

**Title :** Systemic Participatory Prototyping Tools and Methods for Sustainable Collaborative Systems.

**Host institutions and proposed thesis supervisors.** UTT (Ines di Loreto), ENAC (Catherine Letondal, Sylvain Pauchet)

**Context et problem.** Tools and methods are needed today for interactive system designers to take into account the systemic dimensions of ecological problems, with the aim of achieving strong sustainability that preserves the human habitat (Fry 2008). Indeed, without necessarily being aware of it, designers and users of interactive systems contribute to the implementation and development of practices that are indirectly harmful to a safe and just society and incompatible with planetary limits (Raworth&Bury 2018). In particular, it is relevant to distinguish between direct and indirect ecological impacts, with this topic primarily concerning the latter. An example would be Vinted-type systems that induce significant systemic effects, such as the carefree purchase of new clothes causing a rise in second-hand prices, a decrease in donations, the increase in the purchase of useless second-hand clothes with an increase in textile waste in poor countries, and the multiple transports of clothes causing energy consumption and CO2 production. The question that this thesis topic proposes to address is to support the design of applications that prevent and regulate these systemic effects (Bornes 2022) by taking them into account from the participatory prototyping stage. This approach constitutes a real challenge, because if the prototyping of interface models allows a concrete contextualization of interactions in uses, what about interactions on a social scale induced by the interactive systems concerned? How to introduce spatial, temporal and organizational scales in a participative prototyping workshop? How to represent these systemic dimensions? One promising approach is to introduce these non-local and non-immediate scales through the use of "projections", both literally and figuratively. To do this, the Systemic Design Toolkit (SDT) cards (influences, levers, values) can be complemented by "design fiction" (Nova 2023, Burnell 2028) and speculative design (Dunne&Raby 2013) techniques. A possible technical approach for these "projections" would be the use of immersive mixed reality (augmented or virtual) already implemented in participatory design fiction processes (Simeone 2022, McVeigh-Schultz 2018).

**Positioning in relation to the state of the art.** The field of sustainable HCI primarily addresses aspects related to decarbonization and eco-feedback for behavior change (Mankoff et al 2007), but focusing technological interventions on changing individual behavior has its limitations (Brynjarsdottir 2012), and technological "solutions" can lead to rebound effects (Preist 2016). While HCI methods are still immature (Bremer 2022), systemic design approaches (Jones 2020) are a promising direction. A first track of dynamic modeling tools for designers is explored (Bornes 2022), but it also seems necessary to integrate a participatory prototyping dimension in order to bring a concrete contextualization of interactions in uses, as in (Burnell 2028), but relying on mixed reality tools. The use of immersive mixed reality is applied for sustainability purposes (Jansen 2023), but for the use phase only. There is also work on mixed reality to support collaborative design (Simeone 2022, McVeigh-Schultz 2018), but without integration of a systemic approach.

**Approche / Enjeux / Originalité.** L'originalité de l'approche réside dans l'apport de la dimension systémique du prototypage participatif permettant de concevoir des systèmes collaboratifs à grande échelle répondant aux besoins de soutenabilité forte.

**Scientific and technical objectives.** The scientific objective of the thesis is to evaluate the feasibility and relevance of bringing a systemic dimension to participatory prototyping. The thesis will thus investigate the question of concrete and collaborative participation in the prototyping of an interactive system by real users that allows them at the same time to contextualize the interactions at a more global scale, whether it is a spatial, temporal or organizational scale. This objective is ambitious because it implies the integration of projection elements involving dimensions that cannot be directly perceived in prototyping workshops. The technical objective is to design tools that support this collaborative and concrete contextualization through "projections" based on speculative design and immersive and accessible mixed reality.

**Project organization, milestones.** The main steps of the thesis include, after a state of the art, two iterative steps to be carried out in parallel: 1) participative design of case studies: field surveys on practices with systemic effects; collaborative workshops of systemic analysis of situations (cf SDT systemic design toolkit); ideation workshops on projection elements also using, or even extending the SDT; design of case studies; publication of surveys and case studies with implications for the design of projection elements; 2) design and development of mixed reality projection tools: investigation of projection element needs based on analyses performed in previous iterations;

participatory design of mixed reality projection elements; development of these tools; use in participatory prototyping workshop on study cases; evaluation and reiteration of design; publication of tools. The thesis will end with a toolkit proposal for systemic prototyping.

**Partnership: presentation and role of co-supervisors.** UTT : Ines di Loreto (eco-design, permaengineering, multisensoriality, informal learning, socio-technical issues). ENAC : Catherine Letondal (systemic design, end-user development, participatory design, modeling and simulation of complex dynamic systems), Sylvain Pauchet (design, mixed reality, institutional design).

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