“Faustian Bargains” and Design Trade-Offs: Frames of Reference for Quality of Life in the Digital Age

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ABSTRACT

To create socio-technical environments to foster, nurture, and support *“Quality of Life (QoL)”* is one of the most challenging design problems of the digital age. *Design trade-offs* are universal; they are the most basic characteristics in design, and there are no best solutions independent of goals, objectives, and values, specifically for such a broad, ill-defined, and wicked problem as quality of life.

Based on our research over the last two decades, this paper presents a set of design-trade-offs that have helped us to identify *critical alternatives* beyond established approaches. The components of the QoL framework described in this paper are not only grounded in understanding new media and technologies in terms of productivity, efficiency, reliability, and from economic perspectives, but it considers and explores choice, control, creativity, engagement, gratification, and enjoyment as equally relevant design requirements.

One common approach is to conceptualize design trade-offs as *binary choices* representing the endpoints of a spectrum. But often design-trade-offs can spark efforts toward a synthesis leading to new levels of understanding and support. Context-aware systems, meta-design, symbiosis, cultures of participation, and rich landscapes of learning are represented as exemplarary themes integrating the best of the opposing choices.

Grounded in these frameworks and developments, elements of a research agenda for QoL is outlined by describing a small number of fundamental issues defining frames of references and critical alternatives for QoL.

Author Keywords

frames of reference, quality of life, design trade-offs, critical alternatives, Faustian Bargains, binary choices, socio-technical environments

INTRODUCTION

This article analyses the driving forces for articulating and exploring critical alternatives related to the design of information technology and computing derived from a focus on QoL. It is grounded in the problem domains our research has addressed over the last decades (including: lifelong learning, creativity, urban planning, populations with cognitive disabilities, energy sustainability) and for which we have designed, developed, and analyzed *socio-technical environments* [Fischer & Herrmann, 2011].

Based on our emphasis on *design* [Simon, 1996], we have focused particularly on identifying *design trade-offs* as the most basic characteristics of design. Trade-offs are universal because there are no best solutions in design. The basic contribution of this paper is to create frames of reference (illustrated with examples drawn from different areas) that exploring and understanding the implications of design trade-offs will provide insights for the exploration of critical alternatives for QoL.

THE MULTI-FACETED MEANING OF QOL

QoL is a broad concept and a precise, generally accepted definition does not exist. Does it mean being happier in life? Having more leisure time? Having good health? Having a high standard of living? QoL represents a fundamental objective for societies in the 21st century. It transcends many current developments in information and communication technologies that are still mostly focused on improving usability, usefulness, and engagement in order to make people in the world more efficient and more productive. Information and computing technologies have the potential to contribute to QoL objectives in almost all human activities (including objectives articulated in “Europe’2020”: democratizing societies, supporting employment and social inclusion, improving health-care, supporting energy and environmental sustainability, etc.; http://ec.europa.eu/europe2020/). In order to identify more specific frames of reference and design requirements, we will focus on trade-offs and frameworks and developments in *specific domains* derived from our research activities.

Progress in science and technology has contributed to a transformation from *“can not be done”* to *“can be done”* and thereby bringing questions and decisions to the forefront *“should something be done?”* Based on medical progress, the question “how much should a human life be extended?” is today much more a decision characterized by design trade-offs including important consideration about QoL compared to a few decades ago. More directly influenced by information technologies, people may have a choice in the not too distant future whether they want to drive a car themselves or whether they prefer a self-driving car. What are the critical alternatives to conceptualize these questions and which disciplines (medical, legal, ethical, economical) are relevant to reflect on the QoL issues "should something be done?"

Accepting QoL as an important concept does not imply that people would agree which objectives would be desirable or should be avoided. We have questioned [Fischer et al., 2000] a vision that many people regard as highly desirable: an "effortless world" representing an old dream of humankind to return to the *Garden of Eden* or *Paradise* (a place where peace, prosperity, and happiness can be found), *Arcadia* (an idyllic vision of unspoiled wilderness), and *Utopia* (a community or society possessing highly desirable qualities) and live a life of abundance free of all work and pain in which all desires would be satisfied immediately without any effort. However, when all wishes get fulfilled, how would that change the nature of wishing? Would thinking of anything outrageous remain possible? Would we become incapable of even thinking of anything off track [Huxley, 2006]? Human beings value things and relationships for which they have to make an effort to obtain them and in which they find purpose, enjoyment, and flow states in personally meaningful task [Csikszentmihalyi, 1996].

Gaining a deeper understanding and more insights into QoL will require that the designers of information technology and computing target new different objectives and take the findings of different research disciplines into account (see Table 1).

Table 1: Objectives and Disciplines Relevant for QoL

Layer	Objective	Requirements	Disciplines
Layer-3: choices, engagement, and control ("why")	being interested and willing to participate	motivation, ownership, nudges, social capital, reputation economy	ethics, behavioral economics, anthropology, creative practices
Layer-2: knowledge and skills ("how")	thinking slow and fast; being knowledgeable in order to participate	making all voices heard; substantial learning effort	cognitive science, learning sciences
Layer-1: infrastructure ("prerequisites")	hard- and software	availability, access, usability	computer science

The first phase (Layer-1) of research and developments in human-centered computing was focused on concerns about usability and usefulness [Norman & Draper, 1986]. As hardware and software for many applications became readily available, new concerns (Layer-2) emerged including design methodologies such as participatory design giving all stakeholders a voice [Greenbaum & Kyng, 1991], incorporating requirements and insights from different disciplines [Ehn, 1998], and taking advantage from a deeper differentiation of human thinking [Kahneman, 2011]. While QoL objectives need to incorporate the findings and practices of these two layers, it has to take into account new requirements and it needs to look for additional disciplines for insights (Layer-3) [Benkler, 2006; Cialdini, 2009; Thaler & Sunstein, 2009] to inspire new agendas for theory and practice in computing.

DESIGN, DESIGN TRADE-OFFS, AND FRAMEWORKS AND DEVELOPMENTS FOR TRANSCENDING BINARY CHOICES

Design. In contrast to the natural sciences that study "how things are" (being primarily descriptive), *design* is concerned with "how things ought to be" (being primarily prescriptive) [Simon, 1996]. Design problems are wicked [Rittel & Webber, 1984], ill-defined [Simon, 1984], have no definitive formulation and no stopping rule, and their solutions are not "true-or-false", but "good-or-bad". The aim of design is not to find the truth, but to improve some characteristics of the world such as QoL. Design problems are *antinomies* being *"pairs of truth, which, though both may be true, nonetheless contradict each other. They remind us that truths do not exist independently of the perspectives of those who hold them to be so"* ([Bruner, 1996], p 67).

