# Smart for Life: Designing Smart Home Technologies that Evolve with Users

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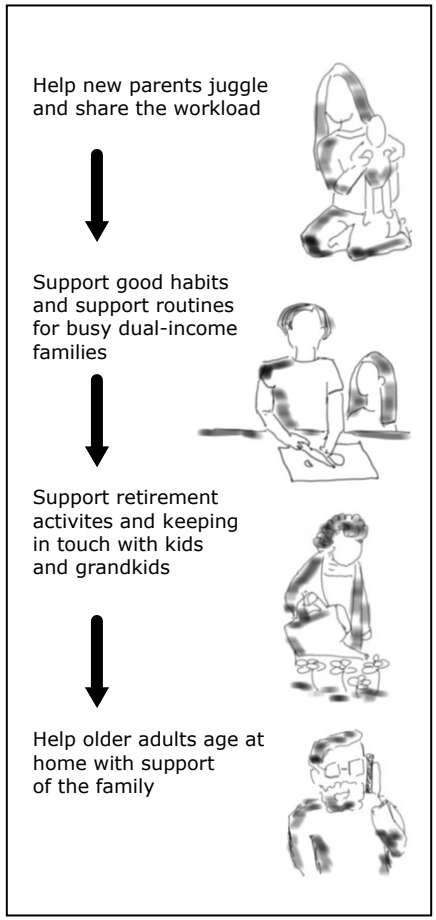
## Abstract
As sensing and actuation technologies grow more widespread, smart home infrastructures will become both feasible and flexible in supporting multiple applications. The development of these "smart home technologies" have been investigated by diverse fields spanning technical, sociological, and health-oriented disciplines, attempting to meet varying users' needs from technology savvy, "mass market", and functionally declining older adult populations. In an effort to promote human-centred knowledge exchange and design expertise between these communities, this workshop aims to explore interaction design for intended smart home users at and transitioning between successive life stages. Ultimately, we will aim to address how smart home technologies can be designed to *evolve with their users* over the life course. By uniting researchers and designers from various backgrounds, we hope to stimulate both actionable insights and design artifacts that better capture the evolutionary nature of users and their home contexts, which participants can then apply in their own research and design work going forward.

## Author Keywords
Home automation; smart home; ambient assisted living; life course; user centred design; interaction design




**ACM Classification Keywords**
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## Introduction

As society grows ever more connected, the promise of smart home technologies continues to motivate research interest across diverse disciplines such as computer science, engineering, social science, design, and relevant health-oriented clinical sciences (e.g., gerontology). Across these domains, research goals may vary from advancing technological innovation, to exploring a specific application domain, to investigating a particular user population. Despite these differences, however, we contend that the creation and/or consumption of knowledge about the problems, needs, and experiences of intended users is shared by all. We believe an untapped opportunity exists for the exchange of rich knowledge and methodological expertise – both in research and design – in the study and design of user-centred smart home technologies.

## Smart home technologies and the life course

We contend that understanding how users evolve over the life course may support the iterative, incremental process of smart home technology adoption and sustained use over time [8]. The concept of "life course" can be understood as "the interweave of age-graded trajectories, such as work careers and family pathways, that are subject to changing conditions and future options, and to short-term transitions…" [4] The notion of "interweaving" addresses *interdependency* across kin, friends, and other social relationships over the life span, which is a central principle of the life course paradigm. Evolving interdependencies would, thus, indeed influence the appropriateness and use (or non-use) of any home-based solution. For example (see also figure in the left margin), new parents may benefit from smart home technologies that facilitate their focus on juggling the demands of infant care. As their children grow, new or adapted solutions for dual-income families may support regular routines and habit-building in their children [3]. As these young adult children grow up and move out, "empty nested" parents may have greater financial flexibility and interest in 'nice-to-have' smart home technologies, especially if solutions support their retirement activities. Finally, as these parents' move into later life stages, health issues (e.g., cognitive deficit, mobility limitations) may suggest opportunities for assistive smart home – also referred to *ambient assisted living* – technologies to promote continued activity and sustained independent living ("aging-in-place"), in a complementary fashion to available family or formal care [5,6]. Although the smart home technology literature has explored, to varying extents, the described life segments (left margin, next page), indeed, the represented actors and activities are socio-culturally limited. Our workshop will pragmatically address issues of diversity by 1) adapting the segments for workshop discussion to reflect participants' submitted work, and 2) encouraging ongoing reflections and reflexivity throughout discussion and design work (e.g., "Which individuals or social groups are included, and which might be marginalized in/by this design?").

