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Reflections on Bradley's Convergence Model

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1 The Convergence Model in perspective

A field of study comes into its own when it becomes capable of explaining and reflecting upon itself at a systemic level. That is, from a perspective that is broad enough to see at different levels of abstraction how phenomena that were once studied independently are related. Most scientific fields have undergone this epistemological evolution. Bradley's Convergence Model (2006) has brought social and community informatics to this stage. For this we are grateful to our colleague and friend.

The Convergence Model has given us a comprehensive framework and a process-view of social and communicate informatics where none existed. This systemic view has enabled us to understand the many, disparate phenomena that have been studied and documented within these two connected fields. It has often been the case that vastly different methodologies have been used to perform social and community informatics research, often without awareness of other approaches or, if awareness exists, without intention to relate a chosen methodology to those used by others. Arguably, there has also not been a sense for what the research roadmap for community informatics is or should be. A systemic view allows the results of different approaches to be normalized and mapped on to each other to produce new knowledge. A systemic view allows seemingly unrelated terms to be resolved into coherent definitions. A systemic view also allows the scientific production of knowledge to fully begin within a field.

A clear example of the importance of developing a systemic view of a field of study can be seen in mathematics with the independent efforts in the late nineteenth and early twentieth centuries by David Hilbert, Alfred North Whitehead with Bertrand Russell, the Bourbaki group, and others to ground mathematics to some unified system. Hilbert's "23 Problems" -- presented in a now famous speech in 1900 -- listed key unsolved problems and influenced the focus of much of the field of mathematics to this day (Rowe & Gray, 2000). The legacy of Hilbert's challenge can be seen in the nature of Andrew Wile's solution of *Fermat's Last Theorem,* which is related to the tenth problem in Hilbert's list and which took over 350 years for the field to solve. Wile's approach drew upon disparate areas of mathematics, the linking of which would likely not have been arrived at without the 'roadmap' set out by Hilbert or the development of a systemic view of the discipline that has evolved out of the work Hilbert and the others (c.f. Kolata, 1993).

Kristen Nygaard and Ingar Roggen of Norway were pioneers in the study of social impacts of computer technology (Liskov, 1981; Førstelektor and Godejord, 2009). Ingar Roggen is believed to have originated the term 'sosioinformatikk'(Førstelektor and Godejord, 2009). A common definition of social informatics is "the interdisciplinary study of the design, uses and consequences of information technologies that takes into account their interaction with institutional and cultural contexts" (Kling , 1999). This study occurs along three principal dimensions: theories and models, methodologies, and philosophical and ethical issues. The Convergence Model is mainly representative of the first category, but it draws deeply from the other two. Community informatics is seen in relation to social informatics as an interdisciplinary field concerned with the development, deployment, and management of information systems designed with and by communities to solve their own problems. Other areas of focus related to social and community informatics have arisen. The most prominent among these is 'development informatics', which is concerned with ICT within developing countries.

The Convergence Model has not been the only important model within the broad scope of research related to social and community informatics. Dervin's (1983) three decade research on sense-making and the resulting Sense-Making methodology is a another example of systemic model on the scale of Bradley's. The Convergence Model is, however, among the first, if not the first, to propose a systemic explanation of the dynamics and interrelationships between a comprehensive set of objects of study within social and community informatics.

A casual reader of Bradley might view her work as solely the result of an exhaustive scientific exercise. For those who have read her more deeply -- and surely for those of us who have been fortunate to be in her presence -- the Convergence Model is clearly the product of an attempt to improve the quality of life within human society. She has stated that an initial motivation for her work was to find out what computer scientists were working on and whether they were contributing to society (2006:6). Her life work represents an assertion that we cannot make appropriate scientific contributions without understanding human needs nor without a comprehensive understanding of how society is affected by the information and communication technologies that we create.

The usefulness of the Convergence Model is critical in this respect and for this period in human development: we confronting multiple global crises, each of which threatens humanity and technology is at the same time implicated in all of them and is seen as offering solutions. It is for this reason that the Convergence Model must be operationalized. A key site for reflecting on the Convergence Model and how it might be extended and operationalised is the renewed interest in cities and a little-known or largely forgotten attempt to model the city-as-system in the way that is analogous to how Bradley has tried to model the relationships between ICT and society.

