CFD Modeling of Thermal Manikin Heat Loss in a Comfort Evaluation Benchmark Test

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The occupant is in the centre of attention!

This presentation deals with a new benchmark test that provides requirements for the design and development of computer simulated persons (CSPs) and CFD benchmark tests for comfort evaluation.
CSP research today

Researchers around the world have developed many configurations in order to represent a Computer Simulated Person (CSP).

These virtual CFD manikins are often very different with respect to size, form, heat generation, turbulence models and computer codes used.
Why a new benchmark test?

The two main ideas behind the new benchmark test have the following reasons:

- **Verify** that the *simulated* heat losses equals *measured* heat losses in order to support comparisons with human experiences.

- **Compare** different versions of CSPs with exactly the same heat loss boundary conditions. Later new decisions on the geometrical level of detail, turbulence model, type of grid etc. can be made.
The experimental setup

A wind tunnel with box shaped geometry with a window on the side at Aalborg University.

The large inlet to the far left followed by the chamber with a window; manikin and the two exhaust holes in the back with ventilation ducts.
Thermal manikin measurements

The measurements were made with a female manikin Comfortina. The manikin run in constant surface temperature mode at 34°C, without clothing in order to get fast and accurate heat loss levels.

The flow field situation was made as identical to the earlier benchmarks with the intention that data will be interchangeable and comparable between the two tests.
Heat loss benchmark results

All heat loss measurements made with Comfortina can be downloaded from cfd-benchmarks.com.

Heat losses from the 17 manikin zones as well as whole body heat loss and air velocities plus air temperatures are reported in great detail.
Equivalent “experienced” temperature

As it is rather difficult to communicate the combined effects from different “heat losses” is it very useful to convert these values into something easier to understand, like equivalent “experienced” temperature ($t_{eq}$).
More benchmark results …

The equivalent temperature shows low values, as could be expected. The results should be compared to the climate an unclothed person experiences, sitting in the air stream during the same conditions as the manikin.
Comfort zone diagram evaluation

Comfort zone diagrams adapted for Comfortina type of manikins. This spreadsheet can be downloaded from the Thermal Manikin Network and the CFD-Benchmark site.
These methods have recently become an International Standard for local evaluation.

“EN ISO 14505, Ergonomics of the thermal environment - Thermal environment in vehicles”.

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Both experiments and simulations

The concept can be used to evaluate and develop both real and virtual environments, minimising the need for subjective tests.
CSP research in the future …

- a new benchmark test now focuses on the different **heat losses** from the manikin
- connect results from thermal **manikin measurements** with real **human experiences**
- results can be presented as **local information** as well as **whole body influence**
- integrated use of new **heat loss benchmark tests** and new **standardized evaluation methods** for comfort evaluation
- research will lead to **general requirements** for the design and development of future CSPs and CFD manikins
Whole-field measuring methods for temperature, contaminant concentrations, particle concentrations and three-dimensional velocities.

Eight test rooms with equipment for measurement of temperatures, velocities, humidity, particles and tracer gas concentrations.

Publications and more information: [www.hig.se/~hnn](http://www.hig.se/~hnn)