Quality of Life in the Digital Age: Exploring Design Trade-Offs between
Artificial Intelligence and Intelligence Augmentation

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ABSTRACT

Over the last decades, information and communication technologies have made tremendous progress. But applying new technologies does not necessarily lead to an improvement of q*uality of life (QoL)*. Currently most information technology professionals and organizations develop technologies that are more usable and more useful in order to make people more efficient and more productive with an insufficient focus on the grand challenge: How does design address the fact that more efficiency and productivity does not necessarily increase the QoL for all of us?

In design, *trade-offs* are universal because there are no best solutions independent of goals, objectives, and values, specifically for systemic, ill-defined, and wicked problems such as quality of life in the digital age.

Grounded in research activities from a broad spectrum of different disciplines and an analysis from our research over the last three decades, this paper critically analyzes the current hype about *Artificial Intelligence (AI)* by contrasting it with the objectives pursued by *Intelligence Augmentation (IA*) by identifying design trade-offs to develop a vision and an agenda for future developments, where the goal is to focus on quality of life for all human beings and prioritize human well-being.

KEYWORDS

Quality of Life, Design Trade-Offs, Artificial Intelligence (AI), Intelligence Augmentation (IA), Adaptive and Adaptable Interfaces, Context-Aware Interfaces, Intelligent Interfaces, Interfaces for End-User Development, Interfaces for Social Interaction and Cooperation

1 INTRODUCTION

This paper is exploring the fundamental assumption that *quality of life (QoL)* represents an important and desirable objective for the digital age. QoL is a wicked problem [Rittel & Webber, 1984] evading a precise definition and simple solutions. Analyzing *design trade-offs* associated with QoL contributes to gaining a deeper understanding by avoiding to being caught in one-sided approaches. The specific design trade-off explored in this paper analyzes two distinct communities which originated several decades ago and emerged with separate traditions, values, priorities, and visions in the computing world [Markoff, 2016]:

- one being *Artificial Intelligence (AI)* (see Figure 3) with the goal of replacing human beings, automating the human experience, and duplicating human behavior with computing systems;
- the other being *Intelligence Augmentation (IA)* (see Figure 4) spanning disciplines such as human-computer interaction (HCI), computer supported cooperative work (CSCW), and computer supported collaborative learning (CSCL) with the goal to expand and complement human abilities with socio-technical environments.

Over the last few years a huge hype around AI has developed with promises that AI will emerge as the most fundamental discipline to address and solve the problems of the digital age [Brynjolfsson & McAfee, 2014]. Most of the discussions and prophesies lack any detail which of the most pressing and interesting problems will be addressed by AI.

The trade-offs between AI and IA are illustrated by discussing specific developments of our own research (see Section 6) to illustrate the merits and pitfalls of the different approaches. The paper concludes with summarizing some of the lessons learned and brief remarks about the challenges ahead. Figure 1 provides an overview of the different sections of the paper and their interdependencies.