Design Trade-Offs. The attributes mentioned make *design trade-offs (*often representing *"Faustian Bargains"* that require people to trade some gain without considerations for the negative consequences and costs) the most basic characteristics of design. Identifying trade-offs rather than only pursuing goals at one end of the spectrum represents a unique challenge to identify, articulate, and assess *critical alternatives* for QoL perspectives. One particular important opportunity associated with a design trade-off perspective and analysis is to spark efforts for *exploring a synthesis* integrating their strengths and premises rather than their weaknesses and perils of the choices.

Design trade-offs can be found everywhere. For example at the beginning of 2015 the implications from the following "Faustian Bargains" are broadly discussed:

- *cheap oil*: consumers often see it as great advantage to save money at the pump, politicians from oil-consuming countries see it as a blessing for their economy whereas the economy of oil-producing countries may be driven toward bankruptcy, and environmentalists are horrified that people are buying large gas guzzlers again.
- the *sharing economy*: Internet-based companies (such as Uber and Airbnb) make billions of dollars, consumers see it as a way to get cheaper services, drivers and renters earn some additional money whereas taxi companies and professional drivers are driven into bankruptcy, taxes are not paid, and safety may be at risk.

Transcending Binary Choices. *Binary choices* represent the end points of a spectrum with each of them providing important perspectives and at the same time overlooking critical alternatives. In the discourses about the premises and perils of information technology and computing at a global scale, we can find numerous representatives arguing for one of the two opposing ends (the two lists are matched against each other):

- *technology utopists* often glorify the future and spread hype about the potential of developments including: (1) AI based claims about expert systems [Buchanan & Shortliffe, 1984], (2) the wonderful opportunities of the Internet [Shirky, 2008], (3) the power of e-memories [Bell & Gemmell, 2009], and (4) the unique educational opportunities of MOOCs [Friedman, 2013];
- *technology pessimists* often glorify the past and spread negative views about developments including: (1) the fundamental limitations of expert systems [Winograd & Flores, 1986]; (2) the limitations of the hive mind [Lanier, 2006]; (3) the virtue of forgetting [Mayer-Schönberger, 2009]; and (4) the absence of serious pedagogy in MOOCs [Vardi, 2012].

To better understand, enhance, and support QoL, research is needed to explore the middle ground between the endpoints. The following sections will describe examples illustrating our attempts to transcend binary choices. Many others have engaged in similar research activities: for example the *Digital Bauhaus* [Ehn, 1998], inspired by the ideas of the original Bauhaus movement, tries to establish new meeting grounds to exploit the synergy of art and science [National-Research-Council, 2003] by establishing new cross-cultural communications between people with technical backgrounds, artists, and philosophers by overcoming the classical barriers between experts of different disciplines through mutual acceptance [Snow, 1993].

The following sections will describe design trade-offs in three different domains by first establishing the existence of trade-offs rather than just one-sided approaches and then indicating possibilities how the "versus" can be turned into an "and" relationship.

Design Trade-Offs in the Domain of Computational Media

Information Access versus/and Information Delivery in High-Functionality Environments

Humans (workers, learners, citizens, decision makers) are supported in today's world with *high-functionality environments* (including: software reuse libraries, MS-Office on laptops, Apps on Smart Phones, MOOCs courses available on the Internet, etc.). There are two basic approaches to cope with and incrementally learn such systems: information access and information delivery.

Information access systems ("pull-systems") in which users initiate the search process with browsing and search methods are designed under the assumption that users are aware of their information needs and that they know how to ask for it. The major limitation of information access systems is: if a user does not know that something exists (components located in L4 ^¬L3 in **Figure 1**), they are unable search for it.

Information delivery systems ("push-systems") provide information to users without explicit requests. Many information delivery systems (e.g.: Microsoft's "Tip of the Day", recommender systems) suffer from the problem that concepts get thrown at users in a decontextualized way. Despite the possibility for interesting serendipitous encounters of information, most users find this feature more annoying than helpful.

Transcending the Binary Choices: Context-Aware Systems. To overcome the shortcomings of the two approaches, we have developed computational environments capable of differentiating between the following domains (L) of knowledge held by individual users (see **Figure 1**):

- L1: elements are well known and regularly used;
- L2: elements are known vaguely and used occasionally;
- L3: elements are believed to exist in the system;
- L4: all elements of the system.

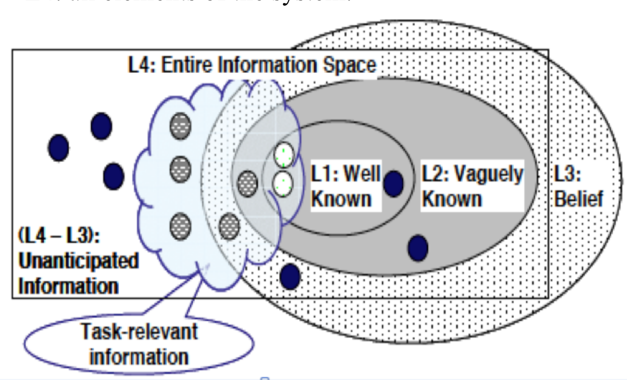

Figure 1: A System Architecture Supporting Context-Sensitive Information Delivery

Identifying the different levels of user knowledge and overlaying it with task-relevant information allowed our systems [Fischer, 2012] to decide between information that should be delivered (the shaded bubbles) and should not be delivered (the dark bubbles because the information is not relevant to the task and the white bubbles because the information is already known to the user).

Most of our work (focused on design activities, high-functionality environments, and learning) has explored *unique aspects of context-aware systems* [Dey et al., 2001] [Fischer, 2012] such as design trade-offs, design intent, specification components, critiquing systems, information access and delivery, intrusiveness, and the synergy between adaptive and adaptable components. The *promises* of context-aware systems are to reduce information overload by making information relevant to the task-at-hand and to the background knowledge of the users and to acquaint users with opportunities relevant to their presumed interests that they are not aware of (as illustrated by **Figure 1**). Particular aspects of context that have been explored in other settings are: (1) *location-based information systems* have focused on a narrow notion of context: how to capture location automatically by hardware and software sensors; (2) *recommender systems* have explored techniques for recommending various products or services to individual users based on knowledge of the users' tastes and preferences as well as users' past activities; and (3) a*mbient intelligence research* has analyzed environments with many embedded devices that can recognize the situational context of users.

