Report for session 10:

Synthesis

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Introduction

The following notes were produced "on line", during the conference. A minimum of corrections and additions were a posteriori introduced, in order to make the text readable. But no attempt was made to "soften" the comments.
Such a report should , in no case, be considered as exhaustive, neither reflecting any consensus. It is nothing more than a set of subjective impressions collected by the author, along the nine previous technical sessions, after having read the corresponding reports (references 1 to 9).

Session 1 : Indoor Environment

Several questions were raised by the Rapporteur of this session about comfort criteria, standards and measuring techniques.
One of these questions is how to resolve the discrepancies between standards and field studies.
Responsibilities are shared by (too) many partners: architects, HVAC engineers, managers,... and occupants! If uncle Karl had attended the discussion, he would have found that there is still too much "work partitioning" in building story! Too often, we hear that "it doesn't matter, because somebody else will pay the bill...".
How to make building occupant happy? That is the question...
Some matters as relationship between Air Quality and human productivity deserve to be studied. Air Quality instruments should be cost effective!
Somebody said that engineering is not as famous as producing movies. It is true, and HVAC is surely not among the most prestigious engineering domains. We don't expect to meet very soon a customer speaking about HVAC in positive terms. Usually, the best we can get is that building occupants don't speak at all about HVAC...

HVAC engineers (as other ones) have to accept the fact that a lot of problems are NOT technical: we do have the technology, the information, the standards, etc...but we don't know how to convince the people to look at long term...
Listening to some of the questions raised about thermal comfort criteria, I also asked myself how to make a little more search than research. That's the danger with a too old Rapporteur: he has the impression of having already heard the same story before...
Let's try to fix better the "good" information we already have and go further in the applications...

Session 2 : HVAC Applications in Domestic, Industrial and Agricultural Buildings

The subdivision between sessions 2 and 3 ("non-commercial" and "commercial" buildings) is, of course, very arbitrary and many of the questions raised are not session-specific.
The Rapporteur claimed, among others, that "active" and "passive" HVAC measures should be combined together. He also observed that the "AC" part of HVAC is too often limited to the "C" (cooling).
It is true that moisture control is very often forgotten. This makes ambiguous the comparison between active and passive techniques. This ambiguity is typical when talking about "passive" (if not "exotic") ways of cooling the indoor environment...

We all have the dream of a global building design, supported by a global life cycle cost analysis, with caution to indoor environment, to energy management and to outside environmental protection!

One of the frustrations expressed by the Rapporteur as well as by other participants is that so few papers are dealing with cost analysis at very first stage of building design process! One of the difficulties is coming from the very temporary cooperation among the many partners involved in the building story. How could we have them trusting each other and cooperating effectively?
Too little attention is paid until now in Europe to building cooling techniques. Cooling has been almost ignored in most important Energy research and development programs... But the cooling demand is now quickly growing almost everywhere and many practical questions (about real comfort, energy and economics) stay unanswered.

How to deal with cooling in dwellings? How far is it possible to go with night cooling? What is the real price of "free" cooling? What are the real effects of such (semi)passive technique on energy consumption and on moisture control?

Let's accept the following fact: even in "temperate" climates, a lot of buildings (including dwellings) could not stay comfortable all along the year without some cooling. Ignoring it will not prevent building occupants to try to resolve their problem in their own way. But what will be the global impact of these individual solutions on energy use and environment?
In Europe, it is time to work on new standards, dealing with cooling loads calculations. This is a good matter of international cooperation: it is easier to agree on the way to calculate a requirement than on the way to satisfy it.
The discussion we had at the end of the session about the interest of reversible heat pumps (in relationship with the way of producing electricity: proportion of hydroelectricity etc.) illustrates the difficulty of comparing specific solution's at international level...

Session 3 : HVAC Applications in Commercial Buildings

For various reasons (occupancy density, internal loads, work constraints, customers requirement, prestige,...) these buildings are usually equipped with most advanced HVAC systems. "Building Energy Management Systems" (BEMS) are also more and more common in these buildings.
But one tentation we should resist, is to relate to the BEMS only, when having to monitor the system: it is a bit risky to ask a BEMS to monitor itself and even more to monitor the whole system when the BEMS has a problem!

As stated by the Rapporteur, simulation is in progress, but how much is it giving at different stages of building life cycle (BLC)?

Each one is asked to make an effort to promote a better use of simulation tools: manufacturers have to make more appropriate data available, scientists have to develop more "friendly" models and designers have to use simulation tools sooner in their design process...

BEMS evaluation is obviously still a hot point of discussion. BEMS is not a magical solution: it will not resolve problems raised by a wrong design of the building-HVAC system. But the BEMS contribution should be taken in consideration early enough in the design process (it should affect the early choices, the HVAC equipment selection and sizing, etc.).And it is impossible to promote a better BEMS use without talking again about one step of the BLC which has been almost "forgotten" (or "underscored") in these last years: the Commissioning.

