Sociotechnical Digital Design

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Sociotechnical Digital Design: The Context

The steady advancement of digital technology that has enabled global connection and integration across populations and organizations has catalyzed fundamental change in societal norms, behaviors, and expectations. Examples that commonly enter into the public discourse include the integration of social media into the lives of populations everywhere, easy access to and expectations of transparency of information, and the impact of the internet on awareness and expectations of people around the world. The designs of organizations have changed fundamentally to reflect the technical and social realities of our times. Among the impacts are: 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 workers replacing loyalty; and commitment-based relationships; and the building of work systems that include robotics, artificial intelligence, and machine learning.

These approaches have been made possible by the generation of 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, by Facebook as it persistently grows its power and role in connecting people, information, advertisers, employers and customers. Airlines are an example of companies that rely on big data and digital platforms to make continual pricing, service and route decisions to optimize revenue. They have decomposed the elements of air travel and connected customers through self-service web platforms where they create itineraries tailored to their willingness and ability to pay for the services they want and the amount of space they and their luggage will take up.

The technical in the sociotechnical equation has changed fundamentally in scope and impact on social organization, driving new ways of working together and getting our needs met, or not. 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 provide the data necessary for the company to provide service effectively in the course of transactions and episodes of product and service provision, and knowingly or unknowingly contribute to large databases that enable the organization to improve services and products, reduce costs and optimize revenue, and gain competitive advantage. In many organizations, customers provide input into (help with) product design, and provide feedback about employees and the customer experience that may determine performance ratings and even incentives. The implications of these changes are just beginning to be systematically investigated and critically examined (Gazzaley & Rosen, 2016; Medeiros-Ward, Watson, & Strayer, 2015).

One clear implication is that digital platforms have become major enabler of the communication and coordination underpinning economic transactions and work systems. They are co-evolving with the strategies and designs of organizations and work systems, and of the economies and societies. The scope for relevant technical and market optimization, integration and design now extends well beyond company boundaries to include industry and cross-industry eco-systems, with significant impacts for all of us. Large elements of the global economy are now linked together by technology platforms that enable the members of the eco-system to operate in a complementary way and generate product and service innovations with sweeping involvement of and impact across many stakeholders. IT platforms, often developed, owned, and controlled by particular economic entities, become the information processors, and the integrators (and in many ways provide the direction and supervision) of activities that often are carried out by customers and by temporary teams cutting across organizational, sector, and geographic boundaries. We label these teams "smart" because the technology provides unprecedented access to data, information and analyses 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. Many organizations are populated by a small core of mission critical employees, connected to contractors and outsourcers, all with tasks and roles defined by the eco-system wide network that is defined through various connections to an IT platform (Weber, 2017).

In short, because of the capacity to connect, work systems are now complex eco-systems that extend beyond an organization and its employees. Organizations rely increasingly on technologically enabled integration and optimization of a network of multi-faceted connections that are integral to each involved organization's ability to perform effectively and carry out its strategy. The design of any particular organization extends well beyond the organization's boundaries to include its lateral connections with many elements the eco-system. Organization designers have to expand focus from bounded organizations to the design of eco-systems. The design of the technical system that links together the members of the eco-system will have to occur interactively with the design of the eco-system's social system. In this article we propose a preliminary framework for the practice of sociotechnical digital design, and provide a case example from the healthcare sector.

Sociotechnical digital design: A conceptual overview

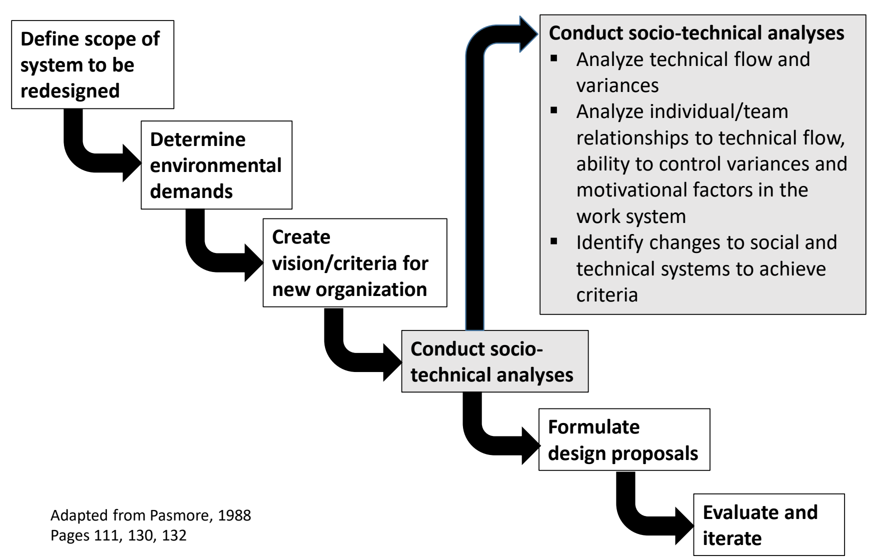
Sociotechnical digital design combines tools and frameworks from traditional Sociotechnical Systems (STS) literature that focused on creating a fit between the social and technical elements of an organization and from a more strategy-driven design framework in which design is driven by the notion of strategic fit. These approaches will be briefly described, along with their expansion and synthesis that provides the conceptual foundation for sociotechnical digital design.

Sociotechnical Systems Design

STS design processes that focus on simultaneous optimization of an organization's social and technical systems have been foundational to the field and practice of organizational design and development (Pasmore, 1988; Emery & Trist, 1978). They were first generated 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 was based on two major premises. (1) Organizations are open systems that are dependent on the environment for inputs and knowledge and revenue. They are impacted by, learn from, and deliver value to a changing environment. (2) Organizations should be designed for the joint optimization of the technical system and the social system. The core of the design methodology is the analysis of the technical system to identify variances that occur when 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 and meaning, and high performance. The STS methodology was associated with the flattening of the organization in order to decentralize decision-making and provide employees with meaningful work, the identification of teams of front line employees who self-manage in carrying out a portion of the work, and the development of multi-skilled employees who are able to carry out more job tasks.

