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In the Age of the Humanchine

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Abstract

This paper argues for and illustrates how the StructurANTion theoretical framework can provide insight into the nature and development of computing. It seeks to develop a combination of two conceptualizations of technology and action, namely structuration theory (ST) and actor network theory (ANT). Introducing the concept of the melded "humanchine," this paper then proposes a modeling technique suited to the development of more socially aware computing. Using the example of the nomadic clinical practice, we explore the concept of the humanchine structurated network.

Keywords: Structuration theory, actor network theory, StructurANTion theory, humanchine, translations, patient centered information system

Introduction

Lyytinen and Yoo (2002) propose that "it is becoming extremely difficult to distinguish between social (or nontechnical) and technical elements in nomadic information environments." As a result of this indistinguishable melding of the human and nonhuman, at the heart of these information environments a dilemma arises not only for traditional "technocentric" theories and developmental approaches, but also those based on wholly social perspectives of information systems. Neither social nor technical perspectives, it will be argued, suffice. Lyytinen and Yoo go on to propose that "new theoretical and methodological tools need to be developed to adequately address this challenge" and, further, that actor network theory (ANT) and structuration theory (ST) are likely candidates for such a framework. Both of these theories have been used extensively within in the Information Systems arena. However, each poses a problem for theorizing about or the development of information environments.

Structuration theory, as originally conceived of by its progenitor, Anthony Giddens (1984), is a wholly social theory, accounting for how human social systems persist and change over time and space as both a result of and as a necessary condition for the existence of human agency and interactions, their institutions, and society. This theory, however, takes no account of technologies as being anything other than resources to be allocated by humans pursuing their agency and in their social interactions (note that while some authors have tried to bring IS and structuration together, none has yet theoretically integrated the two; see Orlikowski 2000; Orlikowski and Robey 1991; Walsham 1993, 2002).

ANT, on the other hand, does accommodate within its concept of the actor network both humans and nonhumans as actors on an even footing. However, it offers little account of how the social or socio-technical network persists over time and space, other than by an exercise of the will by a focal actor—which in these post-ANT (Latour 1999; Law 2002; Mol 2003) times, where all actors are mutable-mobiles, the theory's progenitors chose to disown. In traditional ANT, such focal actors align, through a process of *translation*, other actors' interests and behaviors with her/his/its own in order to address their own *problematization*. But what happens when not only that focal actor moves on, but networks are themselves mutable? How do human–machine networks persist over time and space, yet change? This paper argues that both frameworks lack (to some degree) the ability to account fully for the melding of the technical (i.e., information technologies) and the human. Nor do they account for their existential persistence as dispersed networks over time and physical space. Or that they change either as a result of their intrinsic

properties or an exercise of the will by a powerful actor. A melding of the two theoretical constructs, as is argued and explored here, has that potential.

This paper will present a framework that does offer a capacity to account for these facts in the conceptualization of computing, through it's core notion of the *humanchine* structurated actor network, as situated within StructurANTion theory (Atkinson and Brooks 2003). This paper will explore StructurANTion theory and the potential it offers for accounting for the indistinguishability between social (or nontechnical) and technical elements in information environments. It will then explore how this structurated humanchine may be represented within the design process and then come into being, persist and change, incrementally and dramatically over both time and space within what has been named the "Age of the Humanchine." A necessary precursor to these explorations is an outline of StructurANTion theory and its development.

StructurANTion Theory and the Human Technology Relationship: An Overview

Given conference paper constraints and the conceptual complexity of StructurANTion and its two precursor theories, it will be assumed here that the reader has some familiarity with the latter and focus on the former; in particular ANT translations and the social processes of structuration.

StructurANTion theory drawing on its two precursor theories, structuration theory (ST) and actor network theory (ANT) sets out an ontology of the structurated actor network. Within this theoretical framework, humans and nonhumans of all kinds, in particular here nomadic information technologies, form together into networks that are possessed of the modalities of structurated orders (see Figure 1). They call jointly on these modalities in order to perpetrate their individual behaviors and collective actions. In doing so, the humans and nonhuman technologies autonomically both recreate and incrementally change that structurated order. A fourth structure has been added to that of Giddens' original three of signification, legitimation, and domination; namely, Emancipation (as shown in Figure 1). While the former are intimately involved in the continuous incremental recreation of the humanchine network and its agency, the latter is focused on its overt deconstruction, replacement, and reconstruction. The focus here will be on the manner in which humanchine networks ontologically persist and behave, rather than on the evocation of the emancipatory structure, through problematization and translation (i.e., the processes on which they are brought into being, which is beyond the scope of this paper). This framework, we argue, offers a much more cogent explanation for the ontological persistence of networks than ANT's focal actor translated network and post-ANT's atomistic behavioral voluntarism, where actors simply come together in pursuit of their own selfish interests.

