

Preface to the Proceedings of the XR4CE Workshop

XR for Challenging Environments — Enabling Human Performance and Agency under Stress

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The Workshop on Extended Reality for Challenging Environments (XR4CE) was held on 14 April 2026 at CCIB, Barcelona, co-located with the ACM CHI 2026 Conference on Human Factors in Computing Systems. It brought together researchers and practitioners to address a shared problem: XR research has produced promising demonstrations, but has rarely been designed or tested for the conditions under which professionals in emergency response, military operations, healthcare, critical infrastructure, and advanced manufacturing must actually operate.

The workshop was built on three conceptual pillars: *Calibrated Trust* (adaptive, dynamic reliance on XR and AI), *Resilience by Design* (graceful degradation as a first-class design requirement), and *Situated Explainability* (perceptually immediate, embodied information delivery). These three pillars are interdependent and formed the analytical triad that structured the workshop activities.

The half-day program comprised two interactive sessions. The first opened with participant introductions and two practitioner lightning talks grounded in operational experience: Matthew Wilchek (U.S. Army Combat Capabilities Development Command C5ISR Center) on “What XR Should Solve First: Lessons from Trying to Deploy XR in Challenging Environments,” and Georg Aumayr (Johanniter Austria) on “Missing in Action: Exposing the Gaps in XR Interaction Modalities for Challenging Environments.” A live voting then assigned the most salient tensions and design trade-offs surfaced by the accepted position papers to three breakout groups. Using one of the three aforementioned pillars as a conceptual frame, each group tried to resolve the tensions assigned to them in a principled fashion. In the second session, the three groups developed 10-year research timelines

based on seven identified gaps in the field, with a final plenary synthesising the results. The workshop produced three types of outputs: design principles derived under contradiction, a structured research timeline, and a set of grand challenges for the XR4CE community.

A total of 32 position papers were submitted, one of which was subsequently withdrawn. The remaining 31 submissions each received 2–3 single-blind reviews from the organising committee, assessed for quality, relevance, and potential to stimulate discussion. 22 papers were accepted and are included in these proceedings. The papers address the following application domains: emergency response, disaster management, military operations, medicine and healthcare, industrial manufacturing and production, critical infrastructure, and correctional environments. Trust calibration, resilience by design, and situated explainability together account for the dominant thematic mass, with trust calibration having been addressed by 14 of the 22 papers.

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