Innovating Health Care: Key Characteristics of Human-Centered Design

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Abstract

Human-centered design is about understanding human needs and how design can respond to these needs. With its systemic humane approach and creativity, human-centered design can play an essential role in dealing with today's care challenges. 'Design' refers to both the process of designing and the outcome of that process, which includes physical products, services, procedures, strategies, and policies. In this paper, we address the three key characteristics of human-centered design, focusing on its implementation in healthcare: (1) developing an understanding of people and their needs; (2) engaging stakeholders from early on and throughout the design process; (3) adopting a systems approach by systematically addressing interactions between the micro, meso and macro-levels of sociotechnical care systems, and the transition from individual interests to collective interests.

Key words

user-centered design, human factors, user needs, stakeholder involvement, sociotechnical systems approach, patient journey

1. Introduction

In recent years, new forms of patient care have been introduced to guarantee safe and high-quality care. Many of these approaches focus on organizational optimization and the needs and values of the stakeholders [1]. Examples include organizing care in dynamic multidisciplinary teams of medical professionals to coordinate mutual communication and diagnosis (e.g. networked care [2]), steering treatment on outcomes that matter to patients (e.g. value-based health care [3]), and active patient participation throughout their care path (e.g. shared decision making [4]). Designing and implementing these new forms of care involve major organizational change and demand a holistic systemic approach towards health care. It also requires dedicated, well-designed interventions -i.e. products, services, procedures- to be used by patients, care givers and medical professionals to facilitate and implement these envisioned forms of care.

Human-centered design (HCD), with its systemic humane approach and creativity towards change, can play an essential role in dealing with today's complex care challenges [1, 5, 6]. The field of HCD revolves around discovering human needs, so as to design products or services that meet these needs. The resulting design is understandable and usable, it accomplishes the desired tasks, and the experience of use is meaningful and pleasurable [7, 8]. Characteristic of HCD is its holistic, systems approach towards human needs, ensuring that solutions fit the dynamics of the (complex) socio-technical system the user is part of. Note that 'design' is a broadly defined term used for both the process of designing and the outcome of that process. Moreover, design is no longer used as a process to create physical products only, but increasingly as a process that leads to the creation of any type of intervention that changes existing situations into preferred ones. This includes services,

procedures, strategies, and policies [7, 9]. A large variety of methods and principles exists supporting the HCD process, each with its own specific purpose within the design context or phase of the design process [7, 10]. Examples of HCD methods range from shadowing and contextual inquiry to investigate human needs to co-creation and usability testing to develop solutions. The HCD discipline is closely related to that of Human Factors (HF) and the terms are often used interchangeably [9, 11]. Furthermore, there are many closely related design (research) disciplines using HCD principles and methods without explicitly being called HCD, such as user-centered design, design thinking [12], service design [13], experience-based design [14] and participatory systems approach toward design [15]. In HCD, as in all design disciplines using HCD principles, designers rely heavily on the tools, methods and insights from the HF discipline, as illustrated by the definition of HCD by the International Standards Organization (ISO): *'Human-Centered Design is an approach to interactive systems development that aims to make systems usable and useful by focusing on the users, their needs and requirements, and by applying human factors/ergonomics, usability knowledge, and techniques. This approach enhances effectiveness and efficiency, improves human well-being, user satisfaction, accessibility and sustainability, and counteracts possible adverse effects of use on human health, safety and performance'* [16]. The evolution of HCD and HF started after the Second World War; they were viewed as ways to increase the efficiency of industrial production by 'fitting the task to the worker'. Since then, the focus has elaborated from the physical and cognitive characteristics of users towards their organizational, social and emotional needs and pleasurable experiences [7, 9].

HCD is increasingly recognized as being a valuable contributor when addressing today's complex healthcare challenges (e.g. [5, 6]). In their editorial 'Redesigning healthcare to fit

with people' in the British Medical Journal, Erwin and Krishnan [5] aptly describe HCD's added value: "*The key is to shift our focus from helping people to fit our care delivery system, to one where we design our care delivery system to fit people where they live, work, learn, play, and receive healthcare*." Many healthcare organizations realize that becoming more human-centered is key to dealing with today's care challenges. However, although HCD is increasingly being adopted in healthcare practice, little has been published on what an HCD approach entails when applied to healthcare organizations. In this paper, we address the three key characteristics of HCD and how they relate to the context of healthcare: understanding people, early and continuous stakeholder engagement, and a systems approach.

