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Digital Sociotechnical System Design

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> No society can provide its members with a high quality of life unless it has effective organizations.
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Digital Sociotechnical System Design

Digital platforms increasingly are dictating how work is carried out, breaking down boundaries between companies, geographies, customers, and other stakeholders and participants, and determining who will benefit from advancing technology. Existing organization design frameworks do not adequately address the new reality where both the technical and social elements of the full ecosystem need to be designed. Work is no longer carried out within a bounded organization, and individual organizations can no longer be the focus of design. Building on both the traditional sociotechnical systems framework and strategic organization design frameworks, we propose a digital sociotechnical systems design approach. It involves multiple stakeholders and participants in codesigning the digital system and the social system at the ecosystem level. A case example from healthcare is described and discussed.

Digital Sociotechnical System Design: The Context

The steady advance of digital technology that has enabled global connection across populations and organizations has catalyzed fundamental change in societal norms, behaviors, and expectations, and in work systems and how organizations operate. Organization designs and the processes for designing organizations are also changing to reflect continuous advances in technology, the boundary-less world that has resulted, and the associated fundamental changes in expectations of organizational stakeholders. Because social systems are not evolving as fast as technology and business models, an updated sociotechnical approach to organization design is required to address the resulting gap between the technical and human elements of digitally enabled organization.

Sociotechnical Systems Design (STS) was introduced in the era of electro-mechanical technology. It had two major tenets: (1) Organizations are open systems that are dependent on the environment for inputs, knowledge and revenue. They are impacted by, learn from, and deliver value to stakeholders in a changing environment. (2) Organizations are more effective if they are designed for the joint optimization of the technical system and the social system (Emery & Trist, 1978). After describing the theoretical basis for taking a sociotechnical approach to design, a case example from healthcare will be used to exemplify the application and update of these two STS tenets in a context where strategy, business models, and the delivery of value to stakeholders is increasingly dependent on the effective application of digital technology.

The internet cuts across boundaries and connects interest groups and work systems around the world, and the cloud has become an accessible repository of data and digitized tools that enable information processing on an unprecedented scale, and in a manner that is independent of space and time. Impacts on organization designs include: horizontal organization and industry models characterized by virtual relationships to and among customers; partnerships along the value stream; outsourcing; the increasing use of contract and transaction based relationships that are increasingly replacing loyalty and commitment-based relationships; and the building of work systems that include robotics, artificial intelligence (AI), and machine learning that often shift work to robots and to customers. Routine work is increasingly being carried out by machines. The emergence of AI and big data approaches means that much of what we consider to be non-routine knowledge work is not far behind (Davenport & Kirby, 2016). Exponential technology advances pose great challenges to traditional forms of organization that have not been designed to take advantage of this fourth generation technology. The technical in the sociotechnical equation has changed fundamentally in scope and impact on social organization, driving new ways of organizing, working together and meeting human needs, *or not*. It is in this context that organizational design approaches that simultaneously address the technical and social elements of organization design are needed to ensure that human beings are the masters of technology, not its slaves (Zuboff, 1988).

Pervasive and powerful internet-enabled digital platforms, such as those employed by Uber and other gig-based businesses, by Amazon as it relentlessly pursues complements to its original e-commerce platform, and by Facebook as it grows its power and role in connecting people, information, advertisers, employers and customers, have given an inordinate amount of power and influence to the companies that develop and control these platforms. Digital platforms have fundamentally changed the relationship between companies and with customers, empowering customers to quickly and conveniently get their needs met, and in effect bringing them into the work system through self-service approaches in which customers carry out the tasks once carried out by employees. Customers are often required to connect with and learn to navigate companies' digital platforms. In so doing they provide the data necessary for the company to provide service effectively, and knowingly or unknowingly contribute to large databases that enable the organization to improve services and products, reduce costs and optimize revenue, target customer segments, gain competitive advantage, and generate significant wealth for owners. Customers often provide input into ("free" help with) product design, and provide feedback about employees and the customer experience that may determine employee performance ratings and even incentives. The organizational design implications of these changes that blur the organization-customer boundary are just beginning to be systematically investigated and critically examined (e.g., Gazzaley & Rosen, 2016; Medeiros-Ward, Watson, & Strayer, 2015).

Digital platforms have become major enablers of the communication, coordination and knowledge generation underpinning economic transactions and work systems. They are co-evolving with the strategies, business models, and designs of organizations and work systems, and with the changing nature of economies and societies (Teece & Linden, 2016. The scope for relevant technical and market optimization, integration and design now extends well beyond company boundaries to include industry and cross-industry ecosystems, and both digital and human agents (Snow, Fjeldstad, & Langer, 2017). Work is often carried out by "smart" teams with members cutting across organizations, sectors, and geographic boundaries. Technology provides these teams with unprecedented access to data, information, analyses and learning that provide the foundation for coordinated and complementary activity. In effect, the capabilities inherent in the digital platforms are integral to significantly increased collective intelligence (Hutchins, 1991; Wegner, 1987). Meanwhile, work relationships are increasingly transactional, contractual, temporary, and virtual. An organization's small core of mission critical employees and many contractors, partners and outsourcers, digital agents, and even customers carry out tasks and roles defined by the ecosystem wide work network that is defined and controlled through various connections to an IT platform (Weber, 2017

In short, work systems have become complex, technologically enabled networked ecosystems that extend beyond an organization and its employees, and are geographically dispersed. How these ecosystems operate has fundamental implications for the sustainability of its actors, and the health of society. The design process has to take into account the interests of multiple stakeholders—no longer confined to shareholders, managers and employees. In this context, organization designers have to expand focus from bounded organizations to the design of ecosystems (Mohrman & Winby, 2018). Given the rapid pace of technological advances and the fundamental disruption that is occurring in many industries, organization redesigns will no longer be one-time events. There will be a need to continuously evolve the technical and social design as technical changes enable new business models and ways of doing work that present market challenges and opportunities.

Over the past several decades, strategy driven organization design frameworks such as Galbraith's star model have become prominent and the design of work systems has largely become the purview of the engineering function (Pasmore, Winby, Mohrman & Vanasse, in press). In the era of rapidly evolving advanced digital technology, simultaneously addressing human purposes and technological capabilities is a business necessity for achieving sustainable business effectiveness. We return to and update Sociotechnical Systems Theory (STS) (Emery & Trist, 1978; Pasmore, 1988), the framework introduced more than 50 years ago that introduced the then novel idea that work systems are more effective if they are designed to address the requirements of the technology and of the workers. We propose a preliminary framework, digital sociotechnical system design, to guide the design of organization and work systems in this changed context, and we provide a case example from the healthcare sector.

Digital Sociotechnical System Design: A conceptual overview

Digital sociotechnical design combines perspectives, tools and methodologies from two important organization and work system design frameworks. The STS literature has focused on creating a fit between the social and technical elements of an organization. Strategy-driven design frameworks such as Galbraith's Star Model of Organization Design (Galbraith, 1973) stress that design is driven by the notion of fit of the structures and processes of the organization with the organization's strategy. These approaches will be briefly described, along with their extension and synthesis into a framework for digital sociotechnical system design (DSTS).

Sociotechnical Systems Design

STS design processes were first developed during the pre-internet era, when the relevant electro-mechanical technology enabled linear processes to transform physical inputs into product and service outputs. Face-to-face and analogue communication technology enabled communication among organizational members and with suppliers and customers. STS theory and design approaches were introduced at a period of time when worker safety and security were being threatened by the introduction of engineering developed technologies that were viewed by workers as not taking their knowledge, perspective and needs into account (Pasmore et al, in press). While viewing organizations as open systems that are dependent on the environment for inputs and knowledge and revenue, STS design emphasized the joint optimization of the technical and social systems. The goal was not only to have a company that is financially successful, but also that provides meaningful work, growth and development and positive outcomes for workers. The core of the design methodology is the analysis of the technical system to identify variances where the system does not perform as intended, and of the social system to ensure that it is designed for variance control, high performance, and positive employee outcomes. The STS approach combines industrial engineering concepts, the social sciences of human behavior, and the values of participation, development, meaning, and high performance. STS approaches often included the flattening of the organization in order to decentralize decision-making and to provide employees with meaningful work, the identification of teams of front line employees who self-manage, and the development of multi-skilled employees who are able to carry out more job tasks.