While these promises can contribute positively to QoL, some important *pitfalls* of context-aware systems should not be overlooked. As web companies exploit context awareness to tailor their services (including news and search results) to people's inferred personal preferences and tastes, there is a unintended consequence: recipients get trapped in *"filter bubbles"* [Pariser, 2011], a unique universe of information computed by algorithms exploiting context awareness based on users' previous actions and behaviors with the drawback that users do not get exposed to information that could challenge or broaden their worldview and that unexpected encounters with different topics and opinions are eliminated. Filter bubbles may lead to *groupthink* [Janis, 1972] with a loss of individual creativity and independent thinking, as well as a tendency to minimize conflict and reach a consensus decision without critical evaluation of alternative ideas or viewpoints.

To transcend this binary choice (as exemplified by the promises and perils) is to find the right balance between *serendipity* [Roberts, 1989] and *making information relevant to the task at hand* [Fischer et al., 1996]. One step to achieve this objective is to design interaction mechanisms allowing users to select their own personal, situation- and time-dependent *best mix* of these design trade-offs.

Adaptive versus/and Adaptable Systems

Computational environments model systems existing in the world. As these real-world systems change, the corresponding computational environments need to change requiring open and evolvable systems. *Adaptive systems*, which automatically alter their behavior based on models of users, tasks, and contexts, and *adaptable systems*, which are modified by users in response to breakdowns and missing functionality experienced during the use of the system [Fischer, 1993], are two approaches to address this challenge.

Adaptive systems can contribute to QoL by making desired changes without putting a burden on users. They have a negative effect on QoL in cases where these changes are not welcome or hated by users. A small scale but informative example is provided by *Auto-Correct* in MS-Word changing "hte" to "the" (considered by most a desirable change) and changing "EHR" to "HER" (an unwelcome change if "EHR" stands for NSF's directorate of "Education and Human Resources").

Adaptable systems (supporting end-user modifiability with meta-design) put users in charge. The price to be paid of being in control, however, is that adaptable systems require knowledge and effort on the part of users. They extend the traditional notion of system design beyond the original development of a system to include an ongoing process in which the users of the system become co-developers. Table 2 compares some of the major alternatives between adaptive and adaptable systems.

Table 2: Comparing Different Dimensions of Adaptive and Adaptable Systems

	Adaptive: System Infers Context	Adaptable: Users Articulate Context
Definition	dynamic adaptation by the system itself to current task and current user	user changes the functionality of the system
Knowledge	contained in the system; projected in different ways	knowledge is extended beyond the original system
Strengths	little (or no) effort by the user; no special knowledge of the user is required	user is in control; user knows her/his task best

Weaknesses	user has difficulty developing a coherent model of the system; loss of control	systems become incompatible; user must do substantial work; complexity is increased (user needs to learn the adaptation component)
Mechanisms Required	models of users, tasks, and dialogs; incremental update of models	support for meta-design
Application Domains	active help systems, critiquing systems, recommender systems	end-user modifiability, tailorability, definition of filters, design in use

Transcending the Binary Choices: Meta-Design. In a world that is not predictable, 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. Meta-design [Fischer & Giaccardi, 2006] is focused on "design for designers" (or "design for design after design" [Binder et al., 2011]) and represents an emerging conceptual framework aimed at defining and creating social and technical infrastructures in which new forms of collaborative design can take place. It extends the traditional notion of system design beyond the original development of a system by supporting users as co-designers [Henderson & Kyng, 1991]. It is grounded in the basic assumption that future uses and problems cannot be completely anticipated at design time, when a system is developed. Users, at use time, will discover mismatches between their needs and the support that an existing system can provide for them. These mismatches will lead to breakdowns that serve as potential sources of new insights, new knowledge, and new understanding.

Meta-designers define a context at design time in which users acting as designers at use time can define content (e.g.: a macro definition environments as provided by MS-Word). Meta-designers often create construction kits and domain-oriented design environments [Fischer, 1994] that explore approaches in the middle between

- the *Turing Tar Pit*, in which "everything is possible, but nothing of interest is easy" — this approach emphasizes objective computability (what is doable "in principle") whereas most stakeholders are interested in subjective computability (what they can achieve with their knowledge and within their time constraints);
- the *Inverse of the Turing Tar Pit* focused on "over-specialized systems, where operations are easy, but little of interest is possible" — this approach emphasizes domain-specific artifacts and tools for specific problems but provides little or no support to extend the systems and artifacts.

The goal of making systems modifiable by users does not imply transferring the responsibility of good system design to the user. Normal users will in general not build tools of the quality a professional designer would. In fact, they are not concerned with the tool, per se, but in doing their work. However, if the tool does not satisfy the needs or the tastes of the users (which they know best [von Hippel, 2005]) then users should be able to adapt the system without always requiring the assistance of developers.

Design Trade-offs in the Domain of Participation and Collaboration

Artificial Intelligence ("Automate") versus/and Intelligence Augmentation ("Informate")

Artificial Intelligence (AI) and Intelligence Augmentation (IA) are design-trade-offs with fundamental implications for QoL [Carr, 2014; Fischer & Nakakoji, 1992]. As argued before, without a detailed analysis of the specific contexts and objectives, it is impossible to say whether they have a positive or negative impact on QoL. Automation can make our lives easier, our chores less burdensome, and humans can focus their time and energy on tasks that they consider important and desirable. Few people would argue that we should eliminate traffic lights with police persons, telephone switches with operators, and compilers with human translators. On the other hand, automation can create overreliance in situation where human competence is required and it can eliminate work and activities that people would like to do (e.g.: will people in the future mostly drive around in self-driving cars?).

Transcending the Binary Choices: Symbiosis. The fundamental challenge is to create a symbiotic relationship between humans and computational support. The best mix cannot be determined in the abstract, but needs to be determined for specific situations.

