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Design as a quality improvement strategy: The case for design expertise

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ABSTRACT

Bad design in safety-critical environments like healthcare can lead to users being frustrated, excluded or injured. In contrast, good design can make it easier to use a service correctly, with impacts on both the safety and efficiency of healthcare delivery, as well as the experience of patients and staff. The participative dimension of design as an improvement strategy has recently gained traction in the healthcare quality improvement literature. However, the role of design expertise and professional design has been much less explored. Good design does not happen by accident: it takes expertise and the specific reasoning that expert designers develop through practical experience and training. Here, we define design, show why poor design can be disastrous and illustrate the benefits of good design. We argue for the recognition of distinctive design expertise and describe some of its characteristics. Finally, we discuss how design could be better promoted in healthcare improvement.

Introduction

Much has been written around the use of co-design in healthcare as a key approach to involving a range of stakeholders in healthcare science, delivery, and improvement. However, while the collective, participative dimension of this process has been emphasised, the discipline of design has been largely ignored, and the role of expert designers is thinly described in existing methods and publications.

Design is a fundamental determinant of the extent to which we appreciate, enjoy, and use products and services, as well as of their efficacy, efficiency, sustainability, and safety.[1] In this article, we define design, show why poor design can be a disaster, and illustrate the benefits of good design. We then argue for the recognition of distinctive design expertise and describe some of its characteristics. Finally, we discuss how design could be better promoted in healthcare improvement.

Design – beyond pleasing the eye

Everyone designs who devises courses of action aimed at changing existing situations into preferred ones[2]

In common parlance, design is often reduced to a matter of aesthetics: creating appealing products that can distinguish themselves from their competitors. Although this is important, good design is not just about being 'eye-pleasing'. Good design is about improving our experiences of life by creating useful, intuitive artefacts that solve our problems while fitting seamlessly into our environment, our routines, and our value systems. Within this definition, artefacts are not limited to physical objects but also include services, organisations, spaces and buildings, and, at least as important, systems combining these into integrated wholes. Design is a school of thought and practice which draws on a range of different disciplines and professions, including industrial design, social sciences, ergonomics, as well as both materials and systems engineering. Design can act as a methodological bridge between the largely analytical corpus of medical knowledge, and the action of bringing about change in the world of healthcare delivery. This not only intersects with the emerging quality improvement literature, but also human factors, patient safety, and the design of interventions in clinical science.

To achieve their objectives, designers enact a structured process for understanding the needs of people and the wider social and regulatory landscape, then exploring a range of possible solutions to meet these needs, and iteratively selecting the best options for testing and refinement.[3]

Bad design can frustrate, exclude, hurt and even kill

Bad design infects all areas of modern life, with various degrees of gravity. In its mildest form, bad design can be frustrating. Design expert Don Norman famously holds a grudge against doors that require more than one attempt to find the way to open them,[4] but many of us have ex-

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perienced frustration at poorly designed interfaces, impermeable phone lines or maze-like hospital corridor systems we lose ourselves into.

Although infuriating, frustration usually remains benign. Bad design becomes more concerning when it unwittingly excludes whole categories of users. In medicine, this ranges from respiratory protective equipment designed to best fit a caucasian male body shape to trauma care services and products built around the characteristics of adults without considering those of children.[5,6] In the wider world, women, elderly people, ethnic minorities, or people living with disabilities are often overlooked in design decisions.

Even more sinister, bad design can hurt or kill. Confusing interfaces in prescribing software or radiotherapy equipment can lead to deadly doses being administered.[7] In one example, the only green button on a defibrillator switched the device off, whereas the only red button was for shocking. In simulated emergency situations, it was no surprise that some participants pushed the green button and inadvertently switched the device off when intending to shock.[8]

Good design can make life easier and safer

One of the most curious features of the modern world is the manner in which design has been widely transformed into something banal and inconsequential. In contrast, I want to argue that, if considered seriously and used responsibly, design should be the crucial anvil on which the human environment, in all its detail, is shaped and constructed for the betterment and delight of all.[1]

Poor design has been explicitly linked to impaired patient safety by the UK's Department of Health and Social Care, and the Health Services Safety Investigation Body.[9,10] Yet, as surely as bad design can hurt, good design can make life easier and safer.