2. Key characteristics of Human-Centered Design in Health Care

2.1 Understanding people - solving the right problem

The emphasis of HCD is on human needs and how design can respond to these needs. Understanding people, how they think, how they behave, and how they are influenced by their environment (i.e. their sociotechnical system) is therefore conditional before the actual development of an intervention can start. Or, as the well-known US-based design agency IDEO coined it in their Human-Centered Design Toolkit: "*Human-centered design begins by examining the needs and behaviors of the people we want to affect with our solutions*" [17].

A widely-used visualization of the HCD process is the Double Diamond Model (see Figure 1), developed in 2004 by the British Design Council [18] and which has been applied and

adapted by many designers since. The double-phased model underlines the key principle of HCD: first finding the right problem ('designing the right thing') and then fulfilling human needs by design ('designing things right') [8]. The first diamond is often referred to as the problem space, the second as the solution space; terms stemming from the design thinking practice, a practice closely related to HCD. The diamond structure emphasizes the divergent and convergent stages of the design process, referring to the different modes of thinking that designers use; a process of exploring an issue more widely or deeply (divergent thinking) and then taking focused action (convergent thinking). The HCD designer starts by questioning the problem given to them: they expand the scope of the problem, diverging to examine all the fundamental issues that underlie it. Then they converge on a problem statement. The knowledge of users and their context is then built on, to develop suitable solutions; the second diamond combines divergent and convergent thinking to determine an appropriate solution. First many ideas are created and evaluated, before refining and narrowing these down to the best solution [8, 18].

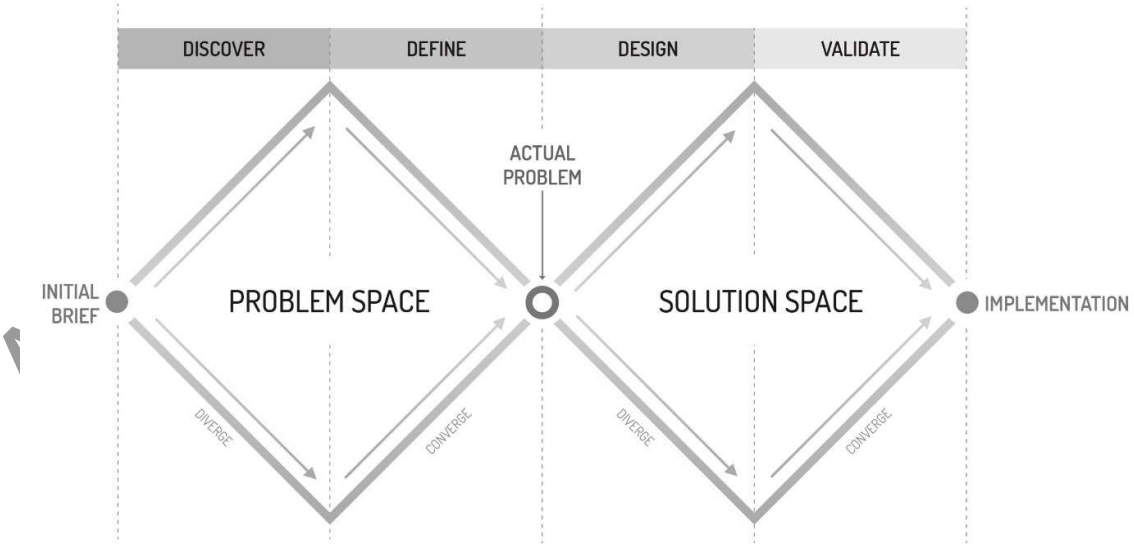

Figure 1. The Double Diamond Model (adapted from [18]), visualizing of the Human-Centered Design process. The first diamond represents the process of divergence-convergence to determine the actual problem. The second diamond combines divergent and convergent thinking to determine an appropriate solution.

