

The Role of Systems Approaches in Health and Care

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Abstract

The concept of Health Systems is ubiquitous in the healthcare literature. However, the question 'what is a Health System' is not easy to answer. The emerging field of Health Systems Design is by nature multi-disciplinary, involving several disciplines with different ontological commitments and diverse perspectives and interpretations of health and system. To avoid confusions in communication and facilitate engagement between the design and health communities, it is important to begin an open exploration of the fundamental concepts of Health Systems. This paper is a first step in that endeavour

Keywords: *healthcare design, systematic approach, engineering design*

1. Introduction

It has been argued that engineering design has the potential to make significant contributions to addressing the complex challenges facing modern society, including health and care systems (Clarkson, 2018; Eppinger and Maier, 2019). With growing interest in the emerging field of Health Systems Design (Komashie *et al.*, 2021), several fundamental questions need to be revisited to explore what they mean for how we design - what is 'health'? What is a system? What is meant by a 'health system'? What is the difference between a 'health system' and a 'healthcare system'? How do we approach the design of a 'health system'? And what are the key differences between health systems? Though seemingly obvious, these questions are non-trivial. A few have been subjects of intense debate for decades. Health Systems Design by nature involves a wide range of disciplines with potentially diverse ontological commitments and interpretations, with their own answers to these questions. Some exploration of these questions, in the context of design, is vital to avoid confusion and improve communication which is known to play a major role in determining the success or failure of collaborative design projects (Maier *et al.*, 2021). Ambiguities in concepts and meanings of 'health system' have caused confusion in public debate and misled policy considerations (Hsiao William, 2003).

The reality is that health systems have different structures, different models of funding, different resource availability and operate in significantly different cultural settings. The following quote from the WHO's framework for action on health systems strengthening captures both the reality and the potential values of better understanding health systems:

"As health systems are highly context-specific, there is no single set of best practices that can be put forward as a model for improved performance. But health systems that function well have certain shared characteristics. They have procurement and distribution systems that actually deliver interventions to those in need. They are staffed with sufficient health workers having the right skills and motivation. And they operate with financing systems that are sustainable, inclusive, and fair. The costs of health care should not force impoverished households even deeper into poverty." (WHO, 2007a)

Modern health and care systems have become increasingly complex - comprising multiple elements connected in a variety of ways. Systems seem to evolve in most places in different ways under different governance and policy frameworks leading sometimes to highly fragmented services as various units develop independently. These present considerable challenges but also opportunities. Addressing this fragmentation will require a systems approach involving effective collaborations (Molina and Qadan, 2019). Our aim in this paper is not to present a systematic review of the literature on the definitions of health and care and systems but to begin an open exploration of these fundamental concepts underlying health and care systems to facilitate effective engagement between the design and health communities.

2. Systems in health and care

In this section, we wish to explore two issues in relation to how the phrase 'health systems' is often used in the health and care literature: the first is that based on existing definitions and common usage the phrase should more accurately be 'health and care system'. Secondly, the phrase 'health systems' is commonly used to refer to the high-level, often, national system but we suggest this represents a limited use of the concept of 'system' and argue for an alternative understanding.

In appreciating the meaning of the phrase 'health systems', it is important to explore the concepts of 'health' and 'systems' to some extent. The question 'what is health?', though seemingly trivial, has been the subject of considerable debate for decades.

2.1. Health (and care)

The World Health Organisation (WHO) was established on a foundation of an understanding of 'health' as a *'state of complete physical, mental and social well-being and not just the absence of disease or infirmity'* (WHO, 2006). In a critical assessment of the WHO definition, Callahan (Callahan, 1973) concluded that as much as a 'complete physical, mental, and social well-being' is attractive, it is not practically possible. The review proposed a definition of health as a 'state of physical well-being', arguing that the 'state' need not be 'complete' but it must at least be adequate (Callahan, 1973). The absolute nature of the word 'complete' in the WHO definition remains the most difficult aspect in most critiques. In the strict sense of the word, most of us will be unhealthy most of the time (Huber et al., 2011).

