End-User Development: Empowering Stakeholders with Artificial Intelligence, Meta-Design, and Cultures of Participation

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Abstract. End-User Development (EUD) represents the objective to empower all stakeholders (designers, users, workers, learners, teachers) to actively participate and to make their voices heard in personally meaningful problems. Artificial Intelligence (AI) is currently being considered world-wide as a "deus ex machina" — despite lacking a generally accepted definition, it is credited with miraculous abilities to solve all problems.
The presentation will explore and differentiate how AI approaches can support or inhibit different stakeholders to cope with wicked problems in a changing world for which EUD is essential.
The relationship between specific AI approaches and meta-design and cultures of participation (being promising frameworks to support EUD) will be explored and critically assessed and prototypical system developments will be described to illustrate different design strategies that will advance EUD not only as a technology, but as a cultural transformation.

Keywords: End-User Development (EUD), Artificial Intelligence (AI), Artificial General Intelligence (AGI), Human-Centered AI (HCAI), AI for Specific Purposes (AISP), Meta-Design, Cultures of Participation, Cultural Transformations

1 Introduction

In a world that is not predictable and in which change is the only constant, improvisation, evolution, and innovation are more than luxuries: they are necessities. The challenge of design is not a matter of getting rid of the emergent, but rather of including it and making it an opportunity for more creative and more adequate solutions to problems. *End-user development (EUD)* provides the enabling conditions for empowering stakeholders by defining the technical and social conditions for broad participation in design and decision making activities.

Artificial Intelligence (AI) is currently being considered world-wide as a "deus ex machina" and is promoted by politicians and scientists having miraculous abilities to solve all problems.

Both EUD and AI are *"suitcase words"* [1]: words carrying many meanings so researchers and practitioners can talk about complex issues in shorthand. Suitcase words contain multiple and expanding meanings across very different contexts and can lead to misunderstandings when we assume that everyone attributes the same meaning to them. To identify research themes surrounding EUD (Figure 1) and AI (Figure 2) represent an attempt to unpack EUD and AI as suitcase words by exploring specific aspects of them.

The paper characterizes EUD and AI in the first two sections and explores in the following sections (1) the relationship between them, (2) their roles and contributions to democratizing the design, use, and evolution of socio-technical environments in specific domains, and (4) challenges for future developments. The analysis of themes, concepts, principles, differentiations, and prototypes attempts to envision a future of EUD by exploiting promises and avoiding pitfalls of different AI approaches towards the empowerment of all stakeholders.

2 End-User Development (EUD)

EUD [2] is instrumental for the ability to reformulate knowledge, to express oneself creatively and appropriately, and to produce and generate information rather than simply to comprehend it. It supports diverse audiences in designing and building their own artifacts by situating computation in new contexts, by generating content, and by developing tools that democratize design, innovation, and knowledge creation. EUD is necessary for coping with *wicked problems* [3] for which the framing of problems is incomplete at design time and continues throughout the whole life cycle of a system in order to respond to the ongoing changes of a living world.

An early inspiration for the desirability and necessity for EUD was articulated by Ivan Illich with *convivial systems* envisioned to *"give each person who uses them the greatest opportunity to enrich the environment with the fruits of his or her vision"* [4]. This objective distributes control among all stakeholders (e.g.: system designers and end-users) and it grants autonomy for end-users to modify computational artifacts to their needs.

Different aspects of EUD have been pursued in numerous domains addressing a variety of challenges and objectives. Figure 1 provides a selection of these domains as an attempt for unpacking EUD as a suitcase word into more specific objectives. The variety of the domains transcends currently existing narrow views of EUD (e.g. seeing it only as a technical challenge to support new ways of end-user programming). It represents a *vision for the future of EUD* as a fundamental research area to increase the quality of life for all humans by democratizing the design and use of social policies and computational artifacts and by increasing the collective creativity to respond to wicked problems. The current world-wide struggle to cope with the disruption and upheaval caused by Covid-19 provides an important examples illustrating these arguments.

