

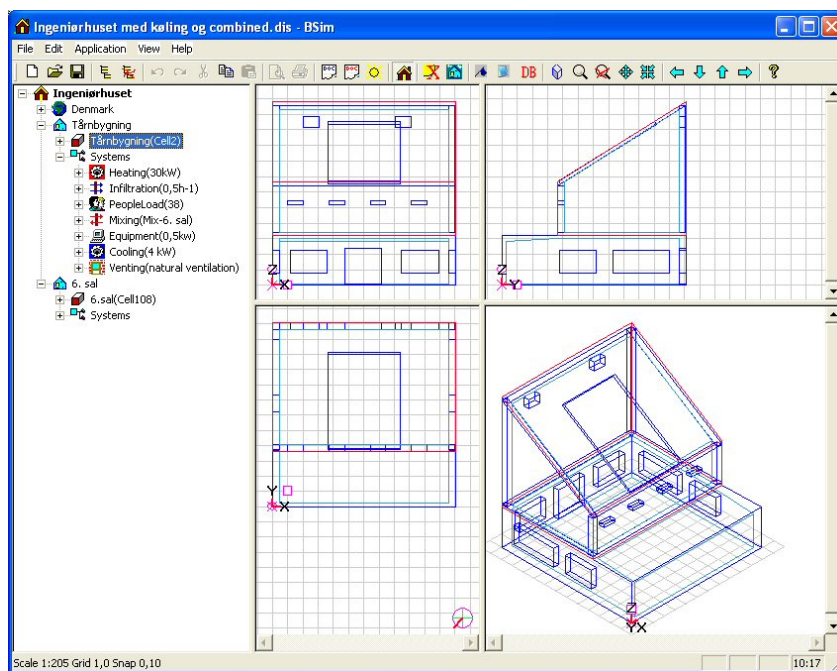


# INTEGRATION OF A MULTIZONE AIRFLOW MODEL INTO A THERMAL SIMULATION PROGRAM

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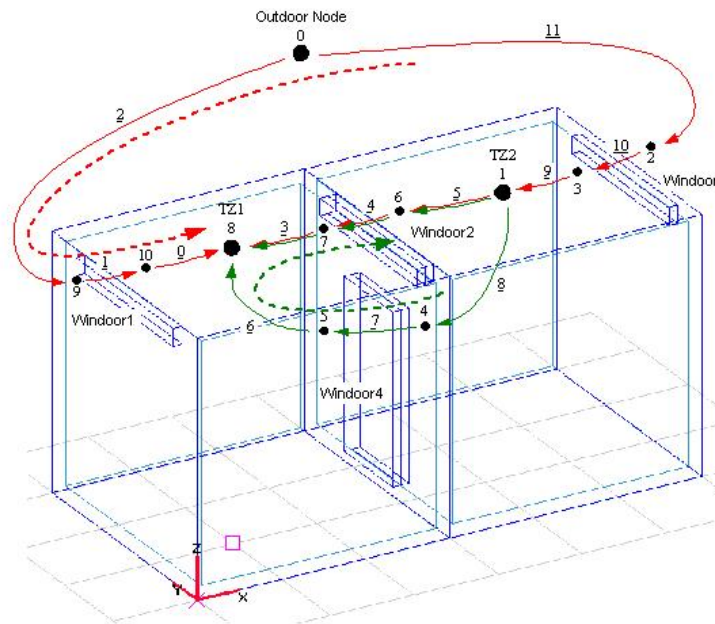


# Thermal simulation program, *BSim*



- Model editor
- Analyses of solar distribution and shadows in and around buildings
- Thermal simulations, and synchronous calculation of transient hygrothermal conditions
- Estimation of the daylight conditions
- Calculation of the potential electrical production from building integrated PV-systems
- Life Cycle Assessment

# Multizone Airflow Model



- In water distribution network loop equations have been widely used
- Loop equations methods
- Establishing the independent loops is based on graph theory
- Conservation of mass (thermal zones)

$$\sum \dot{m}_{in} - \sum \dot{m}_{out} = \dot{m}_{mech,removed} - \dot{m}_{mech,supplied}$$

- Conservation of energy (loops)