Following the Double Diamond Model, the HCD design process is divided into four main activities: Discover, Define, Develop and Deliver [18]. Discover is about understanding, rather than simply assuming, what the problem is. It involves studying the people affected by the issues. The insights gathered from the Discover phase help to define the actual problem. Develop, the first activity in the second diamond addressing the solution space, encourages designers to explore different answers to the defined problem, seeking inspiration from elsewhere and co-designing with a range of stakeholders. Deliver involves small-scale user testing of different solutions, rejecting those that do not work and improving those that do. The four activities - discover, define, develop, deliver - are iterated; they are repeated over and over, with each cycle yielding more insights and getting closer to the desired solution [8, 18].

A common occurrence is that the initial brief given to a designer already describes the problem to be solved. The human-centered designer will always start by going back to investigating the problem space to verify whether the given problem is the actual problem. An example of this in healthcare design is given by Mullaney et al [19] who describe how their design team was asked by a cancer center to reduce patient anxiety during radiotherapy treatment. The center used to focus on reducing patient anxiety by offering

coping strategies taken from nursing theories on coping and disease management. Mullaney et al started their HCD process by first investigating the situational triggers of patient anxiety in cancer treatment and this led to a broader understanding of the problem area and its solution space. A key trigger turned out to be the fixation technology during radiotherapy treatment; "the fixation device confines the patient to a passive, disempowered role within its interactions due to it being embedded with the socially scripted 'sick role'" [19]. Starting from this holistic view on patient anxiety, they reframed the problem and started their idea development phase. Another example is Simons' design project [20], who was asked to improve the patient experience of children admitted to a pediatric acute medical unit (P-AMU). Simons started investigating the problem space by observing and interviewing children, parents and medical staff and mapped their journey from being admitted (unexpectedly) to the emergency department (ED) to being transferred to the P-AMU and being discharged (to home or a regular nursing department). The patient journey clearly showed more fluctuation in patient's emotions and more innovation opportunities at the ED in comparison to the P-AMU. She concluded that improving the patient experience at the P-AMU started with improving the patient experience at the ED, and reframed the initial design brief. Both examples emphasize the overriding principle of HCD: make sure you solve the right problem by first acquiring a deep understanding of the people you design for.

Table 1 provides an overview of the HCD tools and methods as discussed in the examples in this article. Note that this overview is far from complete. It does provide an overview though of the most common HCD tools and techniques used to collect data throughout the different design phases.

Table 1. HCD tools and techniques as described in this paper

HCD phase	Method	Description	Example(s)
Discover	User observations	Observing participants in specific situations in their real-life context to understand phenomena, influential variables and interrelations in real life [10]	Shadowing staff at an orthopedic unit to understand teamwork [23] Observing consultations of patients with Familial Hypercholesterolemia to understand conversation dynamics related to medication adherence [31]
	Interviews	Face-to-face consultations with stakeholders to understand their perceptions, opinions, motivation and behavior [10] Can be individual interviews or in group setting.	Interviews (individual) with cancer patients on what triggers anxiety during radiotherapy treatment [19]
	Generative techniques	Tools used during interviews to gain the deeper, more tacit knowledge of participants [21]	Sensitizing booklets with 3-5 small daily assignments to reflect on a certain topic (e.g. diabetes as experienced in daily life [22]), which are sent to the participants a few days before the interview. The assignment sensitizes and prepares the participants for the follow-up interview.
Define	Stakeholder mapping	Visual map of all stakeholder groups that relate to the design problem [24]	Map of 25 stakeholders involved in child oncology, based on literature and interviews. Child patient at the center, distance between patient and other stakeholders represent the intensity of their interaction [24]