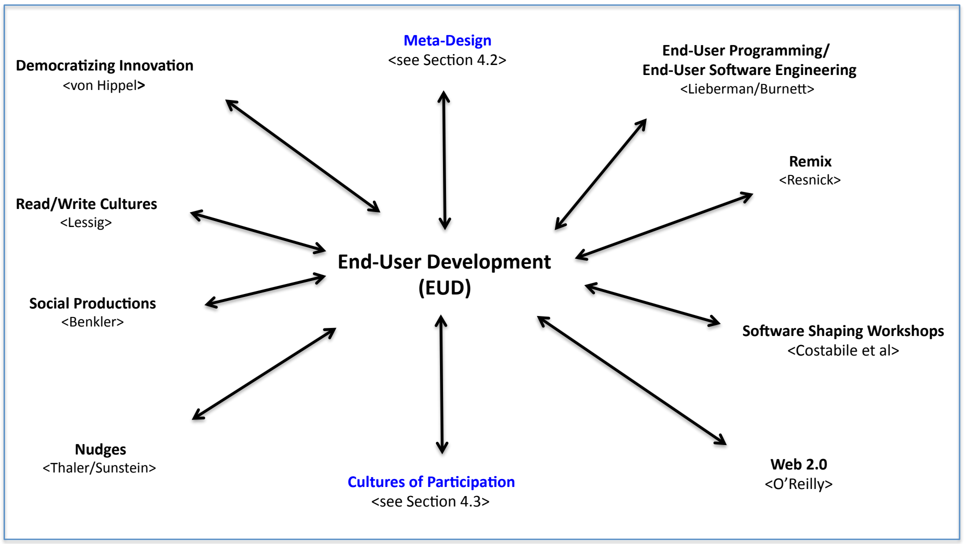

Figure 1: Different Domains of End-User Development (EUD)

The domains mentioned in Figure 1 can be briefly described as follows:

- *End-User Programming (EUP)* [5] empowers and supports end-users to program and *End-User Software Engineering (EUSE)* adds to EUP the support for systematic and disciplined activities for the whole software lifecycle;
- *Remix* [6] supports a core design principle and computational practice that anyone can remix another user's project and add their own ideas (successfully employed in Scratch);
- *Software Shaping Workshops* [7] allows end users to carry out their activities and adapt environments and tools without the burden of using traditional programming languages by using high-level visual languages tailored to their needs;
- *Web 2.0 technologies* [8] support websites that allow mass participation by end-users (as practiced in Wikipedia and Open Source);
- *Democratizing Innovation* [9] provides argumentation that active end-users can develop what they want, rather than relying on professional designers and manufacturers to act as their agents;

- *Read/Write Cultures* [10] explores intellectual property issues allowing all stakeholders to share their creative contributions transcending the limits of Read/Only cultures in which people are restricted to consumption;
- *Social production* [11] analyzes frameworks and examples for effective, large-scale cooperative efforts of peer production;
- *Nudges* [12] provide examples of major social policies issues in which choice architects try to motivate people to engage in certain actions and behavior, but simultaneously provide them with EUD opportunities to have complete choice over their own actions by supporting a methodology characterized as "libertarian paternalism" [12].

The contributions of *meta-design* and *cultures of participation* will be discussed in more detail in Sections 4.2 and 4.3.

3 Artificial Intelligence (AI)

There is no generally accepted definition for AI and there is no defined boundary to separate "AI systems" from "non-AI systems". Despite this shortcoming AI is currently being considered world-wide as a "deus ex machina" and it is credited with miraculous abilities to solve all problems and exploit all opportunities of the digital age.

Figure 2 makes an attempt (analogous to Figure 1 for EUD) to unpack the "suitcase word" AI into more specific research areas (most of them still being only vaguely defined). The overview differentiates between

- *Artificial General Intelligence (AGI)* [13] is the envisioned objective to create intelligent agents that will match human capabilities for understanding and learning any intellectual task that a human being can. While some researchers consider AGI as the ultimate goal of AI, for others AGI remains speculative as no such system has been demonstrated yet. Opinions vary both on whether and when AGI will arrive, if at all.
- *AI for Specific Purposes (AISP)* [14] is an engineering discipline that explores specific well-defined problems for which AI systems performs better than human beings. Many successful contributions have occurred in achieving these objectives providing the basis for the current hype surrounding AI. Human involvement is not a relevant design criteria in these approaches.
- *Human-Centered AI (HCAI)* [15, 16] (closely related to *intelligence augmentation* [17, 18]) is focused on improving the quality of life of humans by creating AI systems that amplify, augment, and enhance human performance in ways that make systems reliable, safe, and trustworthy.

