# Technological Innovations and Cultural Changes for Engaging and Empowering End-Users

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**Abstract**

Engaging and empowering end-users has been a fundamental research objective of our Center for Lifelong Learning and Design (L3D) for the last few decades. My contribution will document how a simplistic and narrow initial understanding has evolved based on identifying the critical roles that end-users can and need to play to address the wicked problems that individuals and communities are facing in the digital age. Grounded in the analysis, the findings, and the assessment of specific frameworks and socio-technical developments, research objectives, requirements, and design trade-offs are described to further refine the concept of end-user in the age of AI ensuring that technological innovations contribute positively to cultural evolution in an increasingly digital world.

**Keywords**

End-Users, AI, Large Language Models, ChatGPT

## 1. Early Insights and Empirical Foundations

This section will describe the development of conceptual frameworks, inspirational prototypes, and empirical findings and insights that provided incentives and design requirements for our work in L3D at CU Boulder for exploring the concepts of “end-users” and “end-user development” and their different interpretations. "End-user development" (EUD) [2][31] is defined as a set of methods, techniques, and tools that allow users to create, modify, or extend artifacts, applications, rules, and regulations. The goal of EUD is to empower users to develop their own solutions, tailor applications to better fit their personal or organizational needs, and participate more actively in the aspects of their work or personal tasks.

### 1.1. Pinball Construction Set: The Importance of Domain Knowledge

In the “stone age” of personal computing (before 1.5 million Apps were available on Apple laptops), we experimented with the Pinball Construction Set — a video game by Bill Budge written for the Apple II and later released by Electronic Arts in 1983 (see Figure 1).

Our experiments with experienced programmers and sophisticated Pinball machine players resulted in the finding that with minimal training the Pinball machine players constructed more interesting and sophisticated games than the experienced programmers with limited knowledge about playing with Pinball Machines.

These findings provided the rationale for the design requirement that *application-domain knowledge* and support environments for *human problem-domain interaction* [14] are critically important for many software systems. The application-domain knowledge is held by domain experts

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rather than by software developers who suffer from a "thin spread of application domain knowledge" [5].

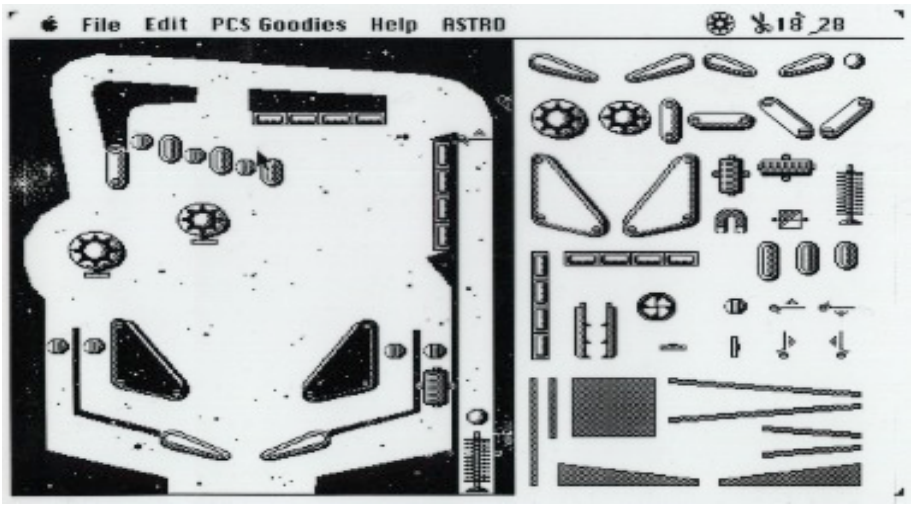


**Figure 1:** The User Interface of the Pinball Construction Set.

## 1.2 Poorly Understood and Ill-defined Problems Cannot be Delegated

In our empirical work at L3D, we interviewed a variety of users of software systems who were not primarily interested in software per se but who were engaged in professional activities that required them to modify, extend, evolve, and create systems fitting their needs. Table 1 [11] documents one of our interviews with a geo-scientist: the left column shows the comments of the scientist, and the right column the interpretation of the comments for end-user development.