A simplified view of the stages of the classic STS framework as described by Pasmore (1988) is shown in Figure 1. It begins with an understanding of scope and context, and the generation of the organization's vision and criteria for effectiveness. Based on this foundation, it proceeds to a social and technical analysis that provides the basis for the development and iteration of design options. STS design is highly participative, seeking input, understanding and commitment by employees and leaders to operate in a changed manner.

Insert Figure 1 here.

The original focus of STS was the design of organization units such as factories and other production units characterized by linear work processes that transform inputs into outputs. As knowledge work became a larger and more critical element of organizations' value streams and a competitive differentiator, STS designers and scholars generated concepts and approaches to fit with non-linear, interdependent knowledge work processes. Such work is often carried out by teams of employees with multiple deep specialties and involves cross-functional and cross level interactions and deliberations (Pava, 1986).

Strategy Driven Design

A strategy driven view of organization design also emerged in the 1970's. It is exemplified by Galbraith's systems model, often referred to as the "star model of design" (see Figure 2) in which the elements of an organization's system are designed to be mutually supportive of the accomplishment of the business strategy (Galbraith, 1977). Based on a cybernetic conceptualization of the organization as a communication system, it too had to deal with the nonlinearity of work within and between units, and the resulting interdependencies and feedback loops. Galbraith posited that such complexity often cannot be handled through hierarchical structure and work processes within the vertical chains of the organization. Designs have to enable cross-functional and cross-unit integration and lateral decision-making capability lower in the organization through approaches such as the creation of cross-cutting teams or by breaking the organization into self-contained multi-functional business units that deliver value to subsets of customer sets and markets (Galbraith, 1994; 2005).

Insert Figure 2 about here.

Building on both the STS framework and on strategy driven systems models, designers began to create frameworks to design organizations as systems of teams and networks for carrying out non-linear work processes (e.g., Mohrman, Cohen, & Mohrman; 1995). Tasks such as new product development and commercialization, solutions generation, technology design, and service delivery are examples of work that is often not neatly handled within the boundaries of organizational units. Organization design process frameworks emerged that include the analysis of strategy, critical capabilities and work processes of the organizations, and the design of a system including both core units and lateral approaches to deliver the value that achieves the organization's strategy.

Handling Complexity with Digitally Enabled Design Solutions

Digital design solutions utilize digital technology platforms and applications to carry out and enable work that previously required physical systems combined with human activity and information processing for direction, coordination and integration. Digital solutions have been the major enabler of the capability to deal with increased complexity as organizations have grown in size, scope, geographic dispersion. Organization designs have built on digital technologies to connect people and knowledge and serve as information platforms to carry out key processes multi-directionally across the organization. Powerful communication capabilities such as telepresence and audio and video conferencing have enabled virtual work and global, networked organization designs. Organization structures can now be independent of geographic location and work is often carried out across boundaries by cross-cutting networks that include both human and digital actors rather than in self-contained hierarchical units.

Through technology, participants lower in the organization have ready access to needed information and analyses, and can access the variety of skills and knowledge required to effectively carry out and manage aspects of the business. Knowledge and work sharing platforms have provided the potential for people to easily coordinate their work and learn from one another, without hierarchical direction. As standardized, increasingly digitalized and even robotically enacted work processes have become the foundation for work systems, digital platforms that build in large data modelling and artificial intelligence are increasingly autonomously performing the functions of coordination, information processing, and decision making. The capabilities built into the software enhance speed, efficiency, reliability, and improvement of cross-cutting work processes. At the same time, the needed protocols, standard processes and infrastructures that enable the digital organization to operate effectively (Snow et al., 2017) may constrain the capacity of human participants to use judgment, innovate, and take initiative (Davenport & Kirby, 2016).

Concern about the impacts of this increasingly technology driven economy has given rise to a sense that the "socio" part of organizational systems are not being fully addressed. "24/7" capabilities of digital systems have sped up work and capacity for quick response to customers, but have greatly impacted employee lives by creating "always on, never off" pressures amid the relentless race to address customer expectations. The tight technical interdependence across complex organizations means that errors in one location may cause service disruptions, delays and even shut-downs in others (Kerstetter, 2017). The capacity of people to deal with technical and organizational complexity and find meaning and satisfaction working in these systems lags the capacity of organizations to create digitally enabled work systems that technically should work -- if only humans can be trained to understand, embrace and be able to operate effectively and thrive within them (Scheiber, 2017.)

Inter-organizational partnerships, synergistic business models, and the increasing use of contractors have been enabled by these same new technologies. There has been a great deal of research and consulting attention to cross-boundary linkages, and to partnerships that have become a key strategic tool for many organizations. This research points to the key role of trust in enabling a solid foundation for cross-organizational collaboration (Powell, 1990). Yet companies often take a company centric approach to design these relationships for their own instrumental purposes, focusing on the technical and contractual elements of the collaboration and not on assuring multiple stakeholder outcomes. Until recently, most organization design frameworks have continued to focus on individual organizations and units, assuming that competitive advantage stems from the resources and capabilities of single organizations including how it strategically chooses to link to other organizations to further its own interests. Our organization design frameworks need to be updated to include the full range of stakeholder interdependencies and impacts.

Two realities make a company-centric view of design inadequate today, and call for expansion in the scope of our design paradigms. The first is the advances in digitization that have led to powerful digital platforms that cut across organizations. These platforms result in the creation of ecosystems: interdependent networks of actors working to achieve their purposes individually, competitively, and through synergy with one another (Axelrod & Cohen, 1999; Holland, 2014). Companies that develop and manage these platforms are realizing that their success depends on choreographed activities across the ecosystem, and on the value that accrues to the members of the ecosystem who now have to relate to each other in quite different ways. Each actor's success depends on the success of the ecosystem, and on the inclinations of others in the ecosystem to behave in ways that support the ecosystem level strategy. The ecosystem has become the locus of economic activity and needs to be the focus of design.

Second, issues of sustainability and the requirement to be successful in an environment of scarce resources has heightened organizations' understanding of their interdependence and of the benefits that stem from achieving synergy and leverage that creates shared value with their stakeholders (Mohrman & Winby, 2018, in press; Porter & Kramer, 2011). The same digital capabilities that allow companies to derive immense economic value from linking together many actors have enabled a power shift to other stakeholders who now have ready access to information. They can bring immediate and often global attention to situations where companies are disadvantaging legitimate stakeholders, not delivering on their public pronouncements, and working at cross purposes with a sustainable future, human rights, national security, and core espoused values such as transparency, equity, privacy.

Achieving relevance in the ecosystem requires design processes that take into account the legitimate purposes and interests of others in the ecosystem with whom a particular organization is interdependent. Taking an ecosystem perspective also highlights the need to consider the legitimate rights of many stakeholders in designing how industries, societies and economies operate.

We use the term digital sociotechnical systems design (DSTS) to refer to an open system approach to design that embraces and addresses the need to understand and deal with the complexity of digitally enabled work systems, acknowledging diverse interests and enabling interaction of technology, individuals, organizations and the actors in the larger ecosystem. In the remainder of this article we use a case example from healthcare to take a step toward understanding DSTS at the ecosystem level. The process we describe emphasizes two elements of this approach to design: (1) integration of the design of digital technology and the social system at the ecosystem level, and (2) multi-stakeholder participation.

