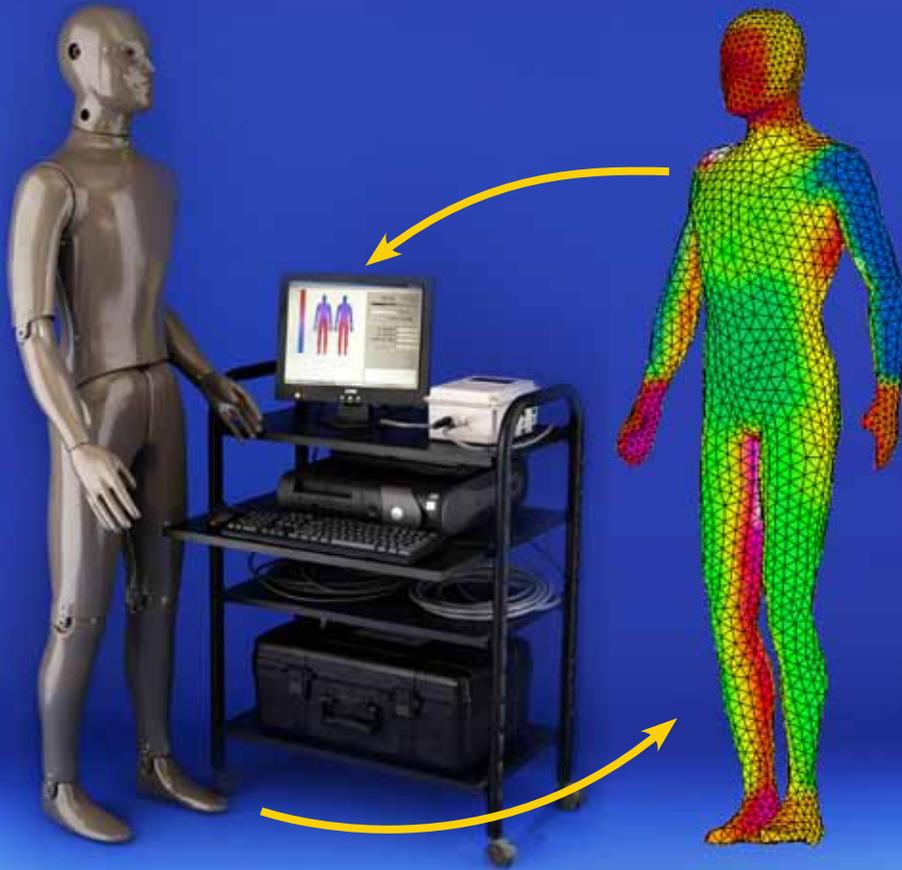


# ManikinPC<sup>2</sup> = Physiology and Comfort



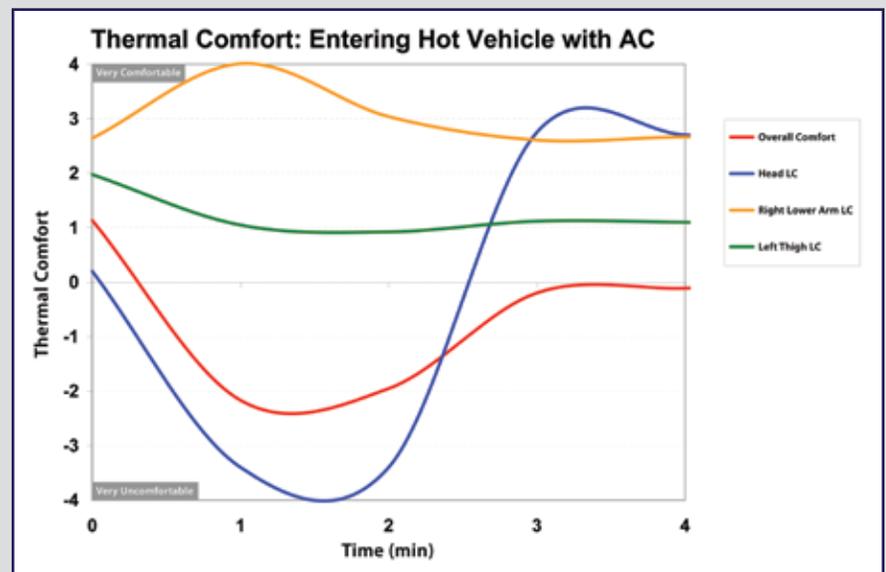
## ManikinPC<sup>2</sup> Adds Thermoregulation to Newton Manikins

ManikinPC<sup>2</sup>, Manikin Physiology Control and Predictive Comfort Software, is a closed-loop feedback control system that accurately mimics the human thermoregulatory system and provides metrics for comfort and sensation.