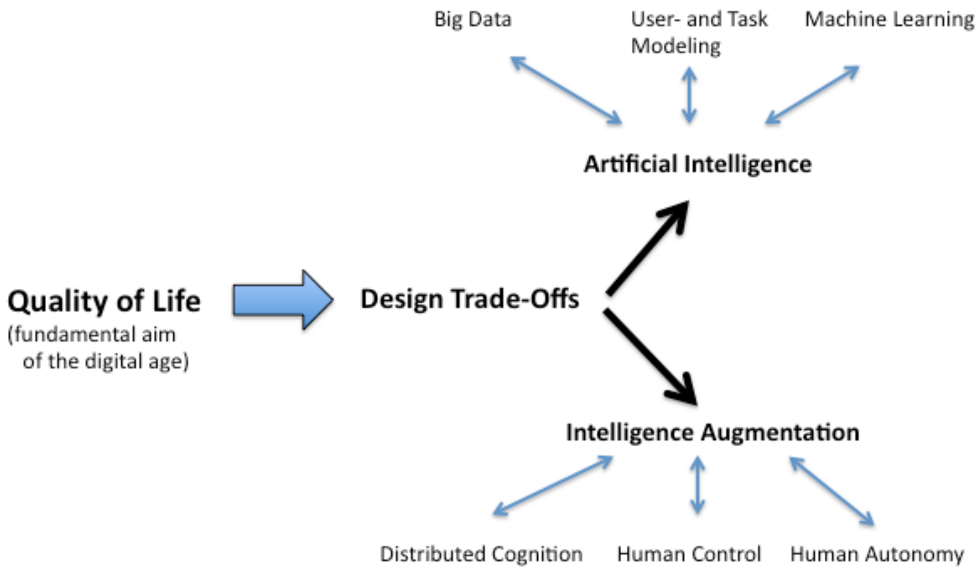

Figure 1: The Structure of the Paper

2 QUALITY OF LIFE (QoL)

Over the last decades, digital technologies have made tremendous progress. But applying new technologies does not necessarily lead to an improvement of *QoL* [Fischer, 2018]. QoL as a concept transcends the domain of information and communications technology as indicated by the QoL objectives articulated in the "UN Sustainable Development Goals" that include: no poverty, zero hunger, well-being, quality education, sustainable communities, innovation and infrastructure, climate action, etc.; https://www.un.org/sustainable development/sustainable-development-goals/). This article focuses on QoL dimensions relevant for the design of socio-technical environments contributing to the digitalization of our societies (see Figure 2).

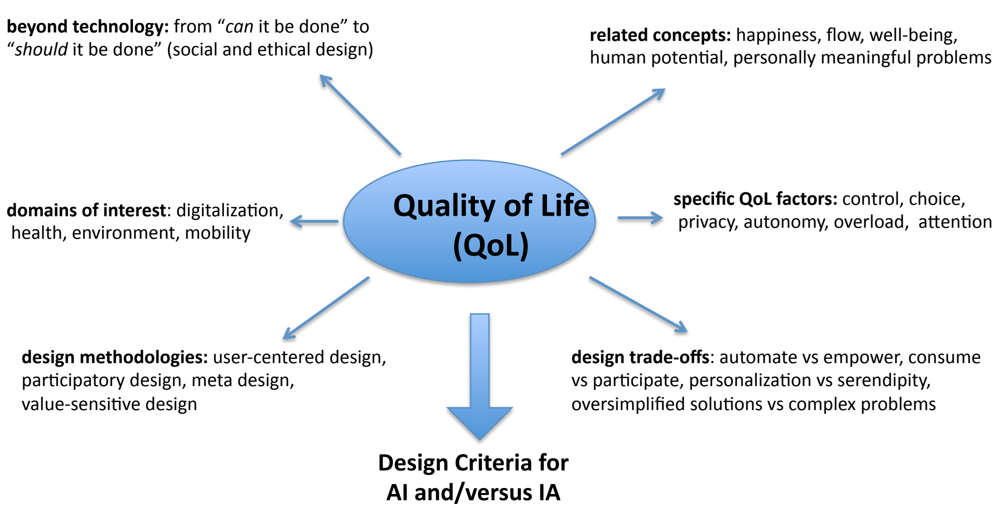

Figure 2: Dimensions of Quality of Life

A metric for progress in the digital age should not be limited to reaching functional goals and addressing technical problems but we need to make sure that technologies are aligned to humans in terms of our moral values and ethical principles [IEEE-Global-Initiative, 2016]. By recognizing that people are different from computers and by aligning the creation of intelligent systems with the values of its users and society, trust between humans and technology can be increased [Shneiderman, 2020] and QoL can emerge as an important objective for progress in the digital age. While QoL will be deeply influenced by new technological developments, technology alone does not determine social structure but it creates feasibility spaces for different and innovative social practices.

3 DESIGN TRADE-OFFS

Design problems such as QoL have neither optimal solutions nor right answers [Simon, 1996]. They requires the careful choice between trade-offs leading to different solutions within a space of possibilities that need to be carefully evaluated [Fischer, 2018]. Digitalization will transform the world, but it does not mandate a single deterministic outcome and design trade-offs can spark efforts toward syntheses that lead to new levels of understanding and can productively exploit the best mixes between opposing choices.