We are in an era of the pursuit of the 'smart city', where long-standing, mainstream desires for automated and networked communities are now being reified. Once discrete areas of automation and data communication like policing, traffic management, telecommunication, and public transport are now being integrated across the ICT architectures of cities, not to mention integration on other geo-political scales. The economic and political models of cities of all sizes now depend not only on operating in a manner that is technologically 'smart', but on offering their residents and businesses advanced ICT infrastructures. ICT are also being viewed as an essential part of proposed solutions to our crises, most especially climate change as we will discuss below.

Cities can only be studied as a systems, or as convergences of subsystems, whether in terms of their economic impact, physical evolution, consequences of policy, or the social dynamics they foster. Sassen (1991) presented an empirically-derived conception of a global city in *The Global City: London, Tokyo, New York* in which she showed through extensive analyses how such cities can be viewed as interconnected systems, particularly in the context of global economic forces. Castells (2004: 90), among others, has described the need for a complex system of requirements in urban planning in this age, which recognizes the 'social and functional diversity' of human settlements and the need to respond to changes in social norms in identifying requirements. The Benton Foundation (2004) has, among others, documented systemic gaps in the technologies that exist within cities.

Given the city as a site for reflecting on and applying the Convergence Model, this chapter attempts to draw parallels between Bradley's work and the body of work by a now seemingly obscure architect and urban planner, Constantinos A. Doxiadis. Doxiadis developed the theory of 'Ekistics' as an attempt to systematize the analysis of 'human settlements', his general term for intentional habitats of any scale organized by humans (1968). Ekistics is not seen by this author as necessarily the sole nor ideal perspective from which to evaluate Bradley's work. It is, nonetheless, seen as relevant, useful, and intriguing for four reasons:

(1) the motivations for Doxiadis's work were similar to Bradley's;
(2) Doxiadis's theory was, like Bradley's, based on extensive empirical research;
(3) the scope of Doxiadis's model was comparable to that of the Convergence Model; and
(4) Doxiadis offered clear ideas for the practice of Ekistics that could be used as a template for future work in operationalising the Convergence Model.

Through Ekistics, Doxiadis pursued the abstract idea of 'anthropolis' (1974:XIII), a city that satisfies the needs of its inhabitants, its environment, and its own evolution through a systematic and empirical analysis of how 'human settlements' evolve and the problems that they cause.[1] He predicted before widespread awareness of the potential impacts of global networks of communication and commerce that human settlements would converge along many dimensions into an 'ecumenopolis' or global city (1974:10). Sassen (1991) and others have later arrived independently at related perspectives.

The Convergence Model is based on a fitting metaphor for our time. One could argue that we are at least approaching the creation of an 'ecumennet': a virtual analog of ecumenopolis resulting from the global convergences of data and communication networks; software services; and, recursively, the social, economic, and political dynamics these convergences enable.

2 The City as Solution

Rachel Carson in "A Fable for Tomorrow", the opening chapter of her influential book *Silent Spring,* conceptualizes the ideal "town" as part of nature. She wrote that it is "in harmony with its surroundings" and it "lays in the midst of a checkerboard of prosperous farms" (1962:1). She went on, as we know, to describe a situation where a "strange blight [began to creep] over the area and everything began to change" (2).

The basis for Carson's critique was technological: "Only within the moment of time

1 Doxiadis sometimes referred to this in sociological terms as a state of 'entopia'.

represented by the present century has one species – man – acquired significant power to alter the nature of his world" (6). Ultimately, she argues that "the public must decide." In this case, of course, the decisions she alluded to would be focused on environmental contaminants, or "elixirs of death" as she called them (13). The implication of Carson's work for this discussion is that her principle has been extended in social and community informatics to say that communities must decide how technologies are to be used and to what extent they are allowed to impact their environments. The term 'environment' in this context includes not only the Carsonian natural environment, but various other domains, including science, law, technology, psychology, sociology, politics, and economics. This type of decision-making can occur only through the development of conceptual models and research programs of the nature proposed by Bradley in her Convergence Model. This must also take place in an ongoing review of impacts.

