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The Next Challenges Ahead: Design Integration and Robustness

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After more than 4 weeks of strong heat and drought, the thermometer in Iowa stood still at 106 degree Fahrenheit for three days last week. In addition, night temperatures did not drop below 80 degrees Fahrenheit, which was considered a record for that particular day in July. The corn was already considered ruined, no rain in sight. Relieve came with a torrential thunder storm, but it also brought along a power outage of 4 hours, which caused the outage of most electrical systems including air conditioning. There have always been weather extremes and power outages, but let me take this as a starting point to discuss the next challenges ahead in the goal to achieve more energy efficient buildings. When the power goes out, there is usually no internet, thus no smart controls, no refrigeration, thus no cooling or air conditioning, no electrical light, thus no activity and no telephone, thus no communication. These are all systems we heavily rely on, especially in buildings, which are designed for optimum thermal comfort control, where windows cannot be opened and spaces are often not sufficiently day-lit. About 70% of the US electricity is somehow consumed in buildings. Sustainable buildings demand a holistic approach towards the design of space, envelope, and active and passive environmental control systems; the construction materials and occupational behavior. A complex relationship exists between building orientation, spatial composition, building fabric, and thermal and climatic conditions. Spaces enhance convection to distribute passive solar heat gained from south-facing windows and natural ventilation for cooling and indoor air quality. Progress in design towards zero-energy construction requires a combination of innovative building design, high performance building envelopes, the incorporation of renewable energy technologies, and last but not least the understanding of human behavior relative to energy decision making. But how do we get there?

Today the 2nd International Conference on Building Energy and the Environment COBBE organized at the University of Colorado in Boulder closed after 177 papers from 20 countries were presented. The majority of papers came from China and the USA, but also researchers from the UK, Germany and many other countries across the globe shared their research outcomes related to energy use in buildings and their environmental impacts. There is a lot of very interesting and promising research. The projects large and small are engaged in the implementation of new strategies and monitoring results or the mitigation of overheating, testing of innovative materials, development of assessment tools and methods, new simulation tools and simulation results as well as thermal comfort studies. What is encouraging is, that there are more and more new buildings and retrofitted buildings in operation, which can act as case studies and successes and failures of various strategies can be studied. Some building energy related research is focused on testing the performance pattern of a specific new material or system, like phase change material or comparison of a selection of heat exchangers. Other studies address the larger urban scale in the attempt to mitigate heat island effect in a warming climate. There also seems to be a new focus in a good portion of the papers, which addresses energy efficient retrofits in various countries and research, which attempts to understand the need to integrate occupant behavior into the energy performance assessment. Another highly complex topic is considered in the need to better understand and optimize the controls of buildings systems, passive as well as active and the dynamic interaction of these various new and existing systems and strategies. The progress in research is encouraging, but market penetration is still very slow, even in countries with a much stronger government mandate than the US, like Germany for example. The number one major barrier mentioned in many research papers is first cost, followed by too long payback periods, lack of knowledge in the real estate community about actual benefits and lack of incentives. It also seems that some of the important decision making stakeholders in the process are often missing from the conversation: the architects, clients and users.

Reducing energy demand by design leads to a whole building approach and demands collaboration among all professions involved in the design and construction process, but yet, where were the architects, designers urban planners in this conference or in many other conferences with similar topics and concerns? Some were in attendance, but we were certainly in the minority. Unfortunately it is still not common, that architects participate in building energy related research in many countries. It is an engineering field, an architectural engineering field at best. But over 50% of decisions in the process are directly linked to architectural design, for example the size of windows, shading strategies and of course building layout and orientation are still considered the number one driver of energy consumption during the operation. And architects need open minded team players to develop efficient strategies. Thus, in order to really develop a design with lowest energy consumption prediction, architects, engineers, economists and possibly even psychologists all will need to integrate their knowledge into the design process as early as possible in order to develop an integrative design process. Thus future challenges are the most complex ones ahead: We jointly need to better understand what it takes to develop a holistic building –systems-user -design integration approach, which accounts for sometimes irrational occupant behavior, possibly in the way of smart controls, but smart enough to empowers the users, rather than taking over from them. But the major goal should be to design buildings, which can be robust enough to deal with future power outages and a warming climate.

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