Hybrid Human Agency:
A Teleodynamic Socio-Spatial Interaction Model for Emergent Human Agency Architecture

by
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A thesis
presented to the University of Waterloo
in fulfillment of the
thesis requirement for the degree of
Master of Architecture

Waterloo, Ontario, Canada, 2010

Author's Declaration |

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Abstract |

People relate with one another in space and through imagined and technologically mediated networks. This thesis is concerned with the relationship between these two types of social connections – spatial and network. Spatial connections structure collectives of people in the same place at the same time. Network connections structure relations between people without regard to place or time. Spatial connections are complex, but rigid by nature, while network connections are simple, but flexible. Essential articulations emerge between these two connection types. These articulations create and evolve contemporary socio-spatial systems such as the city, its many places, and groups of people therein. However, the basic human *experience* of these systems remains largely polarized between spatial and network social practices to the disadvantage of human agency.

This thesis proposes a teleodynamic, socio-spatial interaction model for the articulation of these social practices in human agency architecture. The model is a *mobile experience design* that functions through people with 'smart' mobile devices. It connects them with one another in public place and to global information and communication networks simultaneously. Sociological study informs the model's design – constraints and conditions for the connection *extents* and *integrity* of social interaction. The model supports self-organizing circular relationships between human interaction dynamics and their trace structures based on a methodology for emergence in complex systems. It effects the emergence of the aforementioned socio-spatial, human agency architecture, with great *flexibility*. The model and architecture together serve to better articulate contemporary spatial and network social practices to the benefit of human agency in urban space.

Acknowledgements |

I would like to thank my supervisor, Andrew Levitt, for his patience, support and guidance throughout this process. I am also grateful to my committee members, Philip Beesley and Martha Ladly, for their insight and advice, as well as to my external examiner, Mark Shepard, for his participation in this process.

Dedication |

I dedicate this thesis to my fiancé, Melodie Coneybeare. Our love is everything. To my family, your growing happiness and recent successes are uplifting. To my friends, graduate school was often too much fun. And to my father, I think of you still.

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Chapter 1

Introduction |

"The major challenge for urbanism in the information age is to restore the culture of cities. This requires a socio-spatial treatment of urban forms…capable of connecting local life, individuals, communes, and instrumental global flows through the sharing of public places." (Castells 2004a, 91)

This thesis proposes a teleodynamic, socio-spatial interaction model for making these connections through emergent human agency architecture. The purpose of this proposal is to better articulate contemporary spatial and network social practices to the benefit of human agency in urban space. It is part of an emerging phenomenon called *ubiquitous computing*, which involves the thorough integration of information processing into everyday objects and activities. More specifically, the proposal is a *mobile experience design*. Mobile experience projects allow people with location-aware mobile communication devices to bridge the divide between real space and virtual networks through different activities. The proposal also draws from collaborative *Web 2.0* precedents, which allow people to share, organize, and discuss internet media. Sociological study informs the model's design, which encompasses constraints and conditions for the connection *extents* and *integrity* of social interaction. The model supports self-organizing circular relationships between human interaction dynamics and their trace structures based on a methodology for emergence in complex systems. It effects the emergence of the aforementioned socio-spatial human agency architecture. This architecture is not composed of traditional materials; it is a flexible structure, one composed of human bodies, information and relationships. However, like traditional architecture, it defines space in relation to the scales of human interaction, and it influences the ways in which people gather and flow in this space. It also defines analogous network interaction environments, like those of social web applications. By this avenue, the emergent architecture makes essential connections between urban public place and global information and communication networks directly through socio-spatial human agents. Contemporary mobile digital communications give flexible definition and temporal persistence to this architecture, and augment its functionality. (Fig. 1.1)

The architecture emerges from public socio-spatial activity as opposed to from a strictly authoritative design. However, the model makes this emergence possible and supports a dynamic, scale-free structure as the architecture's foundation. The model's constraints and conditions for social interaction, toward emergent, socio-spatial architecture, are this thesis's main contribution to architecture and to ubiquitous computing disciplines. The desired hybrid real-space/virtual-network nature of the architecture necessitates three categories of exploration towards the development of these constraints and conditions: *socio-spatial connection extents*, *integrity*, and *flexibility*. These, in turn, focus this thesis's review of literature on human spatial behavior, social network structure, and emergence in complex systems.

The *socio-spatial connection extents* portion of this thesis develops the model for defining the architecture's spatial territory and network identity. The model does this through a natural hierarchy of relative cluster formations of people in spatial and network association. Hillier and Hanson's *The Social Logic of Space*, Jakle, Brunn, and Roseman's *Human Spatial Behavior: A Social Geography* and Edward T. Hall's *The Hidden Dimension* are key resources in this development for their direction in giving socio-spatial definition to social formations.

The *socio-spatial connection integrity* portion of this thesis develops the model for optimizing the architecture's underlying structure. The model does this by enhancing the *active integrity* of weak ties between the aforementioned relative cluster formations, and by encouraging the development of connector nodes in a scale-free small world network geometry. Watts and Strogatz small world network model, and Albert, Jeong, and Barabási's scale-free network model are key resources for the development of the model / emergent architecture's structure. Mark Buchanan's *Nexus: Small Worlds and the Groundbreaking Science of Networks* aids in bringing many of the concepts explored in this thesis together, including the relationship between power law dynamics and scale-free structure. Rich Ling's *New Tech, New Ties: How Mobile Communication is Reshaping Social Cohesion*, and Deborah Chambers' *New Social Ties: Contemporary Connections in a Fragmented Society* are significant resources for their insight regarding contemporary social interaction scenarios, especially involving mobile media.