In this context, we have specifically explored the following design trade-offs:

- automation can be a *two-edged sword* [Shneiderman, 2020]: (1) it is a servant, relieving humans of the tedium of low-level operations, and freeing them for higher cognitive functions or (2) it can reduce the status of humans to that of 'button pushers', and can strip their work of its meaning and satisfaction;
- *humans enjoy 'doing' and 'deciding', they want control and autonomy,* they often enjoy the process, and not just the final product; they want to take part in something [Fischer et al., 2000] — but these desires come with a price tag: they require time, engagement, learning, and may lead to participation overload;
- new technologies represent *"Faustian Bargains"*: specific developments involve losing one quality or aspect of something in return for gaining another quality or aspect (e.g.: (1) the advantages and disadvantages of new technologies are never distributed evenly among the population [Schön et al., 1999], and (2) passing decisions to AI systems making decisions in purely utilitarian terms rather than in consideration of richer human values [Awad et al., 2018]);
- the move *beyond binary choices* by identifying interesting syntheses, transcending extreme positions, and identifying meaningful compromises (e.g.: value-sensitive design [Friedman & Hendry, 2019] and ethical considerations associated with AI [IEEE-Global-Initiative, 2016] are important developments addressing this issue).

Identifying the trade-offs associated with technological developments [Fischer, 2018] is not an approach to limit progress, but to enhance progress by providing frameworks to move in a promising future in which all people can participate and profit from.

4 ARTIFICIAL INTELLIGENCE (AI)

In the current world-wide hype surrounding AI too many meanings, different aspects, mechanisms, and levels of understanding are packed into the concept and the phrase "artificial intelligence". The term is invoked as if its meaning was self-evident, whereas it has always been a source of confusion and controversy [Markoff, 2016]. Many of the current "prophets" advertising the amazing things that AI will achieve are unaware that AI has a 70 years history. Some of the major developments (articulating important objectives and findings indicating steps forward as well as recognizing shortcomings) are shown in Figure 3.

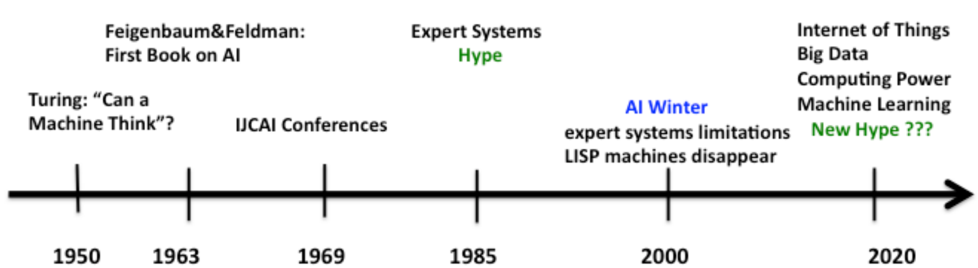

Figure 3: Milestones in the Development of AI

The numerous people (including politicians, journalists, industrialists, and academics) can be grouped in three major categories (the edited book by [Brockman, 2017] contains a large number of short articles defining and exploring facets of these distinctions):

AI Utopians (or Euphoriker): members of this group predict that human beings will not play a major role in the long term because people will no longer be the main decision-makers and that humans should see themselves as an intermediate step in evolution (e.g.: robots will be much better suited to explore and inhabit the universe than humans limited to life on planet earth). They advocate concepts such as *transhumanism* (creating sophisticated technologies to greatly enhance human intellect and physiology) and *singularity* (postulating the invention of artificial superintelligence triggering runaway technological growth).

AI Pessimists (or Apokalyptiker): members of this group argue that AI has failed and is dangerous. They believe and provide evidence that (most) AI programs are still idiot savants, with no generalizations, no internal understanding, no self-knowledge of what to know and not know. In addition, they argue that AI programs are *opaque* (black boxes instead of glass boxes) incapable of explaining how they reach decisions (e.g.: they can show us their weight matrices, but these are not very helpful). What AI pessimists often overlook is the fact that many interesting developments that were initially explored by AI researchers (an overview of early developments are documented in the first AI book [Feigenbaum & Feldman, 1963]) over time got well enough understood and became general applications not being considered AI anymore (the LISP programming language that pioneered dynamic data structures is one famous example for these developments).