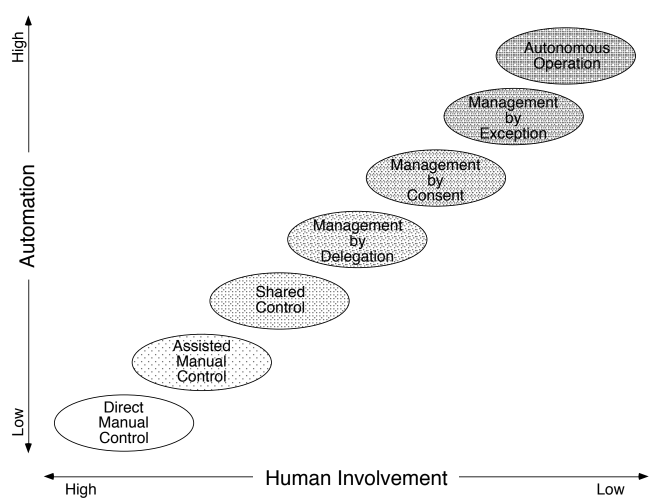

Figure 2: A Classification Scheme Relating Automation and Human Involvement

Billings [Billings, 1991] has developed in the context of airplane cockpit design a classification scheme relating automation and human involvement to each other indicating many different relationships (see **Figure 2**). These differentiations and their implications for QoL can serve as a model for many other domains.

Passive Consumers versus/and Active Contributors

A large number of the new media are designed to see humans only as consumers. Television is the most obvious medium that promotes this mindset and behavior [Postman, 1985] but educational institutions often treat students as consumers, creating a mindset of consumerism for the rest of their lives [Illich, 1971]. Citizens often feel left out of the decisions by policy makers, denying them opportunities to take an active role [Brown et al., 1994].

The traditional notions of developer and user are unable to reflect the fact that many socio-technical environments nowadays are developed with the participation of many people with varied interests and capabilities. Social production and mass collaboration [Benkler, 2006] require contributors with diverse background knowledge who require different support and value different ways of participating. Figure 3 (inspired by the "reader to leader" framework of [Preece & Shneiderman, 2009]) illustrate a richer ecology of participation by postulating different roles. As participants move from left to right, the complexity of the tasks that they do and the demand for how much they have to learn is increasing. To accept these additional efforts participants must consider these tasks as personally meaningful and the migration paths need to be supported by gentle slope systems in which the transitions from one level to another level are smooth. While the Figure is focused on the migration towards more demanding roles, it will be equally important to identify and analyze identify factors that *cause people move in the other direction* (including: not enough time, lack of challenges, and fading of interest).

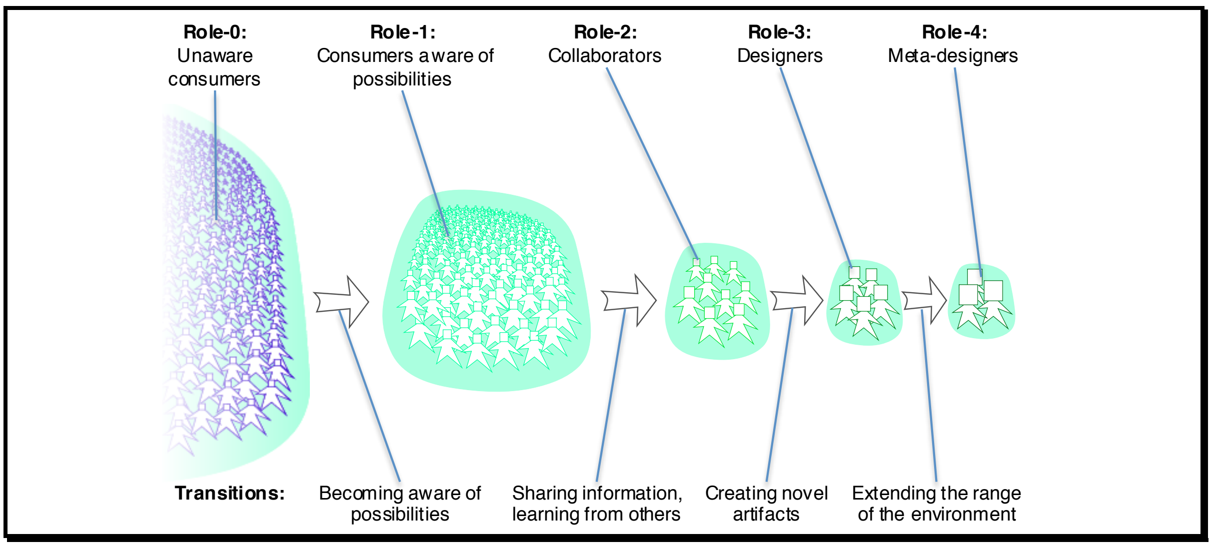

Figure 3: Richer Ecologies of Participation

A detailed empirical analysis of open-source software systems [Fischer et al., 2008] revealed a variety of different roles: (1) *passive users* (using the system); (2) *readers* (trying to understand how the system works by reading the source code); (3) *bug reporters* (discovering and reporting bugs); (4) *bug fixers* (fixing bugs); (5) *peripheral developers* (occasionally contributing new functionality or features); (6) *active developers* (regularly contributing new features and fixing bugs); and (7) *project leader(s)* (initiating the project and being responsible for its vision and overall direction).

Transcending the Binary Choices: Cultures of Participation. For a couple of decades the rise of digital media has been providing new powers for the *individual* and the world's networks are providing now enormous unexplored opportunities for *groups and communities.* Providing all citizens with the means to become co-creators of new ideas, knowledge, and products in personally meaningful activities presents one of the most exciting innovations and transformations, with profound implications in the years to come. The rise in *social computing* has facilitated a shift from *consumer cultures* (in which people passively consume finished goods) to *cultures of participation* [Fischer, 2011; Jenkins, 2009; Lessig, 2008]. *Cultures of participation* are facilitated by the participatory Web [O'Reilly, 2005] contributing to the aims of engaging diverse audiences, enhancing creativity, sharing information, and fostering the collaboration among users. They democratize design and innovation [von Hippel, 2005] by shifting power and control towards the users, supporting them to act as both designers and consumers of the system and allowing the system to be shaped through real-time use. Cultures of participation offer possibilities to transcend the binary choices between "automate" and "informate", and between "passive consumers" and "active contributors".

Design Trade-offs in the Domain of Learning and Education

Access to affordable education, fostering mindsets for creativity, coping with change, and nurturing intellectual curiosity are considered worldwide as major challenges for QoL. There are numerous trade-offs in learning and education: (1) *where* people learn: in formal institutions or in informal learning environments; (2) *what* people learn: basic skills or personally meaningful topics; (3) *when* people learn: in schools or throughout life; and (4) *how* people learn: in instructionist settings or in problem-based, self-directed learning environments (see Figure 4). This last trade-off will be analyzed in more detail.