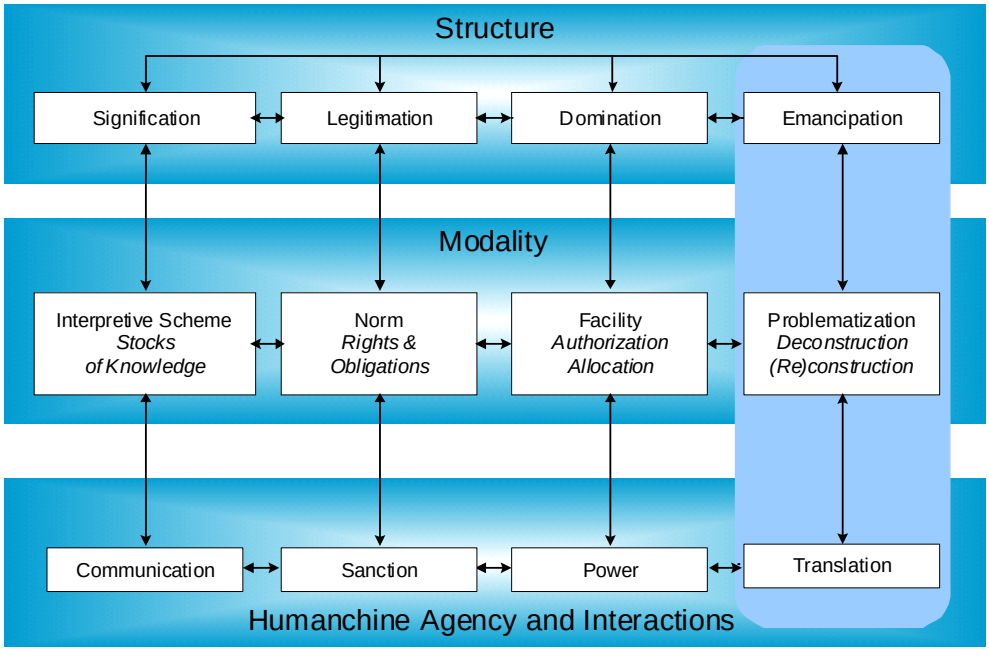

Figure 1. Modalities and Agency in StructurANTion Theory

The relationship between human and nonhumans (here computer based information systems or CBIS) and their joint action is facilitated by them collectively possessing the modalities of a common structurated order. This they recursively (re)create through their individual and mutual agency. Such orders are formed within and by humans through their innate reflexive capacity to draw on the modalities of psychologically internalized structures, in pursuing their own actions and in their relationships with nonhumans. However nonhumans do *not* (as yet) have this capacity for reflexive self-structuration that humans have. Such structurated orders, in the form of their modalities and associated functionalities, have to be inscribed in (or built, reprogrammed into) the technology at their development stage and when situated.

The structurated orders (delineated in Figure 1) become inscribed within the nonhuman partners of the humanchine duality in a number of ways. First, the nonhuman information technology may present to the network almost as a blank tablet on to which the modalities of structurated order, through use, are then imprinted in its functionality by humans when they are translated into the network. For example, a Microsoft Excel spreadsheet (Orlikowski 2000) is developed and used by a clinical team to capture and analyze the clinical audit of the care outcomes they have carried out to improve the networks' clinical performance. Other applications present themselves with a prescribed functionality that has the modalities of the existing structurated order built into them when they are developed and implemented, to which the human who uses it is obliged through the network's internalized structurated order, to conform and share. For example, a community care team's prescribed clinical protocol accessed through that primary care trusts procured clinical information system, which has the current structurated order's modalities inscribed in its functionality by its developer vendor organization, who works closely with the clinical community. In this case the clinician, at the time of treating a patient, would be required to record in the application their enactment of and compliance (or noncompliance) with the protocol. Of course humans may disregard the protocol, although this may incur sanctions from other actors drawing on the structurated humanchine network's power modalities. Under certain conditions, some networks will exhibit multiple structurated orders, a prison being an extreme example. In healthcare, managers and clinicians often clash.

In all of these circumstances, there would be a constant requirement, over time, for the application to accommodate any changes occurring within its patterns of human clinical practice and standards, which in turn effect change to the network's prevailing structurated order and its modalities. If this does not occur, then what is called *modality drift*' or even *rift*, will occur between the human agency and the technologies functionality and services. ERP systems can have this effect. This has considerable ramifications for the network, the humanchine agency within it, and its structurated order; on occasions, it could be deliberate to deconstruct the network under the evocation of the emancipatory structure. These effects will be discussed later.

The next section explores the nature of organizations and societal computer-based information environments from the StructurANTion perspective and its core concept of the humanchine entanglement of human and nonhuman actors, focusing on its ontological persistence.

The Humanchine Context of Computing

Drawing on StructurANTion theory, we argue that organizations are humanchine networks constituted out of the activities of humans and nonhumans acting collectively (although not necessarily universally in concert; Burrell 1997). Nonhumans, for the purposes of this discussion, are both applications and their technological infrastructures, i.e., the IT applications operating both inside and mediating the relationships between organizations. From the StructurANTion perspective, this is a melding of the human and nonhuman into humanchine networks that perpetrate multiple forms of concerted, purposeful agency. These are achieved through their structurated (Atkinson and Brooks 2003, Brooks and Atkinson 2004) individual and collective, human and nonhuman actors acting, across their time and space in both a virtual (non-corporeal) and a face-to-face (corporeal) manner. The humanchines' structurated modality or action cycle, as described above, enables these networks to persist as well as behave over time and space. Humanchines have the potentiality to transform global, social and organizational arrangements, to transcend temporal and spatial boundaries.

Chains of organizations have, through their actors' interactions, structurated orders that mingle and penetrate each other, and in doing so, forming ecologies of networks. Some actors, such as telecommunication networks and mobile devices or applications, pervade multiple organizational networks as well as wider society. They are translated as mutable mobiles (Cooper 2002) into a multiplicity of organizational networks, acting as intermediaries between individual actors and organizational actor networks. Many of the human actors within organizations also exist within other networks, such as homes and communities. Governmental and judicial networks also contribute to the nature of organizational structurated orders via legislation, the courts, judiciary, contracts, markets, and customers. Customers and other client organizations place obligations and affect actor behavior within the organizational network (Lamb and Kling 2003), often though contractual relationships (in which are set their own structurated orders).

Organizations, as delineated by StructurANTion theory, are viewed as humanchine networked artefacts, with overarching, although still locally layered and conditioned, structurated orders. Powerful actors create organizational networks (who themselves change and are changed over time) as a vehicle for the express purpose of pursuing some form of collective agency in line with their interests. These *focal actors* are mandated within the structurated orders of the organizational networks they create to realize their own and their constituency's intentions. However, humanchine actor networks escape their focal actors, to become free, through their autopoietic (Giddens 1979; Maturana and Varela 1980), self-sustaining structurated orders.

