

¹SDI ontology and implications for research in the developing world

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*Dedicated to the memory of Fritz Petersohn
and his indomitable spirit*

Abstract

I examine key SDI concepts: ‘information’, ‘decision processes’, ‘people’, ‘management systems’, ‘social structure’ and ‘information technology’. I attempt to make explicit commonly held assumptions about the nature of these concepts, the ways they contribute to a ‘construction’ view of SDI implementation and their apparent disconnectedness with the realities in the developing world.

I suggest alternative understandings of these key concepts that lead to a ‘cultivation’ perspective for SDI design and implementation. A ‘cultivation’ perspective is more likely to help us understand how human actors strike and sustain a dynamic balance between global uniformity and local contextual solutions in SDI design and implementation, especially in developing regions.

Keywords: SDI ontology, construction, cultivation, research implications

1. INTRODUCTION

“Abraham falls victim to the following illusion: he cannot stand the uniformity of the world. Now the world is known, however, to be uncommonly various, which can be verified at any time by taking a handful of world and looking at it closely. Thus this complaint at the uniformity of the world is really a complaint at not having been mixed profoundly enough with the diversity of the world.”

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– Kafka, Parables and Paradoxes

Geoinformatics research is concerned with the *“use of geo-information technology in organised human enterprise”*. Geographically, this research has focused largely on public sector organisations in developed nations. Since geoinformatics is an applied field, it is not surprising that over the years we have internalised (mainly positivist) concepts and methodologies from broader reference disciplines, such as informatics, management science and social sciences, in order to explain GIS implementation phenomena. The reason is obvious. ‘Geo-information technology’ points to the reference discipline of informatics. ‘Organised enterprise’ points to the reference discipline of management science. ‘Use’ and ‘human’ point to the reference discipline of ‘social sciences.’ With the re-conceptualisation of inter-organisational GIS as spatial data infrastructure (SDI), SDI research has become a growing area of attention within the field of geoinformatics. SDI research is concerned with the use of geo-information technology in organised human enterprise *“across numerous administrative, political, cultural, sectoral contexts, spread out across time and space”* and has also focused largely on developed nations.

Positivist approaches may help in understanding information system implementation, when the geographical, economic, cultural, historical, experiential ‘distance’ between the context of design and the context of use of the information system is small or negligible. However, for infrastructural information systems, like SDI, that span numerous contexts spread out globally, the exclusive reliance on such approaches is unlikely to provide rich insights of how different actors strike and sustain a dynamic, often precarious balance between global uniformity and local contextual solutions. In this paper, I argue for more pluralism and diversity in research especially for understanding SDI implementation phenomena in developing regions. The rest of the paper is organized as follows. In section 2, I discuss the commonly-held but implicit assumptions about key SDI concepts and their apparent disconnectedness with reality in the developing world. In sections 3 and 4, I suggest alternative understandings for these same concepts, and outline implications for SDI research.

2. EVOLUTION OF THE SDI DEBATE AND CURRENT SDI ONTOLOGY

Authors taking a historical perspective identify different phases of knowledge development especially in newer, more technologically driven subjects like information infrastructures. For Ernest J. Wilson III (2000) there are four: the «technical», «mythical», «socio-technical» and «multi-disciplinary» phases. Wilson points out that each and every phase is essential and centrally informs the debate, before a new set of issues comes to the fore in the next phase, with different arguments, audience, principal authors, concepts and methods. The

«technical» phase is dominated by engineers and natural scientists taking a technology deterministic perspective and defining problems in technical terms, needing technical solutions. The powerful technical orientation is not surprising given the central role of technology in the subject at hand.

In the «mythical» phase, futurists take over and advance grand, apocalyptic visions of how information technology will change society, *“blow apart all the monopolies, hierarchies, pyramids and power grids of established industrial society”* (ibid. p. 2) and increase competitiveness. The «socio-technical» phase brings into the picture non-technological dimensions and advances institutional, political and distributional issues, such as who should pay for the infrastructure, who owns it and how it should be operated. The «multi-disciplinary» phase is dominated by university-based scholars, social scientists, natural scientists and engineers who develop and test theories to reflect on the intricacies of the topic at hand from multiple perspectives. A look at the current SDI discourse through Wilson’s lens reveals that we find ourselves, roughly speaking, in the «technical» and «mythical» phases, especially in developing regions. The technical and mythical discourses rely on a certain SDI ontology, in other words, on certain implicit assumptions about the nature of key SDI concepts: information, decision processes, people, management methodologies, social structure and information technology.