Massive Open Online Courses (MOOCs) versus/and Self-Directed Learning

The recent emergence of MOOCs associated with their promises of providing new, scalable models that can provide an "education for everyone by making the knowledge of some of the world's leading experts available to anyone free of charge" has generated a broad interest in rethinking learning and education.

MOOCs enrich the landscape of learning opportunities and they have the potential to reduce the digital divide [Schön et al., 1999]. MOOCs deserve credit because they have woken up academia and the media to bring online learning and teaching to the attention of the public [Friedman, 2013]. A special impact is the challenge of MOOCs to "force" residential, research-based universities to reflect, define, and emphasize their *core competencies*. Lecture-dominated courses often emphasize passive knowledge absorption and serve as the "reproductive organ of a consumer society" [Illich, 1971]. Residential, research-based universities should complement this objective by nurturing and supporting self-directed learning in context where people "want to learn rather than have to learn". Table 3 summarizes important design trade-offs between the two approaches.

Table 3: Distinctions and Complementary Nature of MOOCs and Self-Directed Learning

Dimensions	MOOCs	Self-Directed Learning
major objective	presentation of an organized body of knowledge	nature and support learners in their self-directed, passion-based learning activities
characteristics	problems are given by the teacher or the systems; learning supported from the supply side; adult-run education; prescriptive	problem is based on the learner's needs and interest; learning supported from the demand side; child-run education; permissive
strengths	organized body of knowledge; pedagogically and cognitively structured presentations	real interests, personally meaningful tasks, high motivation
weaknesses	limited relevancy to the interests of the learner or the task at hand	coverage of important concepts may be missing; demand driven, unstructured learning episodes; lack of coherence
primary role of the teacher	"sage on the stage" — presents what he/she knows and is prepared for	"guide on the side" –answers and relevant information have to be culled from questions posed by others
planning versus situated responses	anticipating and planning of the learning goals and content	learning needs arise from the situational context
distribution over lifetime	*decreasing* in importance from school to university to lifelong learning	*increasing* in importance from school to university to lifelong learning
assessment	"standard" assessment instruments are applicable	"innovative" assessment instruments are needed

Transcending the Binary Choices: Rich Landscapes of Learning. The attempt to identify the core competencies of residential research-based universities does not imply that we should simply see them as the gold standard for learning and education. There may be a number of objectives that are better served by MOOCs such as distributed learning communities defined by shared interests rather than shared location and access for individuals to lectures that they would not have otherwise. Just as Amazon offers more books than any physical bookstore (exploiting the "Long Tail" distribution [Anderson, 2006]), the number of available courses in future MOOC warehouses can be substantially larger than the number of courses any university can provide.

What is needed now, more than ever, are theories and practices that bridge the numerous design trade-offs inherent in each of the dimensions of a rich landscape of learning as indicated in Figure 4 and to explore new kinds of computational platforms that can enhance the potential synergy between these contrasting pairs. Future research efforts to explore critical alternatives in the context of rich landscapes of learning with a focus on MOOCS should be focused on creating frames of reference to understand the role of MOOCs specifically from a learning science perspective (in addition to economic and technological perspectives) and moving beyond the exaggerated hype and total underestimation currently surrounding MOOCs [Fischer, 2014].

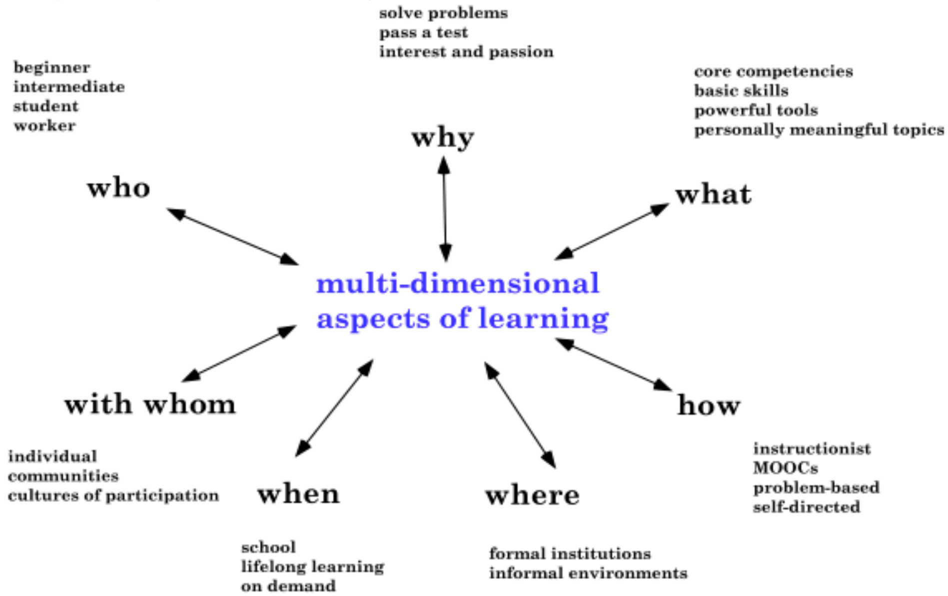

Figure 4: A Rich Landscape of Learning

OBJECTIVES FOR A RESEARCH AGENDA FOR CRITICAL ALTERNATIVES FOR QUALITY OF LIFE

The previous sections of this article have identified and focused on trade-offs in design and described some important challenges: (1) to establish trade-offs to existing one-sided approaches and (2) to identify and explore interesting new approaches by synthesizing the strengths and avoiding the weaknesses of the the binary choices defined by the trade-offs.

As argued before, QoL as a concept transcends the domain of information technology and computing. But even within the domain of information technology and computing there are numerous other themes in addition to the ones analyzed in this paper for which a trade-off analysis can and should be applied including: (1) *privacy* [Kobsa, 2007], (2) *value-sensitive design* [Friedman & Hendry, 2012], and (3) the *digital divide* [Schön et al., 1999].

Grounded in the set of trade-offs discussed in previous sections, this section briefly describes a small number of objectives for a research agenda for critical alternatives for QoL.

Beyond the "more and faster" philosophy of life. Digital technologies have accelerated the pace of production and consumption of more information. More information is provided from humans acting as bloggers, as producers of movies, and as participants in social networks and from sensors embedded in the cyber-physical systems surrounding us [Bell & Gemmell, 2009]. Humans being *want* to and/or *have* to be available at all times. The distinctions between work and leisure are being erased: "work never stops".