Good design accounts for all categories of users. As considerations of equality, diversity, and inclusion come more sharply into focus, an inclusive design approach can help better understand how processes and systems exert demands that exclude some users, eg, how poor dexterity can challenge engagement with COPD treatment.[11] Inclusive design can lead to better systems, such as emergency departments that accomodate the needs of patients with dementia through noise reduction, altered lighting, orientation aids and fixed seating.[12]

Good design also makes it hard to do the wrong thing. Sometimes, design makes it physically impossible to misuse a product: there is only one way to plug a three-pin electric socket. Other times, design simply makes the right way the obvious way. In an experiment on adrenaline injectors, simple, inexpensive changes to the colour and signage on the product improved correct use from 22.6% to 65%.[13]

Good design is also about favouring and structuring creativity to find new ways to solve old problems, while avoiding fixation on the 'normal' way of doing things. The inspiration for the ODON device, a low cost, easy to use inflatable device to facilitate operative vaginal delivery, came from a trick to open corked bottles.[14]

Improvising only takes you so far: good design takes expertise

If good design can be so beneficial, why do we not see more of it, especially in healthcare? The answer is simple: good design is hard and takes expertise. Design is a specialist skill (or range of skills), requiring an understanding of theory married to practical experience. Evidence proves that the mundane issues that are familiar to designers as being important to safety (for example, proper needs analysis, anticipating practical implementation details or prototyping and piloting solutions) recur and risk harm when designers are absent from projects.[15,16] This is because designers have developed their own ways of thinking about problems, which utilises concepts, processes and techniques to account for complexity and practical implementation (Fig. 1) (Tables 1 and 2).

People often jump to solutions without conducting a proper assessment of the causes and manifestations of the issues they face this is akin to making a clinical diagnosis without taking a patient's history, doing a physical examination or conducting any investigations. As a result, they rarely solve the right problem, and can waste time and resources in the process. For designers, the generation of a 'solution-neutral problem statement' is key to understanding the fundamental problem at hand (the 'job-to-be-done'), rather than an easy proxy. They have multiple ways to explore situations and reframe issues to tackle the right problem.[38]

Once the right problem has been identified, designers adopt a number of approaches to foster creativity in identifying possible solutions. These seek to avoid fixation (an overreliance on existing solutions and knowledge), while also remaining within the bounds of physical, regulatory and ethical constraints. Mitigating fixation is difficult, and design expertise includes knowledge on how to best do it.[39]

Finally, designers have ways of developing, visualising, sensing, testing and validating various concepts before deciding on a solution. Visual representation is at the heart of design, with imagery used to help users and designers understand complex concepts, combine quantitative and qualitative data, and explore potential solutions and their consequences. From cardboard mock-ups to 3D-printed prototypes through virtual reality, sketches, journey maps and storyboards, designers use a range of methods to share their insights and test them with users.[40] Crucially, a good designer does not need to be an accomplished artist, but rather they need to be able to consider the different visual abstractions required to explore a range of user needs, identify creative solutions, and manage risks.

Throughout this process (Fig. 1), good design takes a systems perspective on situations, taking account of multiple competing factors and viewpoints. Good design incorporates an appreciation of risk, and the trade-offs required to create a sustainable solution.