AI Realists: the view and aspirations of this group can be characterized with the following statements:

- there is progress in AI. But there are just as many unsolved problems for which human intelligence will be far superior to artificial ones for decades to come;
- AI is not about building a mind; it's about the improvement of tools to solve problems;
- AI denotes a collection of technologies that excel at specific tasks that could previously only be performed by humans;
- AI has made a major comeback from the "AI Winter" period (following the hype around expert systems [Buchanan & Shortliffe, 1984], based on a insightful account of the limitations of expert systems [Winograd & Flores, 1986] [Suchman, 1987]; see Figure 3). The success stories of today's AI technologies are not generally intelligent thinking machines; they are applications that help humans think better based on progress with big data [Mayer-Schönberger & Cukier, 2013] and machine learning;
- The most important purpose of AI should be to enhance quality of life, not ignoring or diminish it.

5 INTELLIGENCE AUGMENTATION (IA)

While AI research is often primarily focused on "Humans *versus* Machine", research in IA is exploring socio-technical environments with a focus on "Humans *and* Machine". The gulf between AI and IA originated in the late 1960's with Engelbart being a pioneer of the IA approach (he created the term "Intelligence Augmentation") [Engelbart & English, 1968]. Figure 4 tries to capture some of the milestones of themes, organizations, and scientific communities (bound together by conferences including CHI and AVI) that establish the IA perspective as being one of the most important and influential scientific discipline of the digital age [Edmonds, 1993; Fischer & Nakakoji, 1992; Shneiderman, 2016]).

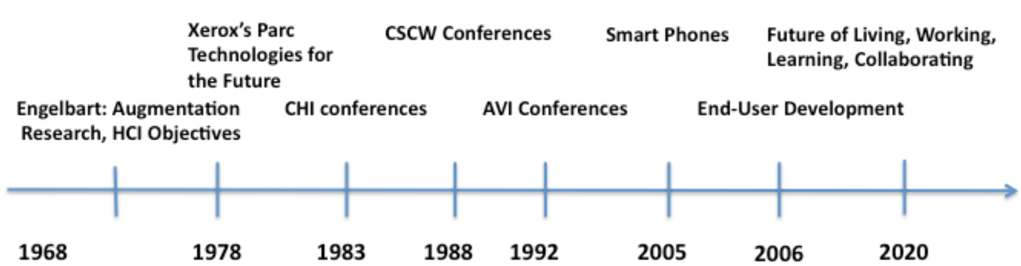

Figure 4: Milestones in the Development of IA

Our own activities moved from an early artificial intelligence focus (e.g.: [Fischer, 1987]), to intentionally choosing and embracing intelligence augmentation as the core objective of our research [Fischer & Nakakoji, 1992]. We engaged in building socio-technical environments in which computers served human needs rather than humans were considered as stopgaps who filled the issues which AI systems were not able to handle. Our objectives were focused on QoL objectives (as summarized in Figure 2), tried to explore design trade-offs and created some inspirational prototypes (discussed in more detail in Section 6).

6 EXPLORING THE SYNERGY BETWEEN AI and IA

This section briefly describes some specific projects grounded in our own research efforts to design for QoL by exploring the synergy between IA and AI.

6.1 Meta-Design and End-User Development

Most AI-based system disallow intervention by their users whereas IA approaches need to be open to engage end users as indispensable mediators for coping with unforeseen tasks and ongoing changes [Winograd & Flores, 1986]. The large population of human beings who have been driven out by AI systems are drawn back into the computational fold by IA [von Hippel, 2005].

Meta-design [Fogli et al., 2020] is focused on "design for designers." It creates open systems at design time that can be modified by users acting as co-designers, requiring and supporting more complex interactions at use time. Meta-design is grounded in the basic assumption that future uses and problems cannot be completely anticipated at design time, when a system is developed. At use time, users will invariably discover mismatches between their needs and the support that an existing system can provide for them making the support of end-user development a necessity rather than an option.

Meta-design contributes to *QoL* with socio-technical environments in which users can express themselves and engage in personally meaningful activities. It supports meaningful human control by addressing the basic challenge that the strongest test of any system is not how well its features conform to anticipated needs but how well it performs when one wants to do something the designer did not foresee.

We explored the need and support mechanisms for meta-design with the Envisionment and Discovery Collaboratory [Arias et al., 2016] by creating an end-user modifiable environment for urban planning to address fundamental limitations of closed system such as SimCity [Electronic-Arts, 2004; Suchman, 1987]. Our user studies identified as a critical shortcoming of SimCity that it does not allow the introduction of elements into the simulation that have not been part of SimCity's designers' conception of the problem. An example illustrating this limitation: in cases there is too much crime in a city created with SimCity, the user can address this problem by increasing the police force in order to *fight* crime. It is beyond the user's control to explore an alternative option such as increasing social services to *prevent* crime.

