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DESIGN AFTER THE RISE OF AI-DRIVEN SERVICES: LEARNING FROM LITERATURE REVIEW

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Keywords

Artificial Intelligence;
Human-centered
Design; Interaction
Design; Service Design;
Decision-making

Abstract

Technology is playing a significant role in shaping the future of design. We are moving fast into a digital era where Artificial Intelligence, Machine Learning, Deep Learning, Big Data, the Internet of Things, Blockchain, Spatial Computing, and several other technologies are becoming part of the designers' lexicon. The designers' roles are evolving, and the touchpoints they need to consider are growing in complexity. Integrating AI developments with User-centered Design and User Experience Design is becoming a challenging task. Motivated by this, we reviewed the literature to understand how AI is shaping the way designers think about their process and how they design for AI artifacts. This research was important for evidencing how designers are adapting their mindsets, skills and knowledge to address these new technological possibilities. The overall search was conducted on ACM Digital Library, Google Scholar, and Springer, for publications about design and AI. The work identifies promising research clusters in the crossroads of Intelligent Systems, Human-Computer Interaction and Design, but few studies were found with concrete guidance on how to design for AI-driven services. By mapping the current literature on AI and Design, we contribute to a broad understanding of how current design methods need to adapt when interactions become living ecosystems and represent complex trade-offs to the designers. Therefore, new principles for human-AI interaction are becoming urgent to study.

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1. Introduction and Background: The age of AI

New conventions in experience economy¹ alongside new technological developments as Artificial Intelligence (AI) are shaping how businesses invest in integrating user-centered design (UCD) and user experience (UX) as a crucial part of their whole service design strategy plan. AI, machine learning (ML) and deep learning (DL)² will be the most important means to improve UX (Yang, 2017). Businesses are chasing AI transformation either to enhance customer experience or to automate businesses and defining a system that extends human capabilities (Daugherty & Wilson, 2018).

Among the paradigms for AI services are UCD and UX. In the mid-1980s, two publications introduced the user-centered design (UCD) methodology (Gould & Lewis, 1985; Norman, 1986). In essence, UCD is a design approach that consists in taking the user perspective in all stages of product development. The user is part of the testing and evaluation process, providing relevant considerations for the final product development. With today's new technological possibilities, UCD is moving from a traditional static convention process to an emergent living ecosystem. By changing the design paradigm, is becoming harder to foresee the effects of our designer's solutions because the center of the problem is now an organic and unpredictable evolving system. The center of design is now an organic and unpredictable intelligent evolving system (Dove et al. 2017; Fischer, 2002; Van Allen, 2017). A system that is designed to constantly adapting to context possibilities, which produces different effects on user behavior according to the situation. For example, an AI service that meets this circumstance is Waze. Waze is a mobile application that combines AI algorithms and real-time data to create living, dynamic, optimized maps that allows peoples' to get to their destinations as quickly as possible (Daugherty & Wilson, 2018, pp. 6–7). Design is evolving into a new context,

1 "As services, like goods before them, increasingly become commoditized experiences have emerged as the next step in what we call the progression of economic value." (Pine II, Joseph B.; Gilmore 1998)

2 Technically, DL is a subset of ML as ML is from AI. But their capabilities are different, meaning a different impact on how designers may design services for each type of technology. Basic ML models do become progressively better at whatever their function is, but they still need some guidance. If a ML algorithm returns an inaccurate prediction, then an engineer needs to step in and make adjustments. But with a DL model, the algorithms can determine on their own if a prediction is accurate or not. (Grossfeld 2017)

An evolving, negotiated, inconsistent, improvised, serendipitous interaction that does not easily resolve to task accomplishments, efficiency, certainty, ROI, customer expectations, or for that matter, one user's experience. (Van Allen 2017, 431).

The International Organization for Standardization (ISO) in the ISO 9241 norm, titled *Ergonomics of Human-System Interaction*, and in particular in its part 210, *Human-Centered Design for Interactive Systems*; defined UX as a "person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service." These perceptions and responses are very broad and include "emotions, beliefs, preferences, physical and psychological perceptions, color responses, behaviors and achievements that occur before, during, and after use of the system, product, or service." This definition is in line with our analysis. With the rise of AI-driven services, how are designers taking into their process all these dimensions when designing for autonomous services?

Design with AI pursues has the goal of enhancing the human experience by extending their capability. Each field gathers data to interpret and predict human behavior and to anticipate what people might do next. But they understand the human significantly different. However, both fields have the power to shape each other. To design for AI-driven services, designers will need to domain the context awareness and personalized customization enabled by AI and its subdomains; and AI needs UXD to be perceivably valuable to the users. For achieving social responsibility, designers will have to learn how to design AI-driven services that address issues of fairness, accountability, interpretability, and transparency (Riedl, 2019).