- Validated thermoregulatory control scheme
- Computes indexes for local and whole body sensation and comfort
- Supports transient analysis for changing environments and activity levels
- Provides accurate perspiration rates
- "Virtual sweating" heat rates can be integrated

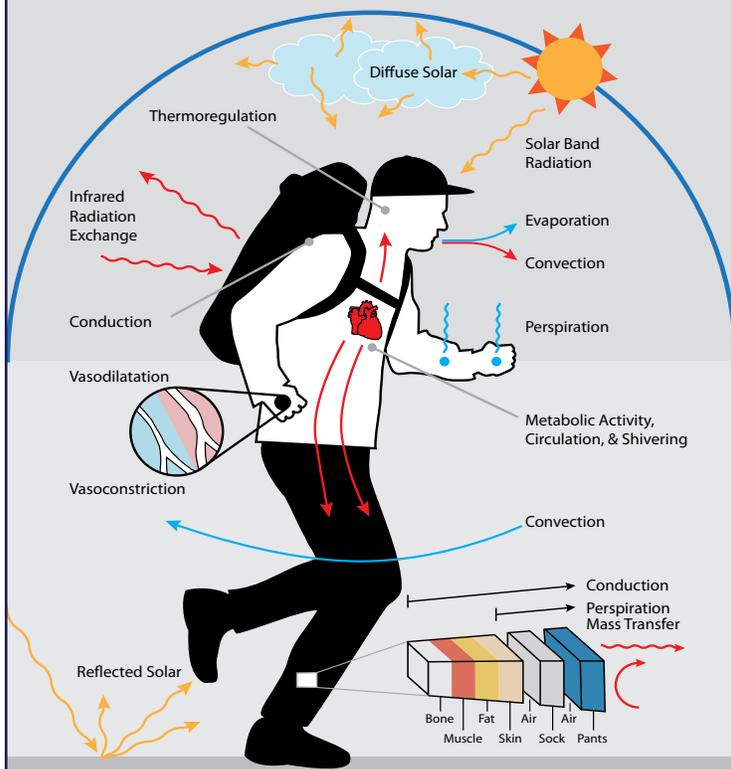
## Overview

ManikinPC<sup>2</sup> defines a new state-of-the-art for human simulation with a thermal manikin. Unlike past systems that were open-loop control systems, ManikinPC<sup>2</sup> reads the skin temperature distribution of Newton and computes accurate physiological and metabolic responses over time. Newton essentially becomes "wired" with software that predicts blood flow rates, perspiration rates, and core body temperature. These are translated to wattages that are imposed onto each zone of Newton to produce a realistic thermal response. In addition to controlling the manikin's heating, indexes for local and whole body thermal sensation and comfort are computed, delivering useful metrics for assessing product design.



Sample plot of thermal comfort when a virtual human enters a hot automobile and engages the air conditioning. Each body segment's comfort index is computed.

# ManikinPC<sup>2</sup> = Physiology and Comfort



## Thermoregulatory Control System

The human thermoregulatory control system is a highly complex network of sensors, blood flow rates, and metabolic heat rates. The ManikinPC<sup>2</sup> control system allows for a variable activity level that simulates the human metabolism while sleeping, resting, working, or exercising. Any level of activity can be input and appropriate metabolic wattages will be imposed onto the various manikin zones.

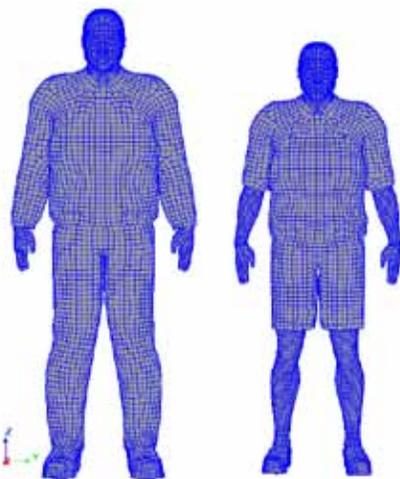
Sensors embedded in Newton's "skin" provide real-time measured inputs of skin temperature, which factor into the sensation metrics and determine vasodilation and vasoconstriction responses. The ManikinPC<sup>2</sup> control system responds in real time with appropriate thermal response to inputs, mimicking the transient behavior of a human body.

## Real Time Controls for Newton

- Virtual thermal simulation of human physiology
- Variable activity levels determine metabolic rates
- Feedback controls in real time set thermal loads
- 'Virtual sweating' can be simulated without water
- Can be integrated to existing Newton manikin

## Newton & Custom Physiology

Future versions of ManikinPC<sup>2</sup> will couple the standard 50th percentile male Newton manikin to virtual humans of any body shape or size to enable the testing of clothing, equipment and environments. The physiology, skin areas, body masses and metabolic rates will be adjusted to predict how a smaller or larger person would respond to the environmental conditions and clothing. Clothes can be tested and designed for the complete span of body shapes in the target market.



## Future Developments

Users can upgrade to the latest version of ManikinPC<sup>2</sup> while keeping their existing Newton manikin.

- Virtual manikin controls based on variable body sizes and gender (regardless of physical manikin size)
- User defined body segments to use custom physiology data
- Improvements to physiology and comfort model based on test data
- Integrate hand, foot and head models with a complete human thermal model



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