Ubiquitous Humanchine Information Environments

This section explores the concept of the structurated humanchine network through the concept of ubiquitous computing. Human beings have had the capacity throughout their history—although not always the opportunity or the resources—to be nomadic in their behaviors. Such nomadism has until recently been the prerogative of the wealthy and the powerful, as well as merchants and armies. However, with the advent of mass air, rail, and road transport and the emergence of the Internet, such (time-consuming) human nomadic activities have spread across whole continents and become globally intercontinental. Computing also globally pervades all aspects of human communications and interactions. To date, such computing has been predominately obvious, intrusive, and static (in terms of accessibility). The overt presence of cyber cafés worldwide and PCs on every office desk exemplify the pervasiveness of modern computing, but they also overtly exemplify its static and intrusive localized nature. However, with the advent of nomadic computing and ubiquitous information environments, humanchines are ceasing to be temporally and spatially constrained by technological partners. Nomadic devices enable them to transcend such constraints and to create their own spatial and temporal dimensionality, through which to interact around the globe any place, any time.

Weiser (1991, 1993) proposed, "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it." In other words, they become embedded partners within the humanchine duality, capable within it not only of a nomadism similar to that of humans, but creating, via the Internet and/or global telecommunications networks, virtual worlds, and links to any and every part of the planet. The physical is now becoming virtual, the human, nonhuman, clock time has transcended into network time. Ubiquitous, humanchine actor networks transcend the constraints of clock time and of physical constraints, by creating their own space-time relationships. Organizations and their structurated orders that, until now, have been limited in their extent and existence by primarily face-to-face social interaction of humans, has now become transcended and transformed. The organization and the wider *sociotechnicalété*,[1] along with their structurated orders, become both corporeal and non-corporeal. In their provision of information and a plethora of services anytime and anywhere, the ubiquitous computing of humanchine networks realizes Weiser's (1993) vision of machine ubiquity. Ubiquitous network information environments and their development are seen through StructurANTion (Atkinson and Brooks 2003; Brooks and Atkinson 2004) as

> *A ubiquitous information system is an amalgamation of all the activities and behaviors of human and (ubiquitous) nonhuman actors across a structurated humanchine network concerned with the capture, storage, manipulation, provision, interpretation and deployment of information (digital and/or analogue), by its humanchine actors in their (nomadic) interactions and pursuance of individual and collective agency as networks across their time and space.*

Ubiquitous information systems development from this StructurANTional perspective is not instrumentally driven, but is an emergent and ever changing property of the network; as a result of the above, the definition becomes

> *the continuous (re)creation across ubiquitous structurated humanchine networks, of an effective capacity for the capture, storage, manipulation, provision, interpretation and deployment of information as a component of its human and non–human actors' actions and interactions in their perpetration of individual and collective agency as organizations or the wider sociotechnicalété.*

This StructurANTion view of information systems and their development emphasizes that they are not reducible to either ubiquitous, technological actors or their interpreting human counterparts, but are a distributed feature of all the actors constituting the humanchine organizational networks. This is not dissimilar from the concept of distributed cognition (Hutchins 1995;

[1]The term *sociotechnicalété* combines the technical with the French *société*. It is intended to replace the wholly human society with that of the sociotechnical "society of the humanchine."

Hutchins and Klausen 1996) but at a much higher level of dispersal that encompasses all aspects of humanchine agency. The informational component of peripatetic spatially nomadic humanchine activity systems is distributed via the telecommunication networks existing within the organizational and potentially global sociotechnicalété. Ubiquitous information environments, from this StructurANTion perspective, are conceived of as dimensions of a humanchine networks and their myriad of actors' individual and collective peripatetic agency. Informated environments, as opposed to systems, are an emergent property of aspects of the networked actors' behaviors and actions, whose collective agency, facilitated by ubiquitous computing, are perpetrated across time and space to a far greater extent and degree of intimacy than has been required or has been possible in the past. This has been achieved via the establishment of continental and global telecommunication (actor) networks and the miniaturization of computing and communication devices and connective technologies, all based on common international standards and protocols forming the informated sociotechnicalété.

The distinguishing feature of these distributed ubiquitous humanchine networks is that they are not spatially fixed (as are traditional humanchine networks due to their artefacts being physically static, often located within other artefacts such as buildings); rather, they are spatially nomadic and accessible on the move, by other technologies and humans. Nevertheless, from the StructurANTion perspective, such a ubiquitously informated humanchine agency still draws on the modalities of the network's existing structurated order spatially extended through both the human and machine agency. As the humanchine network becomes itself peripatetic and nomadic, its structurated order also becomes ubiquitous. The organization's boundaries and its information envelope are not confined and made immutable by its static locations or buildings but are highly dynamic and malleable, constantly being redefined by the extent and the relationships of its peripatetic humanchine actors. The network's structurated order is (re)created through its nomadic human and nonhuman actors' actions and behaviors, mediated by the adoption of nomadic computing. It creates its own time and space framework. Time is not clock time or space proximity prescribed. Action is also always at a distance in these peripatetic networks (Latour 1987).

This does not imply that such networks and their structurated orders are, or should necessarily be, wholly open or easily penetrable. One of the challenges to ubiquitous computing is to ensure the dynamic spacio-temporal integrity of the ubiquitous humanchine network such that its structurated order maintains the differentiation from that which is not the network (i.e., its *other*). This would be achieved through the dynamic legitimizing of those nomadic human and nonhuman actors, their powers, relationships, and actions that may not only access the distributed network but also constitute it. It is particularly important in organizations, such as healthcare networks where patient confidentiality is a statutory, professional, and legal imperative. It is the ubiquitous virtual person proxy (La Porta et al. 1996) who has the role of ensuring the nomadic integrity of such systems. This is in contrast to the open networks, with their *mutable mobiles* (Law and Mol 2001), being explored by the progenitors of ANT through the metaphor of the rhizome (Deleuze and Guattari 1992) as exemplified by the Internet and its users. In the latter, boundaries are porous constructs rather than orchestrated and its actor relationships are non- or weakly hierarchical and often fleeting. Such metaphors may apply to ubiquitous networks that through the mediation of nomadic technologies spontaneously emerge as the sociotechnicalété.