Good design is also about pragmatic change, improvement and problem-solving. To produce acceptable solutions rather than idealistic concepts, good designers engage with everyone impacted by a problem. They integrate different types and sources of expertise and knowledge when framing the issue, looking for solutions and implementing them. Expert designers can support users in participative, rather than expert-led, projects: they can add greatest value at the interface of healthcare providers, researchers, patients, and the public.[41]

This process and these principles may seem simple enough to implement. Yet, studies of expert designers show how they build on accumulated experience to propose early solution concepts that help them explore both the problem they face and the range of possible solutions.[42] Expertise cannot be reduced to rules or formulas, and expert designers have, through training and experience, accumulated a set of 'frames' that allow them to look at a problems in a way that effectively encompasses the fundamental working mechanisms of a set of possible solutions.[43] Where novices can be trapped into analytic, rule-based reasoning, experts can trigger generative, pattern-based reasoning.

Any one designer is unlikely to be expert in all the skills listed above. Designing solutions to complex problems often requires the integration of different strands of design. Good design borrows from a range of other evaluative methodologies, both quantitative and qualitative, and brings these together to solve a given problem. It sits alongside, rather than instead of, existing approaches to improvement.

In particular, design is a key feature of human factors/ergonomics.[44] Human factors/ergonomics is 'the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human wellbeing and overall system performance'.[45] Ergonomics includes *physical* ergonomics (eg, work-related musculoskeletal disorders or workplace layout), *cognitive* ergonomics (eg, mental workload or human-computer interaction), and *organisational* ergonomics (eg, design of working times or teamwork).

However, the reach of good design extends beyond the realm of human factors and ergonomics. Distinctive design expertise is also present in architecture, with increasing attention afforded to how the built environment affects care delivery as well as patient and

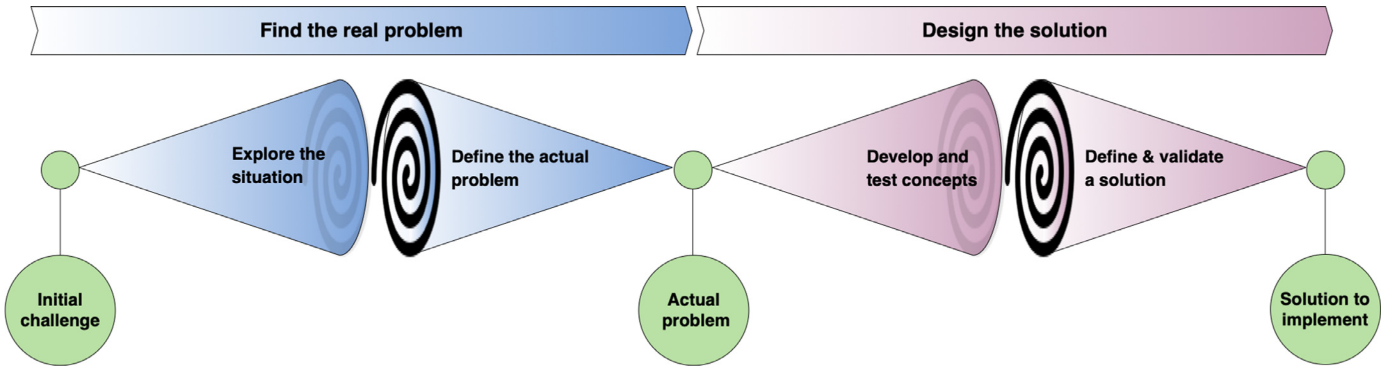

Fig. 1. A model of the design process. The 'double diamond' structure depicts how designers alternate between phases of divergent and convergent thinking to move from an ill-defined initial challenge to the actual problem that needs tackling, to a solution ready for implementation.[3] The 'spiral' patterns highlight how design projects move between steps in an iterative, non-linear way.[55]

Table 1
Examples of design concepts and models and processes.