Despite the debate on definition, there seems to be an acknowledged shift in paradigm in health-related thinking. A shift from the old emphasis on disease to an emphasis on health, functioning and well-being (Larson, 1999). Acknowledging health as a complex phenomenon and the dangers of a simplistic definition, Larson proposed four models of conceptualising health (Larson, 1999). These models - Medical, WHO, Wellness, and Environmental - provide a useful clustering of the myriads of definitions. Table 1 provides a summary of the main definitions within each model from Larson, 1999.

Table 1. Models of defining health

Model	Definition
1. Medical model	The absence of disease or disability
2. WHO (or Holistic) model	State of complete physical, mental, and social well-being and not just the absence of disease or infirmity
3. Wellness model	Health promotion and progress toward higher functioning, energy, comfort, and integration of mind, body, and spirit
4. Environmental model	Adaptation to physical and social surroundings - a balance free from undue pain, discomfort, or disability.

Health was believed to be a balance and a state of harmony within the human body until the rise of the scientific era which gave birth to the medical model of health (Larson, 1999). The medical model distinguishes between disease, illness, and health. Disease is a condition of the body in which its structure or function is disturbed or deranged. In contrast, illness is an individual perception that one is suffering from a disease. Accordingly, health itself is "virtually undefinable" and is relative rather than absolute. (Larson, 1999).

The WHO model has added to medical research and practice an emphasis on well-being and positive states of health. There is more emphasis on the connection between physical and mental health, as well

as social well-being. The Wellness model puts the emphasis on the individual and wholeness, integrating mind, body, and spirit. The environmental model then emphasises not only the person but also their physical and social environment. It is easy, therefore, to see how the view of health that one holds more strongly, can impact on what is perceived as a health system and how to approach design. Whichever model of health definition one uses, there exists the pragmatic need to provide 'care' for people with health needs - that is 'health care' (or 'healthcare'). It is the maintenance or restoration of the human body by the treatment and prevention of disease, injury, illness, and other physical and mental impairments (Griffin *et al.*, 2016).

2.2. Systems

Like 'health', the concept of 'system' is very difficult to define despite its ubiquity. The concept finds considerable application in most scientific disciplines including physics, biology, psychology, sociology and engineering (Hieronymi, 2013). Existing definitions therefore tend to be biased towards their origins and hence fail to apply universally. For example, the International Council on Systems Engineering (INCOSE) define a system as:

"...an integrated set of elements, subsystems and assemblies that accomplish a defined objective." (INOSE, 2010-Systems engineering handbook)

This definition emphasises a very structured aspect of systems and thus reveals its bias towards engineered system. The challenge is not to find a perfect universal definition. Dori and Sollito have argued that there is a need to develop ways of achieving a shared understanding of the concept of systems even if a universal definition is not possible (Dori and Sillito, 2017). The growing field of Health Systems Design by its very nature involves a considerable number of different disciplines or communities with different ontological commitments and therefore different interpretations of the concept of 'system'. These differences may, at least in part, be explained by the origins of the formal developments in systems and the influences of such works on various scientific disciplines as illustrated in figure 1 adapted from Hieronymi (Hieronymi, 2013).

