1 Introduction

Improving healthcare requires good design at multiple levels and stages. In 2017, Royal Academy of Engineering's report, *Engineering Better Care – A Systems Approach to Health and Care Design and Continuous Improvement*,[1] highlighted design as one of four 'key perspectives' necessary for delivery of effective care (the others are people, systems, and risk). Design is especially important in answering three key questions:

- What are the needs?
- How can the needs be met?
- How well are the needs met?

Answering any or all of these questions may require creativity. In this Element, we focus on *design creativity.* Though it is sometimes mistakenly understood as the process for developing novel and useful ideas, solutions, or products,[2] design creativity can be defined more broadly to encompass the wider process of understanding the problem as well as solving it. With its origins in design thinking and design process, design creativity can be thought of as both the means to explore needs for improvement and the means to create new concepts in response to those needs. So, design creativity refers to the process of designing ('design' as a verb) rather than just the output of design ('design' as a noun).

Simon[3] has defined design broadly by saying that to design is to devise 'courses of action aimed at changing existing situations into preferred ones'. *Design science* is the study of the principles, practices, and procedures of design:[4,5] it aims to understand and improve how designers work and think, it establishes an appropriate structure for the design process, and it develops new design methods, techniques, and procedures for various design problems. These problems are often ill-defined, ill-structured, or 'wicked',[6] similar to many quality and safety issues in healthcare. Many design studies have looked at how the design process is managed to deliver consistently successful results and what methods and tools are applied.

We begin by outlining the characteristics of design thinking, the key status of the Double Diamond model, and the role of design creativity on healthcare improvement. We then review a range of tools that may be used to support design creativity.

In order to fully appreciate creativity as the process that enables teams to define the right problem and provide the best solution, this Element should be read alongside Elements on systems mapping[7] and risk assessment.[8]

1.1 Characteristics of Design Thinking

The history of design is almost as long as that of human history: people have either crafted objects (artefacts) or have found someone to do it for them. During the Industrial Revolution of the eighteenth and nineteenth centuries, rapid innovation led to the separation of design and making (manufacturing).[9] In contrast to the artisans of the past, post-Industrial Revolution designers had to meet the needs of large populations. They had to consider functionality, aesthetics, and usability, and balance the needs of manufacturers, including manufacturability, cost, and marketability. By the middle of the twentieth century, the need to combine engineering design and psychology had become more apparent – for example, in improving the design of aircraft controls and displays based on an understanding of human (e.g. pilot) and environmental factors.[10] This recognition led to the development of human factors/ergonomics as its own field of study and, in 1949, to the formation of the Ergonomics Society UK (now the Chartered Institute of Ergonomics and Human Factors). Human factors/ergonomics focus on designing the systems with which people interact in physical, organisational, and social environments in order to improve human well-being and system performance.[11]

Human factors and ergonomics were important in the development of user-centred design philosophy and processes. These processes aim to make the needs, wants, and limitations of the end user the priority focus, and offer a range of methods and techniques to ensure this focus is sustained through the various stages of design. Inclusive design, which emerged in the mid-1990s, encourages designers to create products and services that 'address the needs of the widest possible audience, irrespective of age or ability'.[12] It is defined as 'design of mainstream products and/or services that are accessible to, and usable by, people with the widest range of abilities within the widest range of situations without the need for special adaptation or design'.[13]

Designers rely on a distinctive way of thinking: design has its own way of problem-solving that is different from humanities and science.[4,14] Research into understanding design thinking began in the 1970s by looking at how designers form images in their minds and then manipulate and evaluate those ideas before, during, and after expressing them.[14] Design thinking has been described as applying a designer's sensibility and methods to problem-solving, no matter what the problem is.[15] Alluding to earlier work by Rittel and Webber on 'wicked' problems,[6] Cross has characterised design thinking in the following way: 'The designer's task is to produce 'the solution' in order to cope with ill-defined problems. The designer has to learn to have the self-confidence to define, redefine and change the problem-as-given in the light of the solution that emerges from their mind and hand'.