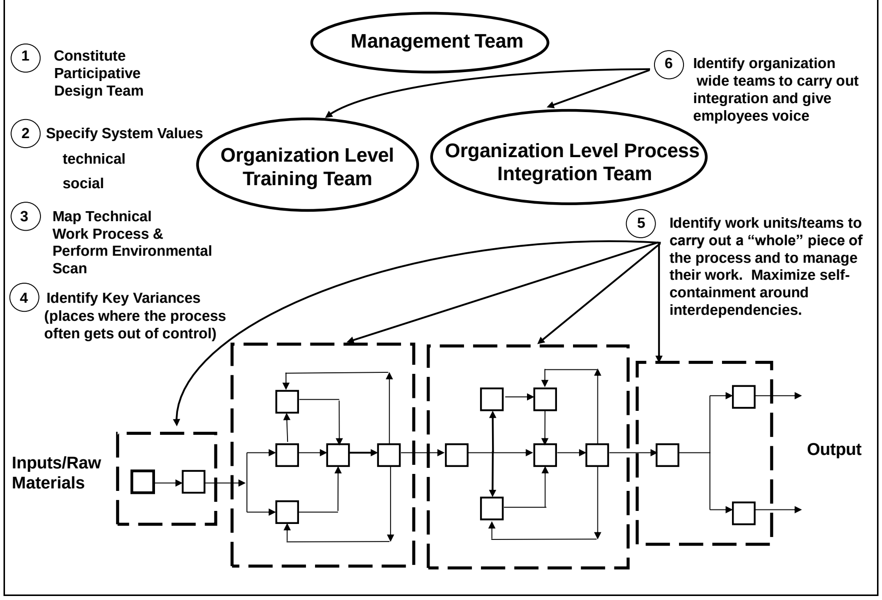
A simplified view of the stages of the classic STS framework as described by Pasmore (1988) is shown in Figure 1. It begins with an understanding of scope, context and market and environmental demands and the generation of the organization's vision and criteria for effectiveness. Based on this foundation,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

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



The original focus of STS was an organization unit, at first largely factories and other production units with linear work processes that transform inputs into outputs. Although the theory of STS calls for joint optimization, STS design processes often did not result in technical innovations or the change and development in the technology itself, but rather provided a systematic way to analyze and array the technology to focus on the optimization of the social system's capability to operate it effectively to achieve both social and technical outcomes. Figure 2 shows a generic and simplified example that depicts the steps entailed in describing the technical flow and its variances, and delineates the work units or teams with collective accountability to reduce the variances and deliver the outputs of a portion of the flow.

Figure 2: Linear Sociotechnical Design



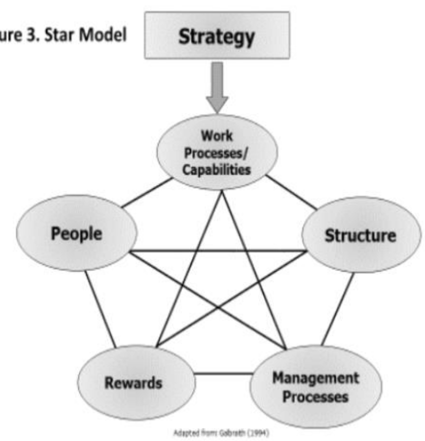
The values of participation, ownership, and meaningful work are captured not only through the team work structure, but also through representative enabling structures that provide the workforce with voice and influence in managing elements of the full work system that traditionally were carried out hierarchically. The figure shows typical examples of such participative structures including a team that determines the distribution of training resources and opportunities and another that ensures integration across the various segments of the technical system.

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 knowledge work processes. Such work is often carried out by 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 was introduced in the 1970's, and has to a large extent become the primary framework that people think of as organization design. It is exemplified by Galbraith's systems model, often referred to as the "star model of design" (see Figure 3) in which the elements of an organization's system are designed to support the business strategy (Galbraith, 1977; 2014). This approach to organization design is suitable for designing systems at various levels in the organization and across multiple functions and work processes. Based on a cybernetic conceptualization of the organization as a communication system, it too had to deal with the fact that the work necessary to carry out the strategy is not linear within and between units, but rather entails interdependencies and feedback loops. Galbraith stressed the important concept that the increasing complexity often cannot be handled through hierarchical structure and work processes within the vertical chains of the organization. Designs had to enable cross-functional and cross-unit integration and lateral decision-making

Figure 3. Star Model



capability lower in the organization through approaches such as the creation of teams and of self-contained multi-functional business units (Galbraith, 1994).

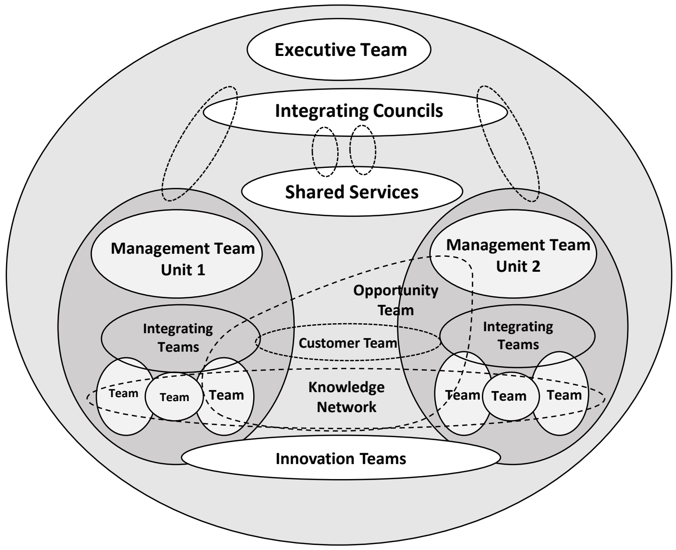
Handling Complexity with Digitally Enabled Design Solutions

These ideas have been advanced over the past decades as cybernetically based digital technologies were developing that can connect people and knowledge to carry out key processes laterally across the parts of the organization, and to enable virtual work and organization designs where organization structures may be independent of geographic location. New organizational forms such as global product lines, matrix organizations, and network organizations have emerged to house multiple cross cutting processes, projects and business units, in which participants have ready access to needed information, and the variety of skills and knowledge required to effectively manage aspects of the business lower in the organization and be held accountable for results.

