

# AI AS A TOOL FOR TESTING AND CERTIFICATION OF CLOTHING

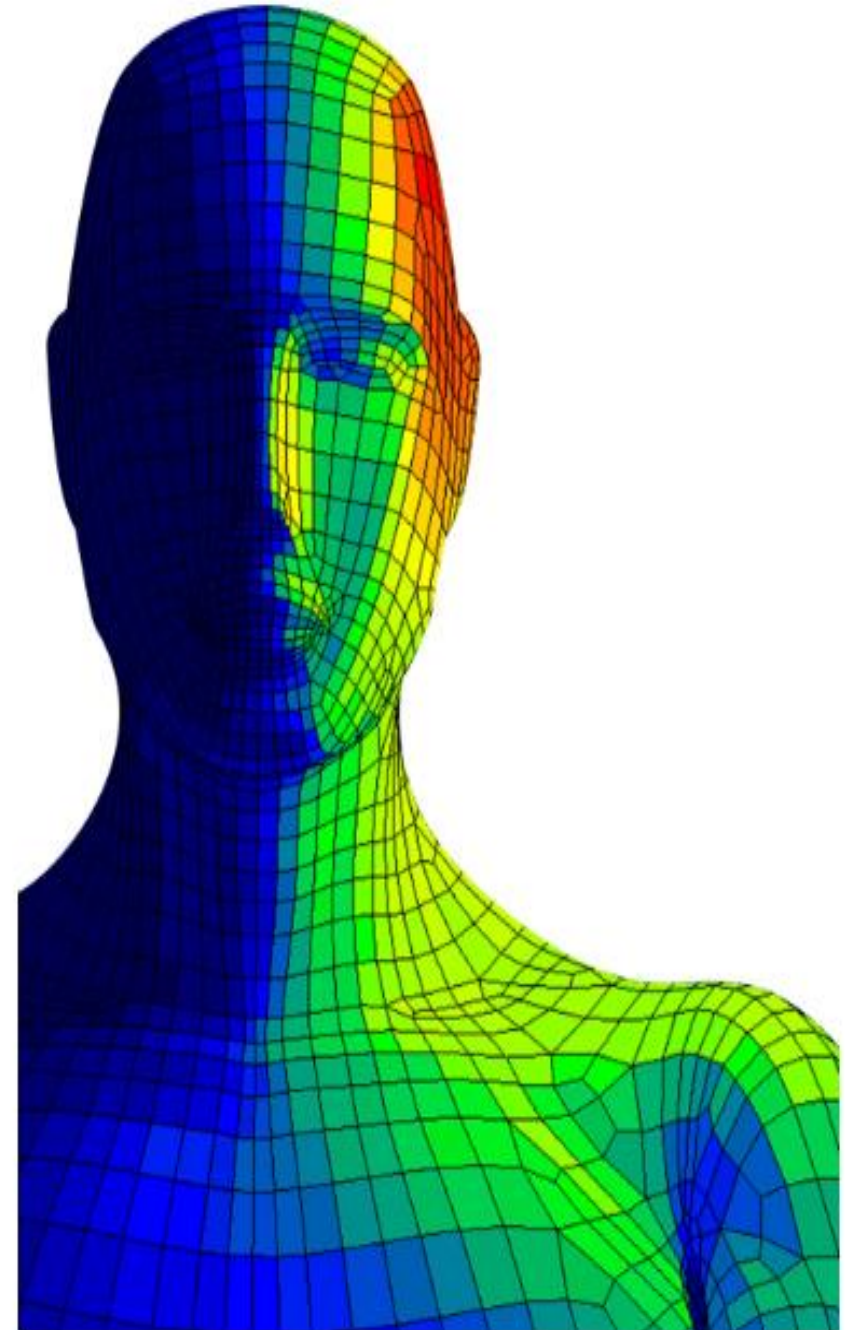
SESSION 3 PERSONAL PROTECTIVE EQUIPMENT

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occupational safety and health”

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# ABOUT AITEX

AITEX is Spain's premier textile research and innovation center, driving technological advancement in the textile and materials science sectors through rigorous testing, certification, and applied research methodologies.



# ABOUT AITEX

## WHO WE ARE

Spanish research centre for textile testing and certification, accredited under ISO/IEC 17025 standard.

## WHAT WE DO

With over 40 years of expertise, we develop cutting-edge solutions for companies through innovation, technology transfer and new developments.

## GLOBAL REACH

10 international offices supporting clients across more than 50 countries, facilitating collaborations between technological centers, universities, industry and regulatory bodies worldwide.