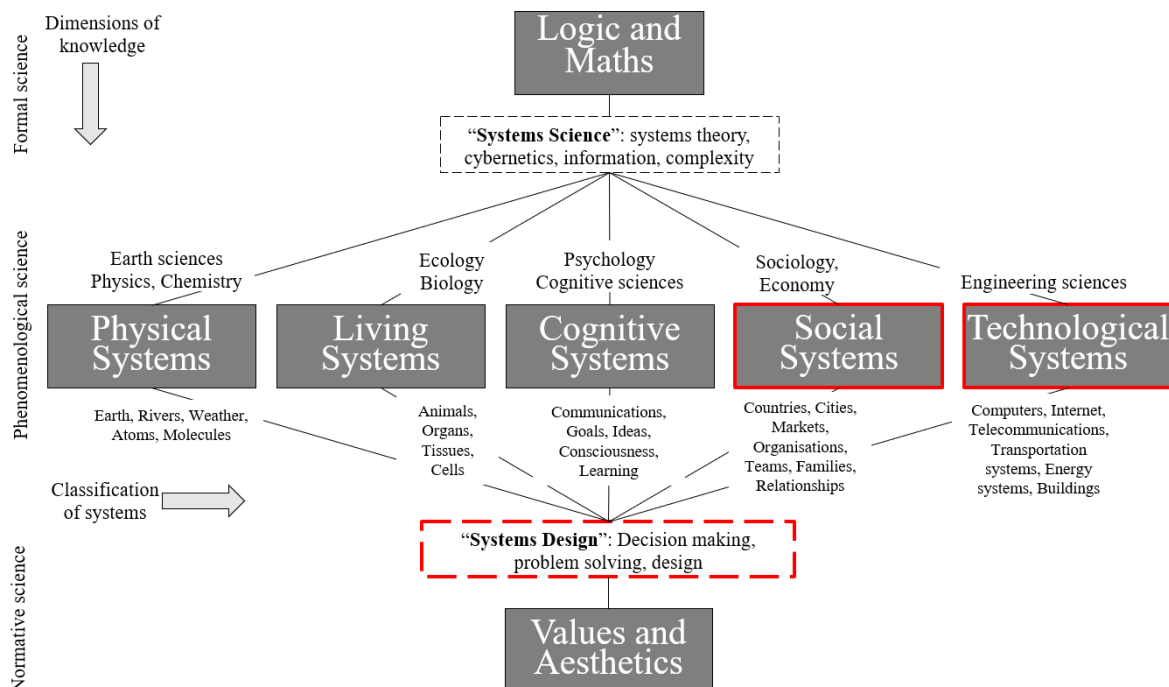


Figure 1. Classification of systems and influences of systems concepts adapted from Hieronymi 2013

At the formal scientific level, the pursuit of systems understanding is significantly mathematical, philosophical, and shaped by related logic. The resulting knowledge from the systems sciences have

found application in the major classifications of system - Physical, Living, Cognitive, Social and Technological systems - and related disciplines (Hieronymi, 2013). Towards the applied end of the dimensions of knowledge, the focus is on designing better systems and informing decisions in real systems. At this point, a mathematical definition is of little value whilst the influences from the disciplines make a common understanding a significant challenge. In focusing on Health Systems Design, the attention is at the normative science or systems design level where the goal is to create value for all stakeholders especially the patient. In addition, all multi-disciplinary collaborations in Health Systems Design are likely to be influenced by perspectives on systems from all the major scientific disciplines but the greatest influences are likely to come from the social and technological systems traditions as highlighted in read in the red boxes. It is essential to sufficiently explore ways of engendering a shared understanding of the concept of systems because differences in ontology and interpretation can lead to miscommunication especially in a multi-disciplinary collaboration. Systems Engineering is one field that has started to rethink its understanding and definition of the concept of 'system'. In a comprehensive review of definitions of 'system', Dori and Sillito reviewed over one hundred definitions of the concept (Dori and Sillito, 2017). They found much common ground in different groups of definitions but also significant ontological differences. The review also found that it was possible to map all identified definitions of a system into one or more classifications of systems as shown in table 2. The classification is hierarchical with 'System' as the highest level and representing everything. The definitions that represent this high-level description are summarised as "***A group of parts combined in a way that creates one or more emergent property or capabilities not possessed by the separate parts***". Under systems, there are also ***Real systems*** and ***Conceptual systems***. Real systems represent the group of definitions that focus on physical observable systems. The emphasis in these definitions is on multiple elements, their interaction in physical space-time and their resulting emergent properties. Conceptual systems are defined as models - products of human thought with the emergent property new meaning that could not be derived from the individual meaning of the elements. The final classification of systems - ***Abstracted systems*** - represents a group of definitions that focus on a particular class of conceptual systems. These systems are an abstraction of corresponding real systems such as a systems architecture or an organisational chart.