Building on both the STS framework that dictates that the organization should be fashioned to effectively use technology to carry out work that delivers the outputs to the customer, and on strategy driven systems models that address the clustering of activities in the organization both vertically and laterally, 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, innovation and information technology design and implementation are examples of work that often is not neatly handled within the boundaries of organizational units. Organization design process frameworks emerged that included the analysis of strategy, critical capabilities and work processes of the organizations, and the design of core units and lateral capability to deliver the value to the customer that achieves the organization's strategy.

The rapid advance of digital technology has enabled increasingly lateral, virtual, boundary less organizations and work designs. Standardized and increasingly digitalized work processes have become the foundation for work systems, with artificial intelligence and large data models often performing the functions of coordination and information processing. Processing capabilities built into the software enhanced speed, efficiency and reliability of cross-cutting work processes and at the same time have often constrained the capacity of participants to use judgment and innovate. Knowledge and work sharing platforms have provided the potential for people to easily coordinate their work and learn from one another, and powerful communication capabilities such as telepresence and video conferencing have provided real-time virtual human interaction. Increasingly, work could be done effectively through cross-cutting networks and teams that cut across functions, geographies, business units and companies. As new business models and organizational design forms appeared, organization design has become a competitive advantage. Figure 4 generically illustrates the complexity of highly connected structures and linkages that have come to characterize today's organizations.

Figure 4. Teams and Networks



As these new and more complex organizational forms have emerged, there are indications that the "socio" part of many sociotechnical systems has not been fully addressed. The resulting "24/7" capabilities have sped up work and capacity for quick response to customers, but have greatly impacted employee lives by creating "always on, never off" pressures, and 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 the technical and organizational complexity and find satisfaction and meaning working in these systems may be lagging the capacity of organizations to dream up 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 have also been enabled by these same new technologies, which provide the basis for designing and implementing synergistic business models. Yet until recently, most organization design has continued to focus on individual organizations and units, assuming that competitive advantage stems from the resources and capabilities of single organizations. Although there has been a great deal of research and consulting attention to cross-boundary linkages, and partnerships of many kinds have become a key strategic tool for many organizations, companies often approach design in a manner to optimize their own performance. Partnerships and other lateral relationships, including with customers, are often approached as instrumental to a company centric view of growth and profitability.

Moving Forward: Digitally Enabled Eco-System Designs

More recently two realities have emerged that make a company-centric view of design inadequate in today's reality. The first is the advances in digitization that has led to powerful digital platforms that cut across organizations. Companies that develop and manage these platforms that link together eco-systems are realizing that their success depends on choreographed activities across the eco-system, and on the value that accrues to the members of the eco-system who now have to relate to each other in quite different ways. The eco-system has become the locus of economic activity. Second, issues of sustainability and the requirement to be successful in an environment of scarce resources has heightened organizations' understanding of their interdependence and the benefits that stem from achieving synergy and leverage that creates shared value with their stakeholders (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, and core espoused values such as transparency, equity, privacy.

These two realities underscore the importance of considering the full eco-system as the focus of redesign. An eco-system is an interdependent network of actors working to achieve their purposes individually, competitively, and through synergy with one another (Axelrod & Cohen, 1999; Holland, 2014). Each actor's success depends on the success of the eco-system that it is part of, and on the inclinations of others in the eco-system to behave in ways that support its strategy. Achieving relevance in the eco-system requires design processes that take into account the legitimate purposes and interests of others in the eco-system with whom a particular organization is interdependent. An increased number of stakeholders have material impact on work that is done across the eco-system. Taking an eco-system perspective also highlights the legitimate rights of many stakeholders to be taken into account in designing how industries, societies and economies operate.

We use the term digital sociotechnical design for an open system approach that embraces and addresses the interaction between digitally enabled technology, individuals, organizations and the larger ecosystem, and builds on the concepts of user experience design (Goodwin & Cooper, 2009). Sociotechnical digital design is an eco-system based approach that includes a focus on the hardware, software, social, psychological, economic, and other elements of the overall user experience. In the remainder of this paper we take a step toward understanding sociotechnical digital design at the eco-system level using a case example from healthcare. The process we describe emphasizes two elements of design: (1) the integration of digital technology and organization design at the eco-system level; and (2) the multi-stakeholder participation that is necessary if the system being designed is to work optimally.

Sociotechnical Digital 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 (Berwick, Nolan & Whittington, 2008; 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 greatly exceeds available resources, and costs of healthcare as currently provided will exceed society's capacity to pay. One trend in health care is to invest in capabilities that will help sustain the system through a shift from fee-for-service to fee-for-value. Value is measured against patient and population health outcomes, and the delivery system is resourced and rewarded based on value delivery. Value based healthcare is sometimes referred to as the triple aim (Berwick, Nolan & Whittington, 2008), as it aims 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 far greater efficiency and integration of care, and to fundamentally change both the role of individuals in their own healthcare and the locus and modalities of care (e.g., Topol, E., 2015). For these reasons, healthcare is a good place to start to identify the elements of sociotechnical digital design.

