The Cambridge-MIT Partnership Programme

Natural Ventilation Solar Heating and Integrated Low-Energy Building Design

Buildings consume about 40% of all the energy used in the UK through heating, air-conditioning, lighting and ancillary equipment such as computers. Reducing the energy consumption of our built environment is vital if the UK is to meet its Kyoto emissions targets. That is why the Cambridge-MIT Institute set up a project to design buildings that consume less energy.

The Challenge

Their work focuses on the design of energy efficient buildings that use natural ventilation processes, solar power, and improved building materials to achieve their goals in a natural, efficient, and sustainable manner.

The Outcomes

The project has drawn together experts involved in architectural design, building engineering, natural ventilation processes, as well as those involved in building environmental safety. Through a combination of complimentary fundamental research, and a joint design project for a specific building, the project has helped to build the foundations of a new discipline of integrated low-energy building design.

In Cambridge, research was conducted at the BP Institute - which was set up in 1999 with an endowment from BP to research some of the fundamental scientific challenges that the oil industry encounters. In the CMI project, the researchers have used their expertise in fluid mechanics and modelled real buildings by using the flow of water through scale models to estimate the flow of air through full size buildings. In the laboratory, small-scale model buildings are immersed in a water bath and currents of dye-coloured hot and cold water are pumped through them at different speeds to simulate the flow of hot and cold air through a building. The researchers film and study the results, and use their findings to develop models and control strategies for natural ventilation flows.

At MIT, the research team has developed accurate computer techniques to predict natural ventilation flow in buildings. These have been used in conjunction with the water studies done at Cambridge and the experimental results from actual buildings.

The team of researchers has now spun out a company called E-Stack to commercialise technology they invented. The researchers have been backed by a new commercialisation grant from BP – which has been funding the research since 2001.

The team has already contributed to the design of a sustainable, low-energy building in central London – University College London's School of Slavonic and East European Studies. The team is currently trialling the E-Stack prototype in a number of schools, where air quality has been shown to be a surprisingly significant factor in students' well being. There are plans to incorporate the technology in a planned new energy-efficient office building for 1,600 BP staff in Aberdeen, Scotland.

As a result of the work contributed to by this project we now know the amount of carbon dioxide emissions from a well-designed, naturally ventilated building can be as much as half that of an air-conditioned building. Results show that naturally ventilated office buildings produce 40-70 kg of carbon dioxide per square metre per year, while standard air-conditioned office buildings produce 80-160 kg of carbon dioxide per square metre per year. In addition, naturally ventilated buildings are much more healthy and pleasant to

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Much of the knowledge gained through this research has been encapsulated in a design tool for architects to estimate the opportunity for using green building technologies. This tool can be found on **http://designadvisor.mit.edu/design/**

Ongoing Activities

The team is now trialling the E-Stack prototype in a number of schools and planning to incorporate their technology in a planned new energy-efficient office building in Aberdeen. MIT is developing a computerised design tool that allows architects to visualise the air flow and estimate the comfort conditions in complex multistorey buildings under the combined action of wind and buoyancy forces.

The Future

E-Stack Limited will disseminate the tools and techniques developed in the course of this project. It will take time for this technology to become prevalent as new buildings come on stream, but there is real potential that the technologies and techniques developed through this research will have an appreciable effect on carbon emissions in the medium to long term.

The greatest impact opportunity is in developing countries, such as China, where new buildings are being constructed at a rate far in excess of the level of development in developed countries, and where energy is relatively expensive.

More Information

For further information, please visit the **Natural Ventilation project pages (BP Institute)** and the **E-Stack** websites.

The principal investigors for this project were:

- Prof L Glicksman, Department of Architecture and Department of Mechanical Engineering, MIT
- Dr K Steemers, Department of Architecture, University of Cambridge
- Prof A Woods, BP Institute for Multiphase Flow, University of Cambridge

BP has invested £2.5 million in the five-year project on integrated low-energy building design. BP's choice of project reflects the concern for minimizing the consumption of energy and production of greenhouse gases whilst maintaining a comfortable and healthy environment within buildings

Last updated: 07/07/08