Digital Sociotechnical Systems Design: A Healthcare Case Example

The Healthcare Context

Many have come to believe that healthcare requires fundamental reconfiguration in order to right itself and carry out its mission in society and the economy (Christensen, Grossman, & Hwang, 2009; Cosgrove, 2011; Porter, 2009; 2010). Demographics, technological advances, increasing costs of medication, and environmental and lifestyle induced health trends all point to a situation where demand will exceed available resources. Costs of healthcare as currently provided will exceed society's capacity to meet the population's needs. One trend in health care is to invest in capabilities that will help sustain the system through a shift from provider-focused fee-for-service to stakeholder-focused fee-for-value. Value-based healthcare is sometimes referred to as the triple aim (Berwick, Nolan, & Whittington, 2008), as it seeks to optimize three dimensions of health system performance: reducing per capita cost, improving clinical outcomes, and improving the patient experience of care. Applying digital technology is expected to create greater efficiency and integration of care, and to fundamentally change both the role of individuals in their own healthcare and the focus and modalities of care (e.g., Topol, 2015). Healthcare is thus a good place to start to identify the elements of DSTS.

The healthcare industry has been characterized by many interdependent departments, organizations, services, and products, each operating with its own logic and technology to carry out its own part in the healthcare ecosystem. In the past decades it has become clear that the sub-optimization that results from this approach is costly and ineffective, and increasingly unsustainable. Many changes are being introduced to increase the integration of the healthcare system, which by definition requires integration across an ecosystem. Underlying these approaches are powerful IT applications that connect clinical and business information, and provide integrated patient information and coordinated care. These applications also enable measurement, feedback, and resource allocation at the level of organizations, groups, and individual patients and providers of care. They also provide aggregated data that enables ecosystem wide learning.

Digitization is enabling a gradual change from the historical operating model that was based on the premise that patients go to doctors' offices, clinics, and hospitals to receivev healthcare, and is emphasizing patients' roles in their own healthcare. These facilities have typically been designed as efficient and convenient work systems for the employees and professionals of the healthcare system, but not for the patient. Digitization enables the provision of tools for self-care and for connecting homecare with healthcare providers and venues. Office and clinic visits are slowly being replaced by home monitors and digital information flows that allow patients to self-administer treatment with clinical patterns being digitally monitored by healthcare professionals who identify variations that require intervention. This transition evokes the next generation of sociotechnical design: one that expands the venues and work system elements that are being designed, crosses organizational boundaries, involves many different stakeholders, and designs technology and organizing approaches interactively.

Satellite Healthcare's Redesign for Kidney Dialysis Homecare

Satellite Healthcare is a not-for-profit kidney dialysis provider that operates 83 dialysis centers with 2,000 employees who treat more than 7,000 patients in six U.S. states. Its value-based transformation process relies heavily on designing and incorporating advanced digital technology to integrate and coordinate across the care ecosystem. The redesign of Satellite Healthcare's home dialysis system provides an empirical example of multiple constituency DSTS and a preliminary framework for such a design approach.

Dialysis is a process for removing waste and excess water from the blood and is used primarily to replace lost kidney function. Dialysis patients move along a life- cycle that may lead to kidney transplant that will remove the need for dialysis, and/or through gradual decline, ultimately leading to loss of life. Dialysis previously occurred exclusively in medical centers and specialized clinics but for many patients it can now be carried out effectively at home. Home dialysis cannot be a stand-alone capability, but rather exists within a complex ecosystem that provides life-cycle care for those with kidney failure. Many patients have multiple co-morbidities and are being treated by multiple specialists. Technology is a necessary enabler, but it has to be designed and utilized as part of an ecosystem that involves many different actors and constituencies.

Background and Context

Norman S. Coplon, MD founded Satellite Healthcare in 1974 to provide personalized dialysis care in centers that are closer to where patients live, and in a friendlier, more comfortable environment than had been afforded in major medical systems and clinics. The philosophy is to focus on the whole person, and the objective is to improve each patient's overall quality of life.

The company has more recently been a front runner in providing the option for home therapy with its WellBound™ centers. In addition to the convenience and independence for patients and their families, home dialysis can be clinically more effective because it can be carried out more flexibly, often with shorter cycles, and nocturnally. This enables closer connection to the patient’s individual physiological cycles rather than at a pre-scheduled time, contributing to wellbeing and to longevity (National Kidney Foundation, 2015).

Training is a fundamental requirement for home dialysis. In the WellBound™ centers, specialty-certified nurses train patients and their families or other care givers to perform dialysis treatments at home, and then ensure ongoing support is provided as needed. Although there is a significant cost to delivering the upfront training, home dialysis is less expensive than regular visits to the center, and the Satellite Healthcare staff are able to provide treatment to a greater number of patients.

The challenge to Satellite Healthcare is that only around 20 percent of its total patients opt for and stay in the program over time. Nationally, 40-50 percent of all home dialysis patients drop out, most in the first months of homecare. The most common reasons are fear of making a mistake, and a desire for more support from nurses and other patients.

Satellite Healthcare knew they needed to design a more effective homecare model with significant changes in how patients are trained, monitored and supported to improve patient engagement, sense of connection to healthcare professionals, and comfort, confidence and ease of self-management of dialysis. In late 2016, the company began "Reimagine Home", a systematic multi-stakeholder, DSTS process to fundamentally redesign the full ecosystem for home dialysis. The sponsor team included the CEO, Chief Medical Officer, COO, and Chief Innovation Officer. The consulting team was multi-functional, including digital designers and organization designers.

The goals of Reimagine Home are:

- Improve the customer experience and increase patient satisfaction
- Develop a digital application that supports deeper patient engagement and connection and better management of their condition
- Increase the number of patients choosing home dialysis and reduce the dropout rate
- Create a new industry standard for dialysis homecare that enhances Satellite Healthcare's industry leadership and serves as a source of competitive differentiation
- Receive a positive ROI from the Reimagine Home initiative in 2018 and beyond

Patients who are self-administering dialysis at home continue to be connected to a Satellite Healthcare dialysis center that monitors their progress and helps them through the spectrum of care. Home patients may periodically come to a center for in-person assessment and treatment, and some may move in and out of the home dialysis modality through time. Thus, the design must include both technical and social linkages to the centers. The design of the centers' roles, structures and workflow will have change to accommodate the redesigned home dialysis system and to address the dynamic life cycle that may move between home and in-center care. To optimize life cycle performance, center managers and care providers were heavily involved in the design of the home dialysis system, and subsequently in the redesign of the centers to integrate homecare into the overall cycle of care.

The Reimagine Home DSTS process heightened the salience of life cycle care to Satellite's strategy, replacing the notion that the organization was providing discrete services. Prior to Reimagine Home, homecare had been serviced by a dedicated staff that was located in the dialysis centers, using the WellBound™ platform. It operated independently of the in-center dialysis operations. The intention was initially to redesign, implement, and initially foster innovation by managing the new digitally enabled homecare system as a second services line, , continuing to keep it organizationally separate from the in-center delivery organization. As the homecare system began to take shape, Satellite Healthcare began to redesign the dialysis center organization for this emerging strategy of integrated life cycle services. The ultimate goal is high performance, life-cycle dialysis centers with an integrated care-delivery model, organization and management system, and digital platform.

We first describe the design and development of the homecare system. Then we will more briefly describe the process being used to redesign the dialysis centers to accommodate it.

Satellite's Digital Sociotechnical Design Approach

Reimagine Home followed a DSTS approach to design a homecare work system that incorporates a digital platform to more effectively meet the needs of the home dialysis patient and others in the work system. Participants included the patients and their care partners, referring physicians who direct patients' overall care, medical device and pharmaceutical companies that deliver the homecare equipment and supplies, and insurance companies that pay for many patients' care. Effective home dialysis programs require social and technical connections among these actors, who have not typically been well coordinated nor mutually reinforcing in meeting patient needs.

A traditional approach to sociotechnical design would focus on optimization of Satellite Healthcare's internal work systems—its processes, technology and employees — to accomplish the technical tasks of delivering high quality care and to set up a social system that allows for meaning, motivation, and development of the workforce. It was clear to the leaders that designing a system to foster and enable self-care would require designing the full ecosystem, not just Satellite Healthcare, around the needs of the patient. This would entail broad participation in the design process. Patients' changing roles had to be more completely enabled, motivated, supported and assured through connections and relationships to all the actors upon whom they rely. Improving the experience of patients and their home support system was the shared purpose of the ecosystem participants, and the primary design criterion guiding the multi-stakeholder design process.

