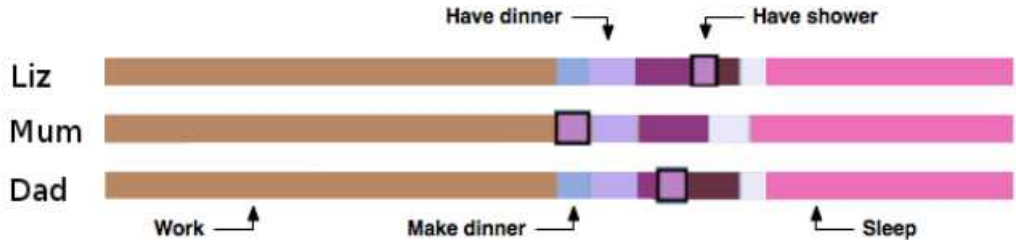
Coupling occupant behaviour with a building energy model - A FMI application

Gilles Plessis[1] Édouard Amouroux[2] Yvon Haradji[1]
[1]EnerBaT – EDF R&D, Moret sur Loing, FRANCE
[2]LIP6 – Université de Paris 6, Paris, FRANCE
gilles.plessis@edf.fr edamouroux@gmail.com yvon.haradji@edf.fr

Occupant behaviour is commonly described in dynamic building simulation tools using standardized occupancy profiles. Various studies suggest that occupant behaviour should be taken into account in a more accurate way, as it can have a dramatic impact on energy consumption especially in the context of low and positive energy buildings.

This paper illustrates the use of *Functional Mock-up Interface* (FMI) standard to couple an occupant behaviour simulator and a building model. Due to their intrinsic nature, occupant behaviour on the one hand, and a building and its energy systems on the other hand, are usually represented by different modelling paradigms. The occupant behaviour is here described by Agent-Based Modelling (ABM) whereas the building is described by a set of hybrid and differential algebraic equations, typical of dynamic thermal modelling. Such different complex systems cannot be efficiently simulated in a single tool. Therefore, one solution is the tool coupling approach.

The FMI standard for co-simulation was used to couple the SMACH occupant behaviour simulator and a building energy model built with the BuildSysPro Modelica library. Variables of interest are passed from one model to another at fixed synchronization time steps. The interactions that are considered between occupant behaviour on one side and the building and its energy systems on the other side are thermal comfort, occupants' control on HVAC systems and internal heat loads supplied to the building's ambient air temperature.



The first results of the co-simulation are presented. Activity diagrams, such as the one presented above, illustrate the variability of the occupants' actions in one given household: some activities are distinct and others can be synchronous, for instance "having dinner".

From a computing time perspective, the coupling is quite heavy. For a one month simulation and a time step of 1 minute, the occupant behaviour simulation takes 3 minutes with SMACH and the building energy simulation takes 10 seconds with Dymola. When coupling is applied, the same simulation takes 13 minutes.

Future work will address computer efficiency by considering variable size of communication steps and the modelling modularity of the building and its systems by composing FMUs.

Keywords: Building simulation; behavioural modelling; Specific use of electricity; thermal comfort; Modelica; FMI; co-simulation