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 eco-system. 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. Underlying these approaches are powerful IT applications that connect clinical and business information, and provide integrated patient information. These applications enable a more integrated approach to patient care and increased capacity for 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 eco-system wide learning.

Patients are customers or recipients of healthcare as well as active participants in the care process. 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 receive 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. Although patients themselves and their personal support network of family members, neighbors, friends, and hired caregivers have always played an important role in ensuring that treatment and care is provided, advances in technology are now enabling many more care elements to move into the home and other life spaces, and to be carried out through self-care. Digitization enables the provision of tools for self-care and for connecting home-care 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 socio technical 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 Health's Redesign for Kidney Dialysis Homecare

Home-based dialysis is an example of treatment that previously has occurred exclusively in medical centers and specialized clinics that for many patients can now be carried out effectively at home. Home dialysis is not a stand-alone capability, but rather exists within a complex eco-system that provides life-cycle care for those with kidney failure. These patients have multiple co-morbidities and are typically being treated by multiple specialists. Technology is a necessary enabler, but it will have to be designed and utilized as part of an eco-system that involves many different actors and constituencies.

Satellite Health is a kidney dialysis company that operates in six states in the U.S. It has embarked on a value-based transformation process that relies heavily on advancing its sociotechnical work system through the design and incorporation of digital technology to integrate and coordinate across the care eco-system. The redesign of Satellite Health provides an empirical example of multiple constituency, sociotechnical digital design, and a preliminary framework for such a design approach.

Background and Context

Fourteen percent of American adults have some level of chronic kidney disease (NIH, 2017). Dialysis is a process for removing waste and excess water from the blood and is used primarily as an artificial replacement for lost kidney function. Dialysis patients move along a life-cycle path that may lead to kidney replacement that will remove the need for dialysis, and/or through gradual decline, ultimately, to death.

Patients with chronically worsening kidney malfunction often have had to travel great distances to get regular dialysis treatment at a medical center. Dr. Norm Coplon, the founder of

Satellite Health, believed it was possible to provide personalized dialysis care in a friendlier, more comfortable environment closer to where patients live. Satellite's philosophy is that the whole person is the focus of care and the objective is to improve each patient's overall quality of life. With only six patients, the first Satellite dialysis center opened on March 1st, 1974. Today, Satellite Healthcare's staff of over 1,500 work to improve the quality of life for more than 6,800 patients, across 80 centers and six states.

The company has more recently been a front runner and market leader in providing the option for home therapy with their WellBound™ platform. In addition to the convenience and independence that this offers to 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--with closer connection to the patient's individual physiological cycles rather than at a pre-scheduled time, contributing to well being and to longevity (National Kidney Foundation, 2015).

Training of patient and their care partners is a fundamental requirement for home dialysis. In the WellBound™ program, specialty-certified nurse's train patients and their families or other support system members to perform their own 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 clinic, and the Satellite staff are able to provide treatment to a greater number of patients.

From the triple aim perspective of focus on clinical outcomes, patient experience and cost, home dialysis would seem for many patients to be a preferred modality of treatment compared to in-clinic treatment. The challenge to Satellite is that only around 20% of its total patients opt for and stay in the program over time. Nationally, 40% - 50% of all home dialysis patients drop out, most in the first months of home care. The most common reasons are fear of making a mistake, and a desire for more support from nurses and other patients.

Satellite Health 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. Solving the problem of home dialysis retention will have significant benefits to the company, to the lives and health of their patients, and to the ability to provide dialysis services to a larger population at a lower cost. In late 2016, the company began Reimagined Home, a systematic multi-stakeholder, sociotechnical design process to fundamentally re-design the full eco-system 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 sociotechnical organization designers.

The goals of Reimagine Home are:

- Reduce the dropout rate of dialysis patients on home care, while improving the customer experience and reducing costs
- Increase patient satisfaction
- Develop a digital application that supports deeper patient engagement and connection and better management of their condition
- Create a new industry standard for dialysis home care that enhances Satellite Healthcare's industry leadership and serves as a source of competitive differentiation and increased market share
- Increase home program EBITDA growth as a result of the new resources and tools
- Receive a positive ROI from the Reimagined Home initiative in 2018 and beyond

It is important to note that home dialysis fits into an overall life-cycle of treatment for patients with kidney failure and that patients will continue to be connected to a Satellite dialysis center that monitors their progress and helps them through the spectrum of care. In fact, 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 optimized sociotechnical design process must include the technical and social linkages to the centers, and changes to the design of the centers' roles, structures and workflow design to accommodate the optimized home dialysis system and to address each center's need to accommodate and optimize the dynamic care life-cycle that may include both home and in-center care. Toward that end, center managers and care providers were heavily involved in the design of the sociotechnically optimized home dialysis system, and have also become involved in the redesign of the centers to incorporate that system into the its overall life-cycle care mission, and to optimize overall performance.

Satellite engaged in Reimagined Home in order to optimize home care. The intention was to design, implement, and manage this home care system as an "ambidextrous" capability (Tushman and O'Reilly, 1997), and once it was functioning optimally, to determine how best to integrate it with dialysis center operations. As the home care system began to take shape, Satellite began to redesign the dialysis center organization to achieve optimal integration of its home dialysis work system with the full set of services that a Satellite center provides. The goal of the center design process is to design high performance, life-cycle dialysis centers with an integrated care-delivery model, organization and management system, and digital platform.

We will first describe the design and development of the optimized home care system. Then we will more briefly describe the process used to redesign the dialysis centers.

Satellite's Digital Sociotechnical Design Approach

Reimagined Home has followed a sociotechnical digital design approach to design a homecare work system that incorporates a digital platform to more effectively meet the needs of the home dialysis patient. By creating a better experience and outcomes, the goal is for more patients to choose home dialysis as their preferred treatment method and stick with it for a longer time.