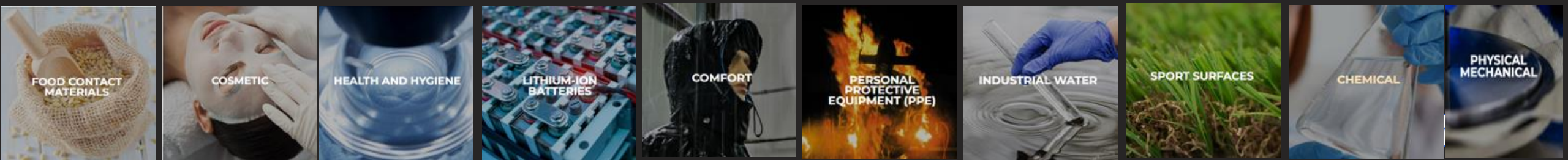


We have more than 30 laboratories at AITEX, which conduct over 600,000 tests annually, employing approximately 400 people in our laboratories.

We have more than 1,000 tests accredited by ENAC in various areas, including comfort, chemistry, microbiology, medical devices, fire behaviour, PPES, ballistics, and more.

3 main areas:

- Laboratory and certification area.
- Research and development area.
- Technical and training area

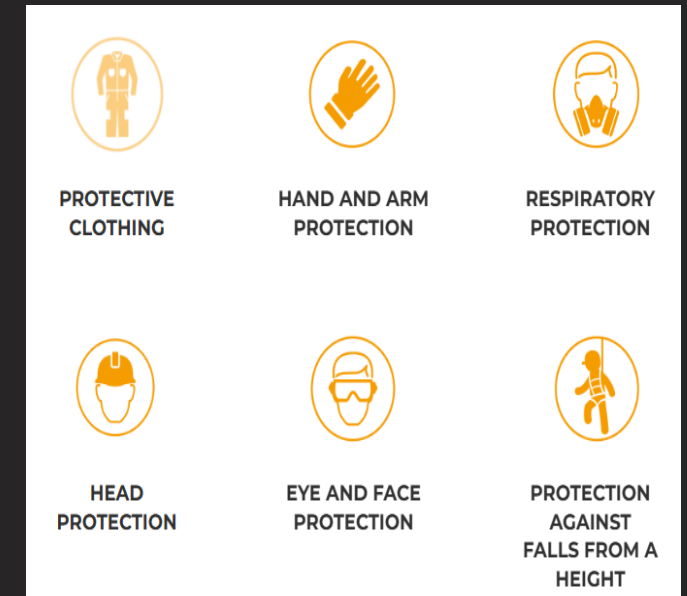
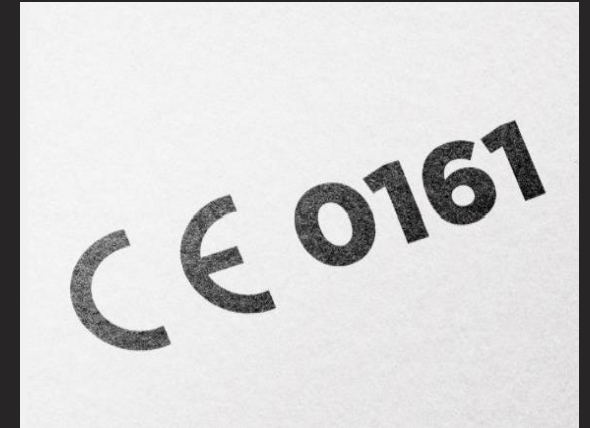


# PERSONAL PROTECTIVE EQUIPMENT

AITEX is a Notified Body No. 0161, for Regulation (EU) 2016/425 on Personal Protective Equipment, which establishes the essential health and safety requirements that personal protective equipment must comply with.

The accreditation covers:

- > EU type examination certificates (Module B)
- > Conformity to type based on internal production control plus supervised control of the product at random intervals (module C2)
- > Conformity to type based on quality assurance of the production process (module D)