The *socio-spatial connection flexibility* portion of this thesis develops the model for encouraging dynamic self-organizing properties in the architecture. The model does this by leveraging the socio-spatial dynamics of human interaction for *emergent* structure. This structure is flexible with the free actions of people, adaptable to dynamic environments, and continually evolving towards a 'best fit' between people, their interests/activities, and places in urban environments. Terrence W. Deacon's technical methodology for emergence in complex systems, presented in *The Re-Emergence of Emergence:*

Fig. 1.1 | Socio-Spatial Interaction Model & Emergent Architecture Parti
The model connects people with one another in urban place and to global information and communication networks, simultaneously, through emergent, socio-spatial, human agency architecture. The model is a set of constraints and conditions for social interaction at three levels: group (red), locale (orange), and city/world (yellow). The architecture is a flexible structure of human bodies, information, and relationships.

The Emergentist Hypothesis from Science to Religion, is significant for its hypothesis regarding self-organizing relationships between interaction dynamics and trace structures in complex systems. It is a basis for all aspects of flexibility in the model.

The problem this thesis proposal addresses is the disparity between spatial and network social practices at the experiential level of the contemporary city. These are divided between urban spatial and information and communication network environments. People with mobile communication devices informally bridge these two social realms. This privileged position has the potential to afford dynamic, hybrid human agency toward significant socio-spatial collaborations. However, little formal structure exists to make this possible. Instead, it remains an awkward point of transition between discontinuous social environments. This social and cultural problem is particularly poignant given the apparent significance of spatial and network articulation in all other matters of the contemporary city, such as economics and politics.

The contemporary city exists at the dynamic point of connection between the global and the local. Information and communication technologies (ICTs) both facilitate and complicate this position, the nature of which is currently debated from two dominating perspectives. The first, based primarily on the work of urban sociologist Manuel Castells, outlines a *coevolution* relationship between cities and ICTs. He suggests that all translocal and transnational information flow constitutes a single virtual realm, which he calls the 'space of flows.' This realm is in a state of recursive interaction with the 'space of places' – localized geographic urban spaces and communities. The two domains give rise to mutual evolution; the tension between them shapes the networked city in contemporary society. "Cities are structured, and destructured simultaneously by the competing logics of the space of flows and the space of places." (Castells 2004a, 85)

A separate *recombination* perspective has its origins in actor-network theory as outlined by sociologists Michel Callon and Bruno Latour; it draws from the cyborg theories of the anthropologist of technology, Donna Haraway. Like the coevolution perspective, it suggests that urban space and technological networks develop in parallel, but it diverges in the details of this relationship. There is no single, unified virtual or spatial realm. Instead, there are a multitude of fragmented heterogeneous infrastructures and actor-networks in varying degrees of association. Actor-networks are composed of human actors or larger social situations that have enrolled specific elements of technology and other material in an attempt to build social order. These complex socio-technical relations are contingent; they continuously recombine into new formations that require human effort to maintain. Consequently, they are embedded in localized social worlds, and "always link the local and non-local in intimate, relational, and reciprocal connections." (Graham 2004, 70)

Both the coevolution and recombination perspectives suggest that complex and essential articulations emerge between urban space and ICT network interactions. "(Cities) are transformed by the interface between electronic communication and physical interaction, by the combination of networks and places." (Castells 2004a, 85) The relationship between spatial and network connections is the essence of contemporary socio-spatial systems.

David Harvey, a geographer, suggests that the ubiquity of Castells' space of flows alongside increased transportation and economic flows causes time–space compression. This is not a new theory, early advancements in transportation technologies were perceived as the annihilation of space and time because of their ability to compress the perceived distance between nodes as a function of their speed. Recent ICTs on the other hand are considered by some to annihilate space *through* time because they allow people around the world to connect instantaneously. These metaphors should not be taken literally. However, they are insightful of the basic human *experience* of the contemporary city, which lacks continuity between spatial and network social practices.

Network social practices such as online or mobile phone interaction are incredibly flexible. This is because networks are simply composed of nodes and connections between these nodes. They are inherently ubiquitous, distributed, and persistent. Digital networks of people and information can quickly and easily organize and reorganize around any parameters that may be defined by a computational function. Online social web applications self-organize around relevant commonalities such as *subjects* of interest, *types* of media, and *locations* of users or data. This flexibility makes it possible for massive numbers of people to form all sorts of communities and organizations online. These communities may support existing relationships such as with friend network and instant message applications; they may bring strangers together based on common interests through blogs, wikis, and media sharing applications; or they may engage a combination of friends and strangers in online or mobile games and activities. Individuals have a real sense of agency because they are free to contribute to the development of their community by sharing and restructuring content. These contributions are immediate and their effects on the community are apparent.