A major focus of the Reimagine Home project was the development of a digital technology application to support the patients' at-home roles and their many ecosystem connections. The vision was that the digital application would work interactively with home dialysis and monitoring equipment, and be aligned with and connect patients, physicians, nurses, vendors, pharmacists, and family members, and other channels of information and communications. The technology, including its connections to the medical dialysis equipment and to Satellite's work system, its use and fit with the patient's immediate context, and its coordination role in the broader ecosystem were jointly designed by the multiple stakeholders, who simultaneously designed the social system in which it would function. This digital sociotechnical approach aims at an aligned ecosystem for a coherent integrated system of home dialysis that creates value for the patient and other stakeholders and extends well beyond the work system of any particular care delivery organization.

The Phases of the Digital Sociotechnical System Design

The design process followed phases that illustrate the increased complexity that has to be addressed in redesigning this value-centered, digitally enabled care delivery system: *research, design, prototype/test, and scale-up.* We briefly describe these phases below.

Research Phase. The consulting team conducted observations and more than 100 structured interviews with patients and their care givers, Satellite Healthcare staff, referring physicians, vendors, family members, social workers, dietitians, pharmacists, and payers. The interviewees came from different states and regions, and included a representative sample of patients and caregivers, and of the staff members and other actors with whom they connected. The purpose was to fully understand the technical processes and the current network connections and interdependencies, the ways in which the needs and expectations of the patients and others in the home care eco-system are being met, and what they would see as ideal to achieve high quality outcomes and patient satisfaction.

The data were coded by the designers for emergent themes and yielded insights about both the social and the technical elements of homecare dialysis. These insights were shared, tested, and iterated with stakeholders during the design phase, becoming the catalysts in the design lab. The critical insights pertained to patient needs, motivations, and behavior as they interacted with the full care delivery system and the technical processes that underpinned it. The interview protocol provided data for three primary analyses to be completed: ecosystem mapping, a touchpoint analysis and a variance analysis.

Mapping the Ecosystem. The ecosystem map is a network diagram of the actors and stakeholders who will be affected by and need to be involved in the changes to the home dialysis process. The basic actors in the ecosystem are: the Satellite Healthcare members who make a care promise to a dialysis patient; the agents, including Satellite Healthcare employees and other provider and supplier organizations who deliver on that promise by providing care and inputs through different channels; and the patient, family and other personal support system members who take on expanded care responsibilities in a home dialysis model. The map serves as a basis for generating new organizing concepts for the ecosystem that will change how actors work together. Figure 3 shows a simplified graphic of the ecosystem that was identified by the participants.

Insert Figure 3 here.

Patient Journey Touchpoint analysis. A life-cycle journey map shown in Figure 4 puts the patient at the center of analysis and adds the care cycle time element. It starts with what the participants identified as “the big D”—the decision whether to embark on home dialysis.

Insert Figure 4 here.

The journey analysis describes every patient homecare dialysis touchpoint event and experience during the cycles and phases of care. For each touchpoint, the following are identified:

- activities the dialysis patients perform
- information they use and share
- people with whom they interact
- care delivery services or products they need
- devices they use and the channels through which they communicate

Variance analysis. Based on the interviews, variances are identified for each touchpoint between what patients feel would be ideal and what they actually experience in the current homecare system. The choice to take a patient centric focus on variance analysis based on customer perceptions of deviations from what would be ideal rather than a variance analysis that focused on technical quality and cost deviations was intentional. Satellite Health's performance data had found near equivalency in quality of home dialysis compared to in-clinic dialysis, but gaps in patient satisfaction that led to patients' discontinuation of self-treatment. Specifically, patients who discontinued dialysis were experiencing fear of making mistakes and the need for social support. This patient centric variance analysis is an input to the multi-stakeholder design process where a system will be designed to eliminate or control variances and meet patient expectations and needs and achieve high quality outcomes. By addressing all the touchpoints in a home dialysis patient's journey, as well as the needs and purposes of the ecosystem stakeholders, a view of the care delivery system is developed in the design phase that can inform simultaneous design of the organizational and inter-organizational system and the technology application that will enable optimal home self-care. Figure 5 shows the variance analysis tool, tracked to the lifecycle stage, that the participants would then use in the Design Phase to confirm and provide a richer understanding of the variances, and to generate design solutions to control them.

Insert Figure 5 here.

Design Phase. Members of the various stakeholders came together in a large group design lab activity to co-design a digitally enabled home dialysis work system to improve the patient experience. The design lab follows a rapid prototyping iterative analysis and design process. Photos, videos, coded transcripts, and visual models and frameworks, specifications and physical prototypes are the outputs. The products from the research phase were inputs to this design phase. Seventy-eight participants brought the full system into the room to design the new homecare social and technical system. The lab included patients, physicians, nurses, center and regional managers, CEO and board chairman, Baxter vendors, family members, pharmacists, and digital application developers. Their ongoing participation allowed for continued surfacing of issues and contribution of knowledge from all eco-system perspectives.

In the lab, cross stakeholder groups (referred to as cottages) redesigned specific touchpoints along the patient journey, in order to control variances that negatively impact patient experience and quality outcomes. The design lab process was iterative. Small groups presented their draft solutions to the larger group for feedback and then returned to their cottages to redesign. Repeated iterations ensured the quality and integrity of the full life-cycle system. Concurrently, in interaction with the stakeholders in the lab, digital application designers created, shared, and got feedback about high level designs for the home dialysis technology solution that would help connect the touchpoints and integrate the full system. Their work informed the cottages, and vice-versa. The process converged on a set of specifications for both the social and technical elements of the work system to ensure that the key variances that had been identified would be controlled.

From this convergence process, it was decided that some variances would be handled through the digital application and others through social connections. A major variance that had been identified was that physicians and their patients often did not go through a systematic process of determining whether dialysis fits the life and health needs of their patients. Physicians would be provided with digital tools that enable them to work with prospective dialysis patients in making that choice. The application provides information to answer many of the questions that the patient and their families might have, and the patient generates information that helps them make their choice. Other variances would be addressed through changes to the social system. For example, the patients in the design lab identified a need to connect to an advocate—a new role that could help them formulate life goals and address the various challenges they encounter as they go about home dialysis. Some of the variances resulted from a lack of consistency in the information and knowledge that the patient experienced when dealing with different members of the ecosystem. The digital application was designed to enable greater consistency, increased cross-functional coordination, and shared knowledge among the various ecosystem members that they encountered. The digital designers were shaping the technology to support the information processing requirements of the emerging roles and teams.

The convergence of the technology and the social system designs were enabled by the common focus on creating a better solution for the patient by eliminating or controlling the variances they had identified. The social-technical optimization created value beyond specifying the design of the digital capability to be used by the newly configured social system. Equally important were the relationships and insights gained through the co-design process, which laid the groundwork of awareness of each others' needs that would be required to operationalize the work system. For example, the Satellite Healthcare staff were exposed first hand to the insecurity that dialysis patients experience when they first try to carry out the procedure at home, without the presence of an experienced medical professional.

Prototype/Test and Learn Phase. The design labs generated the specification of the social and technical solutions to address the variances along the patient journey that had been identified during the research phase. These specifications were the inputs for the prototype phase, during which the detailed design occurs and the digital and social changes to the work system are fashioned into a prototype that is implemented, tested in practice, and iterated. Five centers were chosen to carry out the detailed design of the homecare prototype. In an iterative process, these centers worked together in 30-60-90 day learning cycles to share their experience implementing the solutions. They each operationalized and tested the solutions, and shared what they were learning with each other, and then iterated their prototypes. Through this iterative process, several working models of the Reimagine Home system solution were created and through sharing and learning by experience, the centers converged on a model.

