## Information systems in health: what do you need and how will you get it?

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**1: Introduction**

Healthcare information systems are interesting, intellectually compelling and challenging in equal measure: interesting because they lie between people and technology and, at their best, facilitate remarkable activity; intellectually compelling because information technology has faced serious problems in healthcare, requiring investigation and reflection. The field is challenging for similar reasons: it crosses the boundaries of the technical and the human, and so there are rich corpuses of literatures in social science, from the information systems and informatics communities, by computer scientists and engineers, and as part of the wider academic pursuit of systems in health, not to mention the clinical corpuses related to specialist information systems in diverse fields such as radiology or pathology, to name but two prominent examples.

One cannot, therefore, introduce any writing on healthcare information systems with full recognition of all that has gone before and yet some context setting is necessary. At the same time, if any useful contribution is to be made for clinicians, such writing will have to step neatly from looking back and around to propose guidelines for better development of new systems or for getting better value from what exists.

In this chapter we acknowledge that information systems in health cannot be addressed under a single disciplinary umbrella, and indeed that the variety of umbrellas that exist exhibit a degree of arbitrariness in terms of the best mix of disciplines to consider and how to combine them. We explore conceptual frameworks to address the information needs of individuals in healthcare systems, and the needs of networks of people if they are to make systems or services function well . We draw these ideas together with some recommendations on critical questions to ask in evaluating systems now, or in specifying systems for the future.

**2: Healthcare as a sociotechnical pursuit**

Many authorities have commented on the complexity of healthcare, and found reasons why this should be. They have observed that healthcare systems typically span a number of domains [1], that they involve many stakeholder groups and millions of individuals, and that, in a modern society, they involve a degree of systemic complexity that may be unrivalled – elsewhere, we have characterised modern healthcare systems as uniquely *hypercomplex* [2]. This unprecedented degree of complexity carries with it very testing demands for designing and implementing information systems which will provide productive support. The healthcare field is littered with the carcasses of information systems which have been deemed failures [3, 4, 5, 6], not forgetting that there are also a number of systems which, at one time or another, have been considered successes. Nor is it a simple binary classification: history may yet show that the UK’s *Connecting for Health* project [7], generally dismissed as a failure, may, by driving the digitisation of radiological images across the UK, have delivered a lasting benefit worth much more than the cost of the programme. Success is an issue of degree, subjective [8], and multi-faceted.

In this chapter we consider healthcare as a system of interrelated activities involving, typically, a large number of actors and stakeholders and a diverse set of technologies directed at the overall goal of improving the health of “target” stakeholders (individuals, groups, or populations). In short, healthcare is a sociotechnical pursuit: carried out by and through people and involving various forms of technology. While much of this technology is “front-line”, used by those delivering healthcare, a growing proportion of it is concerned with the management of healthcare delivery. The latter are the information systems (IS) concerned with generating, storing, providing and using information, data, and knowledge to support healthcare delivery.

While we tend to think of advanced information technology (IT) as the platform that supports healthcare information systems, a great deal of information management in healthcare is not based in sophisticated technology. Healthcare is a people-centred activity – involving patients, medical personnel, healthcare managers and others (including carers) – and the interactions between people are central to most healthcare provision. Much of this activity is face-to-face or mediated by fairly standard and ubiquitous commodified technology (such as the telephone). Realistically, this is likely to remain so for the foreseeable future. However, this in no way reduces the challenging complexity of the healthcare management problem – quite the reverse, in fact.

Given the complexity of healthcare systems, how can we characterise the healthcare environment in a way which is conducive to providing appropriate IS solutions? Many authorities advocate an explicitly multi-perspective view when addressing complex sociotechnical problems. Mingers and Brocklesby [9], for example, advocate a “three-world” approach to problems: problems need to be addressed not only in the material world (physical and objective), but also in the subjective worlds of the stakeholders (the understandings, beliefs and needs of individuals) and in the social world in which the problems are immersed (the constraints and opportunities latent in the collective cultural environment which prevails). Problems must be addressed in all three worlds, they argue, or solutions will not work, although they note that the attention needed in each of the three worlds (loosely, the need for change within each world) may differ substantially from problem to problem. In each world, four phases of an intervention need to be carried out: appreciation (of the problem); analysis (of the causal structure of the problem); assessment (of alternatives); and action (for change).

We concur with this, but would suggest that within the domain of healthcare, a tighter focus can be realised by further directing attention specifically to three Es (Figure 1): engineering (the physical world, including information); ethnography (individual and collective perceptions and needs); and economics (resource allocation). These are not natural bedfellows, but it would be very difficult to have confidence that a system is robust and sustainable and works for all involved without eventually applying methods from each of the three disciplines to a formal evaluation. Engineering, particularly systems engineering, focuses on capturing requirements from users, characterising their needs, and designing systems that can be tested and shown to meet those needs. The perspective of ethnography (and, more generally, social science) considers the experiences, cultures and practices of people within the system. And attention to economics acknowledges that, as health budgets are increasingly stretched, it is not simply a case of finding any solutions, but of finding affordable and cost-effective solutions: economic evaluation can no longer be ignored. While the concept of utility has served well in developing the field of health economics, enabling different interventions and drugs to be compared with one another, applying this thinking to health information systems is not straightforward: in an early attempt, for example, to determine the cost-effectiveness of a picturing archiving and communications system (PACS), benefits were identified but not the cost savings anticipated and so the case for adoption was not clear cut, but nonetheless, and presciently, there was confidence that “in the hospital of the future, PACS will be seen as standard” [10].

**Figure 1: A combination of disciplines for a multi-world evaluation of IS in the delivery of healthcare.**

In order to provide a framework to guide the practical introduction of information systems solutions to healthcare problems, we adapt Mingers and Brocklesby’s three-world framework with our own 3E conceptualisation. We limit the focus of our attention to the first three of Mingers and Brocklesby’s four intervention phases: appreciation, analysis, and assessment. Within each of the resulting nine cells of the adapted three-world framework, we direct explicit consideration towards engineering, ethnographic, and economic aspects. Thus, within each cell, three sets of concerns arise (see Table 1). These concerns, in turn, give rise to questions that can be asked of the situation (Table 2).

**Table 1: A framework for healthcare system development.**

**Table 2: Information systems questions.**

**3: A simple model of what information someone in healthcare needs**

In this section, we consider the needs of individuals within healthcare systems. No matter how complicated the world is, we recognise that people are able to live in such a world and routinely make decisions. Our next step, then, is to focus upon the individual seeking to make a decision and therefore seeking information upon which to base that decision. Since we are exploring the world of healthcare, we will call this person the *health information seeker*.

Thus we centre our thinking on information seeking, rather than a particular clinical or social role. The *health information seeker* may be, for example: a patient who has recently received a diagnosis and is trying to find out more about what it means and what needs to be done; a carer, trying to arrange an appointment at a wheelchair clinic; a hospital nurse wanting to know whether it is time for a patient to have another dose of medicine; or a doctor reading a radiologist’s report to see if the X-ray taken last week has revealed signs of cancer. The term is deliberately general. Moreover, the health quest may be for clinical information, economic information, or relate more widely to the person’s private life or social setting.

**Figure 2: A view of information sources that a *health information seeker* might typically use.**

Thus, while we put a person at the centre of the enquiry, we are not doctrinaire about what sort of person it is. We simply recognise that people make decisions about their own health or the health of others, and that to do so, they need information. Figure 2 illustrates how a *health information seeker* will typically have a choice of sources to consult. Clearly the options open to the *health information seeker* and the choice selected will vary: patients and carers, for instance, would tend to have fewer, and less formal, sources than clinicians and health managers, who might also have access to deeper professional knowledge and information. The ease of consulting various sources (in terms of time, cost and effort) may also vary. Further, the seeker may not be aware of the full range of available sources, and the quality of different sources may vary (and be poorly understood). A *health information seeker* may be able to modify information at source, perhaps by scribbling a note on a leaflet, by adding a comment on a website, or by making a formal entry into a record. A source may also contain information that has been generated by a machine – such as an image or a clinical laboratory test result.

There is very much more detail in the upper half of this diagram, which indicates IT-mediated sources, than in the lower half, indicating sources which are generally not IT dependent. There are more apps and systems available today that support the interactions indicated in the upper half. Person-to-person happens for free in corridors, offices, and elsewhere, and more expensively in meetings and at conferences. Meanwhile, though phones and video conferencing services would be placed in the lower half of the diagram, we do not yet have systems to capture and process natural interactions routinely. Our phones, for instance, cannot yet interrogate us after a consultation to make sure we understand all that the doctor said, nor are there systems to listen to a conversation between primary and secondary care physicians and appropriately update the notes of each. Such services would align with the aspirations of care delivery, and they are starting to appear, but mature adoption is still some way away.

The utter and critical dependency of care delivery on the interpersonal dimension, we argue, sets healthcare apart from other sectors.

Figure 2 is not an attempt to provide a taxonomy of information sources but to illustrate the many options that are open to those seeking information. The choice could be broadened, for instance, by including sources that are encountered in a less purposeful way, such as in watching TV. We note that some social media could be placed in the bottom half of the diagram, but in its present form, it is sufficient to assess whether a given system meets the needs of existing *health information seekers*, or whether unmet needs remain.

Our initial observation is that most health information systems connect sources and support services in the top half of the diagram: databases, clinical libraries, medical devices, hospital equipment, clinical laboratory systems, scheduling services, transaction, procurement, or prescription processing and, of course, medical records. Even with phone calls and video-conferences, the knowledge that is communicated tends to remain in human memories and may only make it into the top half of the diagram if the humans record it separately.

How, then, does this help to evaluate information systems or assess the benefits a new service? First, this conceptual model focuses on the match between what the stakeholders need to know, and what the system or service can provide. At its simplest, this might reveal that there is information that some stakeholders need, but cannot get directly. It may be that the underlying data is not provided, either because it does not exist or because it is not visible to particular seekers. Perhaps a nurse in primary care wants to know why a patient missed an anticoagulation clinic and suspects that the patient may have been admitted to hospital recently but cannot see into the hospital systems because they cannot be accessed by primary care clinicians.

Trickier is the apparent overprovision of information: where it appears that an individual has two routes to the same information. If it is genuinely the same information, that may not present a problem, but if two or more sources are poorly synchronised, appearing to contain the same data, but one being more regularly updated or generally better managed, it may create difficulties.

More broadly, we might enquire as to whether a source and a need are mutually appropriate: can the seeker get information that is sufficient to make a good decision in a timely manner? Our conceptual model, then, suggests the questions: how useful is this information, and to whom is it useful? The interest in summary records (see, for example, Reference 11), abridged datasets that can be shared more widely than the original records, indicates that completeness is only part of the requirement for care provision. Some information in a medical record may never be used to deliver any form of care.

Most importantly, this modelling approach enables systems designers to imagine themselves as any of a range of stakeholders who will use the system, and to work systematically through each person’s needs, identifying multiple connections, inappropriate provision and, of course, disconnects. A disconnect need not be a problem if there is another route to the information. But such measures tend to add effort and the risk of mistakes to the activities they are supporting. Such work-arounds [12] may be regarded positively or pejoratively (when described in terms of resistance to adoption). However, in terms of this conceptual model they are a likely outcome of any form of mismatch between the need of a stakeholder and the provision of the information system.

We must not forget the undesirable *health information seekers* – the nosey, the malicious, the hackers. The way in which information systems prevent illegitimate use will impact on the usability of the system for legitimate *health information seekers*. Passwords, even swipe cards, combined with time-consuming login and logout sequences can make a system much less attractive and convenient for the clinician to use.

A final issue – particularly when a system is being deployed – is that the architecture of the information system may mean that certain sources only become available after others are working. Hendy identified this in connection with the National Programme for IT, where the clinical systems would not work without an underlying patient administration system (PAS) [13, 7]. The decision to make the PAS, with its demographic information, a foundational element was a design decision with the (unintended) consequence that doctors could not access clinical information until after the managers could access theirs.

Knowledge is not usually sought in a vacuum, and the context for healthcare information is usually to inform a decision or to enable a process. And so the *health information seeker* is generally in search of information to make a decision or to expedite a process for themselves or for someone else. Without anticipating the dynamics of driving end-to-end processes in the next section, we recognise that even a static representation such as ours has a strong sense of the passage of time:

1. Retrospective information – a medical history or a statistical process chart – may contribute to a diagnostic decision: what is wrong with a patient or with a part of the service. There is a lot of interest in mining repositories of such data in the hope of generating new knowledge about other people with the same complaint, or about the services or similar services.
2. Current knowledge transfer addresses the questions: how can what I can find out now help me to make a decision now, or how will it lessen my worry now?
3. What next? The key in all knowledge systems is to connect people and processes up so that things can happen in future, often somewhere else. A service such as kidney dialysis at home is a complicated logistical challenge in setting up and then supplying a small chemical laboratory in a bedroom, and managing it safely. More than one stakeholder always needs to know what will and what might happen next.

We can take this one step further, by circumscribing a ‘circle of knowledge’ around each *health information* *seeker* – with an upper hemicircle that is the ***interactive*** knowledge exchange region and a lower hemicircle that is the ***interpersonal*** knowledge exchange region, as shown in Figure 3.

**Figure 3: A *health information seeker’s* circle of knowledge.**

For an individual to be part of a care delivery system, as patient, carer, associated professional, clinician or manager, their circles of knowledge need to connect up or overlap in some way. People need to talk to people and they need to share knowledge that provides them with a common situational awareness of what is happening and that allows them to plan together to make things happen in the future. We might visualise it as shown in Figure 4.

**Figure 4: A way of visualising the sharing of interactive knowledge exchange and interpersonal knowledge exchange as a *health information seeker* progresses along a pathway.**

Figure 4 is an illustration of the idea that as an individual progresses along a pathway (supporting care, receiving care or providing care), the forward movement requires knowledge. Sometimes this knowledge may be through other people – the overlapping circles on the left indicate a shared acquaintance or colleague – or through shared access to information stored somewhere and modified or recalled by one or more parties. Sometimes the information flow will be to prepare for the future or it may be to use the past to inform the present or prepare for the future.

To summarise this section: we started by putting a person at the centre of the healthcare world and considered the knowledge that such a person would need. We have undertaken a very coarse binary classification, identifying interactive information or knowledge and interpersonal knowledge or information. We have considered the appositeness of the sources of data, information and knowledge that might constitute each type of exchange, and developed the idea of evaluative questions that will assist in troubleshooting or specifying new systems. Critically, however, we identify that health information systems simply contribute to an individual’s circle of knowledge and that the way in which individuals can develop, align and manage their circles of knowledge will determine the types of processes of which they can be part and to which they can contribute.

**4: A way of thinking about the role of information in care provision**

We now move on to consider the role of information in empowering process.

The literature is rich with frameworks on how to evaluate and assess information systems. Because, however, the accent here is on a pragmatic approach to making decisions about technology selection and use, we adopt a very pragmatic approach that was proposed for a small project a decade ago by one of us (TY). It is certainly not the only way to structure one’s thinking, and we do not claim universality, but commend it as providing (as does the conceptual model in the section above) a way of thinking about information systems that should prove useful in the context of service delivery, troubleshooting or design.

This approach starts with a mnemonic, **PIQuED** (**P**rocess, **I**nformation, **Qu**ality, **E**quipment, **D**ata) that should be accessible to individuals and can be readily shared around a team.

**Process:**

In healthcare, neither people nor information can be productive in isolation and the context is usually a process. Sometimes a *protocol* captures the same idea, and in the UK, the term *models of care* is gaining currency. We note that sometimes people see a new information system as the catalyst to drive better process – for instance, *Connecting for Health* was conceived as a transformation programme through technology [14] – while others see the role of IT in terms of its alignment with existing process. However, in terms of evaluation or design, it is much easier to think of information in the context of process rather than the other way around. Specific issues to focus on will include the following:

* Process maps. A process map illustrates a sequence or combination of sequences of events, with emphasis on who meets with whom or what. It has become popular to sketch out patient pathways, but every person involved has a pathway that will intersect with, or in places run alongside, the patient pathway. Simulation modelling [15, 16] is a good way of capturing the complexity of these interactions, and such models allow stakeholders to explore how the interactions play out under different demand and staffing regimes or when differently configured. However developed, a set of mutually consistent sequences, governed appropriately, is essential.
* Decisions. A critical feature of process maps are the points at which someone has to make a decision, which in healthcare is usually a diagnosis or treatment decision. Decisions usually require information and communication between those involved in the decision. Understanding the timing of decisions, the availability of key stakeholders and relevant information, and having communication channels that support shared decisions where necessary, is critical to connecting a good process to an appropriate information infrastructure.
* Logistics. People have to move around: the choreography of care – ensuring that people and things (such as items of equipment, documents, samples, *etc*.) meet up at the right time – is very complicated. The traditional way of simplifying such a problem was that patients travelled and waited, but this is less acceptable today, so coordinating care for the best experience all round requires excellent logistics.
* Management. Systems cannot run themselves and operational oversight and control is needed.
* Customers. There is no customer in health who is always – as the old adage says – always right. In truth the process will have many stakeholders, all of whom might function as a customer might in other sectors.

**Information:**

Given the process, the next question is what information is needed by the people (or the equipment) in the process to make it work well. Issues such as the applicability to, or accessibility by, particular *health information seekers* will be critical to a successful design. The process outlined in the previous section that enables us to sit where each *health information seeker* sits, combined with a clear picture of the decision-making points, allows us to identify the two main issues.

* What needs to be known by whom (and when, and where): the dependence of effective process upon the availability of timely, accurate, appropriate and accessible information cannot be overstated.
* Who needs to communicate with whom. Again, the traditional way to manage care has been to focus on bilateral conversations, connected up with slower media, such as letters. As noted, new technologies are emerging and there may well be many more options in the future than there are today.

**Quality:**

This entry is a mark of the arbitrariness of frameworks such as this, and a case could be made that quality relates to the process or that data quality is primarily a technical issue. We focus attention on it to make sure that, in designing processes and in considering the information flows needed to make them work, high quality has been design in and poor quality has been designed out. Making it easy for *health* *information seekers* to do the right thing, and making it hard for them to lose situational awareness, or become confused, is about the interplay between the process and the information system supporting it. There are several dimensions to the question of quality, including the following:

* Service quality. This covers everything from governance and accreditation, to efficiency, management and user experience and will rely upon the training, morale and performance of the staff providing the service.
* Quality of experience of all stakeholders.
* Equipment quality. This relates to the next heading, and relates not just to the technical quality, but also to ease of maintenance, calibration, configuration management and upgrade strategy. Note that equipment must deliver appropriate information, not necessarily the most precise available, which in turn raises questions about who will interpret and make decisions based on such information.
* Quality of outcomes. Clearly, clinical outcomes are the gold standard, although linking process changes to such outcomes is not always easy.
* Information quality. As discussed above, this relates to the timeliness, accuracy, accessibility and relevance to the decision-maker. Too much information may undermine quality as much as too little.

**Equipment:**

As noted above, many sources of information (and some destinations for information) are not people but computer systems or healthcare equipment (such as scanners, or point of care diagnostics) with information interfaces. The role that such equipment plays in the pathway will determine whatever is appropriate, and what information is required of it. The field is huge, but some observations are helpful.

* Point of care technologies and fixed infrastructure. In many fields, from home dialysis to diagnostics, there is a marked move to bring care to the patient rather than vice versa. The technical performance of portable or decentralised equipment may be inferior to that provided in central facilities, but the access is much better. Home dialysis, for instance, may take more needle-time, but may be much more comfortable for the patient, especially when travel is taken out of the equation. The onward march of ‘good enough’ technologies, fuelled by a desire for portability, is a key theme of The Innovator’s Dilemma [17] and its subsequent application to health [18, 19].
* Configuration management. Knowing how equipment has been set up and whether it is sufficiently well calibrated is a task more easily performed in a central facility, and issues around such management need to be considered when designing new services.
* Interfaces. Again there is a vast literature on equipment read-outs and the potential for error around the human-computer interface [20]. Here we simply note that the nature of displays and direct-to-human transfer of data needs to be a factor in evaluating equipment. Similarly, the compatibility of the information that interfaces to a network with other equipment supporting the same processes needs to be considered.

**Data:**

It is easy to focus on the data at an early stage. While we acknowledge that much good has come from coding systems and standards, there are two aspects of a strong data focus that are not helpful. The first is that the quest to standardise can obscure the purpose for wanting the data in the first place. It is easy to get caught up in lengthy discussions over exactly what will and will not be allowed – and indeed, the quest for coding standards has taken decades – and to lose sight of why it is needed. A second observation is that data is too often used for audit rather than operational delivery [13, 7]. We contend that the first priority of an information system in healthcare is to facilitate better delivery of healthcare and that audit for policy or financial purposes should not shape the systems architecture.

For these reasons, and perhaps a little idiosyncratically, we have put data at the bottom of the list of what to address. Once everything else is clear, the data sets you need should be relatively straightforward to identify and specify.

**5: Knowledge and process in care delivery**

Finally, we present one other very simply conceptual model about knowledge and process. Healthcare service provision is perhaps the most knowledge-intensive sector in the world. Because of the number of variables and people and the scale and complexity of the interactions between them, it is also one that requires an enormous capability to deploy and manage processes effectively. However, the knowledge piece and the process piece are not separate issues.

In other sectors, such as logistics and supply chain or manufacturing, the really successful players have managed to use knowledge and process in the sort of virtuous circle that is shown in Figure 5.

**Figure 5: A simple view of the potentially reinforcing role of knowledge and process in care delivery.**

It is easy to be cynical about on-line vendors who track your purchases in order to predict what you will require and to sell you more, but the information systems and process control behind such service is really quite spectacular. At its best, it has managed to wrap the customer and the service delivery system in processes that collect information that can be turned into knowledge, and vendors use the knowledge to be even smarter with their processes.

Very simply, this is the ideal to which all information systems in healthcare should aspire, in order to facilitate a continuously improving experience for all concerned and a generally increasing freedom from fear and worry.

It is clear that we have not explored a complete set of methods to be able to answer the questions posed in the title of this chapter: what do you need and how will you get it? We add, therefore, the ideas of knowledge drivers and process drivers to propose a connected model for continuous improvement in one more conceptual model – shown in Figure 6. This concept was developed as part of a proposal in 2016 and is used here to emphasise that thinking about systems is not just an engineering pursuit, but that a service such as healthcare is a system with people and one that consumes resources and delivers value.

**Figure 6: An effective set of disciplines for analysing the delivery of healthcare.**

**6: Conclusion and critical design questions**

In this paper we have sought, using a framework and a set of conceptual models, to cut through the complexity of what is currently available in healthcare information services, systems and apps. Our aim has been to provide help for clinicians involved in evaluating or specifying services and their supporting information systems, so that they may have a fruitful dialogue with all stakeholders, including those who are providing the information systems. To do this, we have adapted the Mingers and Brocklesby framework by appealing to disciplinary backdrop in engineering, ethnography and economics. From there, we considered the individual’s quest for information by imagining a *health information seeker*. In doing so, we have been able to highlight the information that such a person would want to have in order to make effective decisions, and we have partitioned that information into what we have termed either *interactive* – information that is stored somewhere, updated and may be interacted with by the *health information seeker* – or *interpersonal*  – communication-based exchange of information in natural language involving shared decisions, mutual learning, accommodation and consensus.

We moved on to see that information and communication systems need to support both *interactive* and *interpersonal* exchanges of data, information and knowledge, and that the ease with which the most appropriate connections may be made will influence the effectiveness of the processes of care.

From here, we went on the provide a framework comprising process mapping, identification of key decisions points, specifying the information flows needed, the quality of the overall service, the equipment and finally, the datasets needed. Clearly, many of these components will already be fixed by the existing infrastructure or purchasing decisions made by others, but the approach allows the choices at each stage to be formally assessed.

And finally, we returned to the question of how better knowledge can drive the design of better process which in turn can lead to the gathering of better knowledge.

We contend that healthcare professionals could get a lot more out of existing systems, and could have more impact on the development of new systems, if they could use these thinking tools to ask better questions at whatever stage they encounter the system. Our hope is that the debate around healthcare information systems can return to the basics of who needs what, while setting the business of agreeing standards and formats on a firmer basis in which specific types of user are always in view.

There may be other pieces of information system design theory that would help – use cases, for instance, are a way to stimulate the dialogue between information system users and designers by drawing pictures that describe how each user expects to encounter and engage with the system. If you haven’t seen the use-case diagrams for the system you are expected to use, you might have a fruitful conversation by asking for them. But that is a subject for consideration elsewhere.

We contend that although the health information technology scene exhibits a bewildering range of products and services, information management is relatively straightforward at heart and has remained so since the late 1960s. New technologies and apps introduce new ways of addressing what are essentially old questions. The key issue is to keep returning to the old questions in new ways.

To end with, we present a series of possible questions that might be asked when evaluating an existing system or considering a new one. (These questions can be viewed as an informal summary of the questions appearing in Table 2.)

* **What is the problem I am reviewing?** What is the physical system and the social challenge? Who are the individuals?
* **Who are the main information-seekers in this process? C**an I work through what they want using the *health information seeker* model?
* **How do the information and the process that I am reviewing interact?** What arethe stakeholders in the process trying to do and how does the timing and availability of information affect their decisions? What are the engineering challenges of providing this information in a timely way and what are the costs and benefits of doing so?
* **What formal and informal sources of knowledge and information are the individual stakeholders using already and how will a new service or system change this?** How would they like it to be changed? What are the reasons that individuals may or may not want to use the system in the way that the designers have planned that it be used?
* **What are the constraints that limit me?** Is it the engineered solution – can it simply not do what needs to be done? Would it cost too much to get it to do what is really needed? If so, have I fully costed the impact of it not doing what it really needs to do? Does the way individuals will have to use it present a barrier to its effectiveness?
* **If this is a proposed solution, how will I evaluate it:**
	+ With and against alternatives before it is implemented?
	+ After it has been implemented?

Good luck!

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|  | **Appreciation: assimilate the richness of the content (structure and processes) of the world** | **Analysis: understand (conceptualise and model) underlying mechanisms** | **Assessment: formulate and evaluate alternative solutions or ways forward** |
| **Material** | **Engineering: information technology** | Material and physical processes and arrangements | Underlying causal structures: nature of decisions  | Alternative physical and structural arrangements: alternative information sources, decision processes |
| **Ethnography: decision processes** | Information: its availability, how it is transmitted, stored, used, changed… | How information contributes to the decision | Alternative ways of generating and using information |
| **Economics: resources; costs** | Costs and benefits of IS/IT  | Sources of costs of providing data and information | Costs and benefits of alternatives |
| **Individual** | **Engineering: HCI considerations** | Individual needs and capabilities  | How individuals seek, use and conceptualise information | Alternative ways of using and interacting with systems |
| **Ethnography: beliefs and attitudes about IS/IT and decision processes** | information skills, perceptions of information environment | Understand belief systems of individuals | Alternative individual understandings |
| **Economics: individual utilities** | Value of resources used and outputs generated to individuals | Understand underlying value systems of individuals | Alternative value systems of individuals |
| **Social** | **Engineering: role of IS/IT within society; societal constraints** | Social practices regarding IS/IT | How social practices manifest in behaviour and conflicts of interest | Alternative social practices |
| **Ethnography: cultural aspects of IS/ IT**  | Cultural beliefs about healthcare systems | Why people believe what they do | Alternative social understandings |
| **Economics: societal utilities** | Social values | Understand social value systems | Alternative social values |

**Table 1: A framework for healthcare system development.**

|  |  |
| --- | --- |
| **Material: engineering: information technology** | Appreciation:* What physical processes are encompassed by the system, and how might they be informed by data and information flows?
* What, in material terms, does the system do, and by what data and information is it informed by?

Analysis:* What are the underlying causal mechanisms that explain the physical processes within the system, and the way in which they are informed by data and information?

Assessment:* What alternative configurations for the physical processes and data and information flows can be devised?
* How do these alternatives function in terms of the effectiveness of the system?
* How might a chosen alternative be developed?
 |
| **Material: ethnography:****decision processes** | Appreciation:* What decision processes are encompassed by the system?
* By whom are the decisions made?
* How do they access the data and information which inform their decisions?
* Is full use made of the available data and information?

Analysis:* How do decision-makers make use of the data and information they obtain in order to make their decisions?

Assessment:* How might decisions be configured differently within the system?
* How effective might alternative configurations be?
* How might a chosen alternative be developed?
 |
| **Material: economics: resources; costs** | Appreciation:* What are the costs and benefits of different information sources?

Analysis:* How do information sources add value to decisions?

Assessment:* Which alternative offers the best cost-benefit profile?
* How might a chosen alternative be developed?
 |
| **Individual: engineering: HCI considerations** | Appreciation:* Who are the stakeholders in the system?
* How do the stakeholders interact with system?

Analysis:* Why do the stakeholders interact with the system as they do?

Assessment:* What alternative ways of interaction with the system are possible?
* How might a chosen alternative way of interacting with the system be developed?
 |
| **Individual: ethnography: beliefs and attitudes about IS/IT and decision processes** | Appreciation:* What do stakeholders perceive the system to be?
* How do stakeholders understand their own role in the system?

Analysis:* Why do stakeholders hold the beliefs they do?
* In what way does the system confirm their beliefs?
* How do their beliefs explain their actions?

Assessment:* What alternative ways of understanding the system might be available to stakeholders?
* How might such alternatives impact on the way in which stakeholders interact with the system?
* How might stakeholder beliefs be changed?
 |
| **Individual: economics: individual utilities** | Appreciation:* What are the costs and benefits of the system in terms of money, time, and other criteria, to the various stakeholders?

Analysis:* How are costs and benefits calculated?
* What assumptions underlie such calculations?

Assessment:* What alternative measures of costs and benefits might be proposed?
* What alternative ways of assessing such costs and benefits exist?
* How might an alternative set of costs and benefits be made acceptable to stakeholders?
 |
| **Social: engineering: role of IS/IT within society; societal constraints** | Appreciation:* What are the cultural and social constraints under which the system operates?

Analysis:* How do the cultural and social constraints influence the system?

Assessment:* How might different cultural and social constraints influence the system?
* How might alternative cultural and social environments be created?
 |
| **Social: ethnography: cultural aspects of IS/IT** | Appreciation:* How do cultural and social constraints influence beliefs about the system?

Analysis:* How do the cultural and social constraints operate to influence beliefs?

Assessment:* How might different cultural and social constraints result in different understandings?
* What actions might be taken to change the culture and consequent beliefs?
 |
| **Social: economics: societal utilities** | Appreciation:* How does the culture value the inputs to and outputs from the system?

Analysis:* Why does the culture value inputs and outputs in the way that it does?

Assessment:* What alternative value systems might be introduced?
* How might a culture be steered towards such alternatives?
 |

**Table 2: Information systems questions**