To be effective, ubiquitous information technologies have to be capable of "intrajecting" themselves both physically and informationally into the structurated processes of (re)creating and maintaining the integrity of the organizational network's structurated modalities into which they are translated. They have the potential to facilitate the organization's ubiquity and action at a distance, across space and network time, that has not been necessary of any existing organizational information system or has been possible, until now. A necessary feature of humanchine ubiquitous collectives of virtual and material humans and nonhumans is its capacity both to define and maintain its boundaries as well as legitimate access to the network. This is achieved through virtual humanchine personal proxies or avatars and network proxies. Their role is to be context-aware, linking the virtual ubiquitous humanchine information environments with their corporeal humans and portable technologies, convening them together to constitute collectives of nomadic individual humanchines within the organizational network, or defining them within a local or global sociotechnicalété. They operate within the network at its margins, interacting with other human and nonhuman proxies. This organizational ubiquitous or wider sociotechnical network is convened around the human individual within the humanchine by and through its virtual proxy person artefact or more dynamically avatar, in an ongoing and active way. The role of the nonhuman person proxy actor is to represent, through its ontological attributes and services, the human or nonhuman actor virtually within the ubiquitous information environment. It exists to perpetuate the humanchine actor's link with telecommunication networks to enable other humanchines to interact with them and represent the human actor in the peripatetic virtual community. It is also both the network's point of access and its guardian.

The person proxy facilitates interactions (La Porta et al. 1996) between the person and/or their mobile applications and other humanchine actors across the organization or the wider sociotechnicalété. It is also there to nomadically facilitate the continuous link of the humanchine to the pervasive wireless telecommunications environment of the global sociotechnicalété.

There are two models of such a person proxy. One includes all the ontological attributes and data necessary for accessing and providing the services required from a remote data source by the human user at any one time. Another is for accessing and/or convening, via telecommunication infrastructures, access to all remote and disparate data sources necessary to achieve a particular humanchine transaction at any one point in time and space as defined by that network, often via their relationships with other personal proxies, and all safely and secularly (as explored below).

Through the mediation of their personal virtual proxies, humanchines become dynamic nomadic foci within the ubiquitous information environment of the organizational network or the wider sociotechnicalété. They and their personal proxies constitute localized informational gravity wells in the sociotechnicalété as well as being informational emitters.

Where changes to patterns of agency occur as a direct result of an intervention to introduce or induce changes in ubiquitous humanchine agency, the resulting business networks are technically but not conceptually demanding. This is the case, in particular, if a business process is well-defined, repetitive, reengineered, and continuously quality assured, for example, parcel delivery tracking services as provided by FedEx and UPS. Ubiquitously informating humanchine networks are not that difficult to design through the mechanism of traditional design approaches and then through user feedback to improve efficiency and robustness.

Alternatively, this may be achieved through procuring an industry-developed and tested application on the market. The authors' local taxi companies use a GPS application to order, track, and schedule their taxis, although some drivers circumvent these environments using their mobile radio to contact the human controller, with whom they have formed a personal face-to-face relationship, in order to gain privileged access to lucrative fares or reduce inter-fare travel using their own gas. This illustrates the manner in which a humanchine network's technology and humans practices are always situated and locally structurated, and not predetermined by development processes or an organization's formal rules.

However, the ubiquity envisaged by Weiser (1993) is one that transcends the formalisms of business process design, systems operability, and workforce repetitive actions. Rather it is one in which a ubiquitous device insinuates itself into the fabric of the social or rather the humanchine actor's actions and interrelationships across the sociotechnicalété on an almost random, opportunistic basis, and is far more difficult to achieve to any degree of sophistication above that of message sharing or viewing e-mail messages or diaries, although not necessarily impossible in theory. There are also ubiquitous organizational environments consisting of common tasks performed repetitively but not necessary in a fixed order or location, yet requiring access to multiple information sources and services at a distance on a need-to-use basis. These can range from exploring the Internet to accessing business databases, services and applications in multiple locations while on the move. It is these ubiquitous information environments that offer the most challenges to nomadic computing and its design. An exploration of this, illustrated below, also exemplifies the use of the StructurANTion framework.

Representing Structurated Humanchine Networks and Their Ubiquitous Nomadic Information Environments

A healthcare case study is provided here to explore and illustrate how the StructurANTion framework may be used to represent structurated peripatetic humanchine networks and their ubiquitous information environments as a precursor to their development and realization.

The process of representing and analyzing existing and potential humanchine networks involved

1. Capturing the typical daily routine of the clinician and current use of any information technologies and then informating it using nomadic devices (see Table 1).

2. Representing the informated humanchine activity using an integration of SISTeM (Atkinson 1997, 2000) modeling and an extended and modified UML use-case (Bennett et al. 2001; see Figure 2).

3. Identifying the StructurANTion modalities that are or would be drawn on by the humans and inscribed in the nomadic technologies of their integrated clinical agency (see Table 2).

4. Identifying how the nomadic technologies would enable the human actors in their agency using UML collaboration diagrams and as a means of migrating into analysis for technology development that overtly incorporates the network's structurated modalities (see Figures 3 and 4).

Note that the focus here is on representing the mechanisms of the humanchine network's ontological persistence, rather than the deconstructive evoking of the emancipatory structure, which is beyond the scope of this paper.