**Table 1**
Software development as an essential task for end-users

| Statements by the Geo-Scientists | Relevance for Deepening the Concept of 'End User' |
|---|---|
| *I spend in average an hour every day developing software for myself to analyze the data I collected because there is not any available software* | No software exists (despite 1.5 Mio Apps) or a potentially useful app is unknown to the user |
| *Even if there is a software developer sitting next to me, it would not be of much help because my needs vary as my research progresses* | Change is a constant and software needs to evolve |
| *I cannot clearly explain what I want to do at any moment* | Poorly understood, ill-defined problems cannot be delegated and the owners of problems must have the "authority" to change the problem. |
| *If the software developer can manage to write a program for me, I will not know if he or she has done it right without looking at the code* | Externalizations need to "talk back" to the owners of the problems |
| *I spent three months to gain enough programming knowledge to get by* | Personally meaningful activities will encourage interest-driven learning |
| *Software development has now become an essential task of my research, but I do not consider myself a software developer and I don't know many other things about software development.* | End-users engage in programming because they want to get their work done and programming is a mean rather than an end for them |

The design insights and requirements grounded and derived from the interview shown in Table 1 and other empirical and theoretical work included:

- *Putting Owners of Problems in Charge:* Ill-defined problems cannot be delegated; therefore the owner(s) of a problem need to be present in incrementally framing the problems, because they have the "authority" to change the problem. If owners of problems are in charge, then b*ackground assumptions do not need to be fully* articulated [29]. It is a strength of domain experts that they know the larger problem context, which enables them to solve ill-defined design problems, to learn while solving problems, to notice similarities between design problems, and to know when design rules can and should be broken.
- *Support for Unselfconscious Cultures of Design*: Alexander [1] introduced the distinction between an unselfconscious and a self-conscious culture of design. In an *unselfconscious* culture of design, the failure or inadequacy of the form leads directly to an action to change or improve it. This closeness of contact between designers and products allows constant rearrangement of unsatisfactory details. In unselfconscious design, breakdown and correction occur side by side; the knowledge to repair breakdowns comes from the knowledge of the user, who is best able to recognize a lack of fit, and how the artifact should be changed to improve its fit to the environment.

## 2. Engaging and Empowering End-Users

### 2.1 Brief Summary of our System Developments

Figure 2 provides an overview of our developments in L3D to gain a multi-dimensional perspective of the needs, roles, and contributions of end-users.