Online communities frequently adopt physical metaphors of cities, rooms, and walls to designate virtual *places* of social intercourse. However, these distributed networks fall short of the quality of real space communication. The degree to which the full body is engaged gives hierarchy to the many forms of human intercourse. "…Co-presence is the preferred medium for human interaction because of the richness of continuous and simultaneous body and spoken languages, a combination that is mostly unavailable in virtual media." (Kellerman 2006, 23)

In opposition to network practices, spatial social practices are localized, co-present, and temporal. Real space is a vastly more engaging environment than social networks, but it is proportionally less flexible because of physical and temporal constraints. People must synchronize themselves in order to act as a group or community in space. This requires careful organization. However, there is little structure to facilitate such collaboration and the human agency it has the potential to afford in urban space. Instead, virtually all aspects of urban space are determined and regulated by government and increasingly, private industry. These impersonal forces struggle to keep the relevance of public place as a cultural platform competitive with that of rapidly evolving virtual communities. "Online social networking sites such as MySpace and Facebook have replaced the street or the mall as the preferred place to 'see, be seen, and connect' for today's youth." (Greenfield and Shepard 2007, 38)

Virtual information and communication networks and urban space are incongruent by nature. The common scenario of awkward mobile phone use in public places exemplifies this fact. "…personal information technology deployed in the urban context inevitably and invariably enriches the personal environment at the expense of the shared public and civic realms. (Greenfield and Shepard 2007, 39) However, this need not be the case. Mobile communication devices are ideal for bridging the real-space/virtual-network divide because this mobile association can be made anywhere. Consider the meander of a mobile device user engaged in conversation. (Fig. 1.2) She is ambivalent to her spatial surroundings, responding to them only as crude boundary constraints. (Greenfield and Shepard 2007, 33) This is a common contemporary scenario. However, this image is also telling of the potential for space-making through mobile communication. The woman pictured defines a dynamic mobile personal territory within the public environment through her networked engagement. This hybrid real-space/virtual-network territory could be stretched to engage entire groups of individuals and facilitate collaborative activity that is simultaneously co-present in space and networked. This is the essential building block of socio-spatial structure. Considering the ubiquity of mobile devices, vast socio-spatial interaction structures that extend through places and even whole cities, while simultaneously connecting through local and global information and communication networks are possible. This is significant because such structure positions human agents at the center of socio-spatial, and consequently, cultural urban development.

Why is the articulation of spatial and network social practices in socio-spatial structure an architectural concern? What about programming and experience design disciplines? Artist, architect, and researcher, Mark Shepard suggests that in some respects, contemporary concerns are paralleled in the 'Non-plan' architecture of the sixties (by Archigram, Cedric Price, Yona Friedman, the Metabolists, et al.), which sought to give agency to average citizens toward shaping their own environments. However, "…it would seem the locus of current research has shifted from designing the architectural 'hardware' of what effectively became modular space frame structures and services, to the immaterial architecture of 'software' infrastructures and their ability to perform or enact new urban organizations and experiences." (Greenfield and Shepard 2007, 40) In this regard, the problem is still one of dynamic space-making, but involving the simultaneous consideration of analogous network interaction environments in a hybrid condition. The design of contemporary socio-spatial architecture necessitates multidisciplinary collaboration amongst architects and designers of virtual networks, associated applications, and user interfaces. The model and emergent architecture that this thesis proposes are a foundation from which this type of collaboration may extend and evolve with human agency as the central concern.