# INTRODUCTION

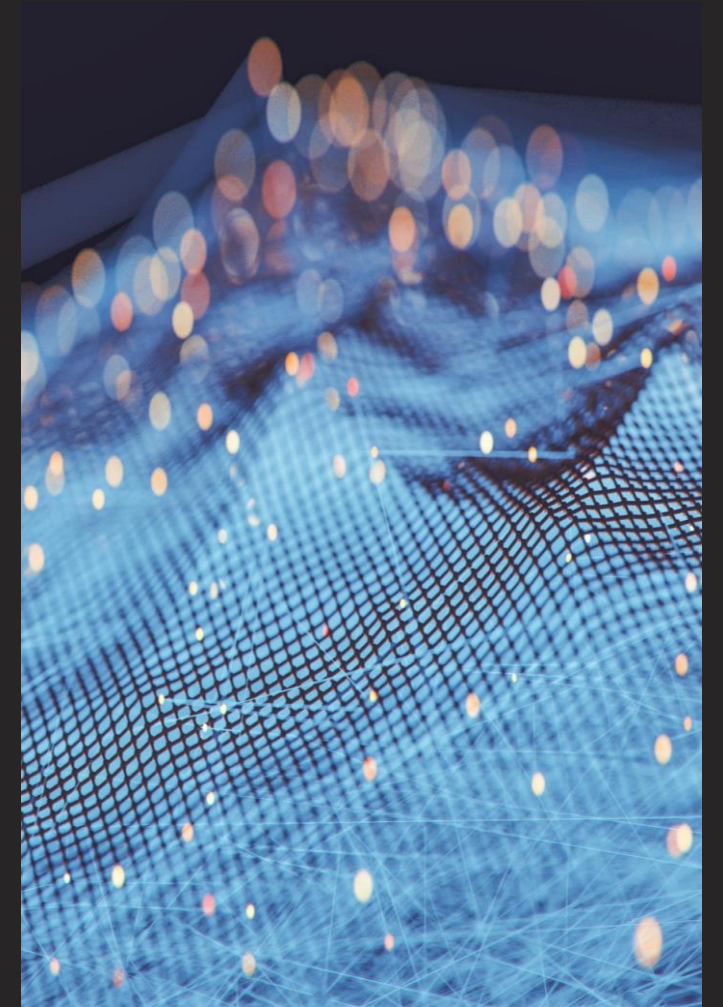
Artificial Intelligence (AI) is transforming multiple industries.

Testing and certification are critical to ensure:

- Quality
- Safety
- Compliance

**Key question:**

**How can AI improve the process of testing and certification?**



# CURRENT CHALLENGUES IN TEXTILE TESTING

## ✓ **Laboratory Testing Constraints**

Textile labs require specialized equipment and trained personnel, making tests time-consuming and costly.

## ✓ **Manual Inspection Challenges**

Manual visual assessments introduce subjectivity and variability affecting the reliability of results.

## ✓ **Complex Standards and Documentation**

Multiple international standards complicate procedures and increase documentation workload in textile testing.



**AI can provide innovative solutions to streamline workflows and improve consistency in textile testing processes.**

# WHAT ARTIFICIAL INTELLIGENCE BRINGS

## ✓ **Advanced Data Analysis**

AI processes large complex datasets, identifying hidden correlations and trends beyond human capacity.

## ✓ **Pattern Recognition and Computer Vision**

AI excels at recognizing patterns and interpreting visual data, improving accuracy in textile testing.

## ✓ **Automation of Repetitive Tasks**

AI automates routine tasks, reducing human error and enabling experts to focus on high-value activities.

## ✓ **Support for Research and Innovation**

AI enhances test robustness and facilitates knowledge transfer, driving innovation in certification processes.

# EXAMPLES OF AI APPLICATIONS IN TEXTILE TESTING

## ✓ **Automated Visual Inspection**

AI-powered systems enable real-time analysis of fabric surfaces, ensuring rapid and accurate defect detection.

## ✓ **Performance Prediction Models**

Predictive AI models estimate textile performance based on material properties and historical testing data.

## ✓ **Test Optimization**

AI helps identify relevant tests, minimizing unnecessary repetitions and improving testing efficiency.

## ✓ **Sustainable Quality Control**

AI-driven quality control increases capacity while reducing material waste and energy consumption.

# AI IN COMFORT TESTS

## ✓ **Complexity of Comfort Testing**

Comfort testing involves multiple variables , such as thermal comfort and thermal sensation, linked to human subject perception.

## ✓ **AI Integration in Testing**

AI correlates laboratory data with wearer responses, managing complexity in comfort evaluation.

## ✓ **Enhanced Product Evaluation**

AI models trained with manikin and wear trial data improve prediction of thermal sensation and comfort.

## ✓ **Complementing Human Trials**

AI enhances data interpretation and reduces iterations without replacing human wear trials.