2.1 «Technical» phase

Typical of Wilson’s «technical» phase, is the notion that the SDI can be engineered or ‘constructed’ by selecting, putting together and arranging a number of technical, managerial and institutional artefacts, such as data, metadata, clearinghouse services, standards, legal frameworks, information policies, partnerships, institutional arrangements, etc. These artefacts will interact among them in predictable ways very much like the ingredients prescribed in a ‘cookbook’ and mixed in a more or less orderly fashion to construct the end-product, the SDI.

The technical discourse relies on certain implicit assumptions about the nature of information, decision processes, people, management methodologies, social structure. Specifically, information is considered standardisable, formal and quantifiable while decision processes are assumed stable, straightforward and based on rational criteria. People are considered uniformly rational agents and amenable to formal, rationalist and objective management methodologies. Social structure ‘impacts’ human agency and system implementation in a uni-directional way.

2.2 «Mythical» phase

Typical of Wilson's «mythical» phase is the notion that when SDI is available, geographic information will be available to people who need it, when they need it and in a form that they can use in order to make decisions with minimal pre-processing. This ideal condition will lead to cost savings in the short term, improved service delivery and more effective policy formulation and implementation in the medium term as well as macroeconomic benefits, such as greater competitiveness and innovation, job creation, new firms, increased GDP and tax returns. The expensive 'construction' activity is justified by the belief that when the end-product (SDI) is available, we will be able to concentrate on real issues - food security, water supply, environmental regulations, law enforcement, national security, economic growth, social progress etc - without worrying about the availability of geographic data and information.

The mythical discourse relies on certain implicit assumptions about the nature of information technology. Specifically, information technology is considered a value-neutral, a-historical and globally enabling mechanism that will launch us into a brand new world. The mythical discourse is a subset of a much broader debate on the digital sublime. Few commentators have explored with more erudition than Mosco (1998, 2003) the myths constructed around the digital sublime and why we feel compelled to believe in them. Myths are not just falsehoods that can be disproved, Mosco points out, but stories that lift us out of the banality of everyday life into the possibility of the sublime, the realization of a perennial dream of humanity for instant access to the world's store of information. Information technology will help us realize, with little effort, those seemingly impossible dreams of democracy and community with practically no pressure on the natural environment because:

"...everything that came before is prehistory, of little value save to account for the extent of the contemporary rupture. [...] The denial of history is central [...] because to deny history is to remove from discussion active human agency, the constraints of social structure, and the real world of politics." (ibid. p.59- 60)

The technical and mythical phases imply that we can assemble sanitized technical, managerial and institutional artefacts in an a-historical process of SDI 'construction' from scratch, if we stick to uniform, standardised solutions. Complexity can be curbed, risk can be controlled and heterogeneity overcome. Paraphrasing Ciborra (2002) this is what we do: we idealise everyday tinkering and call it strategy; idealize technology as a controllable set of means and call it IT; idealize people and call them a rational human agent. The concepts of strategy, IT and rational human agent are granted existence and essence and transformed into boxes with a line between them. Then starts the difficult journey back to the real world to measure 'the strength of the line' or formulate prescriptions to be followed by managers when tracing the line on the field of

practice. The assumptions we make about the nature of reality (SDI ontology) influence the criteria we choose for evaluating knowledge claims (epistemology) and the procedures by which knowledge is generated (methodology). In this case, a positivist epistemology is mobilized to verify hypotheses and search for universal laws and principles. Methodologically we rely on formal propositions, quantifiable measures of variables, hypothesis testing and drawing inferences from a sample to a stated population (Orlikowski and Baroudi, 1991).

However, the international development literature suggests a disconnectedness between such an ontology and the reality on the ground. In developing regions, failures of information systems (including GIS) implementation in general and e-governance initiatives in particular, by far outnumber successes. Heeks (2001) estimates that e-governance projects in developing countries are 35% total failures, 50% partial failures and 15% successes. Drawing upon multiple case studies and individual country reports, he also finds failure to be the dominant theme in the implementation of information systems (incl. GIS) in general (Heeks, 2002). He attributes failure to the gap between 'hard rational design' and 'soft political realities' caused by the three-way association of information technology, universalism and western rationalism. Avgerou (2000) similarly argues that the universalist visions of economic and institutional development accompanying efforts to promote the diffusion of information technology have two effects. They downplay the path dependence and historical contingency of the development process and frustrate efforts to make sense of locally meaningful ways of accommodating information technology in socio-economic activities.