	Patient Journey Mapping	**Visual record of all stages patients go through during their disease, including prevention, first symptoms and rehabilitation. It covers the goals, interactions, emotions and barriers patients experience at each stage [10, 29, 30]**	**Patient Journey Mapping of patients undergoing a gastrointestinal diagnosis in order to investigate whether and how this procedure can be elaborated with video endoscopy technology [28]**
Design	**Brainstorm sessions**	**Creative thinking approach with rules and procedures for generating a large number of ideas. Based on the assumption that quantity leads to quality [10]**	**Brainstorm session with parents of young cancer patients on how they could be involved in the medical care team [24]**
	Co-creation	**Any act of collective creativity, i.e. creativity that is shared by two or more people (includes designers and people not trained in design) [21]**	**Session with designers and orthopedic staff (nurses and surgeons) to create solutions to improve teamwork, starting from data collected during observations at the unit [23]**
Validate	**Interaction prototyping**	**The use of prototypes to simulate and test how people will experience a future design. Prototype testing helps to evaluate concepts at an early stage of development, facilitating quick learning cycles during concept development. [10]** **Prototypes can range from written scenarios and drawn storyboards, to fully functioning prototypes. Research settings can range from interviewing and role playing to observing use**	**Evaluation by medical specialists of a mock-up digital prototype of an eHealth application for patients with Familial Hypercholesterolemia to facilitate a discussion on life style preferences during their annual consultation. The prototype was used in a role-playing setting (researcher acted as patient) [31]**

		in real-life settings.	

2.2 Early and continuous stakeholder engagement

Designers develop interventions (e.g. products, services, strategies) intended for use by people other than themselves; i.e. by people who have skills and experiences the designer does not share. This is particularly true for designers who work in the healthcare domain and who predominantly develop interventions that can affect patients and medical professionals. Gaining a thorough understanding of users' physical and mental characteristics, their needs and behavior, and the sociotechnical context in which medical professionals work or patients cope and manage their illness, is essential to develop long-term usable and useful products. To fully grasp human behavior, underlying values, and motivations, the real user has to be studied in their real-life situation and actively involved in the design process; engaging end user(s) and other stakeholders throughout the design process is therefore key in HCD.

The HCD discipline has an extensive set of tools and techniques to involve and engage stakeholders throughout the design process [9, 21], see also Table 1. Preferred methods for investigating the problem space, i.e. identifying human needs, include ethnography-based research such as observation and interviews, often elaborated with techniques to gain the deeper, more tacit knowledge of users [21]. For example, Smoorenburg et al. [22] extended their patient interviews with so-called generative techniques to investigate experienced self-management of diabetes patients. In order to gain a thorough understanding of how patients perceive self-management, they were provided with booklets with small assignments to reflect on their daily experiences for a few days before their interview. Using

these sensitizing booklets enables the researcher to quickly engage with the interviewee, prepares the interviewee for the interview, and permits elaboration on specific topics addressed prior to the interview [21]. In this way, a deeper (tacit or latent) layer of information about the perspective of the patient could be addressed during the interviews [21]. Caprari et al [23] combined shadowing of medical staff at an orthopedic unit with learning history techniques, including personal timelines of the observed shifts which were discussed afterwards with the staff members in order to understand teamwork from different stakeholder perspectives and to identify themes related to teamwork dynamics. They used these insights to define their final design direction (improving the handover between physician and nurse by accounting for their differences in communication styles, i.e. numeric and emotional) and to define the contextual requirements and restrictions for their future design. In the second, design phase of HCD, designers can, for example, use brainstorm sessions with users or co-creation sessions to initiate ideation. A little further in the ideation process, stakeholders can be asked to reflect on ideas using prototypes, which can range from sketched storyboards, to paper-based prototypes to working prototypes, depending on the phase of the design process and the research question. Prototypes are used to simulate the user experience and thus have stakeholders imagine the use of the new design as best as possible, again to trigger deeper layers of information from the study participants. Design testing focuses on the product/service's usability and efficacy for the user and on the product's impact on the socio-technical environment [10]. A holistic systems perspective in design testing is essential to ensure new designs fit the complex (work) context of healthcare.

