Mgr inż. Barbara Koelblen Warsaw, 26.03.2018

Summary of the Ph.D. thesis entitled

Thermal human simulator as a tool for the evaluation of indoor environment conditions

The major challenges in indoor environment design nowadays arise from the need to reduce the energy use for the conditioning of spaces while ensuring thermally comfortable conditions for the occupants. Since a direct enquiry about thermal sensation and comfort of the buildings' user is seldom possible, tools to facilitate their prediction are applied. However, the modelling approaches applied up to date are not applicable, or have a worse reliability in complex environments resulting from new heating, ventilation and air-conditioning systems, where transient and spatially non-uniform conditions are likely.

The aim of the Ph.D. project was to develop and validate an advanced human simulator for the built environment consisting of a thermal manikin, a model of human thermoregulation, and a thermal sensation model.

The following thesis of the Ph.D. project has been formulated: *an adaptive human simulator can be used to evaluate thermal interactions between the human body and the surrounding environment, and to assess thermal sensation in the built environment*.

In this thesis, an adaptive human simulator consisting of three tools combined together, namely, a thermal manikin, a thermoregulation model, and a thermal sensation model, was proposed. In this way, the strengths of various approaching in modelling the heat and mass transfer between the human body and its surroundings, as well as in thermal sensation modelling, were combined. By using a physical thermal manikin placed directly in the analyzed environment, the integral effect of thermal interactions can be measured, which is then used as input for the thermoregulation model responsible for predicting thermo-physiological parameters under these specific conditions. Thanks to the real-time data exchange between these two components the thermal manikin can 'adapt' itself to the surrounding conditions, reproducing a humanlike skin temperature distribution. The thermo-physiological parameters obtained from a human simulator tests are used in turns for predicting thermal sensation, using a model capable of evaluating transient and/or non-uniform conditions, providing an output on the same scale as could be presented to people.

Within this Ph.D. thesis, the development and validation of a human simulator for the built environment is presented, with additional studies dedicated to the three components

of the system. Furthermore, the capabilities and limitations of the system are discussed. The human simulator is shown to be a promising tool for the evaluation of thermal environments with respect to occupants' thermal perception of the conditions created by conditioning systems.

Barbara Koelblen