The digital work platform was intended to evolve and enable fast, reconfigurable social arrangements and expansion of capability through time. It was tested and further developed iteratively in interaction with the detailed design and testing of the work system in the five centers. As the social system was changed to work integrally with the technology solution to control the variances, changes were made in each. For example, the new patient advocate role, called a “path-finder”, was tested and iterated to guide the home dialysis patient through the Reimagine Home system—to help the home dialysis patient and support system to learn to effectively use the system, adjust, and make choices as the patient moved through the stages of illness. This role is a key sociotechnical integration feature that orients and supports the patient by using a combination of the technology based support tool and communications device that triggers interpersonal response and intervention. To address patients' felt need for more coordinated care, cross functional care teams were defined to provide the various elements of care, track progress, and detect and respond to medical data and alerts, and to provide the inputs and supplies required by the patient. The technology app had features that integrated and coordinated the work of the team members.

Once the work of the five centers converged on a prototype that dialysis patients and other ecosystem stakeholders felt met the specifications, it was ready for scale.

Scale Phase. The objective of the scale phase is to disseminate the prototype design beyond the units that developed it through the design, test and learn process. The scale challenge depends on size and geographical dispersion, the particular configuration of units and their interdependence with one another, and the diversity of contexts in which the new work system will be implemented. Satellite Healthcare's challenge is to disseminate the homecare design in all 83 dialysis centers. It is currently at this scale-up phase. The prototype has been decomposed into bundles of functionality or capabilities, and cross-cutting functional networks of roles such as center managers, nurses, physicians, or path-finders have been created so roles can be described, supported, trained, and practiced. The other centers will be brought together to learn from the five prototype centers and create implementation approaches to embed the homecare functionalities into their work systems. Representatives of the centers will then get together in 30-60-90 day learning and iteration cycles to learn from each other's experiences. The technology and the social system design will continue to be adjusted and modified as learning occurs during the scale-up process.

The original plan for the homecare work system to be scaled up as soon as it was stabilized in the first five centers was modified based on learning from the prototype development process. Satellite Healthcare's management became increasingly aware that flexibly serving the dialysis needs of patients as they go through stages of their illness requires the capacity to work seamlessly across home and in-center dialysis and not treat them as two different service lines. Satellite Healthcare learned that it could no longer manage homecare dialysis as a separate work system, and began to redesign its centers to incorporate the homecare solution into an integrated care system. The digital technology will be extended to serve as the platform for both modalities of care. The scale up phase for the homecare system has been delayed until the social and technical aspects of the integrated care delivery model are designed. The implementation of the redesigned center operating model will happen in conjunction with the scale up of the homecare system.

Organizational Redesign for the Integrated Operating Model

As the digitally integrated home dialysis prototype was being honed, tested, and adjusted, each element of the ecosystem had to change how it operates to accommodate this new work system in a manner that contributes not only to high ecosystem-level performance in support of patient outcomes, but also to achieve high performance in carrying out its own organizational mission. For Satellite Healthcare, the Reimagine Home design process, putting the patient journey at the center of its focus, raised awareness that accomplishing the Satellite Healthcare mission to deliver life-cycle dialysis care required the capability to manage dynamic and uncertain patient journeys. The digital platform that has been developed to connect multiple members of the ecosystem for homecare will now have to do the same for in-center care as well. During the development and prototyping phases, Satellite Healthcare was managing home dialysis as its own unit, in order to give it flexibility to innovate to optimize the ecosystem work system. Based on their learning, the new strategy and design focus is now to redesign its organization to integrate the redesigned homecare and center-based care work systems. It is currently designing toward a future state in which the centers manage integrated, life-cycle care. The Reimagine Home design is not being abandoned, but rather, is becoming part of an integrated operating model.

The corporate organization and its center operating organization are being redesigned, addressing the elements of Galbraith strategic design star model shown earlier. The executive team has been restructured for integrated life-cycle care, and to lead the ongoing evolution of its capabilities. An integrated field operations team is responsible for overall operations, and for leading the design and implementation of the integrated care delivery system. A patient experience function will ensure ongoing attention to the home and center based patient experience. An incubation center will oversee the ongoing evolution of the development of the digital work system and ecosystem, and of other related innovations beyond dialysis care that may be required for full-life cycle care.

A design team has defined the goals and metrics for the centers and a tracking and reporting system is being developed, implemented, and tested so that the cross-functional leadership teams in each center will receive regular performance data. Structurally, the centers are shifting to digitally-supported smart cross functional teams with accountability for the life cycle care of a set of patients. This has entailed further development of Satellite's digital platform to support this new strategy, and the organization approaches that are being developed to fit the strategy and take advantage of new digital capabilities. A team based reward system has been developed. Members have been trained to work in teams, and center managers are being trained to lead and manage an integrated team of teams. The teams are being designed as adaptive work systems, learning the "build – measure – learn" model of managing their own performance. The five pilot centers continue to learn from their own and each other's implementations and through the first 90 days they have begun to converge on the prototype for the integrated center work system that will then be disseminated throughout Satellite Healthcare using a 30-60-90-day learning and implementation approach.

Figure 6 summarizes how the design process unfolded, in planned and unplanned ways. During the Reimagine Home design period, homecare capabilities were developed through an ecosystem-wide DSTS design process that generated the specifications for the digitally supported work processes and the digital technology. The detailed design of the prototype for the new homecare system was developed and tested in five centers, working with the digital designers to embody the specifications in the application and in actual practice, learning from each other, and refining their approaches through a 30-60-90-day iterative learning process. Cross-functional sub-teams cutting across the organization developed the associated new organizational approaches to training, orientation, patient support and responsiveness. Additional digital functionalities and training are being designed as learning occurs, and to support the integration of home and in-center care.

Insert Figure 6 here.

The DSTS design process triggered the understanding that homecare could not be partitioned off from full life-cycle care. This learning led to the need for strategic redesign, including of both the social organization and the digital capabilities for integration, of Satellite's organizational system at two levels. The corporate structure has been modified. The five pilot centers are now being redesigned to incorporate the homecare capability into an overall center operating model that delivers effectively and efficiently on their full mission to provide care to both home and in-center dialysis patients. These will be scaled up as an integrated system rather than focusing first on implementing the new homecare prototype and then changing the full center operating model.

This expansion of focus has required additional social and technical design features, including changing the work flow and role structure for in-center care, adding new digital functionality, expanding the role of the smart teams, and developing new team leadership capabilities. All aspects of Galbraith's star model are being examined. The goal is for smart teams (which include patients as key actors) to manage the patients' clinical outcomes and experience through shared ongoing clinical and operational data that enables operational and clinical effectiveness, enables early detection of issues and solving problems through quick responsiveness, and through machine and team learning. Satellite Healthcare's iterative series of design, implementation, and learning activities builds on the fundamental premise that the digital platform will enable work system communication and coordination across the ecosystem, and that the social system and digital platform must be co-designed.

Conclusion: Sociotechnical Design for the Digital Era

Although based on the premise that the organization is an open system, the unit of analysis in traditional organizational and sociotechnical design has typically been a bounded segment of an organization or the organization as a whole. The stakeholders whose perspectives have been taken into account have been the company and its employees as they together designed a system to deliver valued products and services to customers. At Satellite Health, taking a sociotechnical design approach has enabled the development of the operating effectiveness of the full network of actors in the eco-system, and most important has built both digital and interpersonal interfaces in the network to enable effective patient self-care. In the digitally enabled economy, both the focus and the scope of design involvement must shift to acknowledge that work systems are now heavily embedded in complex, interdependent ecosystems—ecosystems where the customer is part of the work system. Digital platforms are shaping many aspects of human behavior, coordinating and controlling interdependencies across the ecosystem, and to a great extent have become the arbiters of the purposes that are achieved and of who will benefit. DSTS approaches bring stakeholder perspectives and needs to bear on the design of these platforms and the work systems they support.

The approach described in the Satellite Healthcare case fits a changing world where digital technology has broken down boundaries between organizations, customers, and other stakeholders and participants in the ecosystem. Dynamic DSTS provides leaders with an approach to deliver greater value to stakeholders by changing the relationships in the ecosystem and expanding participation in designing the digital platforms and work systems to acknowledge the high levels of interdependence of roles and outcomes. Table 1 illustrates the migration from traditional STS design to today's DSTS design, and shows the changes that are entailed in this migration.