Concern over the impact of humanity's technology on its habitat has steadily increased over the past century. Doxiadis examined human settlements in this context. Still the popular notion of being "environmental" was and has arguably meant "going back to nature" or in other words to go away from human settlements, most especially the city. This notion has been embedded in many popular socio-economic movements over the years. Back-to-the-land movements of the 1960s and 1970s reinforced the rejection of the city and, thereby to a certain extent, human settlements in general, in their quest for ways of living that were less harmful to both natural environments and humans themselves.

Times have changed, however. The environmental movement has in its maturity evolved a more sophisticated view of the role of human settlements in creating a more environmentally-sustainable future. The *2006 Annual Report of the Cities Alliance* – an organization affiliated with the United Nations Human Settlements Programme (UN-HABITAT, 2006) – pointed to the city as a major solution to our environmental, climate, and resource problems. The report states (3-4):

> Cities occupy just 2 percent of the Earth's surface, yet their inhabitants already consume 75 percent of the planet's natural resources for goods and services, and 80 percent of global carbon dioxide emissions originate in towns and cities. Although it has become conventional wisdom for some that cities are threats to both the global and the local environment, the world's urban areas may actually offer the best hope for a sustainable future. ... Cities are already the world's economic engines, accounting for almost 80 percent of total economic growth. Cities are also proven poverty fighters. Urban dwellers have higher incomes than their rural counterparts and consume less energy per unit of economic output.

The recent period has seen these reconceptualizations of the human settlement as solutions to some of the crises facing human society. We have seen this most recently with a rising interest in local agriculture models and, more generally, local economic models.

Whatever the focus, it is increasing difficult, though not impossible, to contemplate these futures without information and communication technologies. An example of this reconceptualization has been the pursuit over the past decade and a half of the so-called 'smart city' or 'intelligent city'. While attractive to many, the smart city is problematic in many ways that must be addressed through social and community informatics research and praxis.

3 Smart Cities

The concept of the 'smart city' or 'intelligent city' has been discussed for some time (c.f. Droege, 1997; Dutton, 1987). Part of Graham's characterization of the interest in "smart cities" has been as a "'post-urban' fantasy" that includes four elements: a move away from materiality, the elimination of distance, electronic forms of democratic transformation, and the 'infinite city'" (2004b:4 – 9). Several formal definitions of the smart city have been derived by organizations that have had as their mandates the evaluation of smart cities. Their definitions each imply subsets of Graham's elements and are invariably and inextricably-linked with the use of advanced information and communication technologies.

The Centre of Regional Science at the Vienna University of Technology; the OTB Research Institute for Housing, Urban and Mobility Studies at the Delft University of Technology; and the Department of Geography at University of Ljubljana have collaborated to produce rankings of smart cities within the European Union. "A Smart City" according to them is "a city well performing in a forward-looking way in [...] six characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens" (Centre of Regional Science, Vienna UT, 2007:11). The six characteristics pertain to economy, people, governance, mobility, environment, and living.

Industry Canada oversaw a "Smart Communities" initiative as part of the Government of Canada's portfolio of on-line initiatives, which included other related areas such as eGovernment and healthcare. The Industry Canada initiative selected twelve communities and provided them with funding to support further development of their smart community visions. Smart communities were defined in this Canadian initiative as those having "a vision of the future that involves using information and communication technologies in new and innovative ways to empower their residents, institutions and regions as a whole" (Government of Canada. Industry Canada, 2000:8).

The influential Intelligent Community Forum (ICF) emphasizes the deployment of broadband. It sees broadband as a "fertilizer" for innovation (Intelligent Community Forum, 2008). Intelligent communities are seen as those which are focused on innovation and those which market their community so as to attract globally-competitive businesses and the workforce necessary to maintain them. The ICF defined five indicators of an intelligent community in 2002: (1) significant broadband communications, (2) programs that develop a labour force for "knowledge work", (3) programs to reduce the digital divide, (4) availability of "risk capital" to fund new businesses, and (5) programs for marketing economic development by leveraging the local broadband and knowledge work resources of the community. The ICF's set of current indicators have evolved somewhat. By 2008, the category of "risk capital" had been removed. That indicator seems to have been replaced with "innovation", which is defined as efforts by local governments to build innovation capacity as well as investment in improving e-government efficiencies.

