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Emerging Forms of Human-Machine Interaction**

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Actuated and Performative Architecture: Emerging Forms of Human-Machine Interaction

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Human-Machine Interaction is expanding its reach beyond displays and objects to its next frontier: the built environment. This involves not only known visions of ubiquitous computing and adaptive environments but sensor-actuator networks, large-scale interfaces, and the Internet of Things. More than and including these systems, Actuated and Performative Architecture renders the built environment as a cyber-physical system aiming to address challenges of everyday life. Embedding computation, including robotics, into the physical fabric of buildings fosters a potentially more intimate relationship between the built environment and people. Mixing the physical and the digital redefines the borders between types of spaces, the affordances and meanings of environments, and the sense of presence. Unlike a conventional space that has a limited range of responses to dynamic, changing conditions, Actuated and Performative Architecture is intimately interconnected with users and local conditions.

This Spool [CPA] #3 issue poses and attempts to answer questions on the nature of this intimate human-machine bond, encouraging the discussion of its potentials also in terms of individual and social resilience. This issue of Spool, moreover, attempts to explore the design of bio-cyber-physical systems, which requires integration of natural, physical, and virtual architectures with digital systems and social organizations. In designing interactions between the (augmented) human and cyber-physical environments, the collection and use of personal data, the management of a multi-layered design approach, and the ethics of such design activity require attention from experts in architectural design, interaction and UX design, civil and architectural engineering, mechanical and electrical engineering, computer and information science, sociology, psychology, education, ethics, philosophy, media arts, and science and technology studies.

The papers in this issue address some of the opportunities and challenges of Actuated and Performative Architecture by exploring concepts such as time-based and experience-based design paradigms, narratives as frameworks for enhancing human-machine social relations, immediate systems, augmented realities, and cyber-physically enhanced environments.

If [Barbara](#)'s paper explores the directions taken by time-based design in order to identify new paradigms for contemporary spaces and their design, [Nogueira et al.](#) explore the digital reinterpretation of the architectural element window by means of image capture and future interactive projection aiming at expanding

experience in indoor environments. [Pavlovic et al.](#) outline the importance of mapping user experiences for cyber-physically enhanced environments by discussing design practices that can support this activity, while [Friedrich](#) proposes immediate systems in architectural research and praxis. Architecture as a Bio-Cyber-physical System that is operating as part of a larger ecosystem aiming to address societal challenges with a broader understanding of sustainability in mind, is discussed by [Pillan et al.](#) In addition to these papers, the Dialogues on Architecture initiated in the first CpA issue are continued in this issue with a dialogue addressing the impact of computation and cyber-physical systems on architecture initiated by [Nicolosi](#).

The attempt to answer questions related to the nature of the human-machine bond in architecture reveals some of the current achievements and even more future challenges. Cyber-physical architecture requires a multi-layered transdisciplinary approach that integrates humans and robots from design and production to operation of buildings.

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