Data Collection and Methods

In this case study, following the recommendations of Klein and Myers (1999), an appreciation was initially created of the workings of a National Health Service primary care general practice in England, specifically the daily routine of the primary care team and its peripatetic nurses. Of particular relevance here, was their growing desire for and use of nomadic technologies to create ubiquitous information environments that enhance clinical practice and patient accesses to services. The source data for the modeling of the existing and possible future structurated humanchine interventions was based on interviews and discussions with members of the community primary care team and general practitioners, with close research links to the authors' and their

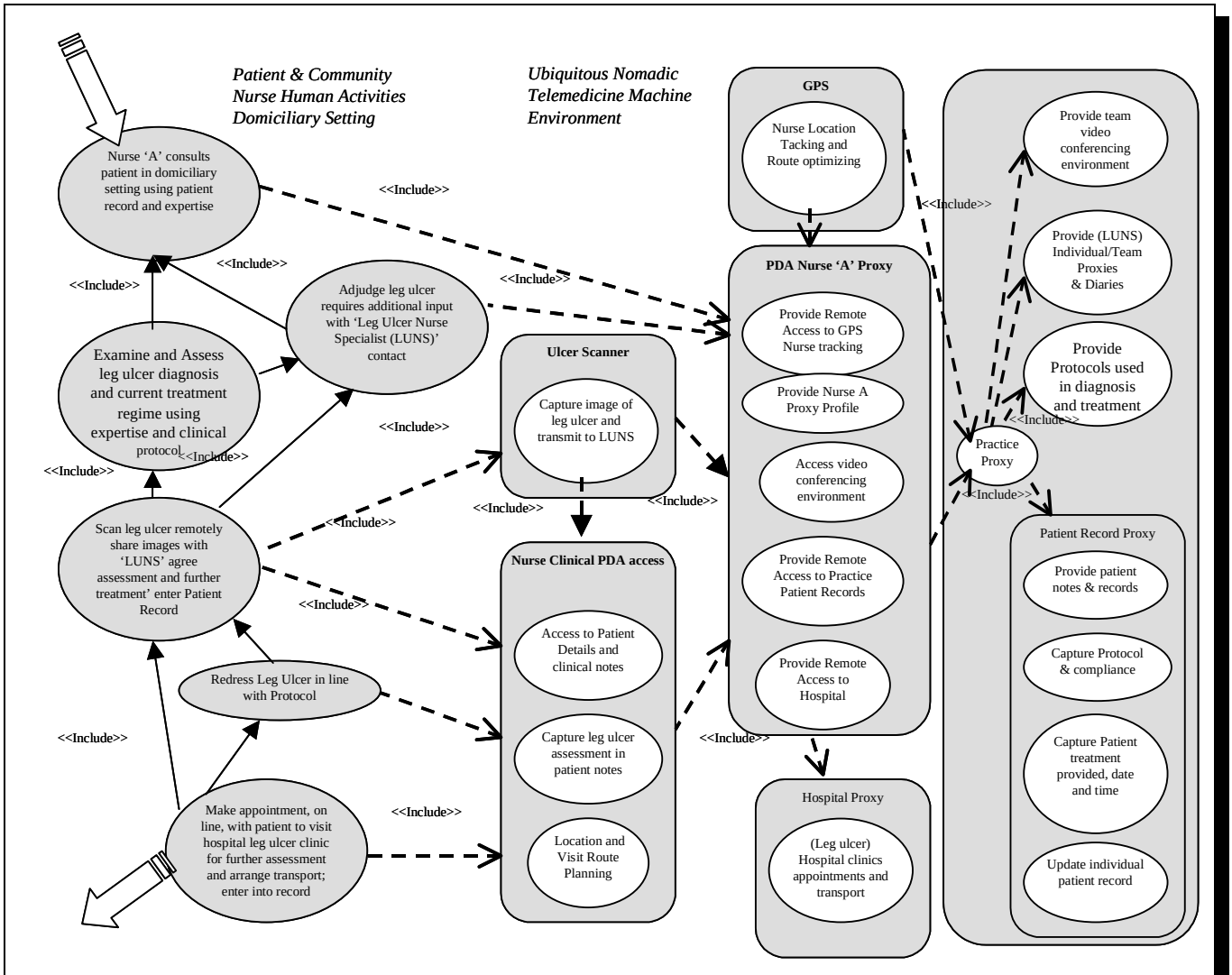

Figure 2. Leg Ulcer Domiciliary Visit Humanchine Nomadic Telemedicine Integrated Development Case

Table 1. Hybrid Expressive Model of a Typical Primary Care Nurse's Practice and Peripatetic Daily Clinical Routine