"More is more" has its attractions and rewards and has been embraced by many people: (1) more slides in a presentation; (2) more Facebook friends, Twitter followers, and LinkedIn connections; (3) more students in a MOOC; (4) more publications and a higher H-Index; (5) more apps on our Smart Phones; and (6) more "new version" messages from the companies whose systems we use.

A critical alternative for a QoL framework is to explore the design requirement *"less is more"* with

- innovations that have helped people deal with the tidal wave of information (including "do not call" telephone lists, e-mail filters and cell-phone-free zones);
- regulations that are targeted to limit or baring email after work hours (http://www.theepochtimes.com/n2/business/-volkswagen-to-improve-work-life-balance- 168056.html); and
- opportunities and incentives for humans to change their behavior, e.g. (1) by engaging as an information consumer in an occasional information celibacy by abstaining from the constant flow of information thereby avoiding that the urgent displaces the important, and (2) by encouraging information producers to follow Blaise Pascal who wrote to a friend: *"Sorry, I did not have the time to make this letter shorter"*.

Exploring Design-Trade-Offs for QoL as a Grand Challenge. G*rand challenges* define a commitment by a scientific community to work together towards a common goal — valuable and achievable within a predicted timescale. Grand Challenges tackle fundamental problems with broad economic and scientific impact and they attempt to change the discourse that drives research and practice.

Some famous grand challenges have been: (1) Hilbert identified 23 Grand Challenge problems in mathematics in 1900; (2) Kennedy declared a national goal as a Grand Challenge in 1961 to put a human on the moon before the end of the decade; (3) the NSF High-Performance Computing and Communications (HPCC) program in 1992; (4) the Bill & Melinda Gates Foundation that identified 14 *Grand Challenges in Global Health* in 2003; and much smaller efforts but closer to the objective of QoL in the digital world (5) grand challenge problems for human-computer interaction [Engeström et al., 2010]; and (6) grand challenge problems for technology enhanced learning [Fischer et al., 2014].

The first three of the six Grand Challenges had clearly stated goals and well defined progress indicators that could be measured. These attributes do not hold for the last three and a major part of them is to identify design trade-offs as critical alternatives rather than clearly specific goals. To create Grand Challenges for QoL will have to identify and resolve conflicts between the opinions and objective of all stakeholders who represent in these cases more a community of interest (CoI) than a community of practice (CoP) (for example most teachers seeing technology as a tool to inspire student learning and most entrepreneurs seeing it as a way to standardize teaching, to replace teachers, to make mone, and to market new products).

Rethinking the Concept of "Free". "Free" as an essential concept and a "Faustian Bargain" for QoL. While "free" is definitely important in an economic dimension, in a world of informational abundance, it should also be considered how "free" an activity is to learn and to undertake. In a world where many books, lectures, and tools are free financially (e.g.: the books from [Benkler, 2006] and [von Hippel, 2005] are available as PDF files for anyone to download and many of the apps are free), the costs is not the money to pay for them, but the time and the intellectual effort required to read them and learn them. Costs are also occurring for people that they pay with a loss of privacy (by leaving traces of their actions that can be exploited by companies).

The promise "Education for Everyone for Free" generated the excitement about MOOCs. At this moment no convincing business models exist for MOOCs. The search for sustainable business models has been a major challenge and the current developments indicate that in the future only "*basic services*" (the lectures) will remain free whereas the *"premium services"* (e.g.: providing mentoring, feedback, and certification) will have to be paid for [Daniel, 2012]. Being "free", MOOCs also raise the issue how the teachers of MOOCs will be financially rewarded for their efforts? In case universities consider this as part of the jobs for faculty members — what motivates university administrators (beyond the fear not to be left behind) to give their faculty members time for MOOC students, of which almost all are not students at their universities? After the initial engagement (hoping to reach fame and have substantial impact) will faculty members sustain their engagement in MOOCs in cases where teaching a MOOC distracts them from their normal on-campus duties?

Identification of the truly limiting Resource: Human Attention, not Information. Simon identified over 40 years ago a fundamental design trade-off: *"What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention, and a need to allocate efficiently among the overabundance of information sources that might consume it."* ([Simon, 1971], pp 40-41). No person can afford to pay attention to more than a very small fraction of new things produced. Because of the scarcity of attention, people must be selective. The challenge is to create socio-technical environments not based on anyone having access to information "anytime and anywhere", but to create *context-aware systems* with a focus on saying *"the 'right' information, at the 'right' time, in the 'right' place, in the 'right' way, to the 'right' person"* [Fischer, 2012]. In this age of info-glut, people can be subjected to deceptions, not necessarily by the deliberate manipulation of facts, but by being inundated with irrelevant information from a variety of interest groups. Postman describes this "Faustian Bargain" by comparing "1984" [Orwell, 1950] with "Brave New World" [Huxley, 2006] and concludes: *"Huxley and Orwell did not prophesy the same thing. Orwell warns that we will be overcome by an externally imposed oppression. But in Huxley's vision, no Big Brother is required to deprive people of their autonomy, maturity and history. As he saw it, people will come to love their oppression, to adore the technologies that undo their capacities to think."* ([Postman, 1985], pp vii-viii).

Beyond the Exclusive Reliance in Big Data. Data can be immensely helpful and overcome beliefs, opinions, and mistaken assumption to document a descriptive account of "how things are". Data collected (1) in the cyber-physical world (e.g.: activity trackers providing data for a "quantified self"), and (2) in e-memories for total recall [Bell & Gemmell, 2009] (allowing people to instantly access all the information they were exposed to throughout their lives) is assumed to help improve people's QoL. *Learning analytics* [Siemens, 2012], based on data that is easily collected in MOOCS (where all interactions and activities take place inside a computational environment) has created big expectations that the insights based on these data will improve learning and education. Some of these expectations have turned out to be successful (1) by exposing when our intuitive view of reality is wrong (e.g.: the largest group of users in MOOCs are learners who have already a Master's degree and not as originally assumed people with little educational background) and (2) illuminating patterns of behavior we have not yet noticed (e.g.: with powerful visualization and simulation techniques).

But we should be aware of the "Faustian Bargain" aspects that are associated with the exclusive reliance on data. The data revolution is giving us wonderful ways to understand the present and the past, but will it improve our ability to predict and make decisions about the future? And the data that we collect reflects the questions that we ask and those depend on the frames of reference that we have established with the identification of design trade-offs. For example: there is ample data about the low completion rates for MOOCs. This data is very troublesome when MOOCS are considered online versions of regular courses in residential universities but it does not come as a surprise if we conceptualize MOOCs as the textbooks of the 21st century (as there is no harm if a textbook is not read from the first to the last page).

