predictable parameters, but which relate to indicators of visual quality which the designer develops by "feel" and experience. If this can be achieved, it will be a much easier task to lead lighting designers down the avenue of exploring energy efficiency as well as aesthetic appeal. In order to optimise this dialogue between the

designers and the "simulators", TG3 will try and convene its meetings in buildings which are generally accepted as being good examples of the lighting designers skills. This will provide an immediate and very real context for the discussions in hand.

TG4 - Standards

This task group has a very wide brief which will take many years to complete (if indeed it is ever fully achievable!). The objectives include

(a) procedures for evaluating models

(b) guidelines for improved user interfaces

(c) Reference input data sets (material properties, occupancy schedules etc)

(d) Standardized pro-formas for documenting the theory and algorithms used by a given model.

(e) Developing detailed specifications of a number of standard buildings which can be used as references in assessing new models, or to assist new users of models build up confidence in their ability to use their newly acquired facilities.

The reference data sets will be invaluable in promoting greater consistency in the application of models, and helping model users to better understand each others work. For example, when modelling a house, the assumed occupancy and heating schedules will have a significant impact on the predicted result. Equally there is no "unique" set of schedules which can be fixed for all time and all circumstances. However there is much to be said for defining a commonly accepted set of default schedules which can then be referenced by a simple code rather than detailed specification with the consequent possibilities of misunderstanding and / or input error.

Some form of guidance on material properties will also be very beneficial. The "standard" UK reference book for material properties gives a variation in the thermal conductivity of "brick" ranging from 0.48-0.96 $W/m^{o}K$. Clearly the users choice from this range will substantially affect his predictions of building performance. A best practice statement on this sort of issue would be of enormous benefit in improving the consistency and credibility of environmental prediction methods.

TG5 - Acoustics

This task group is in the process of being formed, and so little can be reported on its progress to date. However it is anticipated that its terms of reference will be similar to the other task groups, namely to -

(a) catalogue existing design procedures and models

(b) to promote exchange of information and needs between research and practice

(c) to bring the debate on developments in acoustics into the wider context of building performance as a whole.

INTERACTION WITH OTHER GROUPS

It is recognised that BEPAC with its limited membership (currently just over 100) and its modest budget cannot hope to achieve all its objectives through its own efforts. Perhaps its greatest role is to provide a clearing house for information being created by other active groups, and ensuring that all BEPAC members are kept fully briefed on these issues.

One of BEPAC's current tasks is to create a matrix of organisations who are active in the field of environmental modelling for buildings, and to ensure that as far as possible, BEPAC has links with those organisations through one of its members. It is obviously impractical to ensure such links exist with every individual research institute, design practice etc. However it is more practical to try and ensure a link exists between the sponsors of research projects and professional organisations which bring practitioners together in some way.

Although BEPAC is constituted in the UK, it recognises that many of the problems facing BEPAC are common to other countries. There is the strong desire to promote dialogue with groups in other countries, hence the involvement in this IBPSA sponsored international conference.

BEPAC's PRODUCTS

As mentioned above, one of BEPAC's main ambitions is to keep its members fully informed of relevant developments in the field. To this end, BEPAC produces a regular newsletter and sponsors meetings which aims to bring the membership together to exchange ideas and experiences. In addition, BEPAC will be publishing a number of more detailed technical reports based on the work of its Task Groups.

CONCLUSION

Although Building Simulation 89 is a technical conference, we make no apology for presenting a non-technical paper. Science is only good science if someday it will be applied in practice. The aim of BEPAC is to try and ensure that the best brains in our community can be directed towards work which will have real impact on improving the design process. Equally, we must encourage designers to take up these new developments quickly. This will only happen if we have been able to convince them of the relevance and value of the tools we can provide.

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This paper has been presented on behalf of the BEPAC Steering Committee in the author's capacity as the current chairman. Although the paper attempts to state the aims and objectives of BEPAC, the views expressed are a personal reflection of the author.