To provide user with meaning control to address open-ended problems in real world contexts by supporting meta-design creates new design challenges associated with IA. Some of the major challenges that we identified with user studies of the Envisionment and Discovery Collaboratory [Arias et al., 2016] are: (1) participation overload, (2) increased engagement requirements in problems that users find personally irrelevant (and thereby prefer to rely on default solutions provided by the existing system) [Thaler & Sunstein, 2009], and (3) additional learning demands required to understand the mechanisms for extending the system.

6.2 Context-Aware Systems: Modeling Tasks and Users

The scarce resource for most people is not information but *human attention* [Csikszentmihalyi, 1996; Simon, 1996]. *Context aware systems* [Dey et al., 2001] can address QoL requirements by reducing information overload, making information relevant to the task at hand, and personalizing systems to specific user requirements. Progress in "Big Data" developments [Mayer-Schönberger & Cukier, 2013] with its promises to harness information in new ways and to produce relevant insights has contributed greatly to improve the context awareness of AI and IA systems.

In our research we have explored unique aspects of context-aware systems by integrating AI techniques with IA objectives such as design intent representations, specification components, critiquing systems, information access and delivery, intrusiveness, and the synergy between adaptive and adaptable components [Fischer, 1993].

Some of the important *design trade-offs* that we and other have identified with user studies of specific context-aware systems [Ye & Fischer, 2005] are:

- *Filter bubbles and groupthink:* As companies exploit context awareness with Big Data to tailor their services to people's personal tastes, there is a unintended consequence: recipients get trapped in *"filter* *bubbles"* [Pariser, 2011], representing a unique universe of information computed by algorithms exploiting context awareness based on users' previous actions and behaviors. Filter bubbles often lead to *groupthink* [Janis, 1972] causing the loss of individual creativity, uniqueness, and independent thinking, as well as a tendency to minimize conflict and reach a consensus decision without critical evaluation of alternative ideas or viewpoints.

- *Serendipity:* serendipitous encounters can acquaint users with not actively sought after information that they find truly useful, and it can have a fundamental impact on people lives and decision making [Roberts, 1989]. Identifying the appropriate balance in specific situations between making information relevant to the task at hand and serendipity requires human decision making and transcends the boundaries of AI systems.
- *Privacy*: the task- and user-specific information underlying context-aware systems can help us to reduce information overload and support more insightful decisions but at the same time it can be exploited to undermine and erode people's privacy [Zuboff, 2019]. In many contexts (e.g.: to gain some economic rewards) people are very willing to give up their private information in return for perceived benefits such as ease of use, navigation, and access to friends and information.

6.3 Beyond Self-Driving Cars: Mobility of the Future

Mobility of the Future [Mitchell et al., 2010] is a wicked and systemic design problem with major implications for QoL. There are numerous stakeholders who have a vital interest about shaping and influencing this topic: car manufactures, information technology companies, environmental groups, and politicians. It provides an informative example for the core topics of this article to which most people can relate to. Our understanding of the problem was enhanced by our collaborations with two companies focusing their research on this domain: (1) Autonomous Intelligent Driving (AID), Munich; https://aid-driving.eu; and (2) Uber Advanced Technologies Group, Louisville, CO; https://www.uber.com/us/en/atg/

Figure 5 attempts to show that "Mobility of the Future" is greatly influenced by QoL factors, and represents a large number of design trade-offs. It is a much more fundamental change than considering whether cars will be gasoline or electric powered or whether cars will be driven by humans or by computers. It provides an opportunity for a paradigm change from a focus on the automobile to more human-centered mobility environments.

