Abstract
Along with the global community, the Dutch health care system is pioneering in transitioning to electronic medical records. Although certain studies have been conducted on the Dutch experience of implementing its national Electronic Medical Record system, a historical account of this decade long initiative is largely lacking. More importantly, the study of specific challenges and the ways they are treated has been largely undermined. This paper summarizes the history and the current state of the Dutch Electronic Medical Record (EMR) system. The paper highlights the challenges within this system and analyzes the way to handle these challenges. To this end, this paper finds that while the Dutch government is rapidly implementing the EMR system, there is a plethora of socio-technical challenges still unresolved. To handle them, these social and technical challenges require a holistic approach to complete the EMR implementation and deployment with possibly less resistance and concerns of the stakeholders.

1. Introduction
During the 1990s, many industries heavily invested in information technology (IT) that resulted in unprecedented benefits for both investors and consumers. These industries recorded tremendous efficiency and 6–8 percent annual productivity growth, of which at least one-third to one-fourth annually can be attributed to IT. Following the path of other industries, health care sector became a natural focus center for embarking on the pursuit of innovative IT solutions for already skyrocketing health care costs [1].

As patient and patient satisfaction are becoming most important concerns of health care, development and implementation of Electronic Medical Records (EMR) Systems received a global attention. Despite of over decades of scientific and technological efforts and multi billion investment globally, there are only a few countries worldwide [4], where doctors make use of some form of EMR. Among them, The Netherlands, Denmark, Australia and New Zealand have very high usage of EMRs (above 98%) of the worlds developed countries, where the United States, Canada, the United Kingdom and Germany are just starting to implement EMRs. Yet only a small fraction of hospitals (<10%) in any single country has implemented the key components of EMR [2]. The main reason of slow development of EMR systems is complexity rotted in socio-technical challenges.

The use of EMR is high in the Netherlands; nonetheless, there are still major challenges to overcome in order to have full integration of EMR system into the national health care infrastructure. These challenges are dominantly of a socio-technical nature and to overcome these challenges a holistic approaches are needed. The goal of this paper is twofold: first, to provide an accurate account of the Dutch EMR system, current implementation phase, major actors and challenges; second, an explanation of the complexity factors of this socio-technical system is given followed by an approach to address the socio-technical dimensions in a manner that better allows to handle the complexity of these systems.

2. Research Methodology
The research methodology used to document and study the Dutch EMR system in this paper is a blend of knowledge base and experience base. The knowledge base constitutes an extensive literature search and reading of the reports by the Dutch Ministry of Health, Welfare and Sport (VWS - Ministerie van Volkgezondheid, Welzijn en Sport) (or Ministry of Health for short) on the status and developments of the Dutch EMR project and published research papers. The experience base includes an extensive data collection as a part of graduate study at Delft University of Technology. A group of students was assigned a course work of contacting different users of EMR system in The Netherlands and interview. In part, they assignment asked the users (physicians, nurses,
administrators) to discuss the advantages and challenges of using EMR systems. But the main focus of the assignment was on documenting business processes to be supported by an EMR system, identifying the involved actors, draw organizational boundaries. Since there is only a handful of publication on the Dutch EMR systems and the whole account should be documented from rather informal and personal sources, a group of 40 students was divided into some 10 groups and each group was tasked with the same set of questions to be answered by gathering data from observations and interviews. Once the projects were completed, then all the data were consolidated into one piece, which is presented here in this paper.

3. Electronic Medical Record Systems

The concept of Electronic Medical Records Systems comprises a wide range of information systems, from files compiled in single departments to longitudinal collections of patient data [3, 4]. Authors in [5] use a somewhat derogatory definition and state that an EMR is an electronic record of health related information on an individual that can be created, gathered, managed, and consulted by authorized clinicians and staff within one health care organization. Services included in EMRs are: permit both providers and patients to access laboratory results online via the Internet, access to medication profiles, waiting list information, online scheduling of primary care physician appointments, e-mail contact to primary care physicians, and online renewal of prescriptions by patients [5]. Generally, any EMR system encompasses four core functions for patients data and information management: Electronic documentation of providers’ notes, results management, physician order entry, decision support and exchange of clinical data from one provider to another [2].

The rising use of EMRs [6] can be explained because of the perception that the application of health informatics improves patient safety [1, 7, 8], physical office efficiency [1, 8] and mitigates the shortages of health human resources [1, 7, 8], and of course significantly cuts the costs.