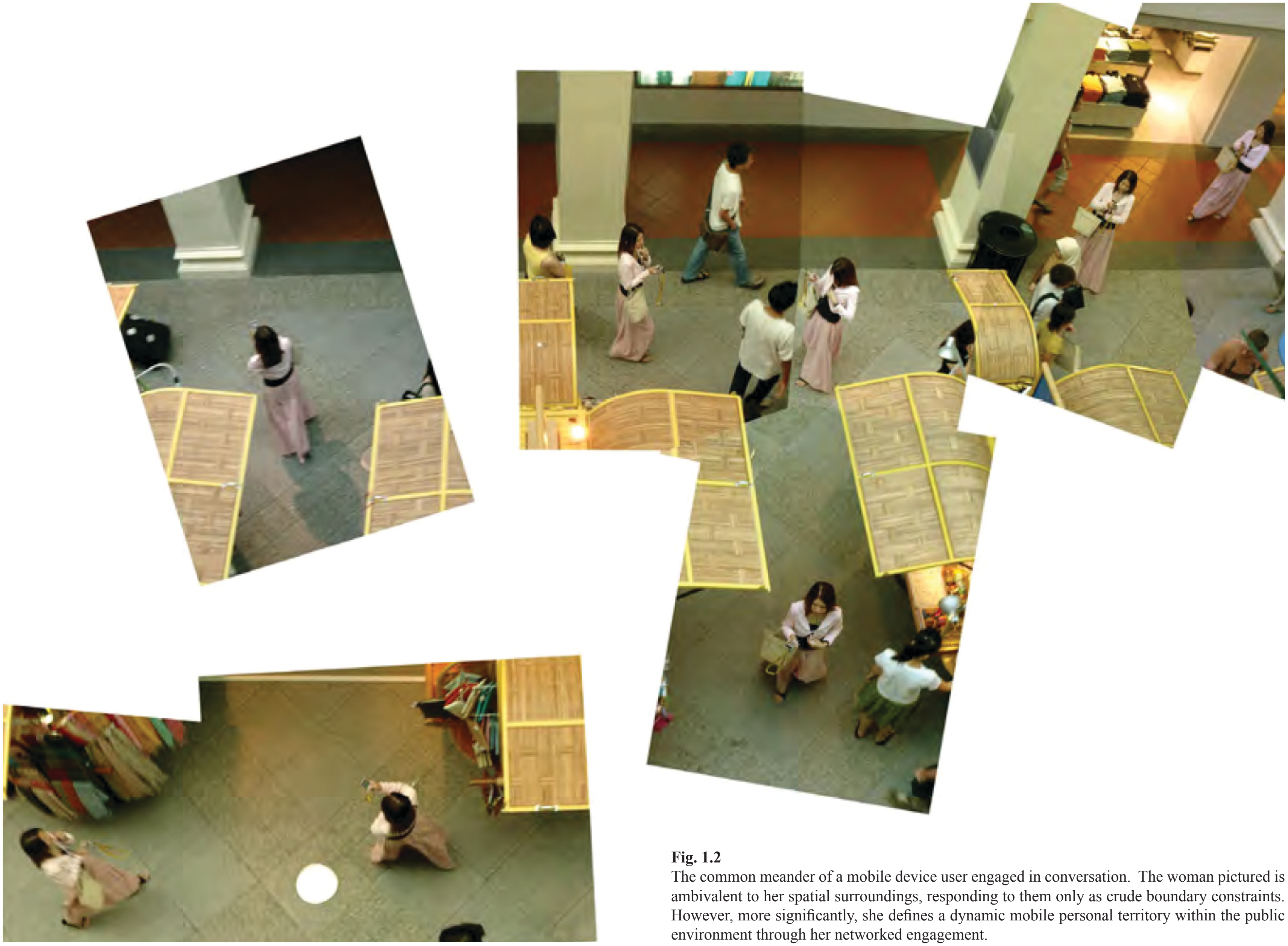


Fig. 1.2
The common meander of a mobile device user engaged in conversation. The woman pictured is ambivalent to her spatial surroundings, responding to them only as crude boundary constraints. However, more significantly, she defines a dynamic mobile personal territory within the public environment through her networked engagement.

Chapter 2

Contemporary Practical Context

Chapter Introduction |

The intention of this chapter is to introduce the multidisciplinary practical context of this thesis in terms of the relevant fields of study, contemporary practitioners, researchers, and thinkers within these fields, and projects of precedence. The chapter will also offer critical analysis of relevant material. The proposal is a *mobile experience design*, which is best understood in the broader context of *ubiquitous computing*. However, it draws mostly from collaborative *Web 2.0* structural precedents and phenomenological qualities. For these reasons, the critiques will focus on the larger disciplines in which relevant material is situated, and will touch upon the shortcomings of individual projects. The material selection and associated critiques will help the reader to understand the intent of the thesis research, as it unfolds in subsequent chapters, and to fully appreciate the model's design.

Contemporary Practical Context |

Collaborative Web 2.0 |

The thesis proposal draws heavily from Web 2.0 context. In its most basic sense, the model may be understood to be an attempt to bring collaborative Web 2.0 structures and phenomena into the spatial realm. Web 2.0 refers to the current, second generation of development on the World Wide Web. The first generation is retrospectively characterized by a one-way flow of information from producer to consumer. Early web pages were mostly 'read-only' spreads of static text and images. They did little to take advantage of the web's network architecture. The paradigm shift toward the second generation web occurred after the 'bursting of the dot-com bubble' in 2001. Faster Internet connections and more widespread computer literacy have allowed the internet to evolve into a viable platform for online software applications. Additionally, unprecedented growth in the digital device market has resulted in an explosion of digital media content worldwide. The most popular websites are developed and used for gathering, organizing, and sharing this media through different types of social networks. Consequently, web content is now ubiquitous and web site structure is paramount.

There are ongoing efforts to bring semantics to the web, but this remains largely unrealized. Instead, the social overlay associated with Web 2.0 is primarily responsible for the indexing within many successful web applications. The most notable means of networking web content through semantics is with user inputted metadata such as *author*, *subject*, *date*, and etcetera. However, such semantic networks are usually sparsely linked on the whole. This is because metatags tend to be ambiguous and inconsistent. They are more useful in sub-communities that emerge within larger sites. For example, subject tags like 'Fred' in *Flickr* are only meaningful amongst small communities that may be familiar with a specific animal or person named 'Fred.' Such tags do nothing to connect between communities, but they are incredibly useful as hubs within the networks of these communities. As another example, *YouTube*, uses the popularity of videos, as attained through links shared externally in emails, blogs, and content aggregating applications to designate hubs in its content networks. This optimizes searches within the site far more than the metadata relating videos. Other sites like *Facebook* and *MySpace* illustrate the significance of content sharing via personal connections by focusing on social, rather than semantic networks. (Hendler and Golbeck 2008, 2-5)

The significance of social networking, as opposed to semantics, being the primary means of organizing information online is that it directly involves the public. Innovative web architectures such as wikis and content aggregating applications allow people to connect with one another through the collaborative production and management of data networks. Everyone has equal opportunity to influence the very structure that binds them as a whole, and this affords human agency. The most successful web designs that guide such collaboration are eclipsed by the resultant meaning and organization of their own content and users. These emergent phenomena are the essence of human agency in these networks.