Concepts	
Affordances	The actions that are possible with a product or system, as perceived by its users.[4]
Abductive reasoning	A reasoning mode that stands at the heart of design, distinct from inductive and deductive reasoning, where designers start from a problem to be solved, and reason back to a concept, and a form.[17]
Function-Behaviour-Structure model	A model of the design process as transitions and iterations between the three spaces of product functions, behaviour, (expected and observed) and structure.[18]
Jobs-to-be-done	What customers hopes to accomplish in a situation, which the proposed solution should help them achieve.[19]
Frames	Mental constructs that connect problem categories and solution categories, based on the designer's knowledge and experience.[20]
Models and processes	
Double-diamond model	A staged process of problem- and solution-definition, alternating divergent thinking (expanding the scope) and convergent thinking (focusing on selected options).[3] Example: co-design of a dementia caregivers' telehealth peer support programme.[21]
Design thinking	A non-linear approach to understand users and their problems, and iteratively prototype and test solutions.[22] Example: design thinking as a large-scale innovation process across a healthcare provider.[23]
Experience-based CoDesign	A participatory approach that draws upon design thinking to bring healthcare staff and patients together to improve the quality of care.[24] Example: improving the care pathway for women who request Caesarean section.[25]
BioDesign	Innovation method for medical technology.[26] Example: development of a disposable patch-based monitor to identify cardiac arrhythmias.[27]
Human-Centred Design	An approach to interactive systems that aims to make systems usable and useful by focusing on the users, their needs and requirements.[28] Example: development of a clinical decision support system in an emergency department.[29]

professional experience.[46] Social and organisational sciences have also embraced design as a mode of action and developed methods to directly engage with problems and stakeholders to solve problems.[24,47] Finally, (industrial) design also stands as a discipline in its own right, with its training curricula, its subspecialties (Table 3), its professional bodies, and its approaches to engage with health services.[1,48] Human factors professionals regularly work alongside designers, engage this additional expertise as required, and frequently rely on many of the methods highlighted above.

Promoting design as a route to improvement by involving designers

Design has contributed to many great achievements in healthcare, from better drug labelling systems to point-of-care digital health records for community health workers, new business models in prescription drug delivery, or better newborn phototherapy devices.[40] Many design skills, like creativity, problem finding, co-production, or idea generation, have been found to be key habits of mind of good healthcare improvers.[54] Initiatives exist to promote design at institutional levels, eg through partnerships between healthcare and engineering or design institutions.[55] We can also learn from innovative healthcare providers.[40] However, some caution is warranted. Despite the enthusiasm around design in healthcare, this field is still victim to false assumptions and expectations, and its impact on health services remains limited. Design is further plagued by its fragmentation between different disciplines and institutions.[56] and the rift of mindsets and worldview between designers and health services researchers.[57]

So how can we make progress? Involving expert designers in improvement efforts is an obvious first step. Aside from project-based design consulting, embedding designers in health services is another possibility. Clinically embedded designers could be a way to identify and solve issues where they arise,[58,59] or support frontline workers' problem-solving efforts. Exciting results have been seen with 'makerspaces', where professional designers support clincal staff to identify problems in their work environments and develop clincal innovations to solve them.[60,61] Giving frontline staff material resources and expert design support has led to innovations that make their own jobs more efficient, safer or better, and are are associated with significant cost-savings, for example limb-splinting devices that use plastic instead of plaster, dressings to improve wound coverage during showering, and structures that protect intravenous cannulas from disruption in paediatric patients.

The know-how of professionals already active in healthcare environments whose training includes elements of design could also be better leveraged. For example, the expertise of biomedical and clinical engineers who are often familiar with design principles and practices could be better harnessed by improvement efforts.[62-65] Software engineering students are also increasingly exposed to design thinking concepts.[66,67] Working with human factors specialists offers synergies to design-orientated improvement, especially those involved in occu-

Table 2
Examples of design tools and techniques.