Bilateral donors concerned with the development of public sector capacity in developing regions recognise that a holistic and pragmatic approach is needed to face the renewed demands on public sector capacity arising from the increased focus on poverty alleviation as expressed in the millennium development goals (MDG) and the targets of the poverty reduction strategy papers (PRSP). For example, a DANIDA report titled *'Between Naivety and Cynicism: A pragmatic approach to Donor Support for Public Sector Capacity development'* stresses that the 'functional-rational' dimension of organisational analysis, which often adopts a rather mechanical view of how to optimise work tasks and performance, must be supplemented by what is lumped together under the label of the 'political' dimension of public sector. *"Broad and sustained change is the result of complex processes that cannot be explained with reference to a few determining factors, nor created by means of a standard recipe across time, sectors and countries"* (DANIDA, 2004, p.6).

3. ALTERNATIVE SDI ONTOLOGY

An alternative understanding for 'information', 'decision processes', 'people', 'management systems', 'social structure' and 'information technology' is needed, to connect these concepts with the reality on the ground, especially in developing regions (see Table 1).

3.1 Information and decision processes

The emphasis on information as a standardised, formal, quantitative resource marginalises the reliance of human beings on informal as well as formal sources of information in decision making processes. Galliers (2003) argues that building information systems which leave little scope for interaction with the host of less formal systems - which are pervasive in organized human enterprise - handicaps the effective use of information technology. Harvey and Tulloch (2006) argue similarly with regard to the wide-spread informal data sharing practices among state-level public agencies in the United States of America and how they may handicap the national SDI initiative, if they are ignored.

The conceptualisation of decision processes as stable, straightforward, formal and based on rational criteria and high quality information raises eyebrows with information scientists and public administration scholars alike. Oettinger (1990) dismisses claims that an ideal military command and control system supporting a commander in the field is such that command decisions are made with confidence and are based on information that is complete, true and up-to-date. *"When I see such ideals expressed, it implies to me either cynical salesmanship mixed in some proportion with naïve fervour or else a sincere belief in human perfectibility,"* writes Oettinger (1990, p.3). van de Donk (1998) warns that ignoring interests and ideology in public policy making, or regarding them as illegitimate or as irrational components of resistance to the truth and beauty of research is to misread the nature of democratic decision-making.

"The real world of information processing in the domain of public policy making [...] is characterised by several types of information (manipulated statistics, high quality research, gossip, editorial comments, evaluation reports, corridor analysis); information pathologies (faulty receptors, failures in communication, information overload, systematic biases) and information politics (manipulation, non-registration, withholding, biased presentation, adding other information, timing, leaking and so on). When looking with an information processing perspective on policy making, it is not surprising at all that one comes up with such a metaphor as a 'garbage can'." (ibid. p. 391)

3.2 People and management methodologies

The emphasis on a universal and a-contextual notion of human rationality leads to the dismissal as 'irrational' of diverse systems of reasoning arising from

particular historical experiences and related to local culture. Avgerou (2000) draws upon case studies of public sector information systems implementations in Greece and Cyprus, to reveal that the apparently 'irrational' behavior of staff was instead a clash between the rationality inherent in the technical innovation and the local, historically developed, system of values and reasoning. Ciborra (2002) is similarly critical of the narrow model of rational, ideal actors in rationalist management science and instead celebrates the 'authentic human person'. Drawing upon many cases of failed automation in various types of organizations, Ciborra (*ibid.*) argues that rationalist management models fail because, due to various, turbulent and unpredictable circumstances, managers are busy muddling through, betting and tinkering. He suggests a style of research that does not estrange us from the worldly existence of people at work and their small and big 'dramas', a style that goes back to the facts themselves, putting into brackets received concepts such as strategy, technology, and in general the power of models and representation, while adopting a new language to talk about the interaction between strategy and technology.