Wikipedia, a democratic encyclopedia that allows anyone to create and edit entries, is an example of how the collaborative production of data networks may bring about human agency through peoples' combined wisdom. This is the 'wisdom of crowds' in effect. That is: large groups can, in a sense, be wiser than single experts. (Surowiecki

2004) *Wikipedia* succeeds with this principal in amassing significant amounts of current and relevant information about people, places, things, events, phenomena, and etcetera entirely through public contribution. "Wikipedia works because those who know the truth, or something close to it, are usually more numerous and more committed than those who believe in a falsehood." (Sunstein 2006, 154) Three important elements of the *Wikipedia* design enable such successful collaboration. The first is the wiki structure, which allows anyone to create, edit, revert to a prior state of, or add to articles. (Fig. 2.1) The second is a deliberative 'Talk' page associated with every entry, and the third, a 'Recent Changes' feed, which allows errors and omissions to be caught quickly. The openness of *Wikipedia* means that the accuracy of entries is never certain, and sometimes poor. However, it is a model collaborative project with almost surprising democratic success and influence.

Content aggregation applications such as *Reddit*, *Digg*, and *Metafilter* are examples of how the collaborative management of data networks may bring about human agency through peoples' collective organization. These applications were designed for democratically sharing web media. However, with massive user bases, they lead to inventive combinations of people, tools, and information. In a sense, they combine the discussion of web forums, the content feed of RSS, and a democratic voting system. Anyone is permitted to submit content links to relevant categories. Each link is associated with a discussion forum and is voted up or down by the public based on the quality of its content and associated discussion. The activity each link receives over a period of time determines its relative position among the other links in category specific feeds and on the main site feed. (Fig. 2.2) This democratic process has proved effective for proposing, or

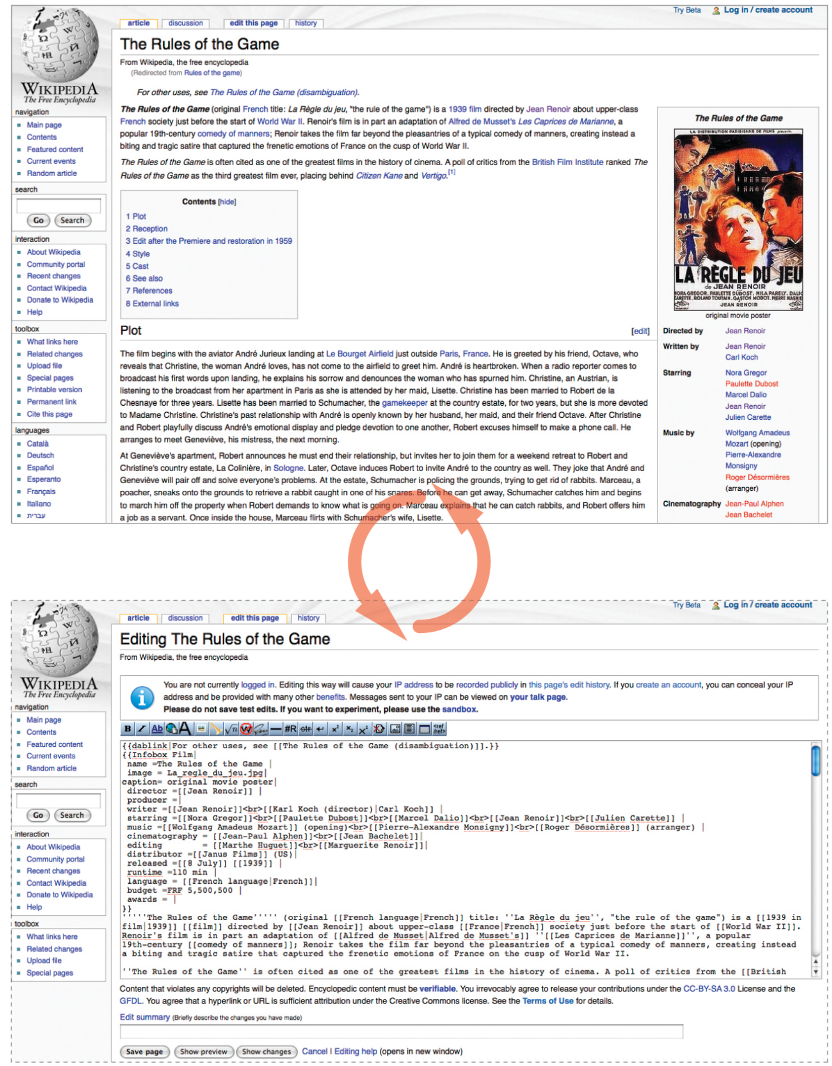


Fig. 2.1
Images of *Wikipedia*: an article [above] and the edit page [below] for that article. The wiki architecture allows for the collaborative composition of dynamic content.

Fig. 2.2
Images of content aggregation web application *Reddit*: the main site feed of user-submitted links [above], the linked media [middle], and the associated discussion [below]. This type of web architecture allows for democratic media sharing.

bringing awareness to, and uniting people under specific causes. The following are a few examples of such exploits: The tracking down of estranged family members, missing persons, and property; the overwhelming of online polls for various purposes like naming ecological mascots and 'people of the year'; the offering of critical and user support to new and failing web businesses; and etcetera. Such emergent social organization can direct all types of action.