Developing creative ideas is one of the strengths of this way of thinking. Over the years, researchers have attempted to identify influences on creativity and how to support creativity in the design process. Some of the interesting questions explored by different design researchers have included: 'How do designers develop new ideas?', 'How do their ideas evolve?', and 'How do they move from one idea to the next?'.[16]

What design research has found so far is still very limited, but some findings are relevant to the development of improvement ideas in healthcare. When generating ideas, designers use their background experiences and skills, as well as different types of internal and external stimuli.[17] Internal stimuli are drawn from a person's working and long-term memories and may take the form of mental imagery or verbal information. External stimuli, on the other hand, are drawn from a person's surroundings and may include pictorial, verbal, audible, or tangible objects, for example.[18] External stimuli can be the result of actively seeking information (deliberately searching for particular information via the internet or in books, for example) or of a passive encounter (randomly encountering relevant information).

Research has also shown that exposing people to previous ideas can have a dual effect on new idea development:[19] it can be both positive, with inspirational sources stretching the potential pool of creative solutions,[19] and negative, limiting ideas to the replication of aspects of existing ideas and examples. This negative impact is called fixation.[16] Professional designers may try to prevent fixation by adopting some or all of the following approaches: promoting teamwork to avoid isolated individual work; use of systematic design methods; use of expert facilitation during idea-generation sessions (to control any negative effects of group behaviour); making and testing models and prototypes; and expecting concept variety.[20]

As designers and those not trained in design work increasingly alongside each other in co-design processes,[21] the importance of scaling up from individual to collective creativity is now recognised, with new definitions of design thinking emerging. For instance, Tim Brown, CEO of the global design and innovation company IDEO, has described design thinking as a human-centred approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success.[22] He also highlights that design thinking can be used by anyone to create breakthrough ideas.[22]

1.2 The Double Diamond Model

An especially important innovation in design thinking is the Double Diamond model (Figure 1),[23] which offers a framework for the design and delivery of

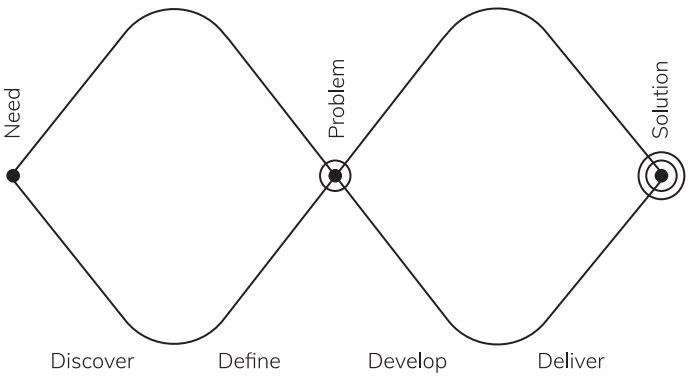

Figure 1 The Double Diamond design process model[23]

products, services, and systems. Developed by the UK Design Council in 2005, and describing a holistic process of creativity, it was originally derived from the observation of a wide range of real design processes. The research on which the Double Diamond is based focuses on those attributes of design thinking that had led to significant commercial success, rather than identifying and avoiding those that led to failure. It is widely cited as a model for capturing the essence of good design practice.

The Double Diamond design process model (Figure 1) identifies four core activities:

- Discover: explore current needs and solutions, and gather insights into the challenge.
- Define: balance the range of needs and articulate a clear statement of the challenge to be resolved.
- Develop: generate and evaluate solutions to the challenge.
- Deliver: launch the new organisation, product, or service.

The shape of the model has a particular meaning: it highlights the importance of translating need into a statement of challenge before developing solutions. It illustrates the value of exploration (or divergent thinking) before refinement (or convergent thinking). Each activity is a key element of the overall creative process, and each requires real creativity to deliver meaningful results. This underlines the importance of exploring the full range of stakeholder needs for improvement before balancing and refining those (often conflicting) needs into a clear statement of the challenge. It also emphasises the importance of exploring a wide range of possible concepts and potential solutions before committing to a particular solution and the means to deliver it into practice.