$$\Delta P_{loss} = \Delta P_{buoyancy} + \Delta P_{wind} = \sum c_i$$

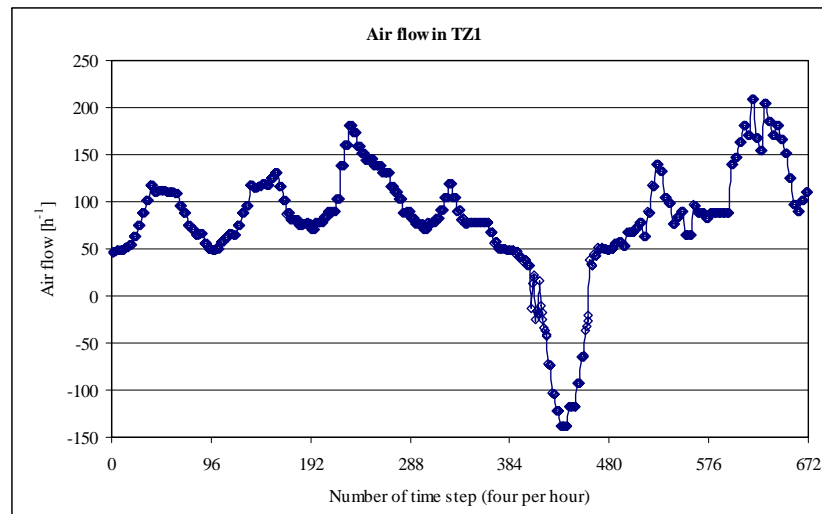
- Solving the equation system

$$\begin{pmatrix} c_1 & -c_4 & 0 & -c_{10} \\ 0 & -c_4 & c_7 & 0 \\ \rho_{out} & \rho_{TZ1} & \rho_{TZ2} & 0 \\ 0 & -\rho_{TZ1} & -\rho_{TZ2} & \rho_{out} \end{pmatrix} \begin{pmatrix} Q_1 \\ Q_4 \\ Q_7 \\ Q_{10} \end{pmatrix} = \begin{pmatrix} \Delta P_a \\ \Delta P_b \\ 0 \\ 0 \end{pmatrix}$$