1.1. New Problems and Perspectives

Design is in a rapidly changing landscape of opportunities. One of AI's affordances is the reduction in the number of users' interactions and decisions within a system. Does this automation, and decrease of qualitative interactions, affects the users' perception of quality? These services are being designed to decide and performing tasks on behalf of users. And the success or failure of a digital service is intrinsically correlated to how users perceive the systems' qualities (Hassenzahl, 2008). AI services are able to reduce users' cognitive overload by

facilitating their decision-making processes. Google service Nest³ exemplifies this approach.

2. Methodology

This paper presents a literature review. Wwe aim to identify dimensions that have an impact on how designers design *for* and *within* AI, to address its new technological possibilities.

2.1. Research Question and Search Terms

The guiding questions of this research aimed to select studies that explore the confluence of AI or ML with UCD, and that consider UX:

- 1. *How is AI shaping the way designers think about their design process?* This question is concerned with identifying all possible dimension where AI is shaping the way they think about design, and design for AI. We need to understand how designing for AI is changing the designer’s mindsets, skills and knowledge to address these new technological possibilities.
- 2. *How does the integration among AI technologies with UCD or UX occur?* This question is concerned with identifying the aspects that affect both fields of knowledge and development. Identifying these aspects will help us identify how designers can engage with AI also as a design material.

Derived from the research questions we identified the following search terms:

Research Question	Extracted Search Terms
RQ 1	Design, Decision-making, User-Centered Design, Design Process, Service Design, Human-Centered Design
RQ 2	Artificial Intelligence, Machine Learning, User Experience, Human-centered Computing, Interaction Design, AI-driven

Table 1 Research Questions and the extracted keywords

3 Nest is an AI service. Is a self-learning thermostat that is programmable to optimize homes and business. Nest can learn people's schedule, and at which temperature they are used to and when, shifting into energy-saving mode when it realizes nobody is at home to conserve energy.

2.2. Eligibility Criteria and Search

The eligibility criteria were: 1) Papers that specify at least Artificial Intelligence or machine Learning regarding design methodologies and concerns; 2) The study needed to consider design for an AI service or AI as a design material to designers.

- **Phase 1:** We follow the PICO strategy (Santos, Pimenta, & Nobre, 2007). The search terms were defined as follows: (“Artificial Intelligence” OR “Machine Learning”) AND (Design OR UX OR “user-centered design” OR “Interaction Design”).
- We selected three main digital databases: Springer, Association for Computing Machinery (ACM), and Google Scholar. The searches were carried out in the period from 2017 to August-2019. Books, journals and conference proceedings were considered with this time frame of three years and a publication language restriction of English.
- **Phase 2:** For each database the terms were used to filter publications titles, abstract and keywords, to verifying compliance with the established eligibility criteria;
- **Phase 3:** The search generated multiple sets of publications clusters. These results were not particularly informative or insightful in terms of revealing solutions for the research questions. However, it was useful to understand the tendencies of keyword clustering among the fields of expertise. The inclusion criteria were if the publication answers one of the RQs, either partially or entirety. Some publications were excluded from Google Scholar results because they were duplicated from ACM or Springer search results.

2.3. Results & Discussion

	ACM				Google Scholar				Springer				Total
	2017	2018	2019	Total	2017	2018	2019	Total	2017	2018	2019	Total	
RQ 1	4	10	13	27	16	16	8	39	5	7	13	25	92
RQ 2	10	18	18	46	3	11	4	18	2	6	9	17	81
Total	14	28	31	73	19	27	12	58	7	13	22	42	173
	Excluded 0				Excluded 28				Excluded 0				

Table 2 Numbers of publications found in each database

With the support of the publication obtained in the research, it was possible to analyze the research questions.

Question: *How is AI shaping the way designers think about their design process?*

Answer: Seeking for ubiquity on design. Design is a human fabrication. Almost everything in the environment around us is designed which make us in part a product of design (Fry, 2015). Designers have to learn how to design AI-driven services that address issues of fairness, accountability, interpretability, and transparency (Riedl, 2019). Design has spread across several domains and AI is following a similar path, which makes them both ubiquitous in many senses. In the beginnings of UCD, users started to be invited into the world of the designer through participatory design⁴ methods (van der Bijl-Brouwer & Dorst, 2017). With the confluence of design with AI maybe we should produce processes were data scientists learn how to summon designers into their processes. However, often designers join AI development after the functional decisions have been made which rise another issue, “UX cannot be an afterthought of AI.” (Yang et al. 2018, p. 469). In this perspective, integrating UCD or UX into AI-driven services becomes a great challenge for designers when designing for anticipation actions in living ecosystems.