Examples of the types of 'smarts' defined above that can be seen in the cities or projects identified using the criteria in the definitions above. The cities of Seoul and Calgary were cited for their aggressive broadband deployment projects. Fredericton was the first city in North America to deploy a free public WiFi network in its core areas. Areas such as Florida's High Tech Corridor and Sunderland, Tyne & Wear have implemented comprehensive advanced technology infrastructure and policy projects to enhance economic development. Singapore is known for its implementation of comprehensive eGovernment Web services platforms for its citizens, in addition to its wide-spread deployment of broadband. Among European countries, Luxembourg has ranked above average in all of the EU's Smart Cities criteria, including in areas of the intelligence, diversity, and creativity of its people; its economy; lifestyle; and mobility. Montpellier, Maribor, and Ljubljana ranked the highest in terms of "smart environment."

There are many other examples of smart city efforts. Melbourne's CityLink was designed to use electronic tolls and vehicle tracking to reduce traffic congestion. CityLink's approach was to reduce 'start-stop' modes of driving, thereby increasing fuel efficiency and reducing congestion (Homes, 2004). Perhaps the most intriguing example of a smart city because of its scale and its ground-up approach is the new city of Masdar in Abu Dhabi. The Emirate is building what they claim will be "a zero carbon, zero waste city, investing in a range of new energy technologies, establishing a post-graduate research institution and developing a carbon management unit" (Abu Dhabi Future Energy Company, 2009).

There exists a strong counter current in popular discourse to the visions of smart cities implied by the definitions above. Research results reported in the academic literature on the use of information and communication technologies in cities have also raised significant concerns about smart cities. These concerns include issues involving impacts of ICT on urban planning, physical and electronic barriers to access for certain populations, transportation, and the restoration and preservation of social interactions in what many see as the depersonalized metropole.

New York Times columnist Timothy Egan (2009) wrote a lament recently about the changing nature of cities in the context of advanced information and communication technologies. He cited examples where cities are using technologies as the basis for money-saving strategies that have potentially dangerous consequences. The Virginia Transportation Research Council showed in a report that the use of cameras to identify drivers who run red lights – the cause of over 800 deaths and 200,000 injuries in the U.S. -- actually caused the number of accidents to increase (Kassebaum et al., 2007). In the interest of improving work-life balance and work day efficiency, some governments (and businesses) around the world have started to ban employees from initiating work-related e-mail discussions during off hours and have banned the use of personal communication devices within meetings (CBC News, 2008). Indeed it is not clear if there is room for non-ICT ways of being "smart" within the parameters defined above for being a smart city, or at least ways of being smart that involve only a minimum or modest amount of ICT.

Graham and Marvin have pointed out that urban planning is evolving to take into account the interrelationships between ICT and various facets of cities, but that a "coherent new paradigm" has not yet been developed (2004:342). Electronic villages within cities are among what Graham identifies as being within the evolution of a sort of integrative urban planning. In developing such a paradigm, we must consider what Castells (2004:90) described as a complex of requirements in urban planning in this age, which recognizes the 'social and functional diversity' of human settlements and the need to respond to changes in social norms in identifying requirements.

Advanced information and communication technologies and transport provide what Graham terms 'complementarities' (2004a:154). Campanella (2004) and other have seen the concurrent advances in transportation and information and communication technologies as playing a role in reducing 'distance' barriers in human interaction and work. Graham (2004a) and many others have, however, pointed out that complete 'substitution' does not exist. Physical presence is still required for certain types of social processes to be effective. This claim has been supported by a range of studies in cognitive processes and human-computer interaction (c.f. Hollan and Stornetta, 1992; Hollan, Hutchins, & Kirsh, 2000).

Software is also being used or proposed in the transport sector to control entry into certain areas within a city based on the mode of transportation. The goals of these schemes include reduction in traffic congestion and improvements in environmental impacts. Mayor Bloomberg of New York tried to implement a scheme whereby drivers of taxis and private automobiles would be required to pay a premium for driving within certain parts of his city – locations in city centres prone to congestion (Chan, 2007). London has already implemented such a scheme. These schemes are seen as introducing potential barriers for those less able to afford entry but who might have critical needs for entry (Graham, 2004c). Similarly, Castells (2004:84) has identified a paradox involving the virtual linkage and expansion of human settlements via information and communication technologies while at the same time many affluent settlements have raised physical barriers to access.