The sociotechnical task is to create joint optimization of the full system, which we are referring to as the ecosystem because it extends well beyond Satellite Health. Other actors who influence the success of home dialysis include 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. The eco-system includes the social and technical connections among all these actors, who have not typically been well coordinated nor mutually reinforcing in meeting user needs.

A traditional approach to sociotechnical design would focus on joint optimization of Satellite's 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 Satellite leaders that designing a system to foster and enable self-care and life-cycle care entailed an expansion of focus and purpose, and required much broader participation in the design process. Improving the experience of patients and their home support system would be the shared purpose for a multi-stakeholder design process, and would serve as the primary design criterion. The patient's changing role has to be more completely enabled, motivated, supported and assured through connections and relationships to the full eco-system upon which the patient relies.

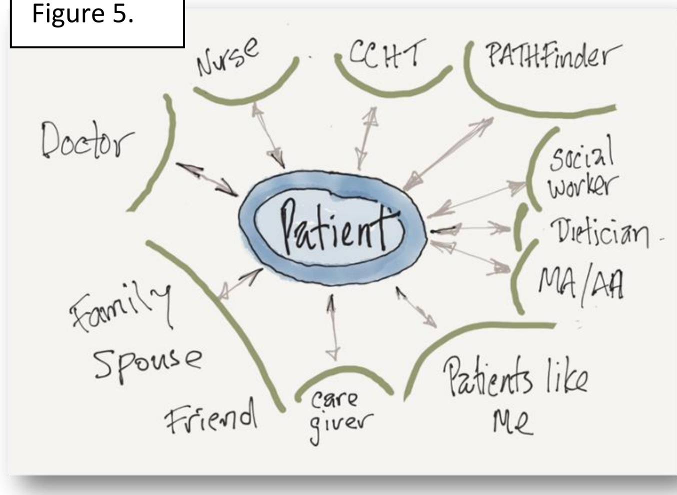
A major focus of the Reimagined Home project was the development of a digital technology application to support the new patient roles and the many eco-system connections and roles. This technology, including its connections to the medical dialysis equipment and to Satellite's work system, it's use and fit with the patient's immediate context, and its coordination role with the broader eco-system have been jointly designed. The digital application serves as a major connective tissue across the eco-system, and it was designed concurrently with the social system. The guiding 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. This expanded sociotechnical approach aims at an aligned ecosystem for a coherent integrated system of home dialysis that creates value for the user and other stakeholders and extends well beyond the work system of any particular care delivery organization.

The Phases of Development of the Digitally Enabled Home Care System

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

Research Phase. The consulting team conducted more than 100 ethnographic interviews and observations with eco-system members, including patients and their care givers, Satellite staff, referring physicians, vendors, family members, social workers, dietitians, pharmacists, and payers. The data were coded 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, and became 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 allowed for three primary analyses to be completed; ecosystem mapping, a touchpoint analysis and a variance analysis.

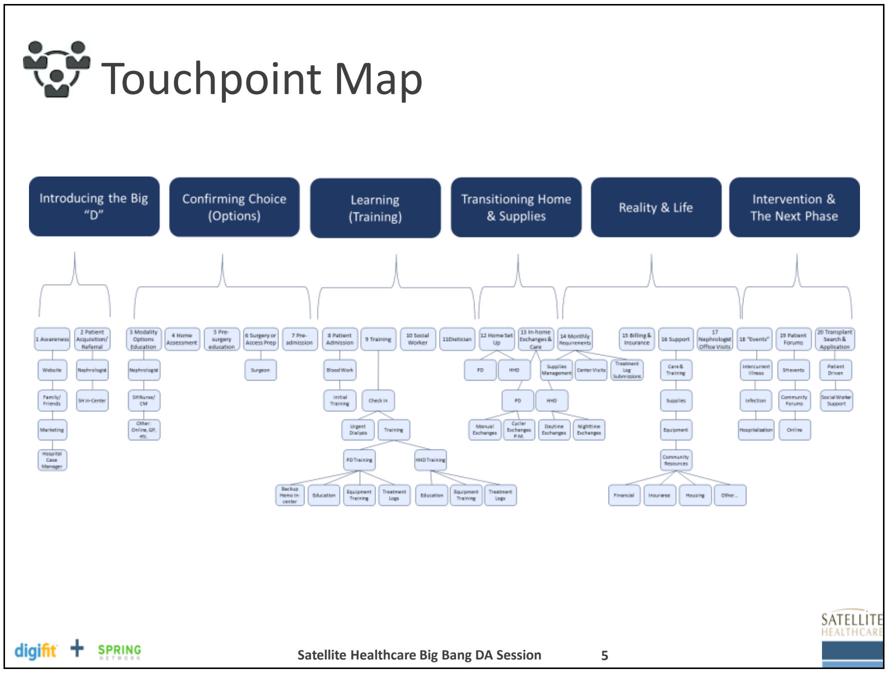
Figure 5.



Mapping the Ecosystem. The eco-system map is a systematic network diagram of all the actors and stakeholders who constitute, will be affected by, and need to be involved in the home dialysis process. It shows how they relate to one another. The basic actors in the ecosystem are: the Satellite members who make a care promise to a dialysis patient; the agents, including Satellite 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 are now taking on expanded care and self-care responsibilities. The map serves as a basis for generating new organizing concepts for the eco-system that will change how actors work together. Figure 5 shows a simplified graphic of the eco-system that was identified by the participants.

Patient Journey Touchpoint analysis. A life-cycle journey map puts the patient at the center of analysis and adds the care cycle time element (see Figure 6). It starts with what the participants identified as “the big D”—the decision whether to embark on home dialysis.

Figure 6.