Table 2. Primary classification of systems with definitions and examples

System type	Definition	Examples
System	A group of parts combined in a way that creates one or more emergent properties or capabilities not possessed by the separate parts	Everything listed below
Real system	Two or more elements interacting in physical space-time to create emergent properties, capabilities, functions, or effects that the elements in isolation cannot achieve	Airplane, planet, solar system, universe, atom, climate system, weather, flock of geese, bridge over an estuary, cat, herd of wildebeest, bacterium, mammal's cardiovascular system, an ant colony
Conceptual system	A model, a product of human thought, with emergence through new meaning not conveyed by the individual elements, and with a boundary designated by the conceiver	Relationships between letters to form words, relationships between axioms to form a theory, relationships between equations to form a mathematical model, relationships between lines of code to form a computer program, a matrix of numbers or mathematical expressions, a topological map, a model of a real system, a machine drawing, an electric circuit scheme, a UML or OPM conceptual model, relationship between elements of belief in religion, politics, philosophy
Abstracted system (A particular class of conceptual system)	Conceptual system that abstracts a corresponding real system	A system architecture, an organization chart, design information for manufacturing a product, a mental or mathematical model of an observed or postulated physical phenomenon, a diagram or sketch of a real-world system

Essentially, it is impossible to find a single definition of 'system' that is precise enough to be useful, and general enough to meet the needs of systems community and all stakeholders (Dori and Sillito, 2017). However, the classification framework in table 2 provides a way of uniting the diversity of beliefs and views on the definition of a system.

It seems the key elements of the above exploration of systems are the multiplicity of different elements and emergent behaviour. Applying this to our exploration of the concept of health and care above, we may argue that whenever a health situation involves multiple elements - for example, patient, clinician, medication, and technology - interacting to achieve a health outcome, we have a health and care system. This may be true at several levels - national, regional, organisational, or even at the patient-clinician interface.

2.3. Health and care systems?

Despite the uncertainties that surround the definitions of 'health' and 'system', several attempts have been made to define or at least describe a 'health system'. In the world health report 2000, the WHO provided a case example to illustrate what a health system involves:

"He ... was born in a big city hospital, staffed by well-trained midwives, nurses, doctors and technicians. They were supported by high-technology equipment, drugs, and medicines. The hospital is part of a sophisticated health service, ... concerned with measuring, maintaining, and improving his health for the rest of his life – as for the rest of the population. Together, all these interested parties, whether they provide services, finance them or set policies to administer them, make up a health system." (WHO, 2000)

From the above illustration, several elements of a health system may be identified - the baby at the centre of it all, the variety of staff involved, the technology and organisation, all within a network of other people and their actions, intended for the entire lifetime of the baby and the whole population. It is clear from this illustration that what is meant by a health system is a very high-level description. The WHO framework for action on strengthening health systems makes the universality of the concept even clearer:

"A health system consists of all organizations, people, and actions whose primary intent is to promote, restore or maintain health. This includes efforts to influence determinants of health as well as more direct health-improving activities. A health system is therefore more than the pyramid of publicly owned facilities that deliver personal health services. It includes, for example, a mother caring for a sick child at home; private providers; behaviour change programs; vector-control campaigns; health insurance organizations; occupational health and safety legislation. It includes inter-sectoral action by health staff, for example, encouraging the ministry of education to promote female education, a well-known determinant of better health." (WHO, 2007a)

Again, what is intended in this definition is anything health-related that occurs within a country. For example, according to this definition, the National Health Service (NHS) in England is only a part of the health system. The health system in England, according to this definition, will include the NHS, Public Health, private sector, and all health-related activities that take place in local councils, schools, charities, businesses, and other organisations. This is important with the emergence of the Health Systems Design as there needs to be a shared understanding between the design community and the health community. When we talk about designing health systems, what do we have in mind?