AISP is focused on "tame" problems whereas HCAI is addressing "wicked" problems [3] for which framing a problem is as important as solving a problem and for which no correct solutions and no boundaries exist. This article is focused on the mutual dependencies between EUD and HCAI in which all human stakeholders play a critical role and the algorithms are glass boxes instead of black boxes capable of explaining how they reach decisions.

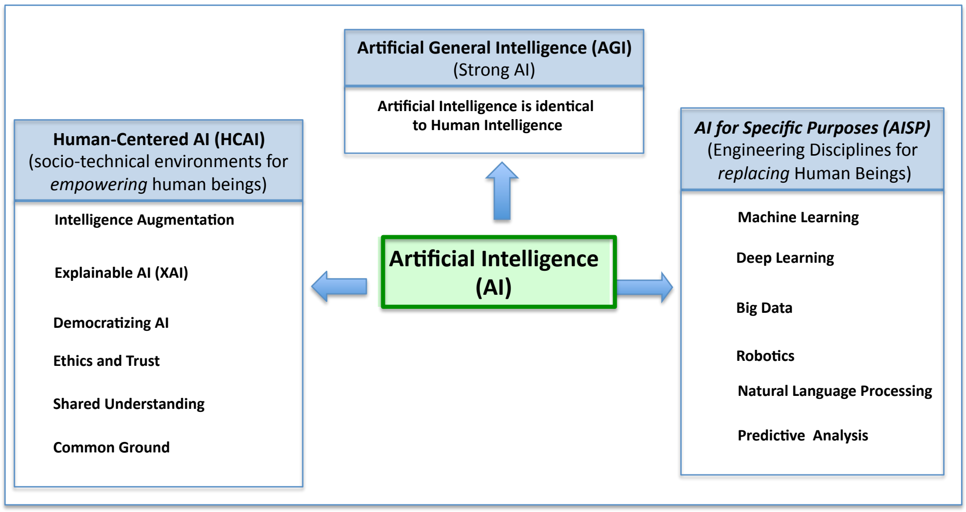

Figure 2: Differentiating AI Approaches

The current views and the goals and objectives of future developments of AI can be differentiated into three major categories (the edited book by [19] contains over one hundred short opinion pieces of prominent AI researchers and critics that address these different perspectives):

- *AI Utopians (or Euphoriker)* [13] believe that AGI is a realistic and desirable goal for the not too distant future and advocating trans-humanism and singularity are desirable and inevitable objective*s*;
- *AI Pessimists (or Apokalyptiker)* [20] argue that AI has failed and the objectives of AGI are dangerous for the future of the human race;
- *AI Realists* assert that there is on one hand substantial progress in pursuing and incorporating AI approaches addressing fundamental societal problems and on the other hand there are just as many unsolved problems for which human intelligence will be far superior to artificial ones for decades to come. They address the reluctance in many segments of society to allow computers to take over tasks that simple models perform demonstrably better than humans. Their efforts are focused not on AGI but on the improvement of tools in the AISP domains and using HCAI for creating supportive socio-technical environments.

The argumentation of this paper is grounded in the basic assumption that in order to advance the EUD agenda the objectives of the "AI Realists" are the most promising way to pursue.

4 Integrating EUD and AI

Democracy distributes the power to process information and make decisions among many stakeholders (meta-designers and end-users, choice architects, and citizens) acting at different times (e.g.: design time and use time). Democratizing the development, evolution, and use of socio-technical environments is the essence of EUD and provides the intellectual glue between the different domains mentioned in Figure 1.

The core theme of IS-EUD 2021 is whether AI will further enhance or hinder the possibilities and support for EUD. The differentiations of EUD and AI by unpacking them as suitcase words provide a basis to assess this question in specific contexts.

EUD is required and most valuable in coping with wicked problems in a changing world. AI has been most successful in providing solutions for specific problems (right column in Figure 2). The efficiency of the algorithms based on their increasing complexity will shift more and more authority from humans to AISP systems. The usefulness and strengths of AISP systems (e.g.: relying on Google's search algorithm for finding relevant and trustworthy information, navigating in physical space with GPS systems, accepting the suggestion of recommender systems for movies to see, articles and books to read, partners to meet, etc.) is evident from their wide spread use. Their negative impacts can be seen that we as individuals and societies increasingly depend on AI algorithms we do not understand because their motivations and intentions shaping their workings, are hidden from us.