4. History of the Dutch EMR Project

1972: The roots of the Dutch initiatives for developing some sort of electronic medical records can be traced decades back. In particular, in 1972, the Leiden University Hospital started working on a project that intended to come to an integrated Hospital Information System [9]. Soon it became clear that the many initiatives were hard to realize because of the diverse demands. The host of these demands can be categorized into technical demands for the underlying infrastructure, organizational demands to oversee, manage and control the whole system, financial demands to fund these long term initiatives, political and legal demands that are hard to meet [10]. It will take years before some simple systems will find their way into the practices.

1985: Around 1985, most of the general practitioners were using some kind of information system for their administration, which laid a solid base for further integration of information technology in the health care [11]. However, those early days of ICT adaptation in health care practices were primarily administration oriented and the practices still used paper based systems for the patient’s medical records. In addition, most of the systems carried characteristics of standalone applications used for purposes such as appointment scheduling, billing and payment, patients data, etc. Rarely did they operate in a networked environment or for the purpose of sharing and allowing third party access to the patient’s records while needed so. Only in the beginning of 90s, EMR projects were initiated that aim at shared health care data – patient medical records that can be accessed and shared among different providers.

The idea for an EMR in the Netherlands initially came from an advice from the Council for Public Health and Health care (Raad voor Volksgezondheid en Zorg - RVZ) in October 1996. At that time, RVZ carried out a research on IT facilities for health care, with the central finding in its advice that the application of ICT can make a big difference in health care with respect to quality, efficiency, accessibility and transparency. They concluded that for health care professionals to exchange patient data electronically, the Electronic Medical Record system is required. They also asserted that the shared data could be of great value for other authorities as well. With this historic advice, the subsequent period of the second half of nineties, many Dutch initiatives for IT facilities in health care took place. These initiatives included more than IT concerns alone, e.g., normalization and standardization.

Normalization and standardization were stated as preconditions for EMR. For this purpose, in 1996, a special association was established: Coordination point Standardization Information facility in Health care (Coördinatiepunt voor Standaardisatie Informatievoorziening in de Zorgsector - CSIZ). The board of this association consists of representatives of suppliers of health care, medical specialists, patients and medical insurance companies. Chronologically, the subsequent main events in the development of the Dutch EMR that have taken place between 1999 and present time are described as follows.
1999: The ICT Platform in Health care (“ICT Platform in de Zorg”) was established. The members of this platform are organizations representing patients, suppliers of health care, medical specialists, medical insurance companies, the Ministry of Health, Public Welfare and Sports and the Ministry of Economic Affairs.

1999 (September): A declaration of intent has been signed which was the first joint act of all parties involved to come to a nationwide use of ICT in health care. Among the most important topics are the infrastructure, identification and authentication of patients and suppliers of medical care, an authorization structure for the access to medical data and the composition of the EMR.

2000 (November): The health minister states in a letter to the Lower House (“Tweede Kamer”) that her Ministry is going to play an active role in the realization of an ICT system in health care. Part of that is the introduction of an EMR. The law will have to be adjusted to make some elements of the project (regarding patient and medical supplier identification) possible. The Ministry allocates 220 million Guilders (approx. 100 million Euros) to launch the project.

2002 (January): Because former initiatives did not lead to a nationwide ICT application in health care, the NICTIZ (Dutch abbreviation for National Institute for ICT in the medical sector) is established by the Ministry of Health. This institute is, again, responsible for the national implementation of ICT applications in the medical sector and receives as of 2002, 10 million Euros subsidy per year from the Ministry of health.

2005 (June): The Dutch health minister introduces a plan for implementation in the “Lower House for the national ICT infrastructure, essential for EMR. This plan is formulated by NICTIZ in cooperation with the Ministry and consists of four program lines:

1. SwitchPoint (LSP – Landelijk Schakel Punt): The national switch point is the central service that offers the necessary facilities for the electronic exchange of information in health care.

2. Citizen Service Number (BSN – Burger Service nummer): The government wishes to use this number for patient identification. Special legislation is required.

3. Unique Health care Provider Identification (UZI – Unieke Zorgverlener Identificatie): Not only patient identification, but also the identification of the providers of health care needs to be possible to communicate in a safe and reliable way. UZI is the electronic identity for health care providers

4. ‘Frontrunners’ EMR: Parts of the EMR are introduced by means of ‘frontrunner projects’ in those regions which are willing to act as frontrunners. They will be the first to implement parts of the EMR using the national infrastructural facilities and in accordance with the national standards. Their experiences will then be used to amend the requirements where necessary and to resolve any problems which may emerge.