3.3 Social Structure

Dualism of social structure and human agency rests on the assumption that social structure (including culture) impacts human action in a uni-directional way. The human agent draws upon a set of cultural norms which are 'out there' and are treated as antecedent, external and coercive vis-à-vis the individual human agent (Sahay and Walsham, 1997). Sahay and Walsham question this dualism between social structure and (managerial) human agency and action. Based on a longitudinal study of an Indian government initiative to use GIS for the management of degraded land, they find that human agency draws upon the rules and resources embedded within the Indian social structure to create managerial agency, which in turn can reinforce or change social structure. They reject the image of a human as a 'cultural dope', - a person who is confined to reproduce the stable features of her society by acting in compliance with pre-established courses of action dictated by common culture. Avgerou and Madon (2002) advocate the broadening of the focus of IS innovation research to trace the roots of behaviours encountered in information systems implementation to economic, cultural and political domains of the social context.

Sahay (1997) criticizes the dualism between social structure and information system implementation. He argues that the dominance of research studies within a positivist tradition searching for reductionist measures such as the elusive dependent variable of DeLone and McLean (1992) takes a static and limited view of information system implementation. He suggests a more integrative approach with efforts being directed towards understanding the social context, the process of implementation and how they relate to each other. The social context and the implementation process are seen as mutually interacting, each being constitutive

of and constituted by the other. Chrisman (2006) similarly argues for a full circle of technology-society implications. *"GIS [...] is constructed and embedded in historical and geographically contingent settings. The full circle requires an openness to studies of the influence from the social realm to the technology. By tracing the full circle, we can better appreciate the implications to society. (ibid. p. 23)"*

3.4 Information Technology

The view of information technology as a value-neutral artefact has been emphatically contested outside and within the GIS field (e.g. Abbate, 2000; Chrisman, 2006). Sahay's (1998) three-year longitudinal study of an Indian government GIS program showed that assumptions with respect to time and space, inscribed in GIS technology, were at odds with indigenous perceptions of time and space, and contributed to problems in project implementation. Also, the view of information technology as a globally uniform mechanism leading to globally relevant products or processes, that is, innovations which are novel and uniform for all rather than novel within specific contexts or environments, marginalises local, contextual technological innovation which is fairly widespread in society and can occur under a very wide set of circumstances (Gurstein, 2004; Warschauer, 2003; de Laet and Mol, 2000). This view is not only flawed but potentially damaging as it favors the allocation of resources to elite academic institutions and research centers, primarily urban and overwhelmingly from those with existing highly advantaged economic and social status (Gurstein, 2004). Local and contextual innovation can have significant impacts through the effect of a 'trickle up' from local adaptations and community based innovation, which can have more significant and broadly distributed impacts and benefits than the 'trickle down' effects of global innovations promoted by global and national scientific elites, because it is locally based and potentially very wide-spread (ibid.).

The view of information technology as 'ending' history blinds us to lessons relevant to information infrastructure development *in a certain* nation from historical precedents, such as the evolution of large scale, physical infrastructures in that *same* nation. Friedlander (1995a,b; 1996a,b) asks for railroad, telecommunication, power and banking infrastructure in the USA: how did the infrastructure begin to develop? When did it achieve critical mass? What were the driving technologies? What were the roles of the public and private sector? How did an integrated infrastructure evolve? Berlin and Schatz (2002) similarly examine the history of the railroad and banking infrastructures in the U.S.A. to understand the future evolution of healthcare infrastructure in the same country. Mosco (1995, p. 18) looks at the history of electrification for inspiration: *"Some of the questions posed about the development of electrification are relevant today. What were the political and economic factors contributing to the*

construction, ownership, management and spatial distribution of the electricity infrastructure? What were the implications of these historical choices for the spatial organization of social and economic life?

To gain useful insights for SDI evolution in India, for example, it may be more appropriate to examine how the development of the STD infrastructure in this country transformed the communication landscape during the 1980s-early 1990s (Chakravartty, 2004), and is now firmly embedded in the fabric of the Indian society, especially in rural settings. Subscriber Trunk Dialing (STD) provides national and international telephonic connectivity to people through more than 700,000 STD “booths” that dot the urban and the rural landscape of India. The indigenous development of digital switching hardware and software for rural automatic exchanges (RAX) by the Centre for Development of Telematics (C-DOT) in the 1980s was the key driver behind this STD “revolution.” These designs were appropriate not only for the hot, humid and dusty operating environment in which the artefacts were deployed, but also the social settings of their use.