In contrast to the objectives of EUD, AI developments could undermine many practical advantages of democracy, and they may further concentrate power among a small elite [21]. People may be forced (or may give up voluntarily) an increasing amount of authority, control, and autonomy over their lives because they will trust the algorithms more than their own judgment and decision making. They will become dependent on high-tech scribes rather than being in charge of their own destiny. These dangers exist specifically for AISP approaches exploiting nonhuman abilities. For example: "Big Data" approaches [22] base their results primarily on *correlations* (not knowing *why* but only *what*). It is important to note that correlations do not imply causations. It may well be that for many everyday needs, knowing what is good enough. But human reasoning and EUD is dominated by causality: therefore HCAI approaches augmenting human intelligence require knowledge about causal relationships for shared understanding and common ground and true understanding. The fact that correlations do not imply causalities (even many in the press and some researchers often imply otherwise) is nicely illustrated by Khan in his episode "Eating Breakfast May Beat Obesity" [23].

The *design trade-offs* [24] between AI and EUD (situated and analyzed in specific contexts) need to be further explored grounded in an initial understanding that position them as opposites on a spectrum of autonomy and control (AI being low in control and autonomy and EUD being high in control and autonomy). Additional important objectives should be pursued such as (1) exploring further synergistic opportunities (as we have attempted in our research effort [25] by using AI components for supporting EUD activities (thereby lowering the bar for people to engage in EUD and to suggest opportunities for EUD), and (2) strengthening and operationalizing HCAI by supporting EUD.

4.1 Explainable AI (XAI)

Explainable AI (XAI) [26] refers to methods and techniques that enable humans to understand, trust, and modify the reasoning and results of AI programs. AISP systems learn to solve problems such as classifying inputs (e.g., is this a picture of a cat or dog?) or making decisions (e.g., what treatment should be given to a patient with particular symptoms?) by automatically generalizing from a large set of examples [22]. The inner workings of such systems are a "black box": given a question, systems provide an answer, but they cannot explain how or why they reached the answer. Lacking the ability to explain itself, systems cannot be trusted particularly in high-stakes applications.

As an example: imagine someone is using her favorite GPS system to find her way in an unfamiliar area, and the GPS directs her to turn left at an intersection, which strikes her as wrong. If the navigation was coming from a friend in the passenger seat reading a map, she may ask, "Are you sure?". However, users do not have any way to query their GPS system. Most current GPS systems are not capable of meaningful explanations, they cannot describe their intentions in a way users would understand, and they cannot convey confidence in the route they have selected.

XAI is an important step toward helping AI systems and people work together in a synergistic fashion. Humans trust and assist other humans based on common ground and shared understanding. We trust others if we understand how others think, so that we have common ground to resolve ambiguities. We trust them if they have the integrity to admit mistakes and accept blame. We trust them if we have shared values [27].

Shneiderman developed a model for HCAI [28] focused on three major objectives: trust, reliability, and safety. His extensive framework for these objectives (supported by numerous examples) represents important foundations for developing XAI systems.

4.2 Meta-Design

Design (being another suitcase word) is focused on how things ought to be in order to attain desired functions and meanings [29]. *Meta-design* ('design for designers') [30, 31] is a theoretical framework to conceptualize and to cope in unique ways with design problems. It is focused on open-ended co-design processes in which all the involved actors actively participate in different ways [32]. It is grounded in the fundamental assumption that design is not a matter of getting rid of the emergent, but rather of including it and making it an opportunity for more creative and more adequate solutions to problems. Many design approaches force all the design intelligence to the earliest part of the design process, when everyone knows the least about what is really needed. The understanding of a problem cannot be complete at any time due to the situated, tacit, and evolving nature of knowledge work [33].

Meta-design provides the enabling conditions for putting users in charge who act until they experience a breakdown that may lead them to reflection and learning new relevant topics on demand. These breakdowns are experienced by end-users at use time and not by system builders at design time [31]. End users need the ability to evolve and refine their problem framing and problem solving attempts. Meta-designers use their own creativity to produce socio-technical environments in which other people can be creative. They define the *technical* and *social* conditions for broad participation in design activities.