Prototypes	Artefacts that reproduce some aspects of the intended solution (eg, through sketching, 3D printing or cardboard mock-ups) to help obtain feedback on this solution. Example: evaluating a prototype for an injection device for contraceptive implants.[30]
Storyboards	Visual representation, akin to short comic strips, showing how users will interact with a solution and how this solution will fit in their environment. Example: developing concepts for technology-enabled support for caregivers of haematopoietic stem cell transplant recipients.[31]
Journey maps	Visual representation of the trajectory of patients in a healthcare system. Example: improving wayfinding in an emergency department.[32]
Persona	A personalised fictional character that represents a category of users. Example: defining six personas of older adults with heart failure to support the development of eHealth solutions.[33]
Scenarios	Descriptions of various possible interactions between users and a solution. Example: defining scenarios of work processes in shared homecare.[34]
Design ethnography	An observation-based approach where the designer immerses themselves in a situation to identify needs and problems, and envisage possible solutions. Example: exploring cooperative home care work before proposing new IT support.[35]
Kansei design	A method to better account for emotions, affects, and subjective perceptions during design. Example: exploration of the influence of colour on users emotions in a lactation room.[36]
TRIZ – Theory of Inventive Problem Solving	A methodology for identifying and resolving conflicting constraints in design. Example: exploring the development of a distant blood pressure monitoring service.[37]

Table 3
Examples of areas and sub-specialties of design.

Visual and information design	Conveying messages in the most effective (persuasive, simple, understandable) way. Example: redesign of Do Not Attempt Cardiopulmonary Resuscitation (DNACPR) forms.[49]
Service design	Designing an arrangement of tasks, people, communications and systems to best meet service users' needs. Example: designing the Portuguese national electronic health record as a service.[50]
Product design	Designing physical products that meet users' needs. Example: needs analysis for medical device development.[51]
Interaction and user-experience design	Shaping digital artefacts that optimise users' perception of utility and ease-of-use. Example: defining guidelines for smartphone applications for people with Parkinson's disease.[52]
Interior design	Enhancing buildings' inner spaces, to provide healthy and pleasing environments. Example: analysing nurses' experience of working in an evidence-based designed ICU patient room.[53]

pational health/ergonomics programmes.[68] Consideration is also warranted on whether quality improvement specialists themselves could benefit from specific design training to help them integrate design into existing QI approaches[69] and build on the specific contributions of different types of design specialists.[70] Design in healthcare has an important role to play in the minimisation of risk and should not be overlooked by quality improvement teams who seek to integrate existing expertise within healthcare. Design can act as a pragmatic expertise which can help coordinate the perspectives of different fields like human factors/ergonomics, behavioural psychology, quality improvement, or implementation science to better mitigate hazards and adapt systems.

We also need to better understand actual design practice in healthcare improvement. Many design-inspired improvement projects do not mention the contribution of designers, and often do not detail the minutiae of the design process: who drew what? Who facilitated which session? What prompts, advice, examples were provided to project participants? Even basic design input can sometimes go a long way in helping non-professional designers come up with more diverse and robust solutions, but this input is hardly ever recorded. We need better knowledge of what good healthcare design entails, beyond methods and frameworks and into practice.

Conclusion

Design has an established body of theory and practice which has a well-recognised, significant role to play in improving healthcare provision. Evidence abounds on the positive impact expert designers can have in various areas, including healthcare (although perhaps not in the form usually expected in evidence-based medicine or epidemiology). Despite this, design is rarely discussed in the medical literature, and there remains a paucity of understanding of its value among clinicians and academics involved in improvement. This may be addressed through greater engagement between designers, health service users, and improvement academics both practically and methodologically. To start with, improvement researchers and practitioners need to consider design expertise as a fundamental part in improvement processes that will lead to safer, more inclusive healthcare. Design is not a 'nice to have' skill, it is seen as essential to all other safety critical industries, where it is integrated into developing safety as well as improvement of quality, performance and the reliability of the system. With its focus on creativity and user-centredness, design can help not only improve, but transform and reinvent our healthcare systems.

Declaration of competing interest

The authors declare no conflict of interest.

CRediT authorship contribution statement

Guillaume Lamé: Conceptualization, Investigation, Writing – original draft, Writing – review & editing. **Alexander Komashie:** Investigation, Writing – review & editing. **Carol Sinnott:** Investigation, Writing – review & editing. **Tom Bashford:** Conceptualization, Investigation, Visualization, Writing – review & editing.

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