Liberterian Partneralism. An interesting design-trade-off discussed broadly in behavioral economics and public policy is the binary choice between partneralism (being prescriptive) and libertarian (being permissive). The book "Nudge" [Thaler & Sunstein, 2009] introduces and advocates an interesting concept exploring middle ground with *"liberterian partneralism"* and associated concepts such as "choice architects" and "well-chosen defaults". The implications and the consequences of employing nudges are illustrated in the book with a variety of examples contributing to QoL in domains such as health, wealth, and happiness. Nudges distribute control between choice architects (e.g.: policy makers in governments, designers, teachers) and customers (e.g.: citizens, users, learners) and they are less coercive than commands, scripts, workflow processes, requirements, or prohibitions. The appeal of libertarian paternalism for its supported is rooted in the respect it has for individual autonomy represented by the libertarian part of it.

The QoL controversies in relationship to "liberterian partneralism" are centered on the issue whether individuals want government, teachers, parents stepping in to protect them from their own mistakes or poor decisions? The "no" people argue that individuals may be imperfect decision-makers, but they still possess more information about their life than others. Their argumentation is based on that even just setting a default position reduces choice and personal responsibility. The "yes" people argue that whatever designers and decision makers do they will inevitably setting contexts and default positions anyway and the libertarian part allows individuals to be free to do what they like.

The "Nudge" framework shares many objectives at a global level that meta-design pursues in the context of the design on information technologies. A choice architect (on the partneralism side) has the responsibility for organizing the context in which people make decisions. The "libertarian" dimension offers the people the freedom to accept or decline these choices.

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<<to be inserted later>>

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. Necessity, importance, urgency are not something imposed by nature upon humanity but these are conceptual categories created by cultural choice. Humans are also creations of desire, not only of needs [Basalla, 1988]. Therefore, 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*. As researchers we need to explore and understand the implications of "Faustian Bargains" and engage multiple voices in constructive controversies. As teachers, educators, and members of scientific communities we need to encourage and support learners of all ages in exploring critical alternatives for QoL and provide opportunities in nurturing mindsets for thinking, reflecting, and acting in an informed way by considering design-trade-offs in all areas of human life.

REFERENCES

Anderson, C. (2006) The Long Tail: Why the Future of Business Is Selling Less of More, Hyperion, New York, NY.

Basalla, G. (1988) The Evolution of Technology, Cambridge University Press, New York.

Bell, G., & Gemmell, J. (2009) Total Recall, Dutton, New York, NY.

Benkler, Y. (2006) The Wealth of Networks: How Social Production Transforms Markets and Freedom, Yale University Press, New Haven.

Billings, C. E. (1991) Human-Centered Aircraft Automation: A Concept and Guidelines, NASA Technical Memorandum, Report No. 103885, NASA Ames Research Center.

Binder, T., DeMichelis, G., Ehn, P., Jacucci, G., Linde, P., & Wagner, I. (2011) Design Things, MIT Press, Cambridge, MA.

Brown, J. S., Duguid, P., & Haviland, S. (1994) "Toward Informed Participation: Six Scenarios in Search of Democracy in the Information Age," The Aspen Institute Quarterly, 6(4), pp. 49-73.

Bruner, J. (1996) The Culture of Education, Harvard University Press, Cambridge, MA.
Buchanan, B. G., & Shortliffe, E. H. (Eds.) (1984) Rule-Based Expert Systems: The Mycin Experiments of the Stanford Heuristic Programming Project, Addison-Wesley Publishing Company, Reading, MA.
Carr, N. (2014) The Glass Cage — Automation and Us, Norton, New York.
Cialdini, R. (2009) Influence: Science and Practice (5th Edition), Pearson, Boston.
Csikszentmihalyi, M. (1996) Creativity — Flow and the Psychology of Discovery and Invention, HarperCollins Publishers, New York, NY.
Daniel, J. (2012) Making Sense of MOOCs: Musings in a Maze of Myth, Paradox and Possibility, available at http://www-jime.open.ac.uk/jime/article/viewArticle/2012-18/html.
Dey, A. K., Abowd, G. D., & Salber, D. (2001) "A Conceptual Framework and a Toolkit for Supporting the Rapid Prototyping of Context-Aware Applications," Human-Computer Interaction Journal, Special Issue on "Context-Aware Computing", 16(2-4), pp. 97-166.
Ehn, P. (1998) "Manifesto for a Digital Bauhaus," Digital Creativity, 9(4), pp. 207-216.
Engeström, Y., Sannino, A., Fischer, G., Morch, A., & Bertelsen, O. (2010) "Grand Challenges for Future Hci Research: Cultures of Participation, Interfaces Supporting Learning, and Expansive Learning (Panel)," Proceedings of NordiCHI'2010, Reykjavik, Iceland
Fischer, F., Wild, F., Sutherland, R., & Zirn, L. (2014) Grand Challenges in Technology Enhanced Learning, Springer, Heidelberg.
Fischer, G. (1993) "Shared Knowledge in Cooperative Problem-Solving Systems - Integrating Adaptive and Adaptable Components." In M. Schneider-Hufschmidt, T. Kuehme, & U. Malinowski (Eds.), Adaptive User Interfaces - Principles and Practice, Elsevier Science Publishers, Amsterdam, pp. 49-68.
Fischer, G. (1994) "Domain-Oriented Design Environments," Automated Software Engineering, 1(2), pp. 177-203.
Fischer, G. (2011) "Understanding, Fostering, and Supporting Cultures of Participation," ACM Interactions XVIII.3 (May + June 2011), pp. 42-53.
Fischer, G. (2012) "Context-Aware Systems: The 'Right' Information, at the 'Right' Time, in the 'Right' Place, in the 'Right' Way, to the 'Right' Person." In G. Tortora, S. Levialdi, & M. Tucci (Eds.), Proceedings of the Conference on Advanced Visual Interfaces (AVI 2012), ACM, Capri, Italy (May), pp. 287-294.
Fischer, G. (2014) "Beyond Hype and Underestimation: Identifying Research Challenges for the Future of MOOCs," Distance Education Journal (Commentary for a Special Issue "MOOCS: Emerging Research"), 35(2), pp. 149-158.
Fischer, G., & Giaccardi, E. (2006) "Meta-Design: A Framework for the Future of End User Development." In H. Lieberman, F. Paternò, & V. Wulf (Eds.), End User Development, Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 427-457.
Fischer, G., Greenbaum, J., & Nake, F. (2000) "Return to the Garden of Eden? Learning, Working, and Living," The Journal of the Learning Sciences, 9(4), pp. 505-513.
Fischer, G., & Herrmann, T. (2011) "Socio-Technical Systems: A Meta-Design Perspective," International Journal of Sociotechnology and Knowledge Development, 3(1), pp. 1-33.
Fischer, G., Lemke, A. C., McCall, R., & Morch, A. (1996) "Making Argumentation Serve Design." In T. Moran, & J. Carrol (Eds.), Design Rationale: Concepts, Techniques, and Use, Lawrence Erlbaum and Associates, Mahwah, NJ, pp. 267-293.
Fischer, G., & Nakakoji, K. (1992) "Beyond the Macho Approach of Artificial Intelligence: Empower Human Designers - Do Not Replace Them," Knowledge-Based Systems Journal, Special Issue on AI in Design, 5(1), pp. 15-30.
Fischer, G., Piccinno, A., & Ye, Y. (2008) "The Ecology of Participants in Co-Evolving Socio-Technical Environments." In P. Forbrig, Paternò, F. (Ed.), Engineering Interactive Systems (Proceedings of 2nd Conference on Human-Centered Software Engineering), Volume LNCS 5247, Springer, Heidelberg, pp. 279-286.
Friedman, B., & Hendry, D. G. (2012) "The Envisioning Cards: A Toolkit for Catalyzing Humanistic and Technical Imagination." In Proceedings of CHI 2012, ACM Press, New York, NY, pp. 1145-1148.
Friedman, T. L. (2013) Nothing Has More Potential to Lift More People out of Poverty, available at http://www.nytimes.com/2013/01/27/opinion/sunday/friedman-revolution-hits-the-universities.html.
Greenbaum, J., & Kyng, M. (Eds.) (1991) Design at Work: Cooperative Design of Computer Systems, Lawrence Erlbaum Associates, Inc., Hillsdale, NJ.
Henderson, A., & Kyng, M. (1991) "There's No Place Like Home: Continuing Design in Use." In J. Greenbaum, & M. Kyng (Eds.), Design at Work: Cooperative Design of Computer Systems, Lawrence Erlbaum Associates, Inc., Hillsdale, NJ, pp. 219-240.
Huxley, A. (2006) Brave New World, Harper (Reprint edition), New York.
Illich, I. (1971) Deschooling Society, Harper and Row, New York.
Janis, I. (1972) Victims of Groupthink, Houghton Mifflin, Boston.