I have to confess that I needed nearly thirty years to discover the real importance of Commissioning. Building and HVAC Commissioning is a unique opportunity of providing the designers, equipment producers and installers with some feedback about the quality of their work and about the real meaning of their work hypotheses. It is also a unique opportunity to tune a lot of practical information provided to the building manager (up-date the "As-Built" files).
It is, at the end, the only one way to establish a safe reference for further fault detection and diagnosis analysis.

BEMS will help a lot in developing continuous HVAC commissioning...if having been included itself in the initial commissioning!
This may look as obvious, but it is also more and more obvious that we should not trust BEMS sensors if not having them carefully commissioned.
Exhaustive commissioning takes time and money, but short-circuiting costs much more in long term.
And quantity will never replace quality: multiplying measuring points will not compensate their individual inaccuracies...

Session 4 : Energy, Environment and Economics

The Rapporteur helps us to stay optimistic: he observes the following positive points in the papers presented:

1. Increasing concern for environmental and economic implications in energy technology research;
2. Opportunities of combining energy savings with environmental protection and with creation of new jobs (for example renovation of heating plants);
3. Better understanding of interactions among HVAC energy use, chemical emissions and atmospheric warming.

But he also recommends political actions as well as further research on these complex interactions, mainly between energy savings and environmental protection.

Everybody agrees that energy, environment and economics need to be addressed simultaneously...but from where will come the motivations?
From legislation? From incentives? From penalties? Or from fashion?...

Session 5 : Control

"Control" is here understood in a broad sense: it includes various control levels (from "lower level" control to "upper level" energy management) as well as fault detection and diagnosis (FDD).

The Rapporteur provocates thinking on three topics:

1. Practical use of Physical Models;
2. Tuning of Control and FDD functions;
3. Choice among different levels of complexity for control and FDD functions.

Provocative statements (selected from the paper of the Rapporteur):

1. More research should be done on the practical use of physical models with focus on easy parameter identification and on data base maintenance all along BLC;
2. Easy tuning is more important than (hypothetical) performances of Control and FDD functions;
3. Functions developments should be much more user-oriented, i.e. with caution to all steps of BLC, including engineering, commissioning, tuning, operations and services,...

The discussion confirms that it is not yet obvious how to make a rational choice between physical and black box models.
Physical models can be generated at design stage, but they need parameter identification (there is no shame in ignoring their real characteristics!). The question is if we are ready to pay the real price for setting up physical models...
Another question is: "Does it matter if practitioners don't understand the operation ? (Back to what Karl called "work partitioning"?).
The effect of modeling and measuring errors is another point of concern: at least we have to know which errors are the biggest. We must recognize the fact that measuring errors do limit performances of fault detection schemes...

Session 6 : Refrigeration

There is a serious need for HVAC engineers to find their way in the very complex "refrigerants story". We should better say "refrigerants saga", because it is obviously not yet ended!
At least, the Rapporteur confirms us that R134a is, at present time, the best substitute for R12 (except in Germany ?) and that only mixtures could replace today R22.
In fact, a lot of usable mixtures already exist, but they are not very popular, may be because their use requires some learning...
Zeotropic mixings might provide some COP increase, thanks to smaller temperature differences across condenser and evaporator.
The real future of other refrigerants is still very uncertain; HC have great advantages, except for their flammability, and CO2 looks as a valuable candidate for some applications as car air conditioning (if we accept to go to much higher pressures).
There is still some reluctance in US and in Europe to use HC and NH3. But a lot of equipment is already installed (in Germany) and enormous progress was made in reducing the charge of NH3.
At the end, NH3 is a very safe refrigerant...
One crucial problem is the too early HFC's phase out date in European countries: there is no time enough for serious experiment and new compressors are not yet available. Europeans are not playing with HC, just for fun!
Anyway, it seems that more attention should be paid to "indirect" environmental impact of refrigerants in the future: we are having smaller and smaller "direct" impact thanks to less aggressive refrigerants, to tighter installation, with smaller charge,...but what about CO2 production at power plants?
Absorption machines might also come back, combined with cogeneration: using waste heat is, at the end, the only one rational solution!
Various sorts of combinations should be considered: in supermarkets for example, it seems interesting to combine AC with R and ice storage, in order to have smaller chillers with smaller refrigerant charge. It seems also interesting to "play" with different levels of temperatures: for example with two levels, when having a cooled ceiling combined with air dehumidifier.
Water could even be a satisfactory refrigerant for such application...
In short, let's say that "R" and "AC" have to work hand in hand ...