This universal view of health systems is common in the health literature especially in global health where it is understandable as the system of interest is often the national system. In a joint review evidence conducted by the UK National Institute for Health and Care Excellence (NICE) and the WHO, the team explored the question 'what is a health system?' They reviewed a range of evidence on health systems and how they affect behaviour change.

"This review employs the broader definition of health systems ..., to encompass the structural, service and population components of the system itself, and the way in which the system – and all its parts – interact with other institutions, settings, and the social, political and economic environment." (Swann et al., 2010)

A 'health system' is, therefore, taken to mean the higher-level health-related activities and systems which will include care provision as well. It is the 'health and care system'.

2.4. Healthcare systems

From the above, it is clear that "A *health [and care] system is more than the pyramid of publicly owned facilities that deliver personal health services*" (WHO, 2007a). It is also true that apart from the concept of 'health systems', one frequently comes across the concept of 'healthcare systems' or 'health care systems' in the literature. What then is a healthcare system?

A definition of "healthcare system" is almost non-existent in the healthcare literature. The most common use of the concept, however, suggests a reference to the aspect of the health system that involves financing, resourcing, regulating and provision of health services in a nation (Toth, 2021; Wendt, 2014; Wendt et al., 2009). According to the WHO, almost all the information available about health systems refer only to the health care system involving its preventive, curative and palliative interventions (WHO, 2000). In England, for example, the National Health Service (NHS) and its related entities represent the health care system (DoH, 2013). Figure 2 below shows the English health care system, the NHS. The Department of health is the government department led by the minister of health. NHS England and the Clinical Commissioning Groups (CCGs) have statutory responsibility for commissioning (or procurement of) health services (Powell, 2020). Local authorities have responsibility for public health and social care provision. Sustainability and Transformation Partnerships (STP) are non-statutory partnerships between local providers aimed at improving efficiency, preventing ill health and addressing pressures facing the care system (Powell, 2020). The Care Quality Commission inspects, monitors, and provides quality ratings for NHS services whilst the Health Watch acts as independent consumer champions.

