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

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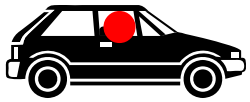
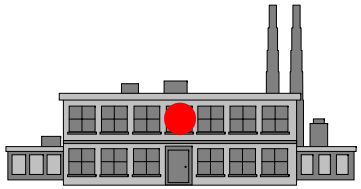
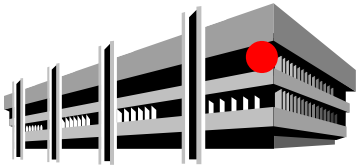
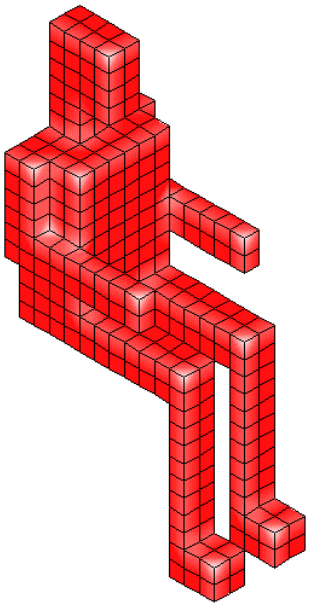
The occupant is in the centre of attention!

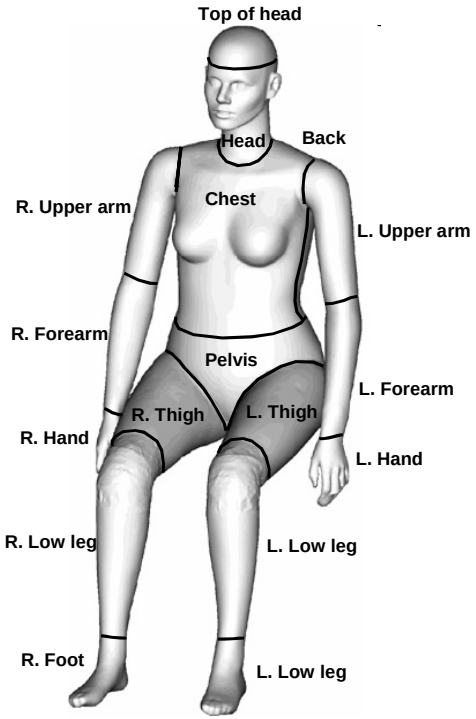


This presentation deals with a new benchmark test that provides requirements for the design and development of computer simulated persons (CSPs) and CFD benchmark tests for comfort evaluation.

CSP research today



Researchers around the world have developed many configurations in order to represent a **C**omputer **S**imulated **P**erson (**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?

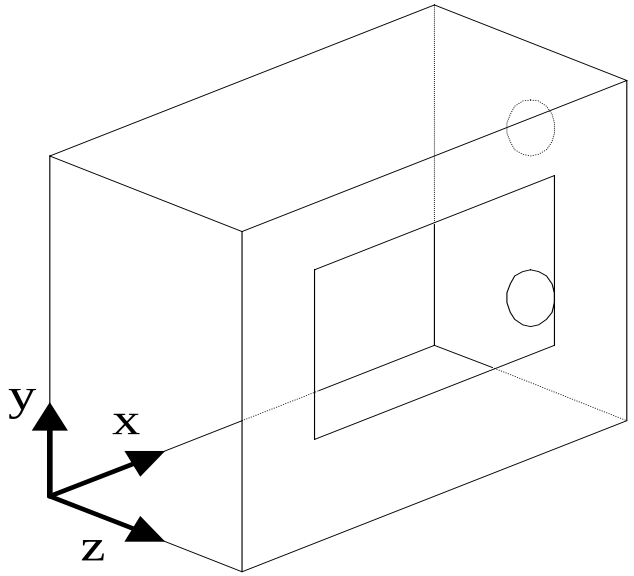
The two main ideas behind the new benchmark test have the following reasons:

- **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 34ºC, without clothing in order to get fast and accurate heat loss levels.

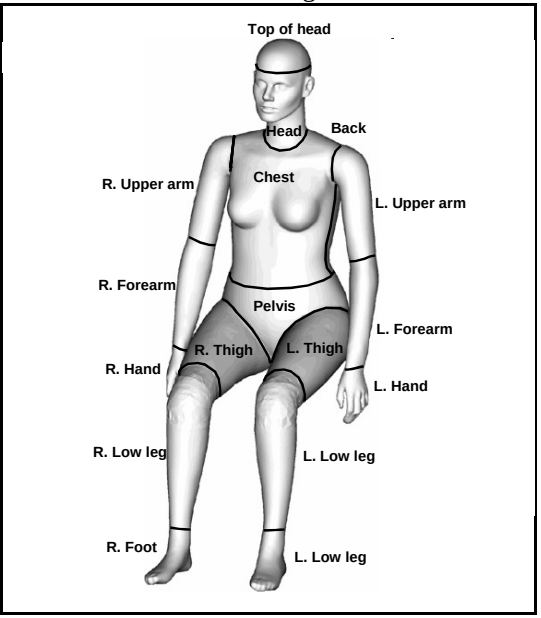
The flow field situation was made as identical to the earlier benchmarks with the intention that data will be interchangeable and comparable between the two tests.