- Air flow through openings

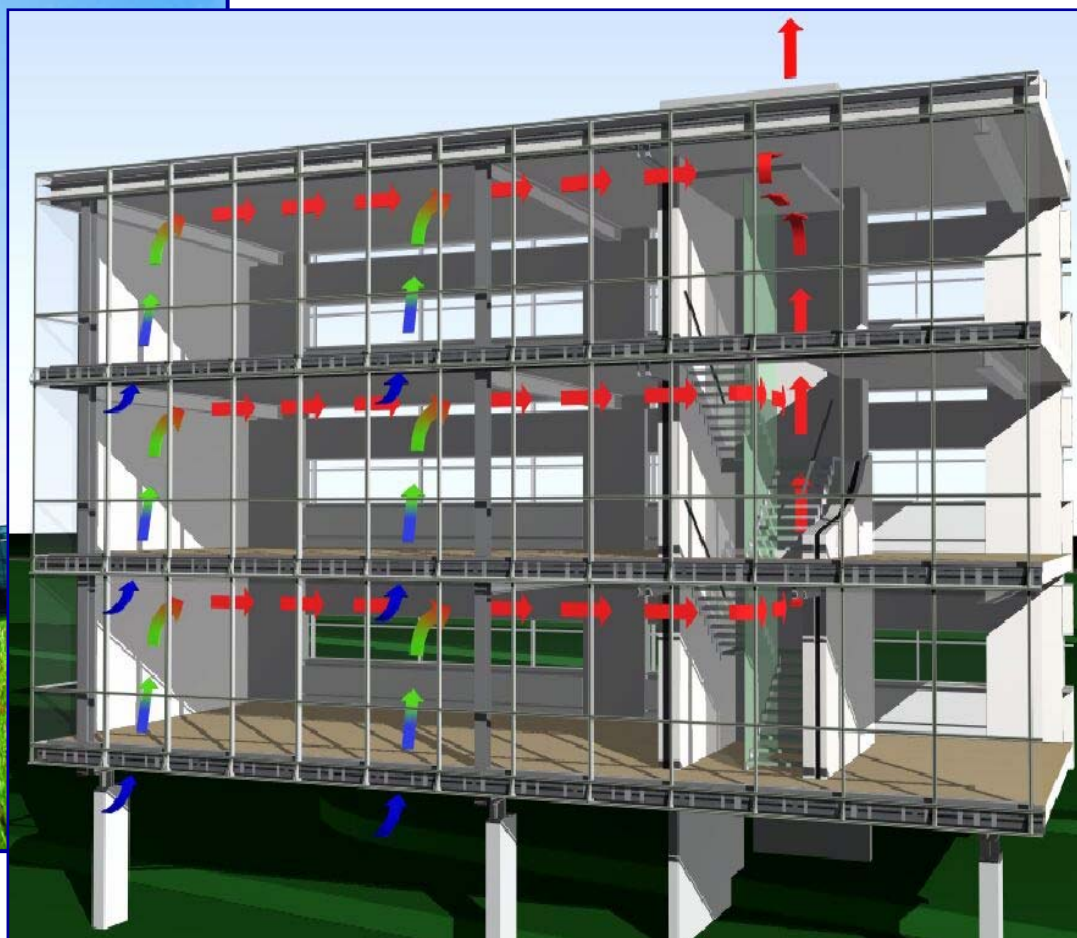


# Validation



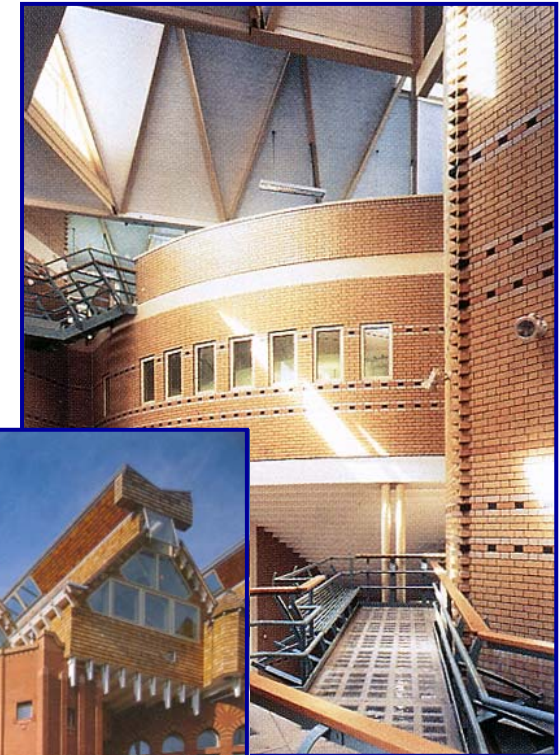
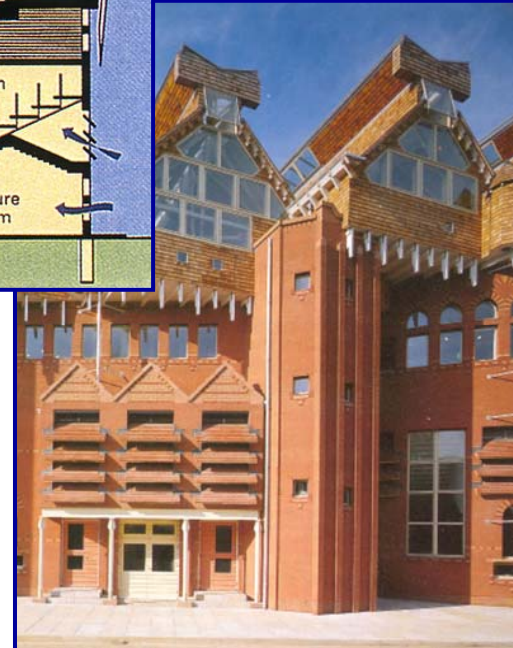
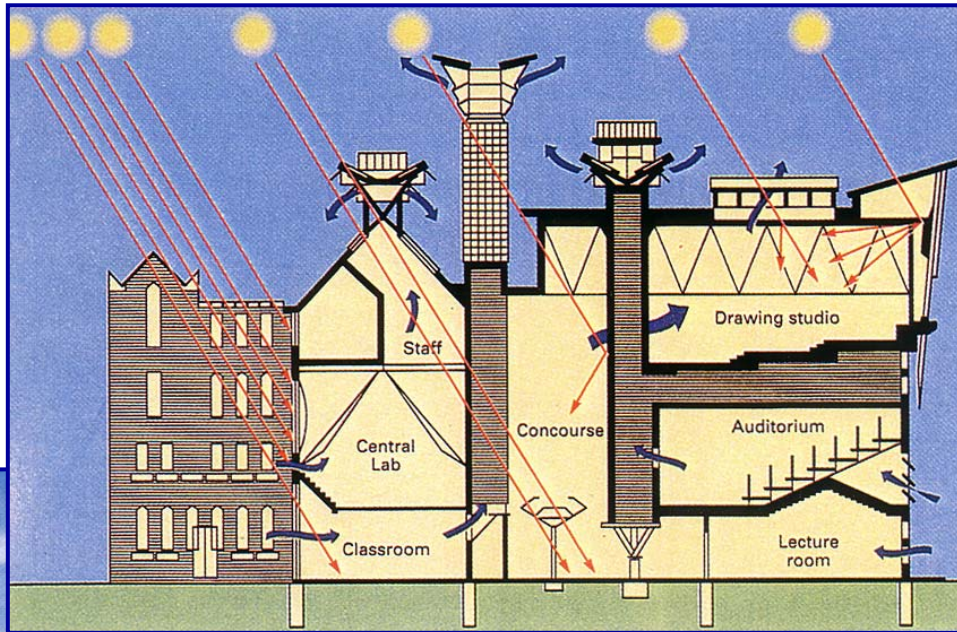
- Airflow ( $\text{h}^{-1}$ ) in thermal zone 1 (TZ1) (negative values indicating that the air comes from TZ2)
- Compared to hand calculations
- Both large and small airflows are handled well as is the change of direction of the air flow

# Existing multizone building, B&O





# De Montfort University



Thank you