Making systems modifiable has to be a design objective for the original system. Adding system components to allow for end-user modifiability in a system constructed without this goal in mind is a nearly impossible task. Meta-Design can be supported with the *Seeding, Evolutionary Growth, and Reseeding (SER) Model* [34]. The SER model is a descriptive and prescriptive model for creating systems that best fit an emerging and evolving context. Instead of attempting to build complete systems, the SER model advocates building *seeds* that can evolve over time. It postulates that systems that evolve over a sustained time span must continually alternate between (1) periods of planned activity and unplanned evolution, and (2) periods of deliberate (re)structuring and enhancement. A seed is something that has the potential to change and grow. In socio-technical environments, seeds need to be designed and created for the technical as well as the social component of the environment.

Meta-design will benefit from the following developments that can be effectively supported by HCAI: (1) offer *task-specific languages* supporting human problem-domain interaction [35]; (2) provide *programming environments* (such as Scratch [6]) that protect users from low-level computational drudgery; (3) support *customization, reuse, and redesign* effectively [36]; (4) tailor *software applications* at use time with component-based approaches [37]; and (5) advance construction kits to *domain-oriented design environments* with intelligent support systems [38].

4.3 Cultures of Participation

Cultures of participation [39] have emerged as the result of the shift from consumer cultures (in which people are confined to passive recipients of artifacts and systems) to cultures in which users are actively involved in the development and evolution of solutions to their problems.

Professional programmers and domain professionals define the endpoints of a continuum of computer users. The former like computers because they can program, and the latter because they get their work done. The goal of supporting domain professionals to develop and modify systems does not imply transferring the responsibility of good system design to the end-user [5]. Normal users will in general not build tools of the quality a professional designer would. However, if a tool does not satisfy the needs or the tastes of the end-users (who know best what these requirements are), then EUD and HCAI support should assist stakeholders to adapt and evolve their systems.

A fundamental challenge for cultures of participation is to conceptualize, create, and evolve socio-technical environments that not only enable and support users' participation, but also successfully *encourage* it. Participation is often determined by an individual's assessment of value/effort. The effort can be reduced by providing the right kind of tools with meta-design, and the value can be increased by contributing to framing and solving a personally meaningful problem and sharing the results with others.

5 Socio-Technical Environments Exploring EUD and AI Perspectives

To assess the viability and applicability of the concepts and components of the framework described in the previous sections, we have developed prototypes in a variety of different domains. Some of these approaches will be briefly described.

5.1 Adaptive and Adaptable Systems

In socio-technical environments modeling changing worlds, the shared knowledge between users and systems should not be static, but should increase and change over time. There are two major ways that this can be achieved: making systems *adaptive* and/or *adaptable*. Table 1 provides a summary of different characteristics associated with the two types of systems. Adaptive systems rely primarily on AI system components whereas adaptable systems exploit different aspects of EUD.

A successful combination for the integration of adaptive and adaptable components can be illustrated using the *"Auto Correct" feature of Microsoft Word* as a simple example. This feature automatically detects and corrects misspelled words, e.g.: "hte" is transformed into "the" and (2) "EHR" into "HER". Changes will not necessarily be noticed by users. While the first transformation is wanted, the second one is not wanted in specific contexts. For example: we sent a letter to a National Science Foundation department called "Education and Human Resources" addressing them with "HER" rather than "EHR" (probably not creating a favorable impression at an agency that was funding our research). In another context (the medical domain) "EHR" may mean "Electronic Patient Record". The designers of "AutoCorrect" recognized the limitations of determining the context in the abstract, and they provided an adaptable EUD tool allowing for users to overwrite the system's feature with specific situated needs of users that include the deletion and addition of specific rewrites and/or the option to turn off the feature altogether. This simple example shows that AI and EUD components can successfully be combined.