Session 7 : Building Physics

The Rapporteur claims that building physics and HVAC are different things and that they should be complementary. Should be, but...
We know that poor understanding of building physics increases dramatically "H" and "C" demands. We also know that crucial options are already taken at early design stages. After that, it's too late,...but there is a lack of research effort at that level. Too much attention is paid at latter stages!
"Performance" is a concept which should be continuously accessible from early design until experimental verifications.
And, by the way, even with the most sophisticated models, experiment stays necessary: even small defaults may have important consequences which couldn't be predicted by theoretical models !...

Session 8 : Experimental Methods and Model Validation

"Validation" shouldn't be considered as a magic word...As observed by the Rapporteur, too few papers are presenting real validation; most of them are dealing with modeling only.
In fact, before starting developing a model, it would be good to know:
-why we do it;
-what we are looking for;
-which information we are supposed to have in hand;
-and if there is any hope to validate anything.

Successful validation requires very clear definition of all inputs (all what is supposed to be known) and also of experimental accuracy. I know this looks obvious. At least let's accept the fact that a lot of things are true,...but will never be validated!

We should also distinguish better validation from calibration and model validation from design validation...
Two good advises to any validation candidate:
1)Don't make any experiment outside your lab and you will sleep better;
2)Watch carefully space and time variations of all variables you are playing with (wind is one of the most difficult variables to handle !).

It is today suggested to reserve "physical" models for component design and "grey" or "black" boxes for almost all stages of building life cycle...
My personal impression is that this choice would deserve much deeper discussion: detailed physical models could help a lot in commissioning, fault detection and diagnosis.
Simultaneous use of different modeling levels is welcome, when having to deal with monitoring of large energy systems.
Calculation is cheaper and cheaper, but measurement is more and more expensive. This justifies an extensive use of all calculation tools available...

Room air flow models are still best sellers...but they are also still generating a lot of questions:

-What to choose: CFD or lumped models?
-Could the models be used in the future to generate simple rules, usable at early design stages?...etc.
Documentation and validation of these models stay very necessary...
At least at present stage, when dealing with air diffusion problems, it's good to "keep a look" on the general air flow pattern (identify the jet trajectory). It might be also interesting to use CFD in order to generate lumped models, usable at different stages of the project.
By the way, after more than 30 years CFD is used by engineers, it's time to tell what we really expect from it!
Of course such question shouldn't be reserved to CFD: all models are challenged.
We should demonstrate we are not developing models only for our own intellectual satisfaction...

Session 9 : Modeling, Simulation Softwares and Applications

As for sessions 2 and 3, the splitting between 8 and 9 is a bit arbitrary. Questions raised by the Rapporteur are also related to the previous session:
-Why are we continuing to produce new models?
-Is there still a market for simplified models?
-Why using neural network models in place of other models ?
-Why aren't we combining lighting and thermal loads calculations (that makes a long time, we know we should...)?
etc...
Powerful simulations are possible today, in fictitious and real time, but bottle necks are located in the modeling, and also in the data management.
A lot of questions stay unanswered about fundamental data to be used in the simulation: heat and mass transfer correlations, etc. But the most urgent need is probably to orient simulation tools developments towards real user needs: we should have started from the actual practice!
Only in some (exceptional ?) cases, the software developers went to visit practitioners to discover their current work, before starting new development work.
Again here (as would have said uncle Karl) we have to fight against the "work partitioning": avoid keeping computer people isolated from practitioners...
Model complexity has to be adapted to the level of knowledge at each design stage and simplified tools must be derived from reference ones.
New modeling languages are under development; they may help for information exchanges.
But information is not the all of it: we need safe tools. It's urgent to agree on a certification procedure, before organizing the distribution of the models.

Some general conclusions

It is in the nature of such a "big" conference to generate a lot of frustrations: the domain concerned is too large and the participants expertises are too much dispersed.

Building business is a "carrefour" of (in)competencies:

A lot of regulations, standards, specifications, hypotheses, calculation methods are referred without common understanding among all partners concerned!
There also remains an important gap between research and current practice. Some CLIMA 2000 participants will say there are not enough practical results presented. Other ones would like to get more scientifical information.
Every specialist finds his own specialty as too poorly represented...

At least most of the partners concerned had here the opportunity to meet each other and to improve their mutual understanding. I feel this as the most urgent: having already in hands a lot of technical information, we should make it easier to be understood by all partners (and not only by specialists).
Better than rushing sometime towards very exotic solutions, we should make easier a correct use of the "classical" ones.

Let's try to (re)establish mutual confidence among all building partners.

Whatever could be our assumptions about the future (energy costs, environmental impact, etc.) and better than arbitrary promoting hypothetical 'solutions", let's cooperate in developing the tools (calculation methods, data bases, measuring techniques) which will make possible a rational choice among the many technical options already available...

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