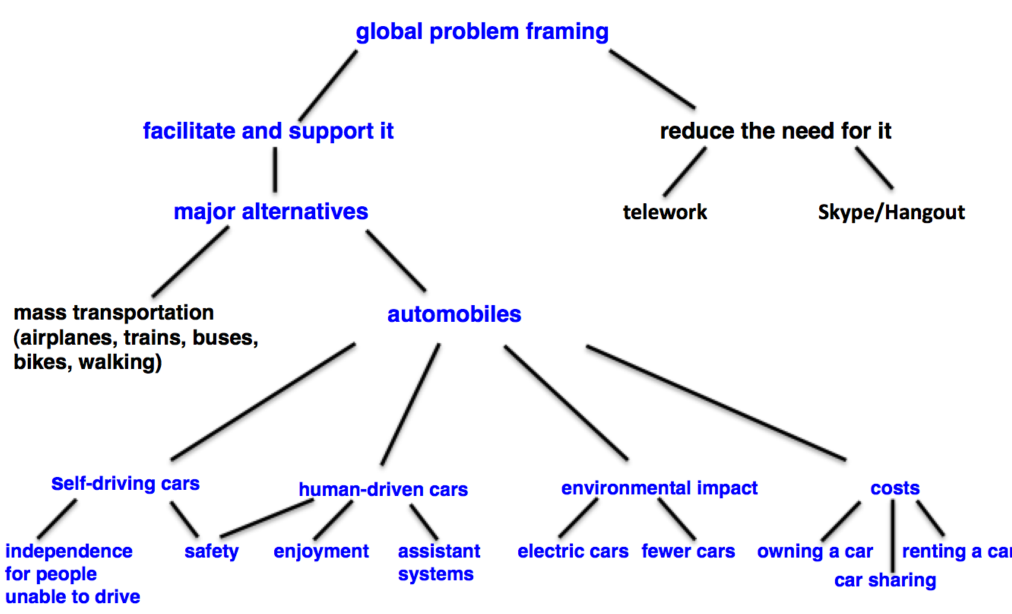

Figure 5: Mobility for All in the Future— More Than Self-Driving Cars

One important challenge in this domain is to explore the design trade-offs between self-driving cars (the AI approach) and intelligent driver assistance systems (the IA approach). Ten years ago, self-driving cars seemed to be more a topic for science fiction than becoming a reality in the near future. As rapid progress is made at the technological level ("it can be done soon"), the design trade-offs associated with "should we do it" (see Figure 2) take center stage. The *proponents* of self-driving cars argue for the following benefits: (1) independence for people who cannot drive (based on impairments such as age or blindness), (2) fewer accidents (no more drunk driving, no more distracted driving), (3) fewer cars (based on the reduced need for owning a car), (4) better use of existing cars (more than 90 percent of all cars are not driven at a particular moment), and (5) spending more time on personally preferred activities (e.g.: reading a book or sleeping instead of driving). The arguments of the *opponents* are centered on: (1) loss of control (for many people driving is fun and engaging); (2) major unresolved consequences such as: (a) loss of jobs in driving (truck drivers, taxi drivers), (b) loss in jobs in the car industry (as substantially fewer cars are needed), and (c) unclear responsibilities if something goes wrong. The different role distributions have been classified in a taxonomy [SEA, 2014] with a simplified version shown in Table 1.

Table 1: A taxonomy for distributed control between human driver and automated systems in automobiles

Level	**Defining Characteristic** ***<with the respective AI/IA contributions>***
Level 0	The driver completely controls the vehicle at all times *<no AI and no IA>*
Level 1	Individual vehicle controls are automated, such as electronic stability control or automatic braking *<simple AI features working independently>*
Level 2	More complex processes are automated (e.g.: adaptive cruise control, lane keeping) *<AI components support IA with driver assistance systems>*
Level 3	The driver can fully cede control of all safety-critical functions in certain conditions and the car senses when conditions require the driver to retake control and provides a "sufficiently comfortable transition time" for the driver to do so *<AI controls "normal" situations and humans needs to step in unforeseen situations transcending the capabilities of the AI system>*
Level 4	The vehicle performs all safety-critical functions for the entire trip, with the driver not expected to control the vehicle at any time *<complete AI and no human control; cars with no steering wheel and no breaks>*

A simple example of a design trade-off related to individuals' notions of QoL is: how much more fun and satisfying it can be to drive a stick shift car as opposed to an automatic [Carr, 2014]. The automatic is easier to drive, but then people give up the challenge and sense of mastery [Fischer et al., 2000]. An example for the partial automation represented by Level 3 [Norman, 2015] is that if drivers do other tasks while relying on the automated system will lead to complacency, causing helplessness and deskilling by ruining destroying native human abilities by over-reliance on tools. The more reliant we become on technology, the less prepared we are to take control in the exceptional cases when the technology fails.