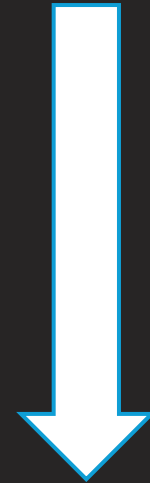


# INTEGRATION OF THE AI IN OUR COMFORT LABORATORY

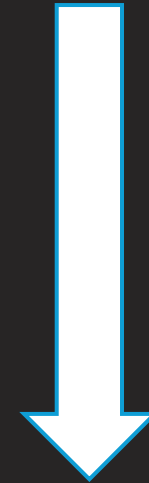
HOW CAN WE USE THE IA IN OUR TESTS?



**Creating test new test protocols  
when there are not standards to  
follow**



**Analysing the results  
during and after the test**



**Helping the customer or  
user in the improvement  
of the qualities of the  
garment**

# PREDICTIVE MODELS FOR TEXTILE PERFORMANCE

## ✓ **AI in Textile Testing**

AI uses historical data to predict textile performance indicators.

## ✓ **Accelerated Product Development**

Predictive models help speed up product development by estimating results before physical tests.

## ✓ **Risk Identification and Optimization**

AI models identify risks early and optimize test plans, reducing development timelines.

## ✓ **Supporting Innovation and Certification**

Predictive AI supports innovation while ensuring integrity of certification processes.



**CASE STUDY**  
**AI-BASED COMFORT PREDICTION**  
**EVALUATION OF COOLING GARMENTS**

# CURRENT EUROPEAN STANDARDS FOR THE EVALUATION OF PPE AGAINST WEATHER HAZARDS

## ULTRAVIOLET SOLAR RADIATION

EN 13758-1:2001+A1:2006

Textiles — Protective properties against ultraviolet solar radiation. Part 1: Test method for apparel fabrics

## THERMAL STRESS

### Cold Stress

- EN 14058:2017+A1:2023  
Protective clothing — Garments for protection against cool environments.
- EN 342:2017  
Protective clothing — Ensembles and garments for cold protection.

### Heat Stress

- No mandatory applicable standard exists for this risk.

# THE CHALLENGE OF HEAT STRESS

Workers in outdoor environments face significant thermal stress from extreme weather conditions beyond their control. High temperatures create serious health risks and reduce productivity.

Whether it's due to high temperatures, heavy clothing, or physically demanding tasks, workers exposed to heat often struggle to stay comfortable and safe.

Personal cooling garments help the body to manage excess body heat by reducing core and mean skin temperature, facilitating the evaporation of sweat from the body to the environment, and providing crucial protection during heat stress.





## STRATEGIES TO REDUCE HEAT STRESS WHILE USING PPE

Actions that can reduce heat stress and can be worn with the PPE include:

- Fire proximity suits
- Water-cooled garments
- Air-cooled garments
- Cooling vests
- Wetted over-garments
- Sun hats
- Light colored clothing
- Sunscreen



# PERSONAL COOLING SYSTEMS

A wide range of cooling garments has been developed to meet diverse environmental and individual needs, offering innovative solutions for heat management. Personal cooling systems differ in the cooling mechanism used.

## AIR COOLING MECHANISM



Circulates air around the body

## LIQUID COOLING MECHANISM



Circulates chilled liquid around the body

## PHASE CHANGE MATERIAL MECHANISM (PCM)



Uses phase change materials with different melting points for cooling

## EVAPORATION MECHANISM



Leverages water evaporation

## HYBRID MECHANISM



Combines multiple methods

# WHY THE EVALUATION OF COOLING GARMENTS IS CHALLENGING

## **Lack of Standardized Metrics**

Cooling garment performance is rarely measured with standardized or comparable metrics, complicating evaluation.

## **Disconnect Between Lab and User Trials**

Laboratory tests and user trials are often conducted independently, causing interpretation difficulties.

## **Variability in Conditions and Technologies**

Environmental factors and garment design vary widely, affecting cooling effectiveness across scenarios.