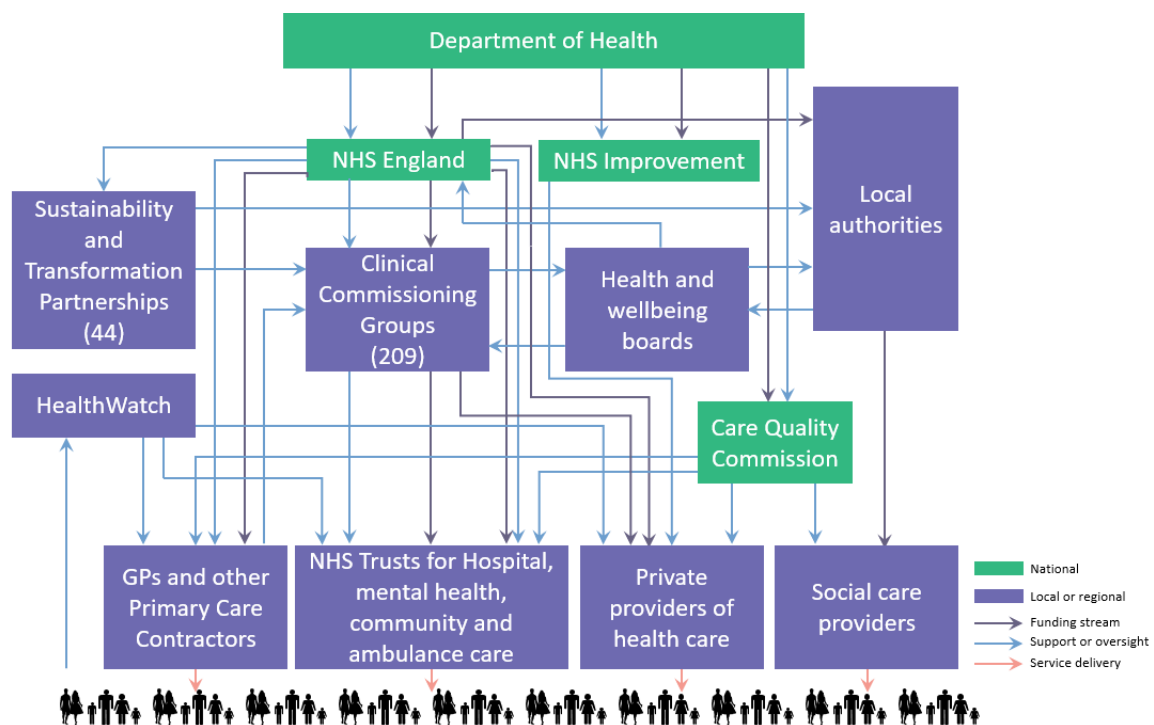


Figure 2. A simplified structure of the health care system of England, the National Health Service (NHS). Adapted from the Nuffield Trust (The Nuffield Trust, 2017)

Different countries will have different structures for how health care is organised but like the NHS they all focus on providing services to patients in need. These needs are impacted by people health actions. Health actions are fundamental to all individuals and are influenced by one's level of health literacy and cognitive ability (Von Wagner et al., 2009). Health actions such as quitting smoking, attending for screening, or complying with medication advice, result from choices between different routes of action (Von Wagner et al., 2009). All health care episodes result from some health actions (whether self-

initiated or initiated by another person or organisation) but not all health actions lead to a health care episode. Consequences of inappropriate health actions may be associated with increased health care costs and a worsening of a patient's condition (Musil et al., 1998).

The need to extend the scope of health and care systems beyond a healthcare system is deliberate. It is to ensure the universality of health as captured in this quotation by the former director general of the WHO, Dr Gro Harlem Brundtland, in her executive summary of the [World Health Report 2000](#):

"Our challenge is to gain a better understanding of the factors that make a difference. ... We have debated how a health system should be defined in order to extend our field of concern beyond the provision of public and personal health services and encompass other key areas of public policy that have an impact on people's health. This report suggests that the boundaries of health systems should encompass all actions whose primary intent is to improve health."

3. An alternative view

The ideas explored in this paper are motivated, in part, by observations the authors have made over the past five years through a new community of Health Systems Design Researchers from across Europe and a new Special Interest Group on Health Systems Design in the Design Society (Ciccone et al., 2020; Komashie et al., 2019). Given the WHO's very broad definition of a 'health system' as presented in section 2.3 above, it is understandable why the proposals for achieving improvements or strengthening systems are mainly at the macro level - good health services, well-performing workforce, well-functioning information systems, good health financing, good leadership and governance and access to medical products (Janovsky et al., 2006; WHO, 2007b, 2010).

In this section, we propose an alternative view of 'health and care systems' that facilitates design at all levels of the national system. A view that takes account of the definitions of 'health' and 'system' not only at the national system level but driven by an identification of a 'system of interest', whether macro, meso or micro. Using the definition of health as "*state of complete physical, mental, and social well-being and not just the absence of disease or infirmity*" and the definition of system as "*A group of parts combined in a way that creates one or more emergent property or capabilities not possessed by the separate parts*", we define a health and care system as:

A collection of people and entities that work together to achieve a defined health or care objective.

In this way, designing a road safety campaign to reduce deaths and disabilities from road accidents will be a design of a health and care system. Designing a new stroke service will be a design of a health and care system as will be any intervention at the national system level. It may be a healthcare intervention or a public health intervention. What will be essential is that a clear 'system of interest' is defined in each case.