Heat loss benchmark results

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

Thermal manikin: Comfortina, No clothing, Software 3.0.30.

	Body Segments
1	L. Foot
2	R. Foot
3	L. Low leg
4	R. Low leg
5	L. Thigh
6	R. Thigh
7	Pelvis
8	Head
9	Top of head
10	L. Hand
11	R. Hand
12	L. Forearm
13	R. Forearm
14	L. Upper arm
15	R. Upper arm
16	Chest
17	Back
18	All



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.

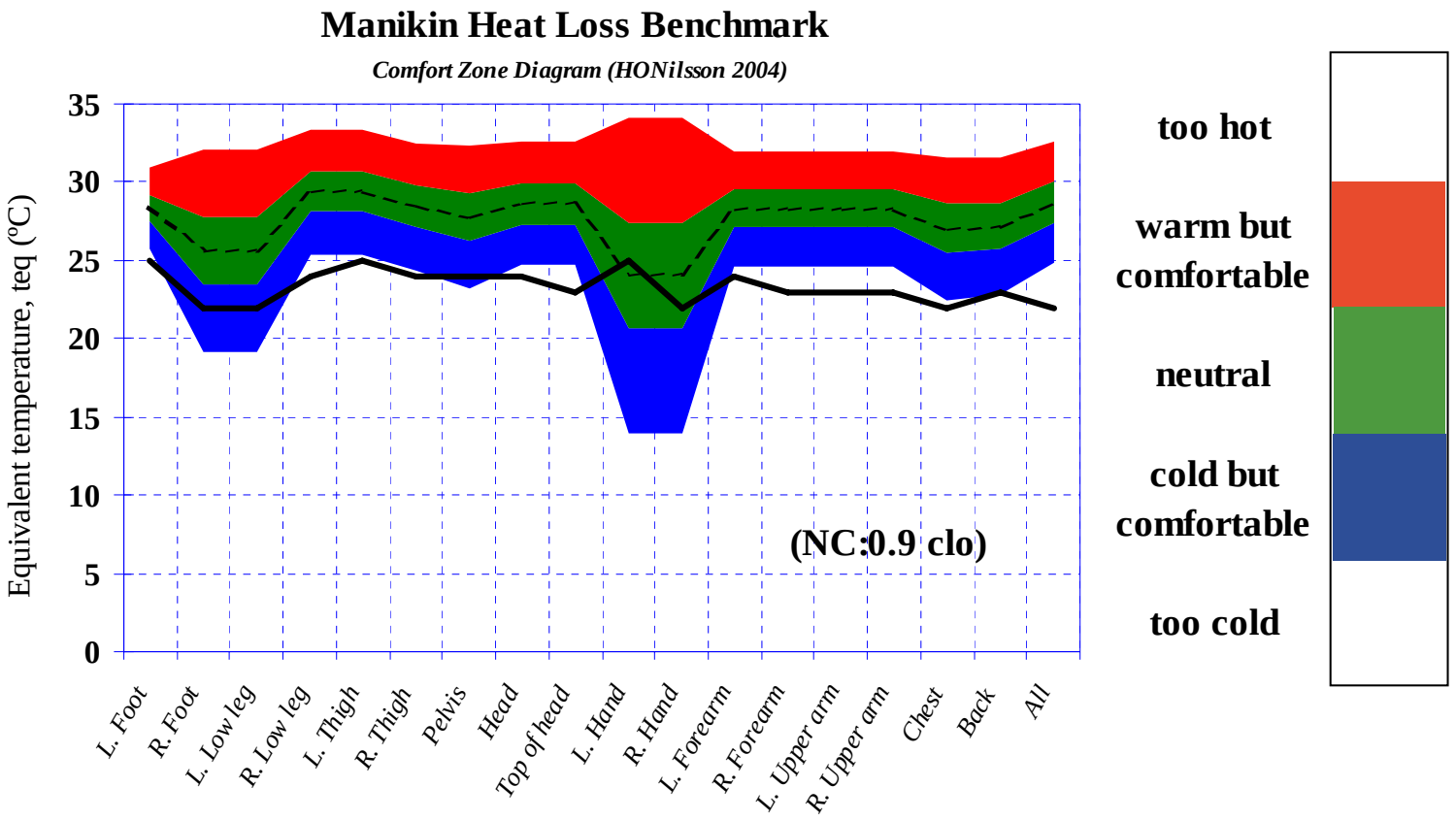
Equivalent “experienced” temperature

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



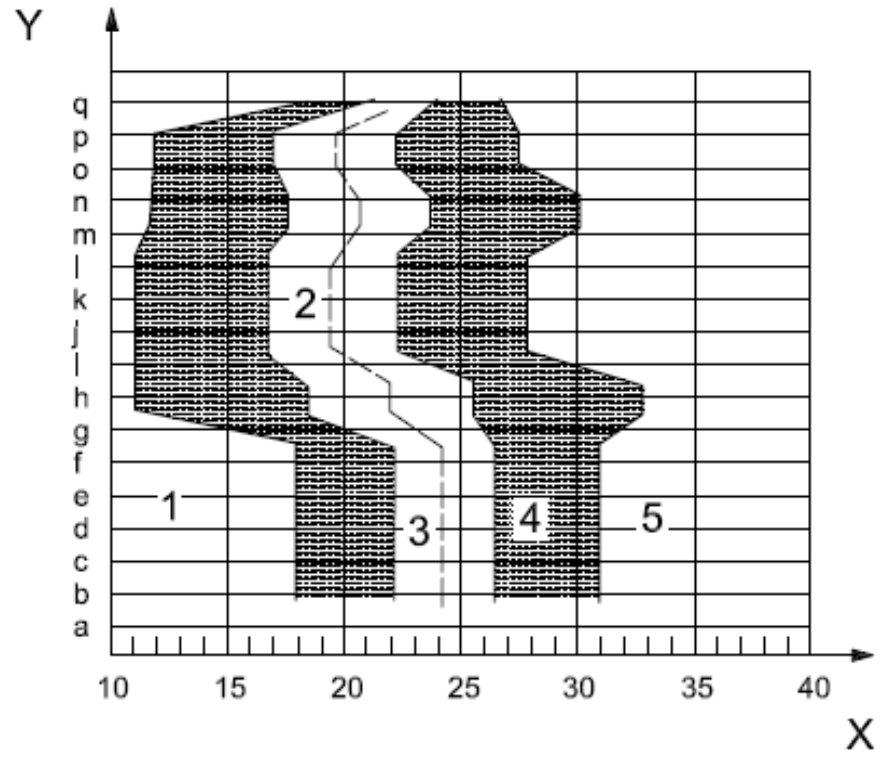
Comfort zone diagrams adapted for Comfortina type of manikins. This spreadsheet can be **downloaded** from the Thermal Manikin Network and the CFD-Benchmark site