2005 (October): The Ministry of Health becomes responsible for financing the national infrastructure. As a follow-up of the first implementation plan, a second one is published this year. This one is mainly focused on the connection of regional systems of different health care providers to the national infrastructure. In October 2005, NICTIZ grants a license to a computer company for the construction of the National Switch Point (LSP).

2005 (November): The Ministry of Health announces the implementation of the EMR has suffered delay. Building the necessary technological facilities takes more time than expected. The projects in the frontrunner regions do not function well enough for the architecture to be used nationwide. Safety cannot be guaranteed at this stage of the project. Besides, for the introduction of the Citizen Service Number (BSN) for the first time in The Netherlands, an appropriate legislation has to be adjusted – a procedure that takes a lot of time.

2006 (January): A fundamental change takes place in the Dutch Health Care System. From this date insurance is compulsory for Dutch citizens and the two-tier insurance system is replaced by a free market based insurance system.

2006 (April): The Ministry of Health informs the Lower House on the progress of the project. The LSP has been constructed and tested. No extra delay has occurred. The Ministry of Health has to report on the progress of the project every six months.

2008 (June): The law ‘Wbsn-z’ regarding the Citizen Service Number becomes operative. As of June 2009 all providers of health care are obliged to connect to the LSP and share the patient’s records with other providers. It is also compulsory to use the BSN when documenting information on patients. The introduction of this measure leads to a lot of resistance from the side of doctors and pharmacist. In their opinion, the EMR is out of date, not an improvement on different regional systems and a violation of professional confidentiality.

2008 (September): Doctors and pharmacists once again step in with their aversion of the EMR. They think it is needless and expensive [13]. The corporations of doctors (KNMG and LHV) and pharmacists (KNMP) do not think it is realistic for the Minister of Health still wanting the EMR to be implemented nationally at the end of 2009 [14].
5. Implementation of the Dutch EMR Project

Since January 2006, the Dutch EMR project coordination is delegated to the Ministry of Health, Welfare and Sport. Together with NICTIZ and the Central Information Point for Health care Professions (CIBG), they are working on the development of a nationwide system for the electronic exchange of medical data. The goal of the EMR project is to create a secure environment in which patient data that are stored in different systems can be retrieved, exchanged and cogently shown to authorized health care providers in order to support the health care processes, independent of where the file is being stored. Utilization of such a shared system is assumed to increase significantly the quality of health care [15]. The patient data will stay permanently where it was created with accessibility from different authorized places. The ultimate owner of the data is the patient self.

The ministry has chosen an incremental approach for the development of EMR in the Netherlands. At first, the Electronic Medication Record (EMD) and Electronic General Practitioner’s Record (WDH) are planned to be implemented. Later on, more care applications will be developed and added to the EMR overall system.

The EMR system is going to be built in different steps with different subsystems, which are connected by the national infrastructure LSP. Once completely implemented, the structure of the Dutch EMR will consist of three levels (see Figure 1): the central national level, the communication level and the decentralized level (level of the health care authorities). The next part of this section will describe each of these layers, where the next section will make a detailed description of all the involved actors in these layers.

The national level will be provided by NICTIZ. Founded in 2002 on behalf of the Ministry of Health, this organization stimulates the use of IT in health care. Different organizations like IPZorg, VIZI, CSIZ and the Zorgpasgroup took part in NICTIZ because of their knowledge of electronic communication in health care [16]. The provision of the central level consists of the National Interconnection Point (LSP), the Sectored Message Service (SBV-Z) and the Unique Health care Supplier Identification (UZI-register and UZI-pas) [17]. Transmission of the patient record will run through the Citizen Service Number and health care suppliers can make use of this number since June 1, 2008. A supplier can only make use of this number if his information system complies with the demands of a ‘good health care information system’ (GBZ). It is planned that from June 1, 2009, the use of BSN to transmit patient records becomes compulsory.

The second level is the communication level. Provided by the network suppliers or IT suppliers (OIZ), this level will provide the technology to send and retrieve the patient’s information [15]. This third and final level is the level of the health care authorities. They are responsible for the implementation of the EMR application, information system and the architecture needed to get access to the national network.