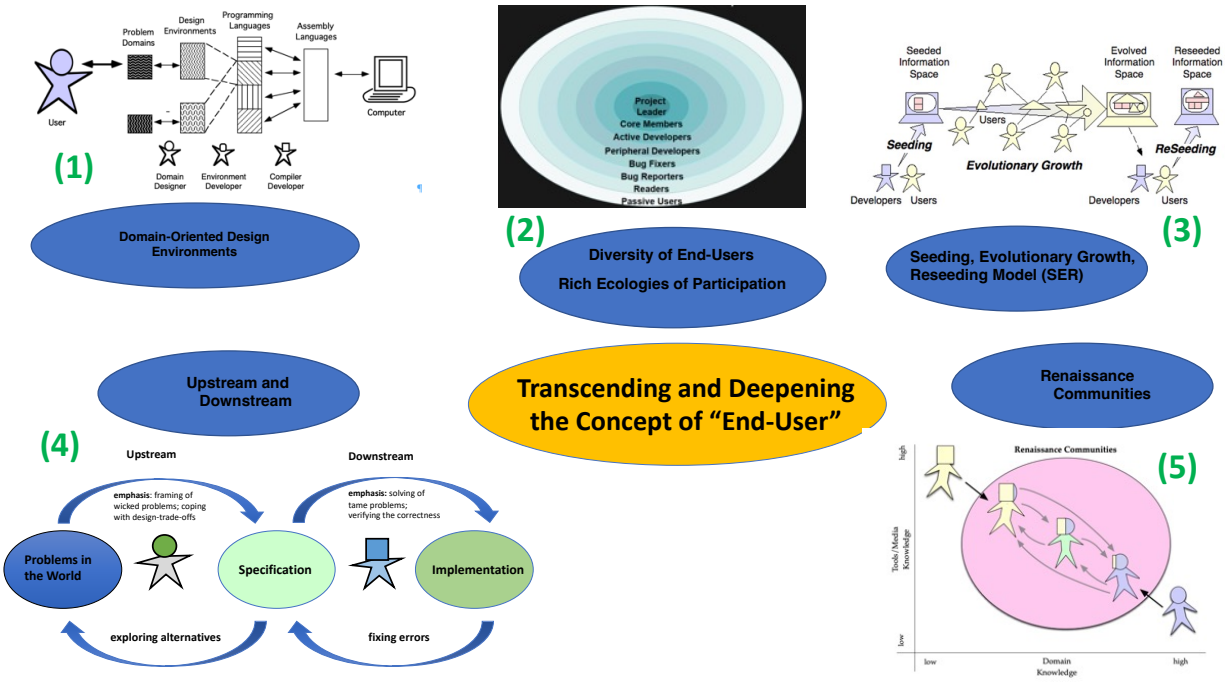


**Figure 2:** Frameworks and Systems to Explore Different Roles and Engagement Opportunities for End-Users.

- **Domain-oriented design environments (DODEs) (1)**: DODEs put end-users (being the owners of problems) in charge by supporting
    - *human problem-domain interaction* rather than just human-computer interaction [6];
    - the *co-evolution* of problem framing and problem solving [27];
    - an enriched *back-talk* of design situations with critics [18];
    - *reflection-in-action* by making argumentation serve design [15];
- **Diversity of End-Users and Rich Ecologies of Participation (2)**: the diagram represents the different roles that users can have as contributors (e.g.: in open-source and in social media environments [19][25]). The new emerging roles have been characterized as
    - *prosumers* [30], who are techno-sophisticated and comfortable with the technologies with which they grew up and they engage in experimenting, exploring, building, tinkering, framing, solving, and reflecting about problems;
    - *professional amateurs* [22], who are innovative, committed, and networked amateurs working up to professional standards.
- **The Seeding, Evolutionary Growth, Reseeding process (SER) Model (3):** its focus is to incrementally refine and evolve systems as living entities [13]. Instead of providing fixed content, rules, and processes, system developers and end-users create seeds for open, living information repositories which end-users can evolve by using the seed for their design activities. If major modifications are required, reseeding efforts will take place.
- **Differentiation of Upstream and Downstream Activities in Design Processes (4):** *Upstream activities* (focused on problem framing and resulting in a specification for a problem) represent the most critical phase for end-user involvement. Since wicked problems are ill-defined, understanding the problem from the perspective of those most affected is crucial. End-users as owners of problems can provide invaluable insights into the nature of the problem, its context, and its impact on their lives*. Downstream activities* (focused on problem solving resulting in an implemented systems based on a specification) [13] will contribute to the iterative refinement of solutions and the identification of errors.
- **Support for "Renaissance Communities" and not only for "Renaissance Scholars" (5):** Based on the constraints on human abilities what people can learn during a lifetime, it is unrealistic to expect from individuals to maintain the prerequisite knowledge in their technological discipline, and at the same time to have the needed competence in the social sciences and in domain-specific application domains [10][24].

### 2.1 Related Frameworks

Related frameworks to end-user development (complementing the ones mentioned in the previous section) have been described in [2]:

- *End-User Programming (EUP)* focused on the objective of empowering and supporting end-users to program (with techniques such as: programming by demonstration, visual programming, scripting languages, and domain-specific languages)[26];
- *End-User Software Engineering (EUSE)* adding to EUP support for systematic and disciplined activities for the whole software lifecycle (including: reliability, efficiency, usability, and version control) [4].

The book "Democratizing Innovation" [32] contributes to the framing of the concept of end-users by demonstrating with specific examples that end-users are not just the target audience for technological products but are integral to the innovation process itself. The book highlights the importance of open innovation and collaborative design processes, where users and producers co-create solutions.

In the societal world at large in which governments create rules and regulations, the concept of *"Nudges"* (based on human behavior and psychology) [31] postulates the principle of *libertarian paternalism* in which officials create rules and regulations to guide human behavior. In doing so, they act as *"choice architects"* (in analogy to meta-designers in our frameworks) influencing people's behavior in a predictable manner without restricting their freedom, autonomy, empowerment, and welfare of choice for the citizens (the "end-users" in this framework). In this approach, default settings are chosen not just for convenience but to guide users towards more efficient and beneficial options. Citizens retain their freedom of choice, but the design subtly influences their decisions in a direction deemed positive by the designers.