Table 1: Current and alternative understanding of key SDI concepts

Concepts	Current understanding	Alternative understanding
Information	Standardised, formal, quantitative	Contingent, informal, qualitative
Decision Processes	Stable, straightforward and formal based on logical criteria	Flexible, complex, based on ideology and power games
People	Universal rationality	Diverse rationalities, culture, values
Management methodologies	Formal objective processes and structures	Muddling through and tinkering
Social Structure	Dualism of social structure and managerial agency Dualism of social structure and SDI implementation	Mutually reinforcing social structure, managerial agency and SDI implementation
Information Technology	A value-neutral, globally enabling mechanism, ‘ending’ history.	A complex, value laden, socially shaped, historically contingent entity

4. IMPLICATIONS FOR SDI RESEARCH

The alternative conceptualizations discussed in the previous sections are well entrenched in the theory of information infrastructures (Hanseth & Monteiro, 2004). The theory of information infrastructures has its roots in the sociology of

technology research tradition (for example, Callon & Law, 1986; Latour, 1987), and has been extensively applied in information systems research to analyze not independent but networked systems whose development is not controlled by any one actor (Hanseth & Monteiro, 2004). The information infrastructure perspective emphasizes that the social and technical are not separable and are instead constituted and constitutive of one another.

However, to analyze the implementation dynamics surrounding SDIs, it is important to go beyond Hanseth and Monteiro's ontological characterization of what an information infrastructure is (enabling, shared and open) to also examine in an epistemological sense the socio-technical processes and embedded practices by which the information infrastructure can be cultivated and to become open, shared and enabling. Georgiadou et al. (2005) provides a detailed account and articulates a potential research agenda drawing from empirical data of a case study in India. Here, I briefly outline the epistemological and methodological implications of an alternative SDI ontology.

4.1 Cultivation approach to SDI design and implementation

Cultivation has been emphasized by various proponents of the information infrastructure perspective (for example, Hanseth & Monteiro, 2004; Rolland & Monteiro, 2002; Hanseth & Aanestad, 2003) as a rich analytical tool to approach the design of information infrastructures. Cultivation methods represent a more conservative approach to design than 'construction,' which tends to privilege the power of human agency in "selecting, putting together, and arranging a number of objects to form a system" (Dahlbom & Janlert, 1996, p. 6). Instead, cultivation emphasizes the *power of the material*; "the tomatoes themselves must grow, just as the wound itself must heal..." (ibid., p. 6), implying that the 'development organization' or 'product' being developed should be considered as a unified socio-technical network without privileging one over the other.

The power of the material which the cultivation approach emphasizes derives from the *installed base* and the resulting *lock-in* effects (Hanseth & Monteiro, 2004). This lock-in effect represents a dilemma in evolving an information infrastructure as it creates inertia and with it a conservative influence. The dilemma cautions against the need to adopt radical (construction kind of) approaches to change and instead favours an incremental (cultivation kind of) strategy that involve modifications to small parts at a time while keeping them simultaneously aligned with the rest of the network. A cultivation approach emphasizes the 'improvisational' processes of change, and the potential of what people do in situated action (Suchman, 1987), and does not just focus on planned and rational approaches (Ciborra et al., 2000). Design is seen not as a well defined process with pre-configured start and end states, but as an ongoing process of ecological change, characterized by 'unanticipated effects' (Walsham,

1993), and 'drift' (Ciborra, et al., 2000) reflecting our inability to fully anticipate future events.

4.2 Methodology

As Wilson (2000) points out, advancing the SDI debate to the next phase would involve rigorous empirical research using multi-disciplinary perspectives. Ongoing conversation taking place between 'tales from the field' (van Maanen, 1989) and theoretical concepts help to develop both our conceptual understandings and approaches to practice. Given the nature of the SDI phenomenon, research teams should be constituted in multi-disciplinary terms (sociologists, anthropologists, geo-scientists, information system researchers and economists) and supported to conduct longitudinal research (rather than one time studies) that can follow the unfolding of the process dynamics around SDIs over time. Also, as information systems research has emphasized, implementation analysis is best guided by an interpretive philosophy where the different social meanings of various stakeholder groups are emphasized, as contrasted to a positivist approach where assumptions are made about objectivity of data and the generation of statistical generalizations (Walsham, 1993; Klein & Myers, 1999).

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