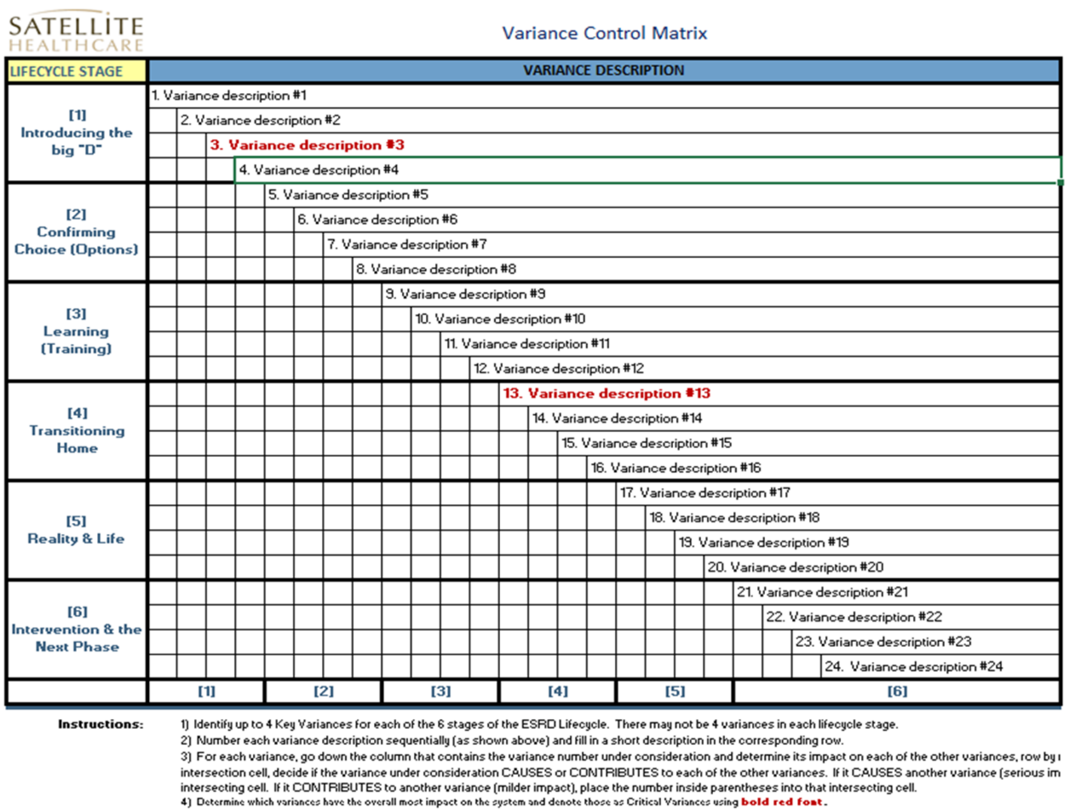


The touchpoint analysis describes every patient homecare dialysis touchpoint moment and experience during the cycles and phases of care. For each patient touchpoint, the following are identified:

- **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. This 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 connecting all the touchpoints in a home dialysis experience, as well as addressing the needs and purposes of all the ecosystem stakeholders, a view of the care delivery system will be 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 7 shows the tool that the participants will use in the Design Phase will use to confirm and provide a richer understanding of the variances, and to generate design solutions to control them. The tool tracks to the lifecycle stage.

Figure 7.



Design Phase. Members of the various stakeholders from the ecosystem were brought together in a large group design lab activity to co-design an eco-system work system for home dialysis that improved the patient experience. The products from the research phase were inputs to this design phase. Satellite's large group design lab involved 78 participants from the ecosystem including patients, physicians, nurses, center and regional managers, CEO and board chairman, Baxter vendors, family members, pharmacists, and digital application developers.

In the lab, cross-ecosystem stakeholder groups (referred to as cottages) were formed to redesign specific touchpoints along the patient journey, in order to control variances that negatively impact patient experience and quality outcomes. These groups presented their draft solutions to the larger group for feedback and iterative redesign to ensure the integrity of the full life-cycle system. Concurrently, in interaction with the stakeholders in the lab, a group of digital application designers were creating, sharing, and getting feedback about high level designs for the home dialysis digital technology solution that would enable integration of the full system. The process generated a set of specifications for the work system to ensure that the variances that had been identified would be controlled.

As the design lab proceeded, the application designers got input from the participants and iterated the digital technology design in concert with the design of the social system. Some variances would be handled through the digital application. Physicians would be provided with digital tools that enable them to work with prospective dialysis patients as they make a choice whether home dialysis fit their life and health needs. The app provides information to answer many of the questions that the patient and their families might have. Other variances would be handled through changes to the social system. For example, the participants in the design lab identified a need for regular patient connection to an advocate who could help them formulate life goals, commit to a dialysis approach consistent with those 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 eco-system. The digital application was designed to enable greater consistency and increased cross-functional coordination, integrated care and shared knowledge among the various eco-system 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 design and the social system design were enabled by the common focus on creating a better solution for the patient by eliminating or controlling the variances that they had identified. Variances not eliminated technically were controlled or eliminated through the social system design. This social-technical optimization fit created value beyond simply providing a digital capability to be used by the existing social system. Equally important were the relationships and insights gained through the co-creation process, which lay the groundwork for operationalizing a work system that reconfigured both the organization and the technology for optimal system performance.

Prototype/Test and Learn Phase. The products of the design labs were the specification of 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 home care prototype. In an iterative process, these centers worked together in 30-60-90 day learning cycles to share understanding of the underlying logic of the solutions, and to develop and share ideas and approaches and results and to learn from each other. In this way, several working models of the Reimagine Home system solution were created and implemented, providing the basis for an iterative test and learning process, and for convergence on a model.