## 3. End-Users in the Age of AI and ChatGPT

In the Age of AI (not just in the last few years but more or less from the very beginning) two *distinct approaches* originated and emerged with separate traditions, values, priorities, and visions in the computing world [17][23][28]:

- one being *(strong) Artificial Intelligence (AI)* to *replace* human beings, automating the human experience, and duplicating human behavior with computing systems;
- the other being *Intelligence Augmentation (IA)* to *expand and complement* human abilities with sociotechnical environments.

The emergence of generative AI and large language models (LLMs) during the last 18 months is transforming how the role of end-users is perceived, expanding their capabilities, changing their expectations, and reshaping their interactions with technology.

Research objectives and design trade-offs (focusing on ChatGPT as an example) that need to be critically examined include *promises* such as that it will

- change our minds about how we work, how we think, and what human creativity really is [16];
- enrich our understanding and increase the support for "distributed cognition" frameworks [12][21];
- assist in generating ideas and offer alternative perspectives [8].

Equal attention needs to be given to analyzing *pitfalls* and *hindrances* [20] such as

- its fluency is an illusion that stems from the combination of massive amounts of data, immense computing power, and novel processing techniques;
- its limited support for asking questions and framing problems;
- the difficulty for humans to scrutinize the answer produced;
- the fact that it hallucinates and gives wrong answers;
- its unreflective use leading to humans suffering from an overreliance on technology.

The *design tradeoffs* and balances between these advantages and disadvantages often depend on the contexts in which ChatGPT is used, the specific needs of the users, and the evolving capabilities of ChatGPT. As these tools continue to evolve, addressing the disadvantages while enhancing the advantages represents a fundamental challenge.

**A Narrative for Different Uses of ChatGPT: Personal Speechwriters**. High-level politicians, industry leaders, and other decision makers are using speechwriters to assist them in giving presentations on a broad range of different topics. If one or more speechwriters provide a text and the "important persons" deliver the speech by reading the text literally given to them — they engage in the least demanding activity: all they need to be able to do is read.

What the listeners of the speech hope for and expect is that the "important persons" superimpose their own ideas based on the ideas provided by the speech writers.

Most people writing an essay, a job application, or an admission letter for a university cannot afford to have another human as a speech writer. They can use ChatGPT as their personal speech writer in two fundamentally different ways:

- *Behavior-1* (undesirable)*:* use the text created by ChatGPT as their final product (governed by an "AI versus Human" perspective)

or

- *Behavior-2* (desirable)*:* use ChatGPT to generate a first draft and then rewrite the texts to reflect their own voices and experiences (governed by an "AI and Human" perspective). In this case, ChatGPT can be a powerful tool by blending its computational power with human intuition, expertise, and ethical judgment.

## 4. Future Directions

A core objective for the 2024 CoPDA Workshop *"Differentiating and Deepening the Concept of "End User" in the Digital Age"* should be to explore what different AI approaches can contribute for enriching our understanding of empowering end-users in the future and which developments will be detrimental.

One drawback is that humans may be forced to cope with the burden of being active contributors in personally irrelevant activities that can lead to participation overload as illustrated by (1) *"do-it-yourself" societies* (e.g., companies offloading work to customers [3]) and (2) *cultures of participation* [9]. Through modern tools, humans are empowered to perform many tasks themselves that were done previously by skilled domain workers serving as agents and intermediaries. Although this shift provides power, freedom, and control to customers, it also has forced people to act as contributors in contexts for which they lack the experience that professionals have acquired and maintained through the daily use of systems, as well as the broad background knowledge to do these tasks efficiently and effectively.

The concept of the *"end-user"* has transformed from a simple role of consumption or operation to a complex, dynamic participant in the design, development, and use of products and services. This evolution reflects broader changes in technology, education, society, and the global economy, underscoring the importance of continuously adapting our understanding of who end-users are, what they need, and what they can contribute.

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