Insert Table 1 here.

The challenge is to design for the functionality, efficiency and effectiveness of such digital platform based work systems, in a way that ensures that value is delivered to ecosystem stakeholders and that they have voice in shaping the environments in which they will exist. In healthcare, for example, the roles of patients, doctors, and other ecosystem members is changing rapidly, often as a result of digital platforms that are designed without their input. The unit of analysis for work system and organization design must become the entire ecosystem. The process is one of co-design by multiple stakeholders, and the focus is on delivering shared value. Only in that way is it possible to design based on an accurate representation of the functionality needed in the ecosystem, the purposes of its participants, and the requirements and outcomes for all the parts of the system. In Satellite Healthcare, integrative design was enabled through a process that focused all stakeholders on the interests and outcomes of the patient, as they worked together to design the digital application and the social system in which it would operate.

Digital technology is advancing so quickly and with such broad reach that DSTS design has to be an ongoing iterative learning process, as characterized in the case by the process of co-design, 30-60-90 day iterative prototyping cycles, the continual exchange of information across ecosystem participants to identify areas of improvement, and the ongoing identification of useful digital functionalities to be introduced into the ecosystem. Learning occurs both in the social system and in the digital system (ultimately through machine learning), leading to continual adjustments in the ecosystem design, and in the design of each of its participant's organizational and personal sub-systems. This was evident in Satellite Healthcare's learning from the implementation of the homecare system in the five prototype centers that the real power of digital technology is to enable life-cycle care through the integration of home and in-center care.

Technology advances will accelerate in the coming decades. If we are not to become "slaves to" technology, we will have to find ways to fit it with our human purposes. DSTS design and learning will have to become an ongoing capability throughout the ecosystem. Designs will be seen as temporary, or even fleeting way-stations on the journey. Pulling together stakeholders to reconfigure the sociotechnical system will become a routine part of maintaining industry leadership.

For designers, DSTS has clear implications. The four stage process used in Satellite Healthcare requires the orchestration of a large set of stakeholders while they make trade-offs and design a system that requires changes in the behavior and stake of each. The intervention team is constituted of several specialties, including those who are designing technology to fit with the work system that is evolving, organization designers who are helping adjust the organizational and inter-organizational features to support the new digitally enabled work and management systems and strategies, and graphic designers who can visually depict the complex system in a manner that aligns understanding among a diverse set of participants. Organizational designers make sure that the evolving work system is crafted to incorporate digital technology that contributes to and serves as the connective tissue in an ecosystem that delivers value to multiple stakeholders—not just to the company that has initiated the transformation.

The specifics of the DSTS process will differ depending on the configuration of actors, the nature of the work, and technologies that are being connected. Yet the core elements, principles and high level flow and cycles of design are likely to be similar across settings. The transition to digital platforms that coordinate, integrate, process information and learn across many actors in an ecosystem is well underway. They may empower stakeholders to address their purposes and interests or they may constrain them to a life that is shaped by others. If this societal transition is to enable an equitable and diverse society characterized by values of development and meaningful participation, our design methodologies must address multiple stakeholders and multiple purposes.

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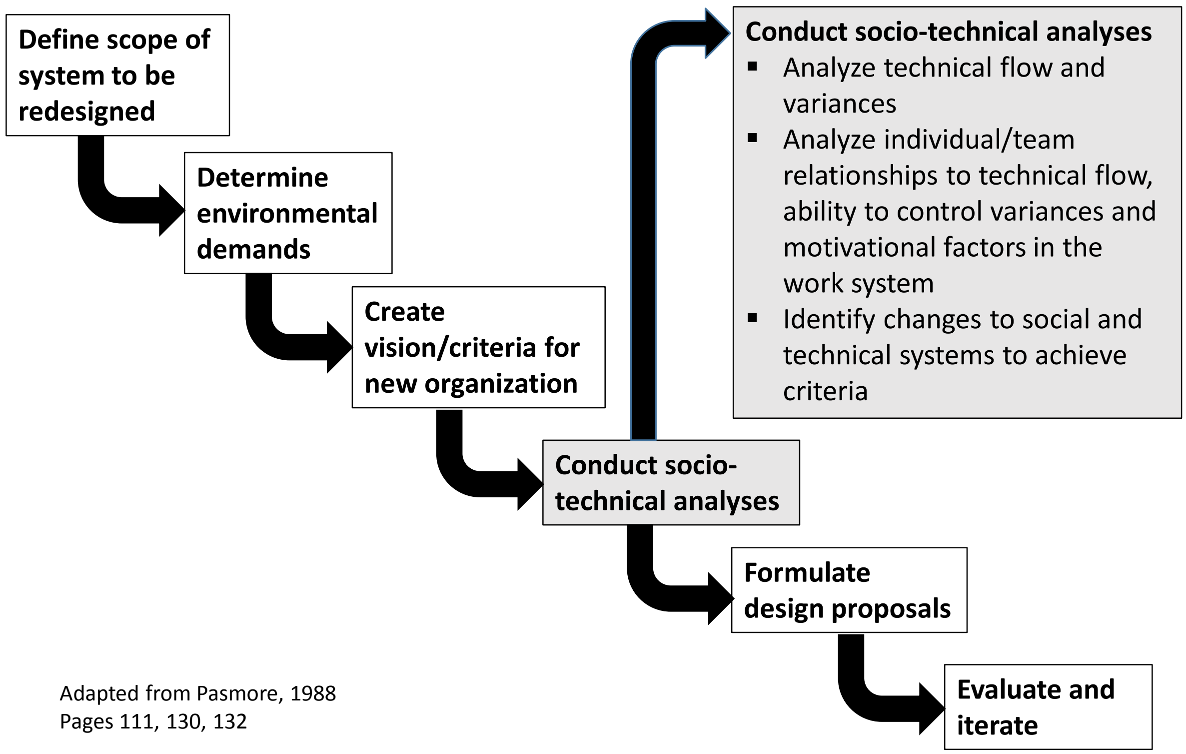
Figure 1: Simplified Classic Sociotechnical Systems (STS) Design Steps



Adapted from Pasmore, 1988
Pages 111, 130, 132

Figure 2. Star Model

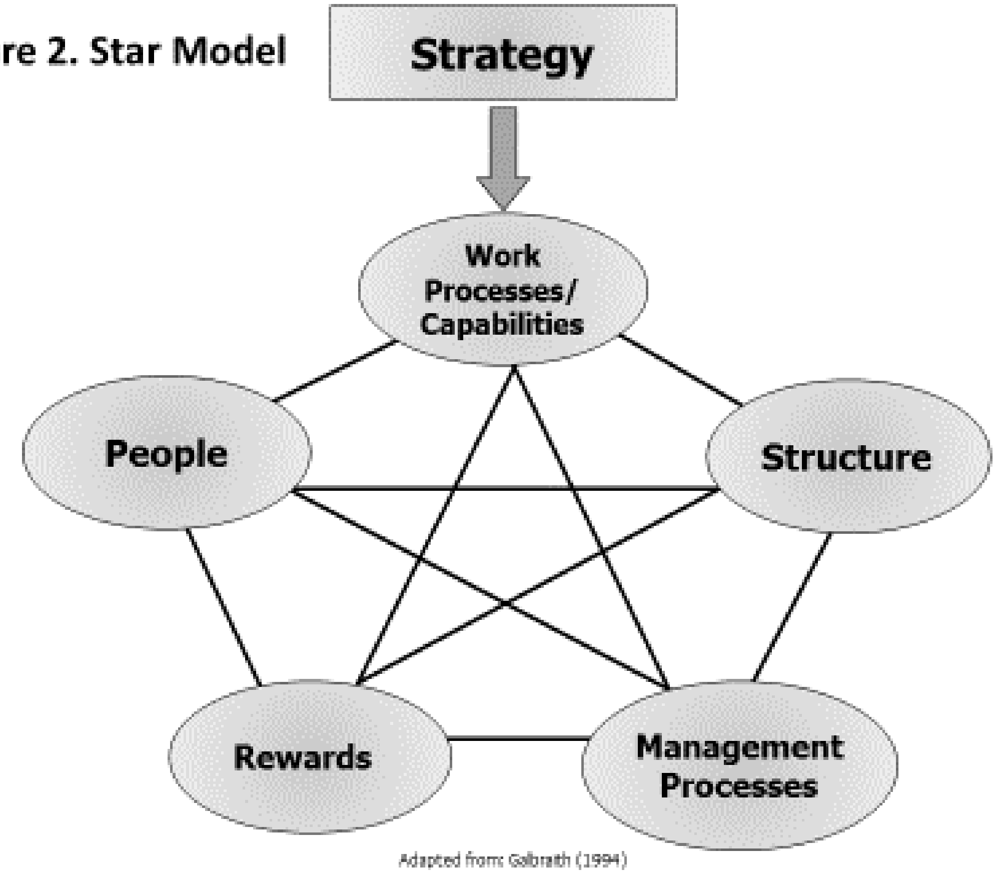


Figure 3.

