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Mitsubishi Electric Corporation

Waseda University

Technical University of Denmark

Global Collaboration Aims to Redefine Thermal Comfort in Buildings

Will develop thermal comfort index that better reflects individual differences and informs global standards

Professors and researchers from Waseda University, Technical University of Denmark, and The University of Sydney, and members of Mitsubishi Electric Information Technology R&D Center

Mitsubishi Electric Corporation, Waseda University and Technical University of Denmark announced today that they have jointly signed an agreement with The University of Sydney to develop a thermal comfort index that accurately predicts individual thermal sensations, which they plan to promote for adoption as an international standard.

There is a growing demand for office environments that support the health, comfort, and productivity of workers, particularly in light of a shrinking working-age population in many countries. While many factors influence office environments, one of the most significant is thermal conditions, which encompass air temperature, mean radiant temperature, humidity, air velocity, clothing insulation, and metabolic rate.

An existing standard, the Predicted Mean Vote (PMV), has been widely used to assess thermal environments by calculating people's expected sensations of heat or cold based on environmental conditions (such as air temperature, mean radiant temperature, relative humidity, and air velocity) and human factors (including clothing insulation and metabolic rate). Since its adoption as an international standard (ISO 7730) in 1984, the PMV has been applied in the design and operation of buildings worldwide. However, because PMV predictions are based on statistical averages encompassing large numbers of people, it cannot fully capture the individual differences that occur within a typical office population. Even when indoor thermal environments are optimized for PMV, some occupants will inevitably experience discomfort, such as feeling too warm or too cold. In today's workplaces, where diverse people come together, it is important to move beyond uniform

indices like the PMV. Developing a new index that more accurately represents individual thermal sensations is critical to improving well-being for all and creating indoor environments that account for diversity.

Since co-signing the Basic Agreement on Comprehensive Collaboration for the Realization of a Sustainable Society in November 2023, Mitsubishi Electric and Waseda University have jointly researched not only themes such as carbon neutrality and well-being, but also initiatives for improving thermal environments. To accelerate this work, they are now launching a collaborative research project with Technical University of Denmark and The University of Sydney, both recognized globally for their expertise in building science and thermal comfort research.

The project's goal is to develop a next-generation evaluation index that more accurately predicts individual thermal comfort. Unlike existing indices, the envisioned index will integrate a wide range of factors, including personal attributes and indoor environmental conditions, and support its adoption as an international standard.

Partner Organizations and Research Roles

Organization	Roles
Mitsubishi Electric Corporation	•Planning and conducting demonstration experiments and providing related facilities, such as the "SUSTIE" Net Zero Energy Building Test Facility •Developing control systems for thermal environments and collecting data accumulated in the experiments
Waseda University (Professor Shinichi Tanabe and researchers)	•Planning demonstration experiments and conducting participant surveys •Analyzing field data supported by thermal comfort studies using the JOS-3[1] human thermoregulation model and thermal manikins[2] to support development of a new thermal comfort index
Technical University of Denmark (Professor Emeritus Bjarne W. Olesen and researchers)	•Planning demonstration experiments and air conditioning control strategies •Data analysis of personal environment control systems and personal comfort studies to support development of a new thermal comfort index
The University of Sydney (Professor Emeritus Richard de Dear and researchers)	•Planning demonstration experiments and air conditioning control strategies •Data analysis of adaptive thermal comfort[3] and thermal alliesthesia[4] studies to support development of a new thermal comfort index

To drive the development and international standardization of a new thermal comfort index, the research team will undertake a series of thermal comfort studies, including large-scale human subject experiments and tests using thermal manikins. Findings will be shared progressively through leading academic conferences and international journals. The project will also propose new approaches to designing thermal environments in future workplaces and actively promote their global application.

[1] The human body temperature regulation model developed by the Shinichi Tanabe Laboratory Group at Waseda University. This numerical model simulates thermal physiological responses, including skin temperature, core body temperature and sweat volume for the whole body and 17 specific body parts.

[2] A human-shaped heating element created to measure the thermal resistance of clothing and replicate its thermal characteristics when worn by humans.

[3] An index related to thermal comfort that takes into account human adaptation to outdoor environmental conditions.

[4] A concept that indicates how stimuli from a given thermal environment can evoke sensations of comfort or discomfort.

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