However, implementation of this system can compromise short-term physician office performance [12, 13], intimidate physicians and their office staff [4], and on occasion, increase medical errors [4]. There are also concerns over privacy, patient safety, provider/patient relations, staff anxiety, time needed to implement, quality of care, financial, efficiency, and liability [4]. With these and many more challenges expected in the future, it becomes important to understand the barriers to implement EMR, so that the change can be made without resistance and with success. These challenges are treated below. The next section will first sum up all the important actors within the Dutch EMR system.
6. Involved Actors

This section will give a detailed description of the involved stakeholders of the Dutch EMR system. The three levels of the Dutch EMR will act as the framework to structure these actors.

6.1 National Level

1. National IT Institute for Health care (NICTIZ - Nationaal ICT Instituut in de Zorg): NICTIZ is the organization that has to execute health care related ICT plans for the Dutch government. As already mentioned, it was founded in 2002. NICTIZ’s mission is to support as disinterested and neutral organization the realization of better information facilities within health care environments through ICT solutions with the goal to have more quality and better efficiency in health care. NICTIZ and the Ministry of Health are therefore responsible for the development of a nationwide network for the EMR. NICTIZ is also responsible for determination of standards and basic architecture of other actors.

2. Ministry of Health care, Welfare and Sport (VWS - Ministerie van Volksgezondheid, Welzijn en Sport): Ministry of Health care, Welfare and Sport is within the Dutch government responsible for developing policy in the fields of health care, social care and sports. The ministry is involved in the process of developing a Dutch EMR system as an initiator and director. In addition, the ministry is responsible for the legislation that makes the EMR possible. Finally, the ministry is to fund the development of EMR, and make policy that enforces other parties to fund the EMR.

3. Ministry of Economic Affairs (EZ - Ministerie van Economische Zaken): Ministry of Economic Affairs strives to achieve a prosperous and sustainable Dutch healthcare as a part of an open national economy. For achieving this goal, the ministry focuses on the following key policy areas: knowledge economy and innovation, competition and dynamic and room to do business. The development of the EMR system has therefore the attention of the ministry of economic affairs.

4. Government’s advice council in health care (RVZ - Raad voor de Volksgezondheid & Zorg): As the government’s advice council in health care, this council advises the Ministry of Health Care, Welfare and Sport. This organization came up with the advice for the EMR.

5. Dutch Data Protection Authority (CBP - College bescherming persoonsgegevens): The Dutch Data Protection Authority supervises the fair use and security of personal data, to ensure privacy. From this goal, the authority makes recommendations regarding change of legislation that is needed for implementing EMR. When an actor does not apply the legislation correctly, it has the authority of intervention.

6.2 National Switching Level

1. The society of health care IT suppliers (OIZ - Vereniging van organisaties voor ICT in de Zorg): The society of health care IT suppliers was founded to make standards for IT in health care to make the individual diverse systems compatible with each other. Important is that most, but not all, EMR suppliers are taking part in this organization. The society can only speak for the ones that do participate and these suppliers are in favor for implementation of the EMR at this moment.

2. IT suppliers: When a system fulfils the demands of GBZ, a supplier can apply for the XIS-qualification. If the qualification is given, the system can be used
within the EMR. The qualification process for a system takes about six weeks.

3. Data communication network suppliers: When a system fulfills the demands of EDP-audit, a supplier can apply for the Health Care Supplier – or ZSP-qualification. If the qualification is given, the system can be used within the EMR. The qualification process for a system takes about six weeks.

6.3 Local Level

1. Health care insurers of the Netherlands (VAN - Verbond van Verzekeraars): VAN stands up for the interests of the Dutch insurance companies. It makes sure that there is an optimal situation in the Netherlands for these companies to operate. VAN wants the implementation of the EMR rather sooner than later because in their opinion, the EMR is essential for safer health care.

2. The College of Health care Insurers (CVZ – College voor zorgverzekeringen): CVZ coordinates and finances the implementation of certain laws and procedures regarding the health care costs. It makes sure that every person in the Netherlands has access to an affordable insurance with all the necessary subjects. Civilians stand central in its mission.

3. Inspection for health care (IGZ – Inspectie voor de gezondheidszorg): IGZ tries to improve the health of the nation by controlling the quality of health care and medical products. This independent organization delivers science-based advice to government independent of the political situation. IGZ has the possibility to act when there is a wrong use of the EMR.