The digital application was intended to be the foundation of a work platform that would evolve through time and enable fast, reconfigurable social arrangements and expansion of capability through time. It was and continues to be further developed iteratively in interaction with the detailed design and testing of the work system in the five centers. It became a common platform for most members of the ecosystem to coordinate and get the information necessary to carry out their roles. As the social system was changed to work integrally with the technology solution to embody the variance control solutions that had been generated, changes were made in each. For example, a new role called a "path-finder" was tested and iterated to guide the home dialysis patient through the Reimagined Home system—to help the home dialysis patient and support system to learn, 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 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 trends 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 clinics converged on a prototype that dialysis patients and other ecosystem stakeholders felt met the requirements that had emerged from the design lab, it was ready for scale.

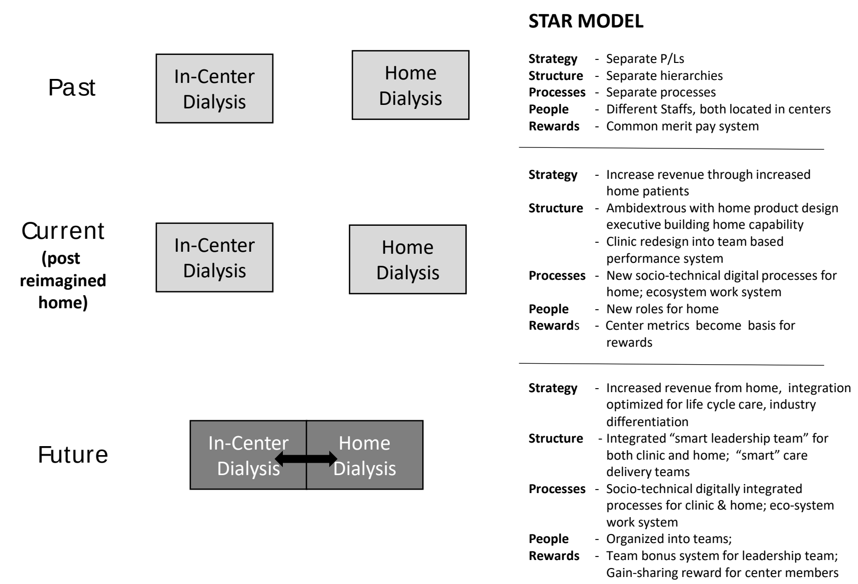
Scale Phase. The objective of the scale phase is to disseminate the prototype throughout the full organization. Satellite is currently at this scale-up phase of bringing the Reimagined Home model to the other 75 centers, thus driving its triple aim value proposition to reality. For this purpose, the prototype has been decomposed into bundles of functionality or capabilities. The plan was that the clinics would 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 would get together in 30-60-90 day learning and iteration cycles to learn from each other's experience about what is working and what needs to be modified. To ensure that the various disciplines and stakeholders that are involved are changing to fit the new work system, cross-cutting functional networks of ecosystem roles such as center managers, nurses, physicians, or path-finders, have been created so roles can be easily understood, supported, trained, and practiced. The Reimagine Home worksystem thus would be built in across the company through a coordinated implementation, learning, and improvement process. The technology and the social system designs would continue to be adjusted and modified as learning occurs during the scale-up process.

The original plan for the homecare worksystem to be scaled up as soon as it was stabilized in the first five centers has been modified based on the learning from the prototype development process. As the prototypes were being developed, Satellite management became increasingly aware of the life-cycle issues of care that require the capacity to work seamlessly across home and in-center dialysis. Satellite realized that it needed to stop managing homecare dialysis as a separate work system, and to redesign its centers for integrated care. The digital technology would 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. Scale up of the homecare capability will occur in conjunction with a redesigned center organizational and work-system model.

Organizational Redesign for the Integrated Operating Model

As the digitally connected dialysis prototype is being honed, disseminated and adjusted, each element of the eco-system, including Satellite, has had to change how it operates to accommodate this new multi-organization work system in a manner that contributes not only to high eco-system-level performance, but also achieves high performance in carrying out its own organizational mission. For Satellite, this mission is life-cycle care. The life-cycle and changing care needs of kidney failure patients means that even for home dialysis patients there is a need for some planned and unplanned care to be delivered in the centers. Satellite's clinical and financial success depends on its ability to manage dynamic and uncertain patient journeys, both for home dialysis patients and those who get all their care in the centers. The digital platform and homecare work system that has been developed connects multiple members of the eco-system for home care, and will now have to do the same for in-center care as well. During development and prototyping, Satellite was managing home dialysis as its own unit, in order to give it flexibility to optimize the eco-system work system. It has now turned to redesigning its organization to integrate the redesigned homecare and center care work systems. The timeline in Figure 8 shows that it is currently designing toward a future state in which the centers manage integrated, life-cycle care.