As many stakeholders are involved in the delivery of care, it is important to select the relevant stakeholders at the start of a design project. In HCD, the stakeholders involve the envisioned end-user(s) of a new design and people who influence the end-user(s) in some way and are, as such, part of their socio-technical system. Vice versa, the work or life of these people may be influenced by the new intervention and therefore they need to be taken into account throughout the design process. Kleinsmann et al. [24] started their design project on parental involvement in medical cancer teams by identifying -based on literature and informal interviews- 25 different stakeholder groups involved in pediatric oncology ranging from the child patient, supervising oncologist and parents to the psychologist and teacher; all were plotted on a team map. In this team map, the patient is central, as the initial design brief was to improve patient care through parental involvement in medical teamwork. The distance between the patient and other stakeholders represented the intensity of their interaction (greater distance = lower intensity). They further divided the stakeholder groups in four sub-teams with their own sub-goals; medical team, research team, psychology team and educational team. Based on the map, they decided to include eight user groups in their research who had frequent face-to-face interaction with the patient and parents. Throughout the design project, they involved 12 participants who represented the eight different user groups. Participants were shadowed and interviewed, and participated in prototype evaluations. The framing needed to select the relevant stakeholders for an HCD project is based on the design brief and the context of the end user(s). Yock et al. [25] propose dividing stakeholders into two groups; those involved in the 'cycle of care' focusing on the care process of a patient, and those involved in the 'flow of money' focusing on the financial side of patient care. Likewise, Dul et al. [9] identify four stakeholder groups; system actors, system experts, system decision makers, and system

influencers. In HCD projects like Kleinsmann's [24] or Caprari's [23], stakeholders are often chosen based on their impact on the actual use of the design, and thus mainly involve system actors.

2.3 Systems approach

Products and services are never used in isolation. For example, an orthopaedic instrument used by a surgeon during a hip replacement procedure might impede the view of the other surgical team members and prevent them from anticipating the surgeon's actions, which consequently might have a negative effect on the safety and efficiency of the entire procedure. In other words, changes (by introducing new interventions) and optimizations at micro-system level (e.g. humans using tools or performing single tasks) will influence the larger meso-systems (e.g. humans as part of teams) and macro-systems (e.g. humans as part of organizations, or societies) [9, 26]. In HCD it is crucial to understand and address the interactions between various system levels in order to create effective solutions at an individual level and in the broader socio-technical user-context. This broad and holistic perspective of HCD is referred to as a systems approach and the third key characteristic of HCD we address here [7, 9].

A system is a set of interacting and interdependent components that form an integrated whole [9]. Likewise, healthcare organizations can be considered complex socio-technical systems comprised of people, technologies, and tasks that interact in an environment to perform processes (physical, cognitive, social/behavioral and organizational) that shape outcome(s) [27]. Outcomes refer to outcomes for patients, professionals and the organization as a whole, and can vary from treatment adherence, patient satisfaction, and

team situation awareness, to compliance with regulations and quality of care. In addition, there is the time factor. Tasks and processes happen over time, where an action at one moment affects an action at a later time [27-29]. A systems approach is essential to ensure that interventions at micro-level do not negatively impact meso or macro-systems dynamics and thus are useful and usable in the entire context over time.

Patient journey (PJ) mapping is a well-established method in HCD to visually record the dynamics of a socio-technical system over time, by including all actors, interactions between actors, and experiences from a patient's perspective [28-30]. Starting from the PJ, HCD designers can identify problems and how these problems arise (making sure they address the right problem, see 2.1), and thus identify human needs. Based on these insights, requirements and wishes for new interventions can be defined. Simonse et al [28], for example, applied PJ mapping to elaborate gastrointestinal diagnosis health services with video endoscopy technology. They co-created the PJ with all the relevant stakeholders in order to reveal and understand the overall experience and needs of all stakeholders involved in the journey. Their project also demonstrates how PJ mapping leads to ideas for new interventions. Mapping the PJ provides insights into current user-strategies which feeds the development process of HCD products and services.