4. Engineering better health and care systems

The engineering approach to designing products and systems is based on the conviction that "*systems that work do not just happen - they have to be planned, designed and built*" (Elliott and Deasley, 2007). There has been a growing interest in design and systems engineering within healthcare, especially over the past two decades (Komashie et al., 2021). This is because engineering has a lot to contribute to health improvement (Clarkson, 2018). We briefly describe three engineering-informed approaches that individually and together bring decades of engineering insight and expertise into the health and care systems world - the techno-behavioural approach (Ciccone et al., 2019; Patou et al., 2020), the convergent health design approach (Pannunzio et al., 2019a, 2019b) and Engineering Better Care, a systems approach to health and care improvement (Clarkson et al., 2017). These approaches are not complete, neither are they the only way to addressing all health challenges. These are presented as the three current approaches that drive our new community of Health Systems Design Research and a Health Systems Design Special Interest (SIG) Group within the Design Society.

4.1. The techno-behavioural approach

This approach, proposed by a team in the Engineering Systems division at the Denmark Technical University, recognises that human behaviour is key to any intervention aimed at improving health. Behaviour is also fundamental to morbidity and mortality (Ciccone et al., 2019). The interaction between the healthcare delivery system, technological opportunity, and behaviour theory is key to the approach which includes a focus on predictive, preventive, personalised, and participatory (P4) healthcare (Patou et al., 2020).

4.2. The convergent health design approach

The goal of convergent health design is to remove the conceptual, methodological and knowledge barriers that exist between design and health (Pannunzio et al., 2019a, 2019b). Maximum design impact on health and care will come from maximum engagement. Design in health needs to be integrative (Pannunzio et al., 2019a). Designing health in this way involves a closed loop where knowledge transfer is seamless and relevant clinical evidence can be made available even at the start of the design research. There is still work to do as it is known that there is not always a shared understanding between design and health communities with regards to the language of evidence (Lamé et al., 2020).

4.3. Engineering Better Care (EBC) approach

EBC is a systems approach to health and care design and continuous improvement with a significant focus on stakeholders and processes (Clarkson et al., 2017). The approach has four key perspectives - People, Systems, Design and Risk - that provide a framework for understanding health systems and includes a set of questions to guide actions. It involves a wide range of tools to facilitate those actions (Clarkson, 2019). The approach is seeing growing application in the National Health Service (NHS) in England.

5. Concluding thoughts

Health and care systems are not all the same. The concepts of 'health' and 'system' in themselves are difficult to define. In the health literature, the concept of 'health systems' seem to be often defined and applied at the macro level of the totality of a country's health infrastructure, financing mechanisms, delivery systems, policy frameworks and regulatory structures. With the growing interest in the emerging field of Health Systems Design, involving engineering design researchers and practitioners, it is important to begin an open exploration of the fundamental concepts of 'health systems' to understand the compatibility of the prevailing definition to design and systems approaches.

This paper has started this conversation. We have explored, in detail, the fundamental concepts of health and care systems and provided a subtle distinction between 'health systems' as often used in the literature to mean the national macro system and a usage that refers to a 'system of interest' whether at the macro, meso or micro level. We have also highlighted three potential approaches specifically from within the engineering design community that together can contribute to transforming health for the future. There is clearly more work to be done in bringing clarity to our dialogue and facilitating communication, engagement and collaborations between design engineers and the health and care community.

Acknowledgement

This work was made possible through Postdoctoral Interdisciplinary Fellowship for AK by The Healthcare Improvement Studies Institute (THIS Institute), University of Cambridge. THIS Institute is supported by the Health Foundation, an independent charity committed to bringing about better health and healthcare for people in the UK. The views expressed in this publication are those of the authors and not necessarily those of THIS Institute or The Health Foundation.

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