Figure 8. Satellite Health – Socio-technical Digital Transformation

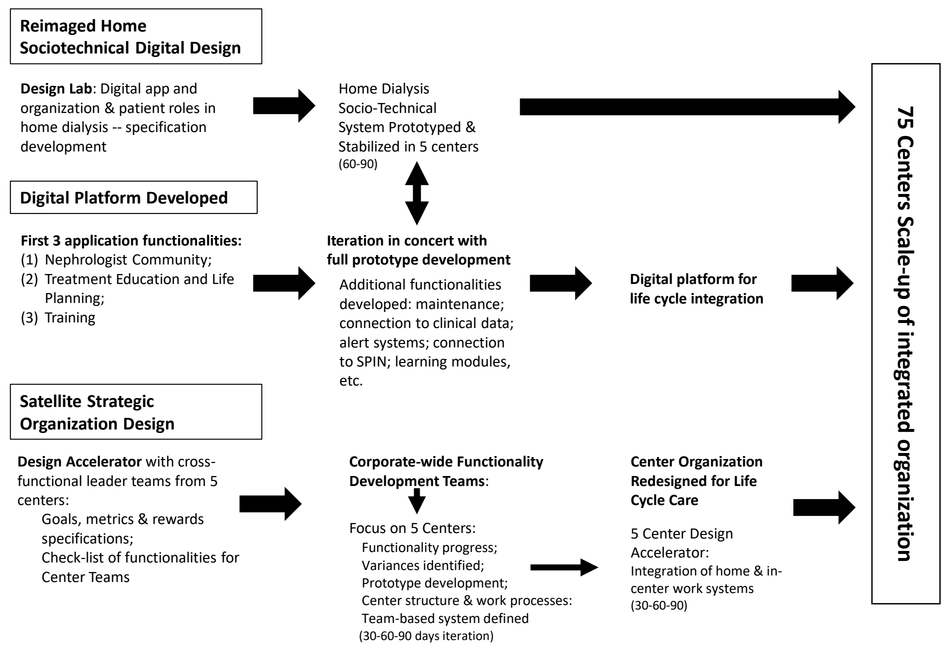


The Satellite corporate organization and its centers are being redesigned, addressing the elements of the Galbraith star model shown earlier. The executive team has been restructured to reflect the expanded mission of providing life-cycle care. An integrated field operations function has been created to manage operations. Instead of having two different executives responsible for center-based and for in-home care delivery, there is now one executive responsible for overall operations, and for leading the design of an integrated care delivery system. A patient experience function will ensure ongoing attention to the digital and center-based patient experience. An incubation center has been created to oversee the ongoing evolution of the digital work system and other related innovations, including the development, through time, of new capabilities beyond dialysis 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 data about how it is performing overall. Structurally, the centers are shifting to digitally-supported smart cross functional teams with accountability for the care of a set of patients. The new metrics and feedback systems are being developed, put in place, and tested in the five clinics. A team based reward system has been developed. Members have been trained to work in teams to optimize outcomes, and center managers are being trained to lead and manage an integrated system. The center's teams are being designed as adaptive work systems, learning the "build – measure – learn" model of managing their own performance. Each center is learning from its 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 using a 30-60-90 day learning and implementation approach.

Figure 9 summarizes how the design process unfolded, in planned and unplanned ways. During the Reimagined Home design period, homecare capabilities were developed through an eco-system wide sociotechnical digital 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 system was developed 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 are being designed as learning occurs, and to support the integration of home and in-center care.

Figure 9. Satellite Design Flow



The sociotechnical digital design process triggered the understanding that homecare could not be partitioned off from full life-cycle care. This learning led to a redesign of Satellite's organizational system at two levels. The corporate structure has been modified. The five centers are now being designed 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.

This expansion of focus has required additional social and technical design features, including changing the work flow and role structure for the in-center care, adding new digital functionality, expanding the role of the smart--digitally enabled--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 actor) to manage the patients' clinical outcomes and experience through shared on-going 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 is moving toward this end state vision through an iterative series of design, implementation, and learning activities that build on the fundamental premise that the digital platform will enable work system communication and coordination across the eco-system.

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 purposes 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. The approach described in the Satellite case fits a changing world where digital technology has enabled the breaking down of boundaries between the organization, its customers, and other stakeholders and participants in the eco-system. We are in a world where companies' ability to deliver value to their stakeholders depends on changing their relationships to stakeholders and expanding participation in designing processes where digital technology connects people's activities and their interests. The reach and functionality of digitally enabled eco-system platforms are advancing inexorably, bringing into bold relief the need to align the social system with these advances.

Taking a sociotechnical design approach has never been more important. Digital platforms shape many aspects of human behavior, coordinate and control interdependencies across the eco-system, and to a great extent have become the arbiters of the purposes that are achieved and of who will benefit. Table 1 illustrates the migration from traditional sociotechnical design to today's sociotechnical digital design, and shows the changes that are entailed in this migration.

Table 1.		
Dimension	**From: Traditional STS**	**To: Sociotechnical Digital 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 that cuts across organizations and includes members of the relevant eco-system, including customers and other stakeholders and participants.
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.

The new 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 eco-system stakeholders and that they have voice in shaping the environments in which they will exist. The unit of analysis for design optimization must be 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 eco-system, the purposes of its participants, and the requirements and outcomes for all the parts of the system. In Satellite, 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 sociotechnical digital design has to be seen as an ongoing iterative learning process, as characterized by the process of co-design, 30-60-90 day iterative prototyping cycles, the continual exchange of information across eco-system participants to identify areas of improvement and the next needed design focus, and the ongoing identification of useful digital functionalities to be introduced into the eco-system. Learning occurs both in the social system and in the digital system (ultimately through machine learning). This means that there will be continual adjustments in the eco-system design, and in the design of each of its participant's organizational and personal sub-systems. At Satellite this was evident in the discovery through the implementation of the home care 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. Sociotechnical digital design and learning processes will have to be an ongoing capability throughout the eco-system, among all actors whose activities are impacted by change in the digital platform. Given the amount of digital advances in healthcare and other industries, this means that pulling together stakeholders to reconfigure the sociotechnical system will have to become a routine part of maintaining industry leadership and designs will have to be seen as temporary, or even fleeting way-stations on the journey.

For designers, sociotechnical digital design has clear implications. The four stage process used in Satellite 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, 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 take advantage of the capacity of digital technology to contribute to and serve as the connective tissue in an eco-system that delivers value to multiple stakeholders—not just to the company that has initiated the transformation. Each participant in the eco-system work system may have to adjust work processes and organization, in ways large and small, to be effective in the changing eco-system.

The specifics of the sociotechnical digital design process will differ depending on the configuration of actors 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. We believe there is increased urgency of developing sociotechnical digital design capability. The transition to digital platforms that enable coordination, integration and information processing across many actors in the eco-system is well underway and is inevitable given the power of these technologies. These work systems 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 be successful in enabling an equitable and diverse society characterized by values of development and meaningful participation, our design methodologies need to involve and address multiple stakeholders and multiple purposes.

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