Table 1: A Comparison between Adaptive and Adaptable Systems

	Adaptive (AI Focus)	**Adaptable (EUD Focus)**
Definition	Dynamic adaptation by the system itself to current task and current user	Users change the functionality of the system
Knowledge	Contained in the system; projected in different ways	Knowledge is extended by users
Strengths	Little (or no) effort by users; no special user knowledge is required	Users are in control; users know their tasks best
Weaknesses	Users often have difficulties developing a coherent model of the system; loss of control	Users must do substantial work and need to learn adaptation components
Mechanisms	Models of users, tasks, and dialogs; incremental update of models	Support for end-user modi-fiability and development
Applications	Active help systems, critiquing systems, recommender systems	Construction kits, macros, specification components

5.2 Domain-Oriented Design Environments (DODEs)

Domain-oriented systems (as an alternative to general purpose programming language) put end-users in charge by supporting human problem-domain interaction. This section briefly describes the steps (emphasizing EUD and AI aspects) leading towards our long-term vision of *domain-oriented design environments (DODEs)* [40].

Domain-oriented *construction kits* reduce the demands for users by providing high-level building blocks for reuse, redesign, and remixing. They intentionally sacrifice generality for more elaborate support of domain semantics. But construction kits by themselves provide insufficient support for creating interesting, high quality artifacts, because they do not support shortcomings of the artifact under construction.

DODEs enrich constructions kits with a variety of HCAI systems, including: (1) *specification components* allowing users to communicate specific aspects of problems to DODEs to increase the shared understanding; (2) *critics* analyzing an artifact under development by using design principles to detect and critique suboptimal solutions and inform users that the current design violates standard rules; and (3) *catalogs* of previous developed solutions supporting design by modification rather than starting from scratch.

Support for EUD is critical for DODEs. They need to evolve to capture the evolution of artifacts meeting the demands of a changing world. We have explored and implemented principles for EUD in our prototypes [25] including the design of (1) new design objects, (2) new critiquing rules, and (3) additional requirements derived from the needs of disabled persons. All of these components rely and can and should be further enhanced with HCAI techniques.

5.3 Context-Aware Systems

Context-aware systems [41] are grounded in the basic assumption that the scarce resource for many people in today's world is not information but human attention creating the challenge not to deliver more information "to anyone, at anytime, and from anywhere," but to provide *"the 'right' information, at the 'right' time, in the 'right' place, in the 'right' way, to the 'right' person."*

Context-aware systems rely on models of tasks and users. P*ersonalization* represent a prominent technique that has been widely used to escape global group identities and replace them with much more detailed predictions for each individual.

The further development of context-aware systems raises numerous issues for EUD and HCAI research activities such as: (1) how to *identify and infer user goals* from low-level interactions?; (2) how to *integrate different modeling techniques* (e.g., adaptive and adaptable components? see Table 1); (3) how to capture the *larger and unarticulated context* for understanding what users are doing and the associated costs for providing design rationale, tagging and rating an artifact, curation of large information repositories; and (4) how to identify the *pitfalls* associated with context-aware systems such as filter bubbles and "group think" as consequences of personalization and privacy protection.

6 Challenges for the Future

To create a synergy between EUD and HCAI, research activities have to identify the social abilities, technical skills, and cultural competencies needed by people to participate in these activities. The scope of human-centered design needs to be broadened from the usability of systems to providing resources, incentives, and information to encourage and sustain participation. A deeper understanding will be required to differentiate domains in which EUD and HCAI will flourish and be successful from the domains for which they are not suited. A few of these global challenges will be briefly elaborated.

6.1 EUD Objectives for Democratizing AI

EUD objectives for democratizing AI are more relevant and more applicable in the "open" domains of HCAI (left column in Figure 2), then in the "closed" AISP systems (right column in Figure 2). But aligning AI capabilities with EUD objectives, it should not be overlooked that these approaches present a number of important design trade-offs that require careful attention and further exploration including:

- *establishing different discourses:* to deeply understand the potential transformation of human lives enriched rather than limited by HCAI technologies, discourses and investigations must not only be focused around technological issues but explore motivation, control, ownership, autonomy, and quality;

- *deskilling and overreliance:* using hand-held calculators, spelling correctors, navigation systems, and automatic translators, will humans loose important cognitive capabilities and how can an overreliance on external tools be avoided?;
- *participation overload:* in the context of cultures of participation will the support for active engagement lead to participation overload (particularly in personally irrelevant activities)?
- *learning demands:* how to cope with extensive learning demands required by tools that allow humans to exploit the benefits of complex HCAI technologies in distributed cognition approaches?