Jenkins, H. (2009) Confronting the Challenges of Participatory Cultures: Media Education for the 21st Century, MIT Press, Cambridge, MA.

Kahneman, D. (2011) Thinking, Fast and Slow, Farrar, Straus and Giroux, New York.

Kobsa, A. (2007) "Privacy-Enhanced Personalization," Communications of the ACM, 50(8), pp. 24-33.

Lanier, J. (2006) Digital Maoism: The Hazards of the New Online Collectivism, available at http://edge.org/conversation/digital-maoism-the-hazards-of-the-new-online-collectivism.

Lessig, L. (2008) Remix: Making Art and Commerce Thrive in the Hybrid Economy, Penguin Press, New York.

Mayer-Schönberger, V. (2009) Delete — the Virtue of Forgetting in the Digital Age, Princeton University Press, Princeton, NJ.

National-Research-Council (2003) Beyond Productivity: Information Technology, Innovation, and Creativity, National Academy Press, Washington, DC.

Norman, D. A., & Draper, S. W. (Eds.) (1986) User-Centered System Design, New Perspectives on Human-Computer Interaction, Lawrence Erlbaum Associates, Inc., Hillsdale, NJ.

O'Reilly, T. (2005) What Is Web 2.0 - Design Patterns and Business Models for the Next Generation of Software, available at http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html.

Orwell, G. (1950) 1984, Signet Classic.

Pariser, E. (2011) Beware Online "Filter Bubbles" (Ted Video), available at http://www.youtube.com/watch?v=B8ofWFx525s.

Postman, N. (1985) Amusing Ourselves to Death—Public Discourse in the Age of Show Business, Penguin Books, New York.

Preece, J., & Shneiderman, B. (2009) "The Reader-to-Leader Framework: Motivating Technology-Mediated Social Participation," AIS Transactions on Human-Computer Interaction, 1(1), pp. 13-32.

Rittel, H., & Webber, M. M. (1984) "Planning Problems Are Wicked Problems." In N. Cross (Ed.), Developments in Design Methodology, John Wiley & Sons, New York, pp. 135-144.

Roberts, R. M. (1989) Serendipity: Accidental Discoveries in Science, John Wiley & Sons, Inc., New York.

Schön, D. A., Sanyal, B., & Mitchell, W. J. (Eds.) (1999) High Technology and Low-Incoming Communities, MIT Press, Cambridge, MA.

Shirky, C. (2008) Here Comes Everybody: The Power of Organizing without Organization, Penguin Books,, New York, NY.

Siemens, G. (2012) "Learning Analytics: Envisioning a Research Discipline and a Domain of Practice." In Proceedings of the 2nd International Conference on Learning Analytics and Knowledge (Lak'12), ACM, New York, NY, pp. 4-8.

Simon, H. A. (1971) "Designing Organizations for an Information-Rich World." In M. Greenberger (Ed.), Computers, Communication, and the Public Interest, The Johns Hopkins Press, Baltimore, MD.

Simon, H. A. (1984) "The Structure of Ill-Structured Problems." In N. Cross (Ed.), Developments in Design Methodology, John Wiley & Sons, New York, pp. 145-166.

Simon, H. A. (1996) The Sciences of the Artificial, third ed., The MIT Press, Cambridge, MA.

Snow, C. P. (1993) The Two Cultures, Cambridge University Press, Cambridge, UK.

Thaler, R. H., & Sunstein, C. R. (2009) Nudge — Improving Decisions About Health, Wealth, an Happiness, Penguin Books, London.

Vardi, M. Y. (2012) "Will MOOCs Destroy Academia?," Communications of the ACM (CACM), 55(11), p. 5.

von Hippel, E. (2005) Democratizing Innovation, MIT Press, Cambridge, MA.

Winograd, T., & Flores, F. (1986) Understanding Computers and Cognition: A New Foundation for Design, Ablex Publishing Corporation, Norwood, NJ.