Social and community informatics has a role in guiding the implementation of smart city visions with respect to the appropriate use of information and communication technologies, as well as in an ongoing monitoring of technology's impacts on society. The range and complexity of the issues involved, as briefly surveyed above, require a model of the scope of the Convergence Model.

4 The Convergence Model

Bradley's Convergence Model (2006:52-57) represents the results of her fourth period of research. Her fourth period takes into account the pervasiveness of network technologies and services. Bradley developed, validated, and refined several models over her career based on careful field-based empirical research. Her work culminated in the Convergence Model, which represents the confluence of information and communication technologies and all facets of society (53). The Convergence model has five principle elements (in this author's ordering):

Element 1: human environments, including work and home;
Element 2: characteristics of information, communication, and media technologies;
Element 3: simultaneous life roles of people as a private persons, professionals, and citizens;
Element 4: processes of globalization of values, labour, and technologies through networks; and
Element 5: the resulting impacts on humans of the multidimensional interactions between all of these elements, including this element.

The Convergence model is characterized further in terms of six perspectives:

Perspective 1: it represents four levels of analysis: individuals, organizations, communities, and society(ies);
Perspective 2: it recognizes that human environments may be viewed both objectively and subjectively;
Perspective 3: there may be interactions between the four levels of analysis (*Perspective 1*);
Perspective 4: there may be interactions between the objective and subjective perspectives of human environments.
Perspective 5: there may be interactions between life roles (*Element 3*); and
Perspective 6: all of the elements and perspectives in the Convergence Model are part of a life cycle that causes them to change and evolve.

Bradley's stated goal has been to contribute to "a deeper understanding of the relationship between information and communication technologies and changes in the social and psychological environment (psychosocial life environment)" (2006:1, sec 1.1.1). The comprehensiveness of her model is no doubt due to her multidisciplinary background in psychology, sociology, educational psychology, and ethnography. She has stated that her "theoretical basis" is aligned mainly with social psychology and organizational behaviour (6).

Bradley's focus on community was arguably influenced by the process of electrification in rural Sweden that took place while she was growing up. She has recounted how she accompanied her father while he worked on that effort (5). Her *Computers in the Bakery* project was an example of community-oriented praxis defined by her theoretical work (1996).

The parallels between the processes of development and the current forms of the Convergence Model and the theory Ekistics are, as we will see, remarkable and useful.

5 Ekistics

Ekistics was defined by Doxiadis as the "science of human settlements" where the term 'human settlement' represents a community of people, or an 'ekistic unit' (1974:10). Ekistics was Doxiadis's response to what he saw as the need to "arrive at a proper conception and implementation of the facts, concepts and ideas related to [the problems with] human settlements, and the attempt to re-examine all principles and theories and to readjust the disciplines and professions connected with settlements..." (1968:15). Doxiadis was concerned with the reality that people were most often not happy with their cities or villages (1968:5). He and his research associates sought to predict possible courses of evolution for human settlements by examining the possible evolution of the various dimensions of human society that give rise to and enable the functioning of cities (1974:xv). They exhaustively catalogued and analysed the wide variety of structural elements, patterns, and life cycle processes involved in human settlements around the world; and the ways in which humans corrupt these environments in ways that make them uninhabitable. Doxiadis believed that the development of Ekistics could not occur in the "laboratory" (1968:16). He felt that Ekistics required the study of both the archaeological record of human settlements of the past as well as field studies of existing settlements. He sought to draw the resulting knowledge together into a coherent organization for the field of Ekistics.

Doxiadis defined five basic elements of analysis for human settlements within Ekistics (1968: 21): (1) The characteristics of the natural environmental foundation upon which human settlements are built, (2) humans, (3) society, (4) shells, and (5) networks. The term 'shell' was Doxiadis's generalization of the concept of structures that provide physical covers for functions within the human settlement. A house would be an obvious shell for many human functions, but electrical conduits, airports, and stadiums might also be seen as shells for other types of functions. The term 'network' was Doxiadis's generalization of the concept of arteries through which functions for human settlements are delivered such as people, goods, vehicles, and communications. Roads, postal services, power distribution systems, and shipping routes would all be considered networks.