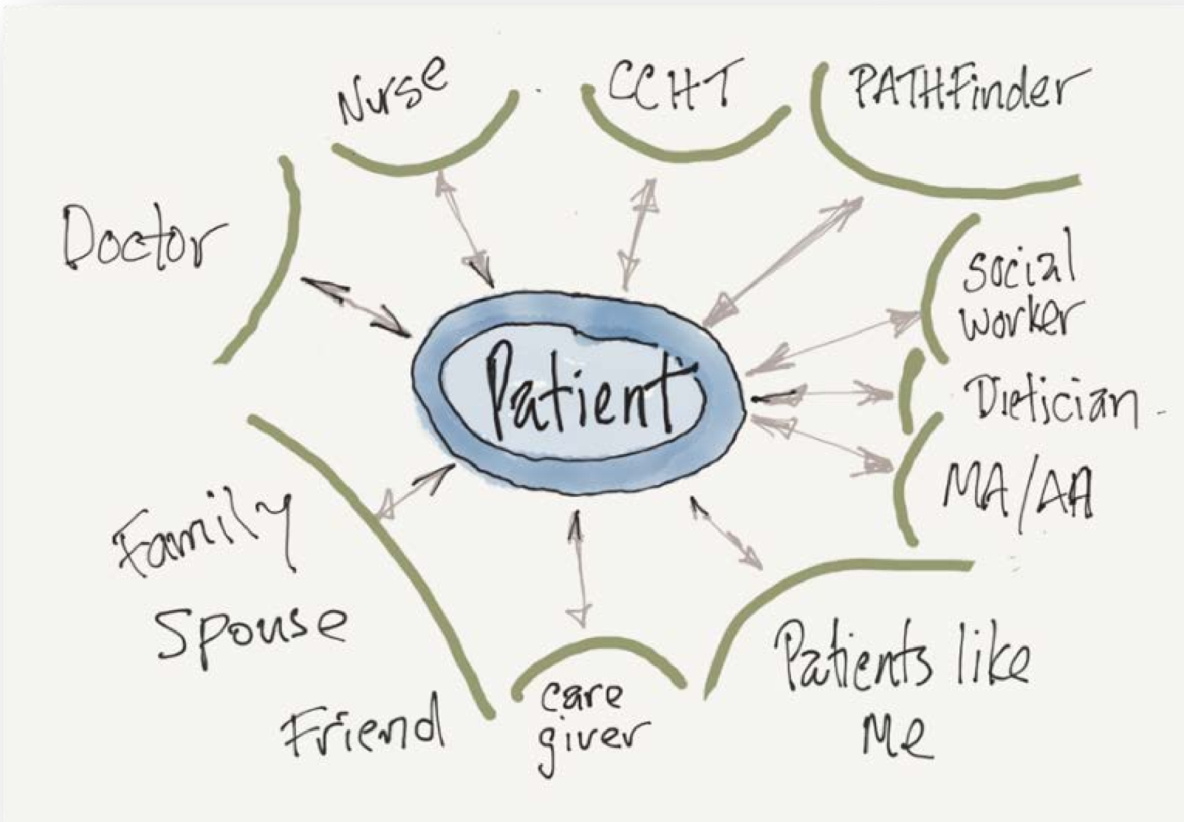

Nurse
CCHT
PATHFinder
Doctor
social worker
Patient
Dietician
MA/AA
Family
Spouse
Friend
care giver
Patients like Me

Figure 4.