At the heart investigating successive segments are two high-level questions this workshop will aim to address: 1) How and why might these users adopt smart home solutions at a particular life stage? 2) How can we design smart home technologies with adequate flexibility to support use *at and (as they transition)*

1. ***Early 30s segment*:** One stay-at-home and one working parent with young children (1yo, 3yo); not yet homeowners but interested in economical do-it-yourself smart home solutions.
2. ***Mid 40s segment:*** Dual-income family, recently moved into their own new home with older children (12yo, 15yo). New homeowners interested in 'modernizing' their home to facilitate family and household coordination.
3. ***Late 50s/Early 60s segment:*** Soon-to-retire/early retired parents of young adult children who have moved out. Both in fairly good health with the disposable income for home upgrades and travelling. Keen to stay connected to their adult children and grandchildren.
4. ***Late 70s/Early 80s:*** Widowed older adult who has now moved alone from his/her family home into a smaller apartment. Experiencing both physical and cognitive decline (early dementia) and therefore increasingly seeking help from adult children (e.g., shopping, finances).

*between* successive life stages? Previous CHI workshops have set the stage for these questions, discussing appropriate methods for studying technology in the home [2] and developing scenarios for future smart home technologies [1]. Others have proposed approaches for designing future technological states, (e.g., *fieldwork of the future* [9]). We believe that a life course perspective applied to this design space can encourage researchers and designers to clarify their intended users, investigate how users and user segments evolve over time, and map opportunities for smart home technologies onto these dynamic trajectories.

## Smart home interaction design: Converging on resonance

This workshop will adopt an interaction design approach to investigating our questions of interest. We contend that, despite differences between how users specify and value their smart home solutions, the ways in which users interact with the technology can share common workflows, design patterns, and/or interaction metaphors. Interaction design can further converge as multiple smart home applications share similar technical infrastructure. In support of designing interactions for different user segments, this workshop will explore how interaction design for younger user segments may benefit older persons with functional limitations. Likewise, we will also explore how interactions designed particularly for these older adult users might also *resonate* with others, who may not necessarily have the same deficit/disability, but whose circumstances may also lend themselves to benefit [10]. Exploring opportunities for resonance aims to generate designs that will meet the broadest range of users and needs, and thereby position these technologies to be used over time as users evolve.

## Workshop Themes and Methodology

Our goal for this workshop is to strongly build on the expertise and insights that our participants bring with them and incorporate it with our hands-on design activities. In order to do so, we will require workshop participants to synthesize their research in a specific format. Our design activities will be guided by a method introduced by Kolko [7] who proposes a creative process by which to connect (research) insights with design patterns in order to generate well-grounded design ideas. Each *insight* should provide a "clear, deep, meaningful perception into human behavior in a particular design context", while each *design pattern* should represent "a trending paradigm that describes invariant qualities, referencing history and similar solutions" [7].

We will invite participant submissions of three types: a) ethnographic, user, and/or life course research papers that contribute insights and observations about prospective users and their contexts (e.g., research informing/generating personas or scenarios); b) design or development papers that demonstrate the use/examples of design patterns or state technology paradigms (i.e., toward the development of novel technologies); or c) visionary or conceptual papers inspiring the ideation of design ideas (e.g., scenarios of life in a technological future, discussions of smart homes in popular media).

In preparation for the workshop, we will structure the ideation of smart home applications around four scenarios, each representing one specific user segment.

- How might smart home technologies facilitate users' transitions between life stages?
- How might smart home technologies (i.e., infrastructure, applications) need to be modified during these transitions, and what conditions/circumstances would trigger/indicate these changes?
- How might pragmatic issues, such as budgets, technical maintenance and the spectrum of technological expertise, be addressed in these transitional processes? What would it take to turn the idea into an actual consumer-facing product?
- What are the implications for the end-to-end user experience? If we think about the design idea as a consumer product, how will the experience from buying a product to its installation and its disposal look like?

Building on the generated design ideas, the last part of the workshop will involve a semi-structured discussion about how smart home technologies can support and evolve with users *as they transition between* life stages (see questions in the left margin).

## Goals and Outcome

The high-level goals for this workshop are to 1) generate design ideas that participants can apply in their own work, 2) identify aspects of resonance through which smart home technologies may evolve over life course, and 3) exchange user-centred knowledge and expertise between diverse research and design communities. In particular, we hope to bring together the communities interested in more general-purpose smart home applications with those invested in more health-oriented ambient assisted living applications. While the former often focuses on technical feasibility and pushing the boundaries of technological innovation, we believe the latter possesses unique knowledge of the particularities of aging, disability and the life course for which the same technological innovations may resonate.

To promote continued exchange between participants after this workshop, we will aim to summarize synergistic and actionable design opportunities in the forms of personas, scenarios, and/or articulated design ideas, which participants may then apply in their own research. Contingent on discussion and engagement, we aim to co-author with interested participants a summary article posing key questions, insights, and future directions back to the HCI community.

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