Primary Care Team Community Nurse Activity	Proxy	Nomadic Clinical Information Environment
Engage in primary care team (PCT) case conferencing via home video link.	District nurse person proxy maintaining ubiquitous relationship with clinical telecommunication networks, facilitating automatically and on request access to required clinical data bases, patient proxy, clinical team proxy and location monitoring sources	Provide primary care video link, agenda and patient files.
Agree diaries with care team for coming days.		Access individual and PCT diary .
Note any particular at-risk patients flagged by primary care team and priorities on shared team patient record.		Flag up at-risk patients. Prioritize on shared team record. Place note on patient individual record.
Review, from home or car, daily list of patient visits and attendances at community health clinics.		Provide daily patient list and community clinics lists.
Access remotely each patient's record and review requirements for each visit.		Provide patient record—general practice, specialty and hospital.
Assess nature of visit and degree of patient urgency or routine visit.		Capture degree of urgency and severity or routine visit.
Prioritize visits list if necessary using patient summary record.		Access summary records NHS net. Capture prioritized list.
View practice late addition lists to check if any additional patient required from visits list.		Provide late additions list. Capture inclusion on nurses list.
Optimize patient visit list routes and times using GPS tracker application, condition and urgency.		Optimize list according to location, urgency and severity.
Visit patient, access remotely patient general and detailed record for particular service, e.g., leg ulcer.		Provide general patient record and detailed record for this episode of leg ulcer care.
Consult patient in domiciliary setting using patient record and expertise.		Provide patient notes and records.
Examine and assess leg ulcer diagnosis and current treatment regime using clinical protocol and personal expertise and experience.		Provide leg ulcer treatment protocol and capture compliance and outcome of intervention.
Adjudge, drawing on expertise and experience that leg ulcer requires additional input with "Leg Ulcer Nurse Specialist (LUNS)" and contact.		Capture, by voice or text, initial leg ulcer assessment.
Scan leg ulcer remotely using portable application to develop images and share with LUNS agree assessment and immediate appropriate treatment and further treatment—enter into patient record.		Provide video conferencing environment. Capture image of leg ulcer and transmit to LUNS. Provide protocol used in diagnosis and treatment. Capture agreed assessment and treatment decision.
Treat and redress leg ulcer in line with protocol.		Capture treatment provided, date and time.
Make appointment, on line, with patient to visit leg ulcer hospital clinic for further assessment and arrange transport; enter into record.		Access leg ulcer hospital clinics appointments. Capture appointment and patient agreement. Update patient record.
Note that patient is becoming increasingly sedentary and confused, also bruising on arms notify, via email, social services of these facts. Flag up for virtual patient case conference with primary, community care team and social services.		Access patient primary care team record. Access at risk elderly person list. Capture general comments about patient condition. Capture/flag up patient name, number for primary care team and social services conference.
Update patient record for this episode of care, via voice application; down load image into it.		Update general record of patient and specific service record for patient to audit/management function.
Complete round of patient visits, check any extras from car and sign off shift.		Provide extras lists. Capture all patient visits, up date patient record.
Review putative patient and clinic list for next day.		Provide patient and clinic visits for next day. Provide team/practice calendar.
Review clinical outcome of the interventions and clinical protocols used.		Monitor clinical interventions and information sources used. Update data source/action menu.

Table 2. The Humanchine Network Structurated Order Modalities for Leg Ulcer Assessment and Intervention

Activity & Structure	Signification	Legitimation	Domination
Structural Modality / Humanchine Actor Activity	Interpretive Scheme *Knowledge Language*	Norm *Rights Obligations*	Facility *Authorization Allocation*
Community Nurse (CN) Scan venous leg ulcer remotely using portable application to develop images and share with LUNS.	Clinical knowledge. Detailed knowledge of patient and their history. Community knowledge. Clinical vocabulary. Local vernacular.	Rights with patient to make clinical decisions. Obliged to make professional clinical judgments with patient and initiate action.	Authorize LUNS input. Authorize scanner use. Allocate for patient access to diagnostic and treatment services.
LUNS/Community Nurse Agree assessment with LUNS and immediate appropriate treatment and further treatment; enter into patient record.	Clinical specialist. Knowledge leg ulcer. Familiarity with patient. Community knowledge. Clinical vocabulary. Local vernacular.	Right, with patient and community nurse to make clinical judgments. Obliged to contribute clinical expertise in support of CN and patient.	Authorize consultation and community services. Allocate access to diagnostic and treatment resources. Authorize and allocate treatment to patient.
Patient Confer with professionals and make decision on treatment.	Personal experiences presenting condition and its history. Community. Local vernacular.	Right to make final decision on and receive proper treatment. Obliged to participate.	Authorized, through NHS and statute, to receive proper treatment. Allocate home for visit.
Community Nurse Personal Proxy Provide access to ubiquitous information environment and other proxy and/or application proxy controller within it. Provide access to telehealth services.	***Human Specific*** Clinical knowledge bases. Patient knowledge bases Clinical languages. Technology specific. *Telecommunications protocols and standards.*	Right to provide to legitimate user access clinical info resources. Obliged to provide access on password to maintain tele-access and data exchange to/from CN, LUNS, patient records.	Allocate community nurse personal/organizational proxies in ubiquitous environment: teleconferencing access in text/voice and access to patient record, imaging and diagnostic images and protocols; hospital services.
Practice Proxy Provide access to practice.	Identification coding for proxies seeking to facilitate access to practice virtual ubiquitous environment .	Right and pbliged to provide access and facilitate data interactions to practice environment to proxies.	Authorize and allocate access to nomadic proxies (here community nurse) to specific practice functions.
Protocols Data Base Provide protocol used in diagnosis and treatment of venous leg ulcer.	Clinical terminology re venous leg ulcers. Clinical knowledge, diagnostic and treatment procedures regarding leg ulcers.	Right to be used in the diagnosis and treatment and leg ulcers. Obliged to provide research proven, practice protocol.	Authorize nurse diagnostic assessment and standards. Allocate leg ulcer treatment and procedures,
Practice Patient Record Provide access to record. Capture agreed assessment and treatment decision.	Clinical terminology re patient, details, current condition, and history. Clinical terminology and clinical imaging,	Right to accrue patient details and record. Obliged to maintain an ongoing accurate, patient record.	Authorize access to CN and LUNS clinicians' proxy to patient record. Allocate record space to images on diagnosis and treatment provided.
Hospital Proxy Controller Provide access to leg ulcer clinic booking and patient transport.	Patient accessible language. Knowledge about clinic applications and how to facilitate patient access,	Right and obliged to provide patient accesses to clinics and transport in clinic appointment application.	Authorize clinician and patient access to clinic and transport booking,
Hospital Clinic Appointment Application	Clinician vocabulary and knowledge. Diagrammatic representation of clinic slots booking.	Right to provide clinics slots and transport to patient. Obliged to allocate slots and transport according to hospital protocol.	Allocate clinic slots and transport to patient. Authorize patient access to slots/transport and their booking.