Standardisation

ISO/FDIS 14505-2:2006(E)

These methods have recently become an International Standard for local evaluation.

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



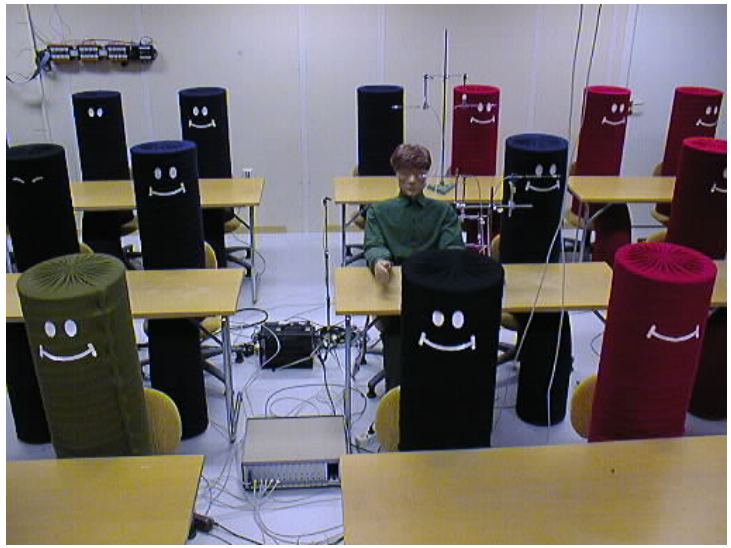
Both experiments and simulations

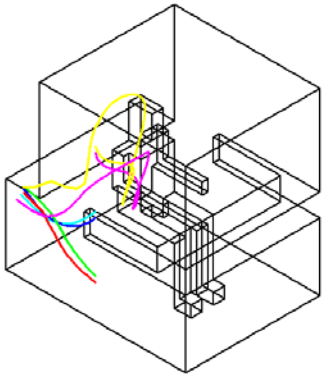
The concept can be used to evaluate and develop both real and virtual environments, minimising the need for subjective tests.

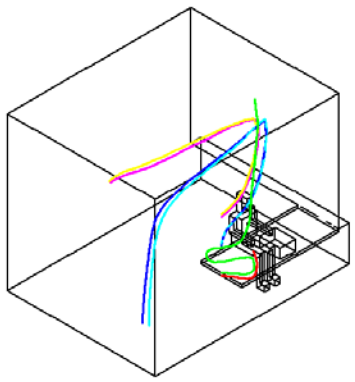
Vehicles

Offices

Classrooms







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

Laboratory of Ventilation and Air Quality

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