Doxiadis also defined the 'ekistic unit' as an element of analysis corresponding to the ranges of size and complexity of human settlements (Doxiadis and Papaioannou, 1974:10): (1) people (anthropos), (2) room, (3) house, (4) house group, (5) village, (6) neighborhood, (7) town, (8) city, (9) small metropolis, (10) metropolis, (11) small megalopolis, (12) megalopolis, (13) small continent-spanning city, (14) continent-spanning city, and (15) a global city or an *Ecumenopolis*.

Doxiadis (1968: 109-286) organized Ekistics into four main areas of study and praxis: (1) Ekistic analysis, (2) Ekistic evolution, (3) Ekistic pathology, and (4) Ekistic diagnosis. Ekistic analysis involved the systematic examination of different facets of human settlements, including its basic elements, its ekistic units, and its demographics. Ekistic evolution involved the examination of the processes and forces for the evolution of human settlements, as well as the development of techniques for planning to accommodate this evolution. Doxiadis used the metaphor human diseases as the basis for Ekistics pathology, which examines the types and causes of problems with human settlements. This includes a categorization of "basic diseases" of human settlements including disorderly changes and patterns, and abnormal three dimensional growth (265 – 277). Doxiadis asked if "Ekistics were an act of medicine or one of creation?" He answered that "the truth is that it is both" (278).

Doxiadis's ultimate objective in developing Ekistics was to articulate a theory and a set of laws for governing human settlements. These included laws of development, laws of extinction of settlements, laws of internal balance between elements within settlements; laws of physical characteristics of elements of settlements, including size, location, functions, structure, and form (1968:287-316). The following are arguably the most important laws of Ekistics, particularly in terms of their parallels with Bradley's Convergence Model:

> *Law 1*: "A human settlement is created in order to satisfy certain needs expressed by different forces, needs of both its own inhabitants and of others" (1968: 288).
> *Law 2*: "Following the creation and operation of a settlement new functions are added which had not been foreseen, and consequently the settlement has to satisfy the initial as well as the additional needs. The more it grows the more important these additional needs may become" (1968:289).
> *Law 3*: "The ultimate goal of a human settlement is to satisfy the needs of its inhabitants, and of the others it serves – particularly those needs leading to happiness and safety" (1968:289).
> *Law 4*: "The satisfaction of the inhabitants cannot be ensured unless all their needs – economic, social, political, technological and cultural – are largely satisfied. There is a unity of purpose in the creation of a settlement; it cannot fulfill *Law 1* if it covers only a few of Man's needs" (1968:289).
> *Law 22*: "... the balance among the elements of a settlement is dynamic" (1968:298).

6 An 'Ekistics' for Technologies of Information and Communication

Bradley's Convergence Model offers us an invaluable framework for carrying social and community informatics forward. The critical question for her fellow colleagues is 'how do we build upon her research in useful ways?' Bradley has outlined a plan for us (2006:197-236). What should be considered now is a rigourous process to develop specifications for operationalising her plan and to identify new territory that the Convergence Model might cover. Again, the development of the theory of Ekistics offers close parallels in this respect: both the Convergence Model and Ekistics sought to do the following:

- identify and characterize a comprehensive set of objects under study;
- identify and characterize the comprehensive sets of processes or dynamic forces that impact on those objects under study;
- identify and characterize the full range of environments in which these processes and objects under study exist; and,
- account for the multidimensional interactions between the objects and processes under study.

Ekistics differs from the Convergence Model with respect to the level of operationalisation that was performed with the former. Doxiadis's massive work, *Ekistics: An introduction to the science of human settlements,* is an example of this. It and subsequent books documented not only his theory, but provided documentation for the systematic analyses of the many human settlements that Doxiadis and his associates performed using the laws and units of analysis that he defined within the theory.

There is a critical need for this type of systematic pursuit in social and community informatics. Many scientific disciplines have matured through this type of pursuit. Practitioners within certain disciplines like physics and mathematics usually have clear notions of the research 'road map' that identifies their discipline's direction and the research problems that are of prime importance. Practitioners within such disciplines can clearly define their own work in terms of its principle areas of study and praxis in the context of their road map. This is the stage to which we must take community informatics and the Convergence Model.

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