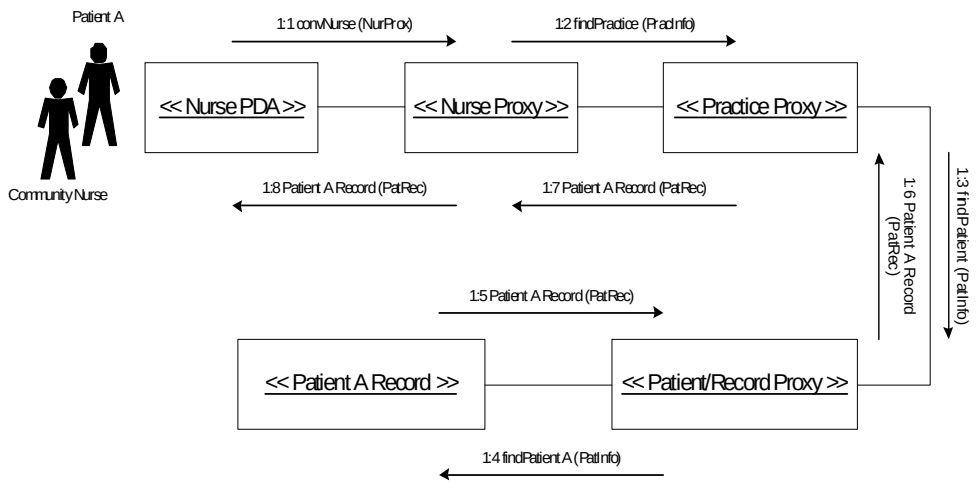

Figure 3. Actor Nomadic Object Collaborations for Accessing Patient Record Remotely

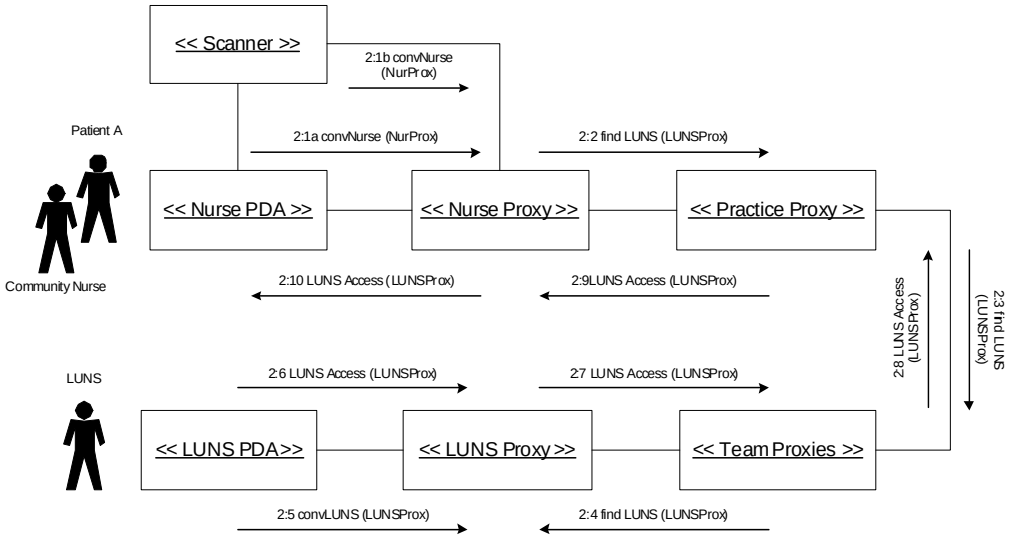

Figure 4. Actor Nomadic Object Collaborations for Community Nurse LUNS Dialogue

universities. An electronic patient record shared and accessed remotely by the primary care team has been developed *in situ* with major university input. Data collection involved interviews and discussions with community nurses and general practitioners within the practice. These activities focused on how the daily routines and clinical practices were currently performed and could be performed and enhanced in the future with the aid of nomadic devices (see Table 1, the primary care community nurse's routine). Filming of the current peripatetic workings of the leg ulcer nurse (with suitable patient anonymity) was made available to this study, illustrating current use of ulcer scanning devices in the domiciliary setting. The need for and issues of accessing patient records and providing additional expert advice and services, peripatetically, was discussed with clinical team members and general practitioners. With this rich multisourced data available, the peripatetic management of leg ulcers, it was decided, would afford an appropriate focus for the use and testing of the StructurANTion framework and its humanchine modeling as an research and development framework. In addition, it had the potential to inform existing and future clinical practice developments

incorporating the use of ubiquitous technologies. This exercise was also an exploration into the potential of StructurANTion to incorporate systemic approaches to inform and underpin future research and development. The soft information systems and technology methodology (SISTeM) afforded a modeling and conceptual framework for doing this. It also integrated a proven mutable language capable of the representation of nonhuman nomadic applications and devices, UML (Bennett et al. 2001).

SISTeM models take several forms (Atkinson 1997, 2000). They may be expressive (i.e., representations by actors in a problem situation of a set of humanchine activities currently being enacted). They may be conceptual (i.e., when compared with a real world problem situation they facilitate stakeholders' debate and decision-making). They may be normative (i.e., act as templates or designs for the realization of a new humanchine activity system in the real world). They may, as in this case, have a hybrid status in that they aid insight and afford potential for future development of humanchine activity. Hybrid expressive/conceptual humanchine activity models, as in this case, aid understanding of the primary care team's work routines. These types of narrative-based hybrid models (Table 1) were developed to specify the products and services being offered by prospective application suppliers as part of a multi-professional clinician-led application scoping and procurement process (Atkinson 1998). They were deployed here to explore, with the practice, the potential future use of nomadic computing in its capacity to enhance their peripatetic working from the practice into the community. These models capture the human and nonhuman actors and their structurated agency found in the StructurANTion framework. The StructurANTion sociotechnical modalities they draw on (and recreate) in performing these activities were considered later.