Collaborative production and management of data have become common social activities online. The continued growth and development of web applications that facilitate these practices indicate the success of the social web model. Yet, little has been done to formally design it into the spatial contexts of cities to leverage the agency it currently affords users online. There are benefits in the persistence of written instruction and the freedom associated with anonymity inherent in the current state of online communication, which is largely accomplished through written forums and instant messaging. However, the associated lack of direct connection with tangible circumstances and the expressions of people inhibit the potential for truly meaningful and affective human agency to be gained strictly through network collaboration. Network collaborative practices would benefit from vastly superior communication options by integrating with urban spatial contexts. This would also benefit the spaces in which they may be deployed with dynamic interconnectivity/self-awareness and highly flexible practical organization. However, the greatest beneficiary would be the public, directly through whom this would be realized. Collaborative Web 2.0 structures, especially those of the wiki and content aggregation applications – or their constituents; the forum, and the web feed – highly influence the design of the model at the scales of gathering and co-present interaction. This is because they simply organize direct collaboration between people to great effect, the spatial side of which remains largely unexplored.

Ubiquitous Computing |

Ubiquitous computing is the broad context in which the thesis proposal is best understood. It is an emerging urban phenomenon that involves the thorough integration of information processing into everyday objects and activities. It is sometimes referred to as Web 3.0 and is expected to supersede the desktop paradigm of human-computer interaction. Associated areas of study and practice hint at how spatial and network qualities of the city may come together in human experiences. The final vision of ubiquitous computing for many researchers involves billions upon billions of networked data tags, sensors, and processing/visualizing/actuating devices on our person and distributed in all significant materials and environments. These systems engage one another and "users" of ubiquitous computing simultaneously and constantly for many common-place ends. Together they form complex systems from which a *sentient city* emerges.

The underlying structure of ubiquitous computing is a semantic web. Radio-frequency identification (RFID) tags and various sensors such as global positioning systems (GPS), accelerometers, biometric sensors, and etcetera identify people, objects, and environments in the networks of ubiquitous computing through the data they transmit. The semantics, or meaning, of this data is just as significant as the data itself. The speed data of a vehicle, for example, in combination with the longitude and latitude of both its current position and its destination, and the geometry of its route are only useful to a GPS system for estimating travel times if the meanings of these numbers are known. Semantics allow systems to satisfy the requests of not only people, but also computers to combine and use data in different ways.

RFID tags are simple, extremely cheap devices that hold electronic identification data. They borrow small amounts of energy from RFID readers in close proximity for data transmission. (Fig. 2.3) In the most basic sense they are like a more advanced and versatile bar code used for such purposes as identifying objects and people. However, they may easily be integrated into more complex systems involving distributed computing networks. They are currently most widely used in transportation and commercial industries for tracking goods, in ID cards for students and employees, and for banking, especially micro-transactions at public transportation turnstiles and in similar situations. Future ubiquitous computing scenarios involving RFID may identify, catalogue, and respond to individuals and groups through public display. This is exemplified in *The Networked Omniscient*, a projected rendering of Times Square by Columbia graduate students Even Allen and Matthew Worsnick. (Fig. 2.4) It illustrates through various billboards some of the potential associations that may be made between *location* and *object* (There's a Glock G-34 pistol crossing 44th Street. We're on it. -NYPD) as well as *identity*, *place*, and *time* (Molly Seamans: If you don't get that cab at 45th Street, you'll miss your flight to Morocco.). (Greenfield and Shepard 2007, 15)

Environments and the conditions of more complex objects and systems are identified through recorded and sensed data. This data is most commonly used in visualizations. *Oakland Crimespotting* by Stamen Design is an example of a Google Maps mash-up with Oakland Police Department crime data. (Fig. 2.5) It plots reported instances on a map of the city accessible online. (Greenfield and Shepard 2007, 11) Visualizations such as this can have a profound effect on one's mental image of the city. However, situated data is best presented on location in real time. *Pollution Visualized*, an application by

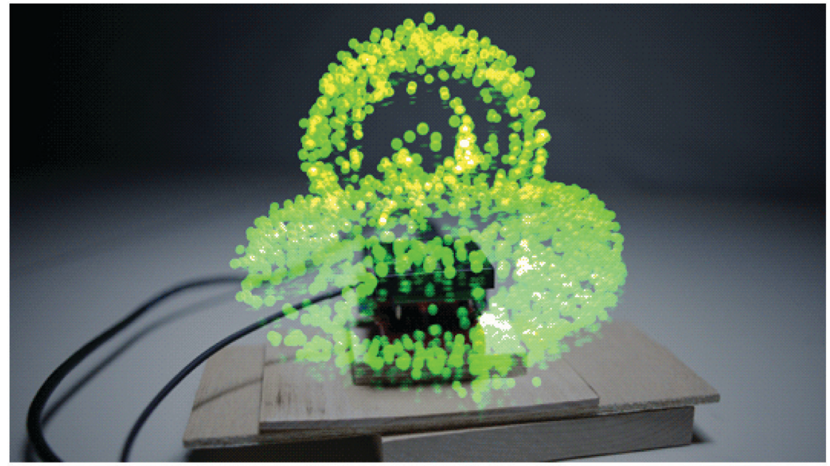


Fig. 2.3 [Above]
Typical RFID tag field volume.

Fig. 2.4 [Below]
The Networked Omniscient by Even Allen and Matthew Worsnick. A projected rendering of a sentient Times Square.

Steven Feiner, a professor of computer science at Columbia University illustrates the flavor of augmented reality experiences. (Fig. 2.6) It displays carbon monoxide levels as a layer of information directly integrated with one's view of the city through a personal device like a smart phone with GPS, a compass, and a camera. (Grifantini 2009) Augmented reality is starting to take off, but probably won't see its full potential until it is accessible through fashionable or effectively invisible wearable displays. In the mean time, two-dimensional presentations on smart phones remain the best way to visualize situated ubiquitous computing data.