4. Science and Research organizations: Universities and research organizations play a role in the implementation process of the EMR system with the research they carry out (for the actors). Also in a later stage when the EMR system is operational, they could use information from the system to conduct research to develop better treatments and medicines.

5. Dutch Standardization associations (NEN – Nederlands Normalisatie instituut): For the EMR system to work properly, there are standards of communication and data storage needed. NICTIZ is responsible for the determination of standards in collaboration with other actors. After a standard is determined, the NEN publishes them, so the knowledge can be transferred.

6. General Practitioners
   - National general practitioners association (LHV)
   - Dutch general practitioners society (NHG)

7. Medical Specialists
   - Order of Medical Specialist (OMS)

8. Health Care Organizations
   - Dutch association of hospitals (NVZ)
   - Association of academic hospitals (VAZ)
   - Association of GP practice of the Netherlands (VHN)

9. Pharmacy
   - Royal Dutch Pharmacy Association (KNMP)

10. Other associations
    - Dutch association of ambulances (AZN)
    - Netherlands Centre for Excellence in Nursing (LEVV)
    - Dutch homecare association (LVT)
    - Royal Dutch Society for Physical Therapy (KNGF)
    - Dutch dentists association (NMT)
    - Dutch association of disabled (VGN)

    This account and overview of different actors and stakeholders in the Dutch EMR project clearly manifest the extent and the breath of the project on one hand, and the possible social and technical challenges it may pose on the other hand.

7. Main Challenges of the EMR Project

The multi-actors environment around the Dutch EMR project creates challenges. After talking to different representatives and actors, the following list of six challenges has been emerged. Although a literature study proved this list adequate, it is still rather a partial as a more complete list would require a profound survey of all actors and use of adequate techniques to prioritize them. For example, in [18], the authors address similar issues for the Dutch Electronic Child Records from ethical and non-ethical perspectives. In the list below, we rather mention categories of challenges then a specific challenge.

Privacy issues: One of the most vital challenges of the Dutch EMR system at this moment is the privacy issue involved with the implementation [14, 15]. Many different actors will have access to the patient’s record. How can it be made certain that this information does not come out openly? This concern alone caused the failure of the planned EMR implementation at the end of 2008.

Legal issues: The system has to be fitted in the current rules and laws and where not possible, new rules and laws have to be created. These rules and laws will have influence on all the actors. This might cause resistance from some of the actors [14].
The primary objective of socio-technical systems design is to ensure that both technical and human factors are given equal weight in the design process [20]. The social and technical aspects of the Dutch EMR will be discussed next.

**Social dimension:** In practice, parties are frequently not on the same line when it comes to the subject of problem perception. Each of the actors described above has its own goal and ideas regarding the desired situation. This has to be taken into account when working towards the implementation of the Dutch EMR. The awareness must be that there is not simply one objective of how the implemented EMR will become a success, but there can be several problem perceptions besides each other, which can all be correct. Only a few papers offered descriptions of the structure of EMRs or the terminologies used. This alone means that the actors do not share the same view of the concept of EMRs. Some of these views can live together while others are conflicting. As [21] states:

“…some groups of users might have a political agenda embedded in the new system—insight in the working patterns of other groups, for example, or access to another group’s information resources. Such agenda’s might lead to open conflict with other groups, thus leading to non-use of the system.”

**Technical dimension:** Working towards the implementation of EMR required on the one hand a social solution as different actors have divergent interest and goals. At the other hand a technological solution is needed, which has a normative perception and is tended to be seen by many actors as the main problem solving solution. Anderson [15] admits this and states that a barrier of EMRs is the complexity of clinical IT applications. The technology itself is already very complex. Consisting of a host of interrelated hardware components and thousands or millions of lines of code, its behavior never becomes fully transparent [21]. In addition, [5] state that the concept of EMR is comprised of a wide range of information systems, from files compiled in a single department to longitudinal collections of patient data. In order for the full benefits of EMR adoption to be realized, a comprehensive health information technology network is needed to facilitate the efficient exchange of information between individual EMR systems. Without such a foundation, significant barriers will exist to health information following patients as they access care and health providers who adopt EMR will not be able to leverage many of the potential benefits of adoption [21].
To make a distinction between a problem which has mainly a technological complex nature or a social complexity or both, authors in [22] have created a framework (Figure 2) in which these problems can be compared to each other. This framework shows that an ill-structured problem can be created by uncertainty regarding the technological and/or social dimension of the problem.