6.2 Participation Overload in the Context of Personally Irrelevant Problems

Our research in meta-design and cultures of participation has identified a fundamental design trade-off between developments that should be avoided: (1) in *personally meaningful activities* someone wants to be a designer but is forced to be a consumer versus (2) in *personally irrelevant activities* someone wants to be a consumer but is forced to be a designer.

The second development leads to *participation overload in* "Do-It-Yourself (DIY)" societies. Currently, AI techniques are employed in numerous contexts that allow or force people such as (1) to check out their own groceries or check in by themselves at airports; (2) make their own travel arrangements (including relying on aggregator systems such as Kayak or prediction systems such as FareCast); (3) take care of their banking needs; (4) write and typeset their papers, and (5) constantly provide feedback about services (e.g.: for hotels, flights, repair shops, support provided via the Internet).

Participation overload will become a burden in complex, unfamiliar, and personally irrelevant domains where freedom of choice becomes a burden rather than a benefit and people would prefer not spending time on a problem or activity at all. The problem can be illustrated and analyzed with the concept of *"libertarian paternalism"* [12], a design-trade-off discussed in behavioral economics and public policy. The approach explores middle ground as the choice between paternalism (being prescriptive) and libertarian (being permissive) by distributing control with nudges between choice architects (e.g.: policy makers in governments, designers, teachers, meta-designers) and users (e.g.: citizens, learners, end-users). A reasonable amount of paternalism (e.g. by establishing sensible defaults) will reduce the burden on users and simultaneously the libertarian components will respect the autonomy of users.

6.3 Cultural Transformations

The context for human development is always a culture, never an isolated technology. EUD and HCAI are *society-changing inventions* with the potential making it easier to deal with the world's complexity and wicked problems.

Providing all citizens with the means to become co-creators of new ideas, knowledge, and products and giving them more control to evolve systems in personally meaningful activities presents one of the most exciting innovations and transformations with profound implications in the years to come. This objective characterizes the vision behind EUD as a *cultural transformation*. To make this vision a reality, the EUD research community needs to establish new discourses and shared languages about concepts, assumptions, values, stories, metaphors, design approaches, and learning theories.

EUD developments will erode monopoly positions held by professions, educational institutions, experts, and high-tech scribes. They will empower all stakeholders to design, build, and evolve their own artifacts supported by meta-designers and choice architects who create environments to foster cultures of participation. These objectives will situate computation in new cultural and material contexts. HCAI developments will make a contribution to these objectives when they are focused on *enhancing* quality of life, not ignoring or diminish it.

For analyzing the promises and the pitfalls associated with different approaches *there are no decontextualized sweet spots* but the investigations must be situated and explored in specific contexts. The objectives "self-driving cars" and "mobility for all" can illustrate the distinction between technological objectives and cultural transformation. Ten years ago, self-driving cars (focused on technological advances) seemed to be more a topic for science fiction than a near-term reality, but rapid progress is now made at the technological level towards this goal. While self-driving cars are an important component of "mobility for all" (conceptualized as a cultural transformation), they are only *one component* in a complex network of interrelated topics. By considering "mobility for all" as another wicked problem with no boundaries, the following objectives and design trade-offs need to be taken into account: (1) reduce the need for it (e.g.: by facilitating working from home) versus supporting it; (2) improve mass transportation instead of focusing on individual car traffic; (3) limit the environmental damage with electric cars; (4) explore different models of ownership of automobiles (including car sharing); (5) support the independence of people unable to drive, and (6) reduce the number of accidents and traffic deaths.

7 Conclusions

To deeply understand the potential transformation of human lives enriched rather than limited by EUD and HCAI technologies, discourses and investigations must not only be focused around technological issues but explore motivation, control, ownership, autonomy, quality of life, and cultural transformation. Changes in complex environments are not primarily dictated by technology but they are the result of a shift in human behavior and social organization. The design of socio-technical environments requires the co-design of social and technical systems.

While the growth of technologies such as EUD and AI is certain, the inevitability of any particular future is not. In a world facing wicked problems the aim is not to find truth, but to improve the quality of life for all humans. A mutually beneficial relationship between EUD and AI will not happen by itself but will require a serious commitment to the objective to initiate cultural transformations that will empower all stakeholders

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