A systems approach is also leading in the ideation phase of HCD, where new solutions are developed and evaluated on their fit within the (work) context of the user(s). An example of a technique used here, i.e. interaction prototyping (see also Table 1), is given by Thomson et al. [31] who developed an eHealth intervention to improve medication adherence for patients with Familial Hypercholesterolemia; a genetic condition that requires life-long

treatment by statin and other medication. Part of the product functionality was to facilitate a discussion of patients' lifestyle preferences with their specialist during the annual consultation. During the design process, a working prototype was developed, the functionalities of which were discussed with physicians in a scenario-based set-up in order to investigate the product's perceived value and its impact on their work process. Based on this evaluation, the product's functionalities were optimized.

In addition to the above micro-meso-macro approach, starting from a macro-systems perspective a systems approach is essential to determine how to 'design' individual behavior in order to contribute to the envisioned output at an organizational level. Given the current societal challenges such as ageing, limited resources, and more recently, pandemic-awareness, there is an increasing shift from the individual to the collective interest with a focus increasingly centered on the implications for an organization, community or society. The management of COVID-19, by for example introducing the concept of social distancing to reduce the disease spread, or joining vaccination programs are good examples of this. The HCD discipline can contribute to addressing these complex societal challenges by providing a much needed holistic approach.

3. Discussion and conclusion

HCD is about understanding human needs and how design can respond to these needs. In this paper we describe the three core characteristics of HCD: understanding people, stakeholder engagement throughout the HCD process, and a systems approach towards the development new products, services, and strategies. All three elements are described and elaborated on in the context of healthcare. For highly complex matters such as patient

safety and quality of care, which involve multidisciplinary (sub)teams, divers work processes, many regulations and increasingly the (required) participation of patients, HCD may provide a much needed systemic and humane perspective to develop meaningful innovations to improve safety and quality.

Although HCD can play a valuable role in healthcare, collaboration between the disciplines is challenging. First, there is the difference in research methodology. HCD relies heavily on qualitative research methods and user studies with small sample sizes, which is in sharp contrast to the clinical trials and evidence-based mindset in health care. Convincing the medical discipline of the effectiveness of an HCD approach can be challenging, although more and more medical researchers advocate the implementation of more qualitative approaches to accelerate the improvement of systems of care and practice (5, 32]. Embracing a wider range of scientific methodologies, reconsidering thresholds for action on evidence, rethinking about trust and bias are some of their recommendations to broaden the evidence-based mindset [32].

Second, designers may encounter several more practical challenges when working in the health care context compared to non-health domains. Based on experiences of healthcare designers, Groeneveld and colleagues [33] identified three clusters of challenges designers need to consider and deal with in practice. The first cluster, practical challenges, includes issues regarding conducting fieldwork, involving users, and dealing with sensitive situations. Adapting to restrictions and unexpected situations, approaching vulnerable patient groups carefully and responsibly, and effective involvement of the stakeholders throughout the whole project, were mentioned by designers as experienced challenges in practice. The

second cluster, managerial challenges, concerns relationship management and communication: Keeping stakeholders informed and engaged, recognizing differences in understanding between design research and clinical research, and clarifying the added value of design work to the stakeholders. Finally, the third cluster addresses attuning to time and financial restrictions. Limited availability of medical specialists in design research, creating a safe and open research environment to communicate easily and without prejudice were the more generic challenges mentioned by the participating designers [33].

For health care to adopt an HCD approach, it is important for the HCD discipline to understand the evidence-based mindset of clinicians and acknowledge the ethical considerations of doing (design) research in the context of healthcare. Starting the collaboration with a constructive alignment of the different perspectives is crucial for a trustful and sustainable relationship. Being flexible and anticipating to the changes with creativity will increase the commitment of the stakeholders to the project, create ownership among stakeholders of solutions and improve implementation. Healthcare organizations are currently facing major organisational and societal challenges and changes and are looking for new and improved forms of human-centered patient care. As a response to this shift towards a more holistic, humane care perspective, an increasing number of healthcare organizations acknowledge the importance of HCD approaches. We encourage healthcare organizations and HCD experts to continue to implement this much needed multidisciplinary collaboration in dealing with today's care challenges.

Data Availability

No new data were generated or analysed in support of this review.

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