A forward looking web-based company, *Pachube*, has created an open-source plug-and-play backbone for the creation of responsive environments. (Fig. 2.7) *Pachube* effectively mediates any type of input and output that hobbyists, researchers, and professionals may wish to 'plug-in'. That is, data from multiple sources worldwide may be used to drive visualizations such as the examples above or local actuators. For example, *Pachube* could connect data from personal biometric sensors through a third party application for modulating residential lighting and heating systems. The more inputs and outputs that get added to *Pachube*, and this is true of ubiquitous computing in general, the greater the number of potential mash-ups and the more precise and relevant systems become. (Shute 2009a)

The benefits of ubiquitous computing are immediate, otherwise difficult or impossible to attain information of local and global systems, and thus greater potential individual autonomy and efficiency of all things involved. Adam Greenfield, writer, user experience consultant, and critical futurist, suggests that ubiquitous computing has the potential to "…lower the information costs associated with ar-

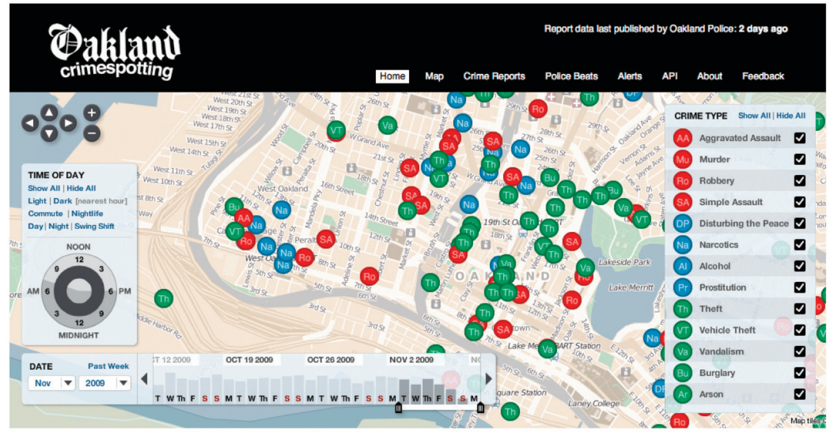


Fig. 2.5 [Above]
Oakland Crimespotting by Stamen Design. A Google Maps mash-up with Oakland Police Department crime data.

Fig. 2.6 [Below]
Pollution Visualized by Steven Feiner. An augmented reality application for carbon monoxide levels in the city.

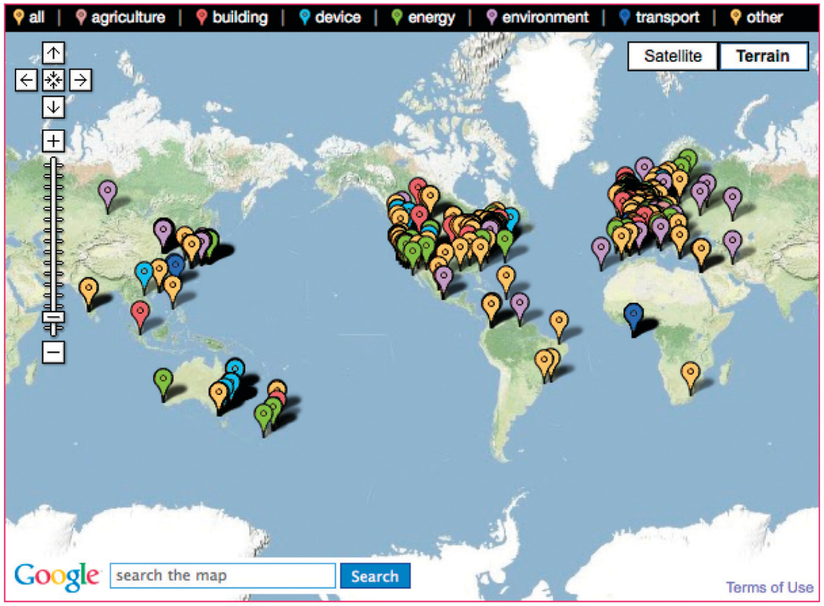


Fig. 2.7
Pachube, an open-source plug-and-play backbone for responsive environments. It mediates all varieties of user-contributed data inputs and outputs. Those currently available are indicated in the image above.

riving at a choice presented to you, and at the same time mitigate the opportunity costs of having committed yourself to a course of action." (Shute 2009b) That is, everyday problems are made easier to understand and more dynamically manageable. "…A properly-designed networked informatics could underwrite the most transformative expansions of people's ability to determine the circumstances of their own lives." (Shute 2009b)

This is a profound, but merely hopeful emergent scenario for ubiquitous computing a long way down the road. It speaks almost of a psychic meshing of people, place, and their situated circumstances. However, the underlying semantic structure of ubiquitous computing does not inherently connect people to one another; nor does it direct opportunities for them to build agency as a collective, as with collaborative Web 2.0 applications. The primary purpose of semantic data aggregation is to *reveal* otherwise invisible layers of situated information. This function is limited to the ability of tags and sensors to relay and discover such data, and the potential effects of this are limited to the situated data's relevance to people and everyday situations. Collaborative Web 2.0 inspired programs, on the other hand, may be used to *assemble* new layers of information into situated scenarios inspired by the boundless resources of the internet, and they involve direct collaboration between people. The experience of ubiquitous computing, in general, favors the individual and computer-computer and human-computer interaction, while that of the model is designed specifically for the collective and favors human-human interaction. Social considerations are an often overlooked, but essential part of ubiquitous computing.

Mobile Experience Design |

The proposal is a mobile experience design, which may be considered a branch of ubiquitous computing that deals specifically with the coupling of an individual and his or her mobile communication device. Phones and PDAs are now so portable that they have become an extension of their user, or wearer. They effectively augment individuals with network computation and communication capabilities. Most of these devices are also location-aware via satellite GPS or mobile network triangulation. This results in a mobile association between virtual network and real spatial environments, which transforms people into intelligent socio-spatial agents. Beyond merely transmitting status data and responding to computer processed visualizations, there is the potential for individuals to collaboratively create and manage the data networks with which they associate, much like what is currently done online.

Smart mobs, as described by Howard Rheingold, are the essential socio-political phenomenon of ubiquitous computing. They are not something tangible, but rather, they are analogous to the world-shifting uses of computers and the internet such as word processing, virtual communities, an e-commerce that emerged from the complex systems surrounding their use. "Smart mobs are an unpredictable but at least partially describable emergent property that I see surfacing as more people use mobile telephones, more chips communicate with each other, more computers know where they are located, more technology becomes wearable, more people start using these new media to invent new forms of sex, commerce, entertainment, communication, and as always, conflict." (Rheingold 2002, 182) The most iconic smart mobs are swarms of people who organize themselves in place without hierarchical structure through text messaging networks for the purposes of protest or artistic happenings, such as massive displays of affection. (Fig. 2.8) However, this organization may be for any purpose and may be attained through all types of network communication. The only thing common to smart mobs is their lack of consistency. They simply arise out of need, desire, or circumstance. Some degree of formal structure could harness their emergent power and give it more refined direction.

Fig. 2.8
A smart mob in action. Hundreds met in the Westin St. Francis hotel lobby in San Francisco, pretended to sleep, and then left.

Many mobile experience designs of varying complexity, geared toward public authoring, offer such structure with the aim of affording human agency. They connect people to one another and to place through situated information management activities in urban contexts. *Murmur*, by Shawn Micallef and Gabe Sawhney, is the most basic of the following examples. It is a location-based mobile phone documentary project that is active in Toronto, Montreal, Vancouver, Calgary, San Jose, and Edinburgh. The project allows people to record anecdotal stories and other information related to local places to the *Murmur* database. Physical signs with a common phone number and unique identification codes are installed in the locations associated with selected recordings. (Fig. 2.9) These indicate and give public access to the recordings for playback in situ. (Micallef 2008, 111) The *Park Walk Project* for High Park in Toronto and Banff National Park, by MDCN researchers Martha Ladly and Bruce Hinds, takes a similar authoritative, but more technical approach to public authoring. It is a guided outdoor experience that employs a mobile phone application and GPS to deliver situated information such as stories, photos, flora and fauna guides and maps in geo-located hotspots in these parks. (Fig. 2.10) The project allows people to upload photos and data collected during their park experience to the MDCN server for review and possible subsequent interweaving into the application. (Ladly 2008, 147-156) Both of these projects allow people to connect through editorially mediated shared situated data. They exemplify the most basic potential for socio-spatial urban public intervention through mobile experience design.

Proboscis' *Urban Tapestries* and Mark Shepard's *Tactical Sound Garden (TSG) Toolkit* boast of more open structures for sharing situated data. *Urban Tapestries* takes a literal approach to the exploration of local place and knowledge through mobile technologies. It allows people to identify places on a virtual map, then tag these places with text, audio, and video content, and finally to connect them

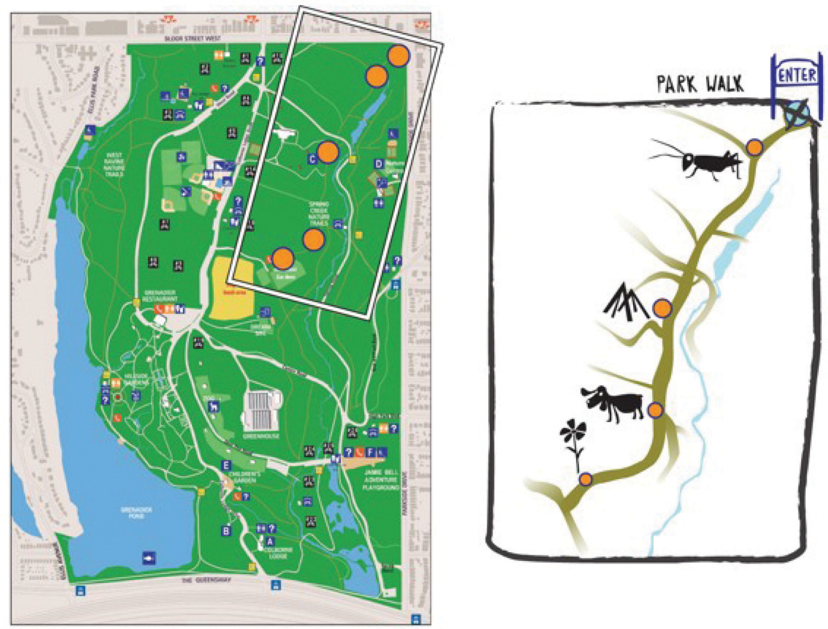