7 LESSONS LEARNED AND LOOKING AHEAD

Accepting QoL as an important concept does not imply that people would agree which objectives would be desirable or should be avoided [Markoff, 2016]. Based on the initial framework and the illustrations with specific developments, this section of the paper will briefly describe some of the lessons learned that will provide a roadmap to look ahead.

Decontextualized sweet spots do not exist. An identification of design trade-offs is important for understanding the nature of wicked problems (as illustrated by Figure 5 for self-driving cars). But while abstract analyses can show us the overall space, the identification of preferable actions requires the situated analysis in specific contexts [Wulf et al., 2018]. What represent the right mix between human control and automation needs to be explored by paying attention to contextual factors (e.g. "Mobility for All" in big cities will favor and require different solutions compared to achieving this objective in sparsely populated rural areas).

QoL is different from the Promise of the "Garden of Eden". We have questioned a vision that many people regard as highly desirable [Fischer et al., 2000]: an "effortless world" representing the old dream of humankind to return to the *Garden of Eden* or *Paradise* (a place where peace, prosperity, and happiness can be found) and live a life of abundance free of all work and pain in which all desires would be satisfied immediately without any effort. Human beings value things and relationships for which they have to make an *effort* in obtaining them and in which they find purpose, enjoyment, and flow states in *personally meaningful task* [Csikszentmihalyi, 1996]. The preference for more automation or more control are different for tasks that people consider “personally meaningful” versus “personally irrelevant” (a distinction analyzed in detail with the concept of “liberterian paternalism” in [Thaler & Sunstein, 2009]).

Beyond user-centered design. Human-Computer Interaction has made important contributions in the last few decades by emphasizing design criteria such as “user-centered design” [Norman & Draper, 1986] and developed technologies that are more usable and more useful. But who cares? Are we content that users are more efficient and more productive or do we want to increase the “quality of life” for people living in the digital age [Calvo & Peters, 2014]? Contributions to previous AVI conferences [Czerwinski, 2018; Nishida, 2018; Vitiello & Sebillo, 2018] have explored different aspects of moving beyond interface, interaction, and visualization research and developments with socio-technical environments that enhance and transform people’s abilities to work, think, communicate, learn, critique, explain, argue, debate, observe, decide, and design. The QoL perspective emphasizes that the future of digitalization has to be focused on humans and their tasks — not only on computers and their tools.

Evaluation. The choice of an evaluation methodology must arise from and be appropriate for the actual problem or research question. "AI success" is easier to evaluate and to quantify than "IA success" (e.g.: in an AI recognition task, precision and recall provide a metric and in a game playing task, one system is better than another if it wins more often).

IA with a focus on QoL does not have easily measured metrics [Muller, 2018]. A challenging task for the years to come is to develop a better understanding and applicable metrics for the important dimensions of QoL such as distributed control, autonomy, informed decision making, and privacy.

Evaluation is often done that we “value what can be measured”, whereas the real challenge is that “we measure what we value”. While evidence-based research (broadly discussed in medicine) is a critical activity in interface and interaction design, we have to be aware of the design trade-offs associated with that not everything that is important is measurable and much that is measurable is not too relevant. Greenberg and Buxton [Greenberg & Buxton, 2008] support this observation with their argument that *“usability evaluation has a significant role to play when conditions warrant it. Yet evaluation can be ineffective and even harmful if naively done ‘by rule’ rather than ‘by thought’.”*

Design Trade-Offs: Exploring the Best Mix of Binary Choices. For many developments (e.g.: personalization leading to privacy violations) there is a price we pay for things that make life easier [Zuboff, 2019]. To identify this price in specific situations is one major objective of identifying design trade-offs. Instead of narrowing our horizons by forecasting a single definitive scenario, trade-offs aim to broaden our horizons and make us aware of a wider spectrum of options.