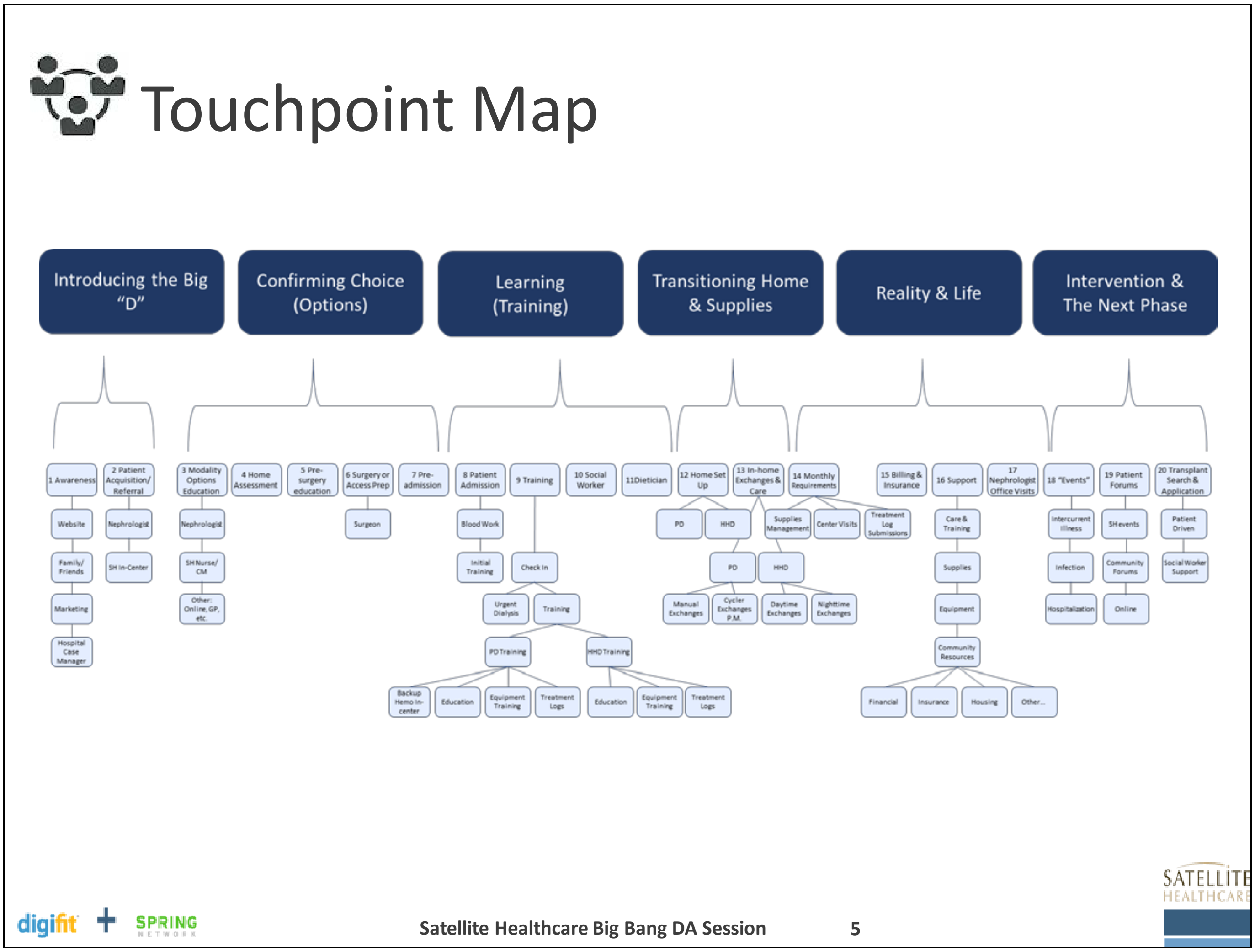

Touchpoint Map
Introducing the Big "D"
Confirming Choice (Options)
Learning (Training)
Transitioning Home & Supplies
Reality & Life
Intervention & The Next Phase
1 Awareness
Website
Family/ Friends
Marketing
Hospital Case Manager
2 Patient Acquisition/ Referral
Nephrologist
SH In-Center
3 Modality Options Education
Nephrologist
SH Nurse/ CM
Other: Online, GP, etc.
4 Home Assessment
5 Pre-surgery education
6 Surgery or Access Prep
Surgeon
7 Pre-admission
8 Patient Admission
Blood Work
Initial Training
9 Training
Check In
Urgent Dialysis
Training
PD Training
HHD Training
Backup Hemo In-center
Education
Equipment Training
Treatment Logs
Education
Equipment Training
Treatment Logs
10 Social Worker
11Dietician
12 Home Set Up
PD
HHD
13 In-home Exchanges & Care
PD
HHD
Manual Exchanges
Cycler Exchanges P.M.
Daytime Exchanges
Nighttime Exchanges
14 Monthly Requirements
Supplies Management
Center Visits
Treatment Log Submissions
15 Billing & Insurance
16 Support
Care & Training
Supplies
Equipment
Community Resources
Financial
Insurance
Housing
Other…
17 Nephrologist Office Visits
18 "Events"
Intercurrent Illness
Infection
Hospitalization
19 Patient Forums
SH events
Community Forums
Online
20 Transplant Search & Application
Patient Driven
Social Worker Support
digifit + SPRING NETWORK
Satellite Healthcare Big Bang DA Session
5
SATELLITE HEALTHCARE

Figure 5.

SATELLITE HEALTHCARE

Variance Control Matrix

LIFECYCLE STAGE	VARIANCE DESCRIPTION
[1] Introducing the big "D"	1. Variance description #1
	2. Variance description #2
	3. Variance description #3
	4. Variance description #4
[2] Confirming Choice (Options)	5. Variance description #5
	6. Variance description #6
	7. Variance description #7
	8. Variance description #8
[3] Learning (Training)	9. Variance description #9
	10. Variance description #10
	11. Variance description #11
	12. Variance description #12
[4] Transitioning Home	**13. Variance description #13**
	14. Variance description #14
	15. Variance description #15
	16. Variance description #16
[5] Reality & Life	17. Variance description #17
	18. Variance description #18
	19. Variance description #19
	20. Variance description #20
[6] Intervention & the Next Phase	21. Variance description #21
	22. Variance description #22
	23. Variance description #23
	24. Variance description #24
	[1] [2] [3] [4] [5] [6]

Instructions:

1) Identify up to 4 Key Variances for each of the 6 stages of the ESRD Lifecycle. There may not be 4 variances in each lifecycle stage.
2) Number each variance description sequentially (as shown above) and fill in a short description in the corresponding row.
3) For each variance, go down the column that contains the variance number under consideration and determine its impact on each of the other variances, row by r intersection cell, decide if the variance under consideration CAUSES or CONTRIBUTES to each of the other variances. If it CAUSES another variance (serious im intersecting cell. If it CONTRIBUTES to another variance (milder impact), place the number inside parentheses into that intersecting cell.
4) Determine which variances have the overall most impact on the system and denote those as Critical Variances using **bold red font**.

Figure 6. Satellite Design Flow

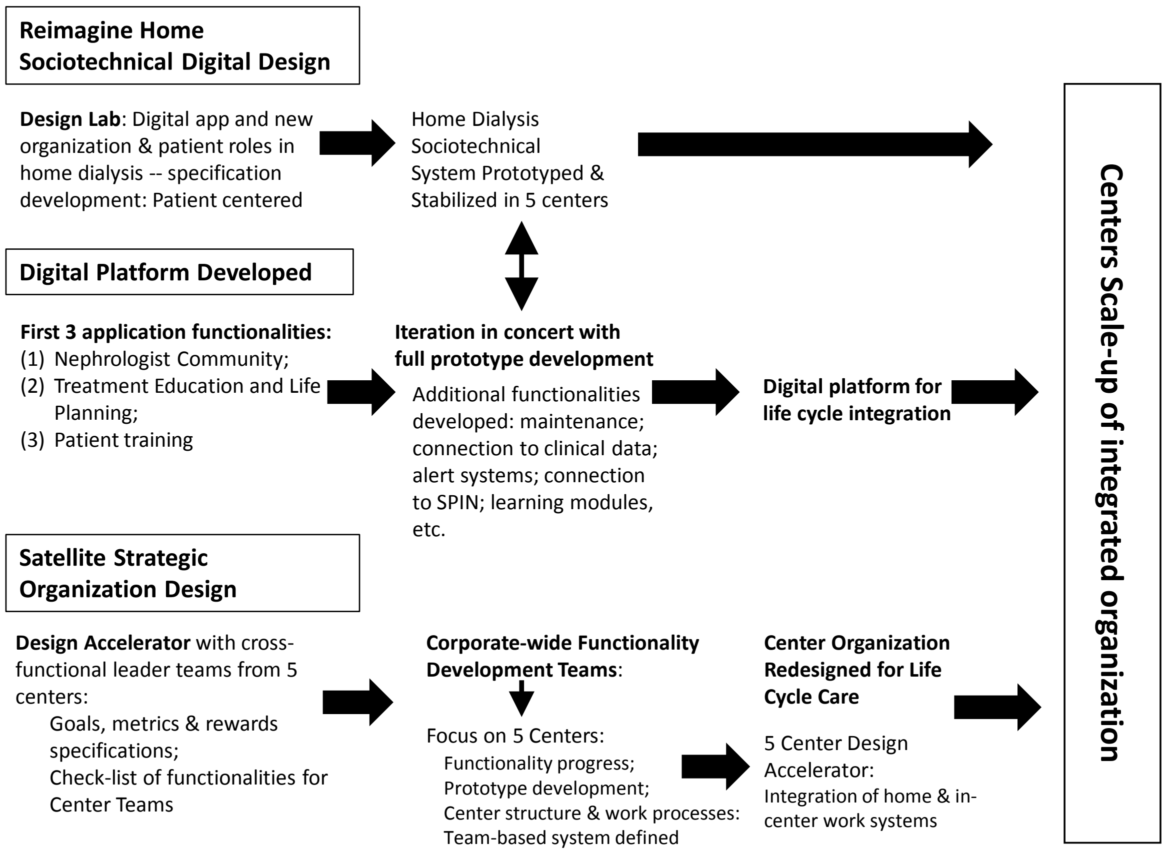


Table 1.		
Dimension	**From:** **Traditional STS**	**To:** **Digital STS Design**
Era and time	Industrial and Computer 1950 - 2010	Digital Era 2011 – current – future
Technology	Mechanical and computer	Digital, machine leaning /AI
What leads to high performance	The organization's social and technical work system optimization and fit. Absorption of uncertainty.	Social (stakeholder motivations), Technical (work processes), digital technology, and information optimization and fit. Agility in face of uncertainty and variation.
Unit of analysis for design	The organization and its work units	Ecosystem
Technical system	Internal focus, Linear, Routine, Production/office processes	Internal and external focus, Network of activity, Non-linear, uncertain, e.g., Customer user Journey.
Social system	Workers, work processes, and management	Ecosystem / network
Work system	Work Units –Jobs, roles, teams, and workflow regulation. Interpersonal deliberations and iterations.	Operating Model – Smart Teams with digital system central to coordination, integration, and learning. Work systems that cut across organizations and include stakeholders and members of the relevant ecosystem.
Cybernetic system	Self-regulation	Artificial intelligence, Decision Criteria built into digital system, Continuous learning system
Approach to design	Design project by project: Implementation, assessment and iteration	Continuous Design: research, accelerated design and build – measure learn, and iterate. Automated data and feedback providing ongoing sensing of problems and opportunities and trigger redesign.