Column 1 of Table 1 presents an expressive model of a typical nurse's practice and peripatetic daily clinical routine plus their reflections on future working if they had access to nomadic sources of information. This was formed from the narratives of the participants within the project and the video of the workings of the leg ulcer nurse. Against these human activities have been added conceptually a nomadic clinical information services environment (Column 2, Table 1) accessed by the community nurse practitioner deploying from disparate sources using what was anticipated would be a clinical PDA and other devices. The peripatetic nurse practitioner in current practice deployed both a standard leg ulcer care protocol and a scanning device to assess and treat a patient's venous leg ulcer (Schofield et al. 2000) in the patient's home. As she is slightly concerned about the state of the ulcer, rather than go back to the practice in the future, the nurse, through her PDA, would access the patient's electronic notes and the leg ulcer nurse specialist for additional advice. The same verb/noun combination, within the SISTeM modeling, is used to expressively represent human and nonhuman activities. Together with the teleconferencing application and conversations, these would constitute a ubiquitous information environment that would cover not only this activity, but all of the peripatetic community nursing services. The practice clinical team then uses the models to reconfigure and improve information-driven ubiquitous clinical practices. A selection of these activities in Table 1 has been highlighted to illustrate how the ubiquitous information environment may be represented using a combination of SISTeM expressive modeling and modified UML nomenclature and is represented in Figure 2. It captures the manner in which the services of the ubiquitous nomadic information "object" actor environment, orchestrated by the nurse person proxy object, are integrated through links with the general practice proxy with clinical care services activity of the human nurse, the patient, clinical information, and nomadic conversations between nurses. Together they form a nomadic humanchine activity system delivering peripatetic services to the community, drawing on the delineated ubiquitous information environment. In addition Figures 3 and 4 illustrate the collaboration occurring between human and nonhuman actors in providing nomadic access to information and interactions between clinicians at a distance. In this case, a community nurse practitioner is treating, peripatetically, within their own home an elderly patient with a chronic and, apparently, deteriorating venous leg ulcer.

The community nurse is accessing informational resources within a ubiquitous health care information environment from the communicative structures she embodies from patient records accessed remotely within the general practice and remote conversations with a leg ulcer nurse specialist. She is drawing (Thompson 2004) on her own past experience and expertise of these cases as well as her innate immediate intrajected social structures to conduct her clinical activities. The use of standard UML nomenclature illustrates how such ubiquitous information environments are component dimensions of organizationally ubiquitous humanchine multitasking environments and may be incorporated within both research and development processes.

One of the main features is the manner in which humans and their nonhuman proxies form humanchine corporeal and virtual partnerships, mediated by mobile technologies, such as clinical PDAs and National Health Service general practice patient data bases. These interact with each other to constitute the structurated nomadic working information environments.

From within the StructurANTion theoretical perspective, if these nomadic human–machine active systems and their ubiquitous information environments are to persist over their time and space as well as exhibiting concert agency, it will be necessary for them to draw upon and hence recursively reproduce the intended humanchine network's distributed structurated modalities. To be effective in delivering clinical services nomadically and continuously over time and space within the network, it is important

that these structurated modalities not only underpin human action but are also inscribed in the artefacts that constitute the nonhuman component of a network's ubiquitous information environment and are reproduced through their functioning.

To that end, an analysis of the modalities of the ubiquitous distributed humanchine network needs to be undertaken. First, this ensures that humans' modalities in the existing or prospective humanchine and their agency are commensurate with that of, here, good clinical practice. Second, it is carried out to ensure that the required modalities are linguistically inscribed, functionally provided, and physically engineered into the nonhuman technical (i.e., the clinical information network and its multiplicity of artefacts). The result is that translation into the network creates a ubiquitous information environment commensurate with the network's desired structurated order and anticipated agency. To that end, an analysis of the desired modalities is carried out (see Table 2; note that this analysis is of an existing ubiquitous network and its incumbent structurated order, not one that is being created through the evocation of the emancipatory structure).

Appreciating what the desired modalities are is of importance in ubiquitous environments because (despite the interactions being virtually mediated across, sometimes considerable, distances and several time zones) they are still network (or one convened in the wider sociotechnicalété). Of particular concern here are networks that draw on multiple, dispersed actors, where some, such as the Internet or telecommunication environments, are not necessarily inscribed or inscribable with the anticipated network's desired functional modalities. In the example here, it would be necessary to ensure patient clinical confidentiality, patient data security, and the provision of images that are of sufficient resolution and clarity to diagnose conditions and provide care. In addition to this would be the ability for the ubiquitous environment to secure access to another network's information environment, for example, remote booking of hospital outpatient appointments achieved through a telecommunications environment that resides behind the UK NHS firewall.

This StructurANTion analysis, it is argued, not only facilitates research but also delineates how traditional technocentric approaches to information system development and implementation could be remodeled to accommodate the structurated orders of existing or prospective informated humanchine networks into which the technologies are translated and become, along with humans, constitutive actors in their own right.

Conclusion

The rapid pace of changes in nomadic information technologies, and especially the humanchine intimacies entailed within ubiquitous information environments, have to learn not only how to address this technically but to be able to adapt and recreate humanchine networks operating across increasingly globally dispersed nomadic humanchine networks. Change is always a feature of the humanchine, even when this only entails technological implementation and user training rather than an overtly sociotechnical intervention. Creating ubiquitous information environments entails changes to humanchine networks, but with added problems. First, accommodating multiple technologies and resources that transcend the normal strictures imposed on them by technologically static infrastructures and applications within traditional organizational settings. Second, these technologies and their standards and protocols are rapidly evolving. Third, there are, as yet, no technologies that change autonomically in the way humans do to changes in the networks modalities; this will be part of the future of the humanchine nomadic network. Finally, there is a need for theoretical research frameworks and pragmatic approaches to developing ubiquitous information environments that move away from a technocentric focus toward that of the humanchine network. In proposing the StructurANTion framework, this paper sought to explore how theoretical developments lead to pragmatic developments.

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