Some directions within the world-wide AI developments are emphasizing the importance of an IA focus; specific examples of these research efforts are:

- the *Stanford Institute for Human-Centered Artificial Intelligence* (https://hai.stanford.edu) focused on objectives such as (1) for AI to better serve our needs, it must incorporate more of the versatility, nuance, and depth of the human intellect, and (2) the ultimate purpose of AI should be to enhance our humanity, not diminish or replace it;
- the *AI Now Institute at New York University* (https://ainowinstitute.org) dedicated to understanding the social implications of artificial intelligence;
- the AiTech Institute at TU Delft (http://designforvalues.tudelft.nl/projects/ai-tech-meaningful-human-control-of-autonomous-intelligent-technology/) with a focus on how new digital artifacts are designed and engineered that are under meaningful human control;
- the report *“Ethically-Aligned Design”* [IEEE-Global-Initiative, 2016] with the subtitle: “A Vision for Prioritizing Human Wellbeing with Artificial Intelligence and Autonomous Systems” puts human wellbeing as the primary goal for new technologies and consistently asserts that people are different from machines;
- the *“Moral Machine”* [Awad et al., 2018] (http://moralmachine.mit.edu) representing a platform for gathering human perspectives on moral decisions made by artificial intelligence (as required self-driving cars;
- the paper “*Human-Centered Artificial Intelligence: Trusted, Reliable & Safe”* [Shneiderman, 2020] arguing for human responsibility by trying to achieve the best mix of high levels of human control and high levels of automation.

8 LOOKING AHEAD: FROM "HUMANS VERSUS COMPUTERS" TO "HUMANS AND COMPUTERS"

The current hype about AI needs not only be critically examined but alternatives frameworks need to be explored. We should not only be asking what computers *can* do, but what computers *should* do (see Figure 2). The focus should not only be on "systems that think" (AI) but on "systems to think with" (IA) — particularly by the human-computer interaction community. The observation by Harari [Harari, 2018] (p.382) *"it is dangerous to trust our future to market forces (Apple, Google, Facebook, ….), because these forces do what's good for the market rather than what's good for humankind or for the world"* should be taken up as a challenge by academics communities. To account for human values in the design of information systems (for example as pioneered by [Friedman & Hendry, 2019] with value sensitive design) is at odds with many current AI approaches that can be characterized by "automate whatever can be automated, leaving the rest to people" — a design philosophy in which computers are first class actors reducing people to the second-class participants serving as stop gaps when the first approach fails (e.g.: Level 3 in Table 1). Our vision with its focus on QoL is putting humans in the center supporting and empowering them with socio-technical environments. IA systems can incorporate AI-based components which complement and support humans — but for these collaborative architectures, the AI systems must be inspectable, understandable, explainable, and trustworthy. *Explainable AI (XAI)* [Samek et al., 2019] refers to methods and techniques in the application of AI such that the results of the solution can be understood by human experts. It contrasts with the concept of the "black box" in machine learning where even their designers cannot explain why the AI system arrived at a specific decision.

9 CONCLUSIONS

If information and computing technologies are developed to improve the QoL of all humans, then it is necessary to analyze what those needs are and how technology is required to meet them. Importance, control, autonomy, choice, privacy, necessity, and urgency are not something imposed by nature upon humanity but these are conceptual categories created by cultural choices. A QoL framework should not only be grounded in understanding new media and technologies in terms of productivity, efficiency, reliability, and from economic perspectives, but it needs to explore innovative socio-technical environments contributing to human creativity, gratification, and enjoyment. Design trade-offs are important because the future is not out there to be discovered but is has to be designed. This design challenge is not an easy undertaking because the future of digitalization is an ill-defined, wicked design problem that does not have simple "right" or "wrong" solutions. As researchers (specifically in human computer interaction) we need to explore and understand the implications of design trade-offs and engage multiple voices in constructive controversies.

The important objective of the paper is to invite and encourage the participation of the AVI community to critically examine the outlined approach and hopefully refine, extend, and revise it by addressing some fundamental assumptions and challenges for the future of digitalization: (1) to consider quality of life as a fundamental design objective for the digital age; (2) to explore and contrast the contributions of different research paradigms (AI and IA) towards this objective; (3) to identify innovative and additional concepts and frameworks; and (4) to illustrate how things could and should be with inspirational prototypes for specific contexts.

ACKNOWLEDGEMENTS

The author would like to thank Ben Shneiderman, Ernest Edmonds, Daniela Fogli, Antonio Piccinno, Anders Morch, and Stefan Carmien for providing valuable feedback and suggestions to earlier versions of this paper.

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