Answer: Investing on a new educational system. An AIGA’s (2018) report, a professional organization for design, mentions that a big portion of today’s designers still focus on an object-driven process that addressed one independent physical constraint at a time. “Current educational systems around the world continue to focus on teaching our students to undertake tasks for which machines are now better suited” (Susskind & Susskind, 2015, p. xi). Institutions are struggling for educating for the future (Fry, 2015). We question if designers are seeking to be prepared to explore and exploit the integration of experience and interaction design with AI? Which will be the designer’s professional demands of the future? Are we preparing young designers for long and productive careers? We need a new educational agenda for UXD field that is able to exploit AI domains. Given the potential of AI to impact our lives, building intelligent algorithms without a purpose will not serve us properly. “There is a growing awareness that algorithmic advances to artificial intelligence and machine learning alone are insufficient when considering systems designed to interact with and around humans” (Riedl, 2019, p. 2). To understand and master

⁴ Scandinavian participatory design movement of the 1990s.

this complexity, designers will have to understand the technologies behind it (Hebron, 2016). With the proviso that understanding AI is not the same as learning it from a technological point of view. As a result, several authors propose that current design students should be prepared with additional skill sets like basic interpretation – *Human-centered Artificial Intelligence* (Riedl, 2019) – understanding and manipulation, or either one, of quantitative data (Girardin & Lathia, 2017; Yang et al. 2018) – Co-designing with data (Dove et al. 2017).

Answer: Demanding for new set of skills. As more services are built with AI, it becomes clear that designers still have a lot to learn about how to make users feel in control of the technology (Dove et al. 2017). “Designers face challenges in understanding ML capabilities, in envisioning new products and services, and in collaborating effectively with data scientists” (Yang et al. 2018, p. 591). The author expresses that designers don’t think that learning more about AI will make them better designers. This could be a fallacy. Because they perceived they don’t need to learn about AI to be a better designer when actually they need to. AI might not achieve the productivity gains expected, because designers do not understand how to exploit it into their projects. Almost all designers do not know how to bring their UXD expertise to bear on AI (Dove et al. 2017). Now, designers do not possess enough inferred knowledge of AI to operationalize interaction flows that proactively adapt or evolve over time to this new organic leaving state (Yang, 2017). Furthermore,

It is no longer enough for UX designers to only improve experience by paying attention to usability, utility, and interaction aesthetics. Instead, the best UX may come from services that automatically personalize their offers to the user (...) that leverage more detailed understanding of people (Dove et al. 2017, p. 278).

The consequence is a disconnection between design practices and innovation. Nevertheless, there is a lack of new resources and tools that may allow designers to move into a more effective engagement approach towards AI as a design material or as a service design. But can designers work with a material they do not fully understand?

Answer: Requesting a shifting paradigm with design process. Powered by AI developments, the current paradigm of design offers an exciting and challenging stimulus for innovation.

We are shifting from ...	
Formulating research questions based on user's insights: <ul style="list-style-type: none">→ Surveys→ Interviews→ Focus Groups→ Direct Observation	To a hybrid approach: Users' insights as well as formulating research questions that arise from the current availability of data: <ul style="list-style-type: none">→ Data Analysis→ Business Intelligence→ Pattern Recognition

Table 3 Shifting paradigm with design process (Girardin & Lathia, 2017)

We may consider an evolution on the HCD field by moving into coexistence with the formal method of putting human beings in the center of the design process as well as putting data. Also, shifting from formulating research questions based on users' needs and insights, towards formulating research questions that arise from data and patterns recognition – “smart hypothesis” (Daugherty & Wilson, 2018, p. 72). Which raises an important question. What will happen to the scientific process and to design problem framing process when hypotheses can be generated automatically? Now, designers have the advantage of not only being able to formulate hypotheses from the users' perspective, but also to formulate hypotheses from big data. Designers can start co-designing with data (Dove, 2015). The author proposes a new collaborative approach to seek insights from data through design workshops in which working with domain-relevant data is the key distinguishing feature. He helps designers to gain an understanding of the context these data might come from, and to inspire creative design ideas. Creating a synergy between the two methods to achieve an increment on the efficiency of AI-driven services and establishing a new discipline that moves between humans and data.

Question: *How does the integration among AI technologies with UCD or UX occur?*

Answer: **Requiring new principles for human-AI interaction.** Design problems require several knowledge domains and a broad range of skills and they are one of the most complex problems to tackle within AI (Grecu & Brown, 1998). It is time to rethink the standards of interaction design inside AI and IoT (Marenko & van Allen, 2016). First, we need to raise awareness among designers to the importance and relevance of educating themselves to new technological practices and domains such as AI, ML and DL. And second, prepare an ecosystem where designers can ground fundamental knowledge about AI and their subdomains within mind best practices for designing with and for it. Notwithstanding, a few steps already were made in this sense.

The University of Helsinki⁵, developed a pilot project to educate the general population to AI awareness. The program is a free course with the goal to help people to be empowered, not threatened, by artificial intelligence (AI). They built *Elements of AI*⁶, a non-technical course to teach the basics of AI to people from a wide range of backgrounds. In the spring of 2018, they launch the first part of the course with the intuition to introduce people to AI concepts. For the end of 2019, they are preparing to launch the second phase of the program focused on *Building AI*.

Another course was developed by Deeplearning.ai⁷, also a free non-technical course, *AI for Everyone*⁸, that unleash an understanding of AI technologies by teaching how to spot opportunities to apply AI to problems in people's own organizations. Both courses were aimed at the general population. A similar approach, oriented to design filed and designers, could be a strategy to literate designers to AI and orient them to a new set of skills for designing AI-driven services and products.

3. Conclusion

Without proper methods and prototyping tools, it becomes hard to successfully prototype for interactions that may follow an unpredictable course (Dove et al. 2017). AI are “not yet a standard part of UX design practice, in either design patterns, prototyping tools, or education” (Yang, 2017). There is an opening door for designers to collaborate with data scientists (and other stakeholders) to innovate and co-create exciting meaningful experiences that will benefit users and the future of the interaction design.

A possible method to address UXD within AI is by approaching *Animistic Design*, a method for “fostering affects, sensibilities and thoughts that capitalize on the uncertain, the unpredictable and the nonlinear, and their capacity to trigger creative pathways” (Marenko

5 The course was designed by [University of Helsinki](#) and Reaktor. The lead instructor of the course is Associate Professor [Teemu Roos](#) with industry insights from Hanna Hagström. The course is a part of the AI Education program of the [Finnish Center for AI](#), and offered in cooperation with [The Open University](#), and [Mooc.fi](#).

6] <https://course.elementsofai.com/>

7 Is an organization to promote the world-class AI education accessible to people around the globe so that we can all benefit from an AI-powered future <https://www.deeplearning.ai/>

8 <https://www.deeplearning.ai/ai-for-everyone/>

& van Allen, 2016, p. 432). This may become a way to reimagine digital interaction between the human and nonhuman. The method can help the design shifting from crafting task-oriented experiences for users, to building evolving, diverse, autonomous ecologies that support collaborative exploration and creativity for machine and human participants alike.

Another possible method to address the synergy between design and AI is by approaching *Anticipatory Design* a design method that personalizes the user flow by making and eliminating user choices (Shapiro, 2015; Van Bodegraven, 2017). This design pattern has the determination of predicting UX. The premise behind it is to reduce users' cognitive overload by facilitating their decision-making process on behalf of them. This new design method moves around three major concepts:

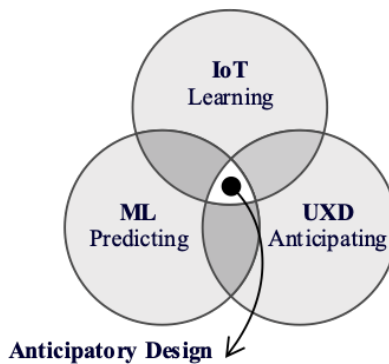


Fig.1 Anticipatory Design structure retrieved from Van Bodegraven (2017).

If one of these three actors fail, we cannot design for anticipatory design. “The goal is not to help the user make a decision, but to create an ecosystem where a decision is never made” (Shapiro, 2015). In sum, designers lack prototyping tools for working with AI (Dove et al. 2017). Without good tools for tools to prototyping unpredictable intelligent evolving courses that support *Anticipatory Design* and *Animistic Design* principles and methods, designers struggle to explore the space of possibilities.

It is vital to comprehend how will designers design for unpredictable courses, and how they are preparing themselves to deal with data to design responsible AI solutions. Aiming to contribute to the field in that sense, we already started to map the biggest challenges inherent to AI and design. This will allow us to initially understand how design methods need to adapt when interactions become living ecosystems and represent complex trade-offs to the designer. This will lead us to a major area of inquiry: How to do anticipatory experience design for AI-driven services?

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