## **Commercial and Regulatory Challenges**

Lack of objective data complicates substantiating performance claims for industrial and health sectors

# EVALUATION OF PERSONAL COOLING SYSTEMS

## ASTM F2371

Standard Test Method for Measuring the Heat Removal Rate of Personal Cooling Systems Using Sweating Manikins



## ASTM 2300

Standard Test Method for Measuring the Performance of Personal Cooling Systems Using Physiological Testing



**OWN TESTING PROTOCOLS  
FROM EACH LABORATORY**



# AITEX'S EVALUATION METHODOLOGY

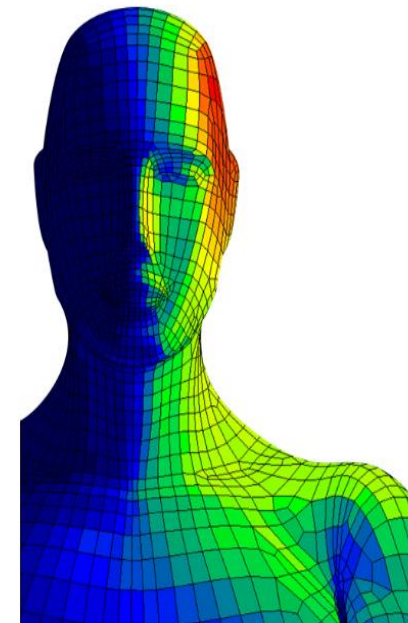
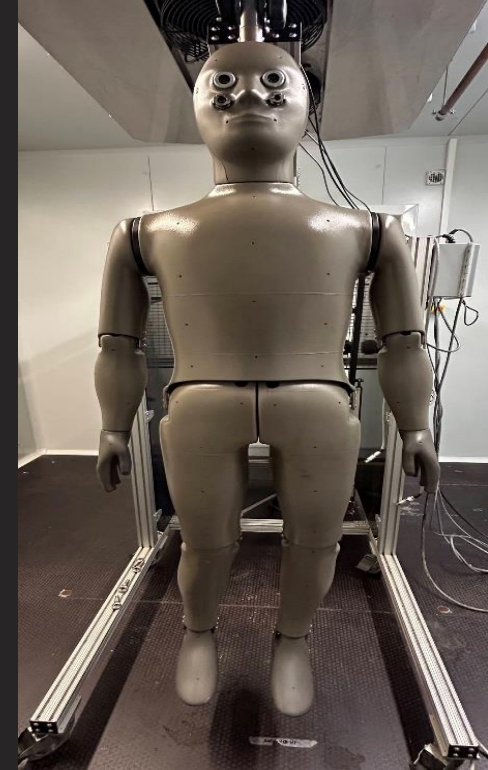
**34-segment thermal manikin** from Thermetrics paired with Manikin PC Software from Thermoanalytics.

**Thermal manikins** can evaluate: heat loss, insulation, and breathability by maintaining a constant temperature and a determined sweat rate.

Using a virtual physiological model, they can predict both subjective parameters and physiological metrics.

**Key Benefits** of using a manikin with a virtual physiological model:

- Reduces reliance on human subjects
- Better reproducibility and repeatability of testing
- Safe tests in extreme or prolonged conditions



# AITEX'S EVALUATION METHODOLOGY- "INPUTS"



## SIMULATION OF THE ENVIRONMENTAL CONDITIONS



Simulation done in the climatic chamber



## MANIKIN ACTIVITY SIMULATION



Simulation of the activities of the user according to the energy that the user would generate performing the activity



## PHYSIOLOGICAL MEASUREMENTS



Measurement of the skin temperature and hypothalamus temperature equivalent with the thermal manikin

# AITEX'S EVALUATION METHODOLOGY- "OUTPUTS"



## THERMAL PERFORMANCE METRICS



- ✓ Thermal sensation index (ranging from -3 to +3)
- ✓ Thermal comfort index (ranging from -3 to +3)

Scale	Thermal Sensation
+3	Hot
+2	Warm
+1	Slightly Warm
0	Neutral
-1	Slightly Cool
-2	Cool
-3	Cold

+3	Hot
+2	Warm
+1	Slightly Warm
0	Neutral (Comfort)
-1	Slightly Cool
-2	Cool
-3	Cold

# VALUE OF THE USE OF THIS PREDICTIVE MODEL

## **Engineering Design Validation**

Integrated data supports design validation and optimization of cooling garment materials and configurations.

## **Marketing Credibility and Differentiation**

Quantitative performance data enables credible claims and competitive differentiation in the market.

## **Occupational Health Support**

Data provides evidence for heat stress prevention, supporting safety managers and worker protection investments.

# CONCLUSIONS AND FUTURE OUTLOOK

## ✓ **AI as Key Enabler**

Artificial Intelligence is essential for advancing textile testing and certification with improved accuracy and efficiency.

## ✓ **Complex Comfort Analysis**

AI supports complex comfort analysis by integrating data and predicting textile performance factors effectively.

## ✓ **Future Certification Models**

The future textile certification will be digital, transparent, and predictive, fostering trust and innovation.

# Thank you

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**Questions**