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Figure 2: Dimensions of complexity [22]

A simple problem (1) is a problem with no social or technological uncertainty. Untamed technological problems (2) are problems in which all the actors share the opinion that that these are problems, but there is not yet a technological solution for them. Untamed managerial problems (3) have no technological complexity but do cause a lot of social resistance. Untamed problems (4) share both technological and social uncertainty.

9. How to Handle the Dimensions of Complexity of the Dutch EMR

Before designing a new system that can overcome the complexities, the designer has to consider both the technical and social perspectives. In [19], the authors have created a framework where the seven points of consideration of both what they call the systems (technical) and the actor (social) perspective are defined. This is presented in Figure 3.

It is not intended to present a detail description of how to handle each of the challenges of the Dutch EMR since that is beyond the scope of this paper. It is rather attempted to define the both dimensions and how to work with them.

The main dissimilarity between these two perspectives is that the systems perspective treats it subjects as “mechanical” beings, while the actor perspective treats it subjects as reflective actors [19]. When designing the technical system (systems perspective), the designer has to take the functional requirements, the objectives and the constraints from a fixed set of requirements, which the system must fulfill into account. There is a major difference between technical perspective and the actor perspective (social perspective) mainly on the fact that actors are reflective and will display strategic behavior. The designer has to consider the hierarchical interventions since ‘command and control’ will be impossible in a multi-actor environment. Other factors that have to be taken into account in this perspective are how to manage such a process, how to involve the main actors, how to get commitment to both the process and the results of the process, how to discourage them from leaving the process when they are not completely satisfied. One might call this a process design: a design of rules of the game that prescribe how the actors involved will make their decisions in both the analysis of a problem and the required interventions [23]. So, in addition to the substantive design that is needed from a system perspective, there is process design to facilitate the interaction between the actors with their different interests.

The challenges facing the implementation of EMR cannot be handled without knowledge of both the technical and the social system. Accordingly, an approach that can deal with both systems must be sought instead of leaving the hard technical systems to the engineering experts and the social systems to the social experts. These two separate groups of experts will come up with separate solutions, each contradictory to the other and impossible to implement fully next to each other. For example, the optimal solution for the IT system of the Dutch EMR can result in much resistance from the doctors as they can experience this as a violation in their immunity because the IT system needs data that could assault their core values.

However, integration of these standpoints is, in principle, impossible since the main difference between systems and actors is that actors are reflective. Actors can learn and show strategic behavior in contrast to systems. The risk in this case is that the actor perspective will be forced into the rigid framework of systems thinking, in which there is little opportunity for reflectivity on the part of the actors. A good example is a solution where the doctors are forced to use an IT system that cannot offer the complete scope of requirements that the doctors would need. Since they are forced to use the EMR system, they are forced into the rigid specifications of the IT system. On the other hand, the actor perspective offers a framework, which is not accurate enough to allow a full description of the systems. For example the requirements of the doctors for such a system can be too vague for the developers of the IT system to design or even impossible to realize with the current resources available.
10. Conclusion

As the Dutch EMR system has proven, an EMR system is a complex socio-technical phenomenon within a multi-actors environment with significant societal impact. This socio-technical system cannot be solved without taking simultaneously the social and technical dimension of the system into account. Where the technical dimension focuses on the optimization of the IT system, the social dimension strives for an optimal system to ensure that the actors are satisfied with the result.

Optimizing just one system on its own will not lead to a success. A systems approach is one that focuses on the system as a whole, particularly when making value judgment (what is required), and design decisions (what is feasible) [24]. However, it remains an illusion that both systems can be integrated entirely since the main difference between the social and technical dimension is that in the social dimension the units, called actors, are reflective. Actors learn and show strategic behavior in contrast to the technical dimension. The risk is that either the actors are forced into the rigid framework of the technical dimension or that the technical dimension can’t work as needed because the actors framework is not accurate enough to allow full description of the technique. Actor perspectives and technical perspectives are competing perspectives, which must be used alongside each other. Using both perspectives alongside each other means that complex socio-technical systems need to be designed by systems engineering designers who are able to switch perspectives continuously, and are able to apply both perspectives in a fruitful manner [19].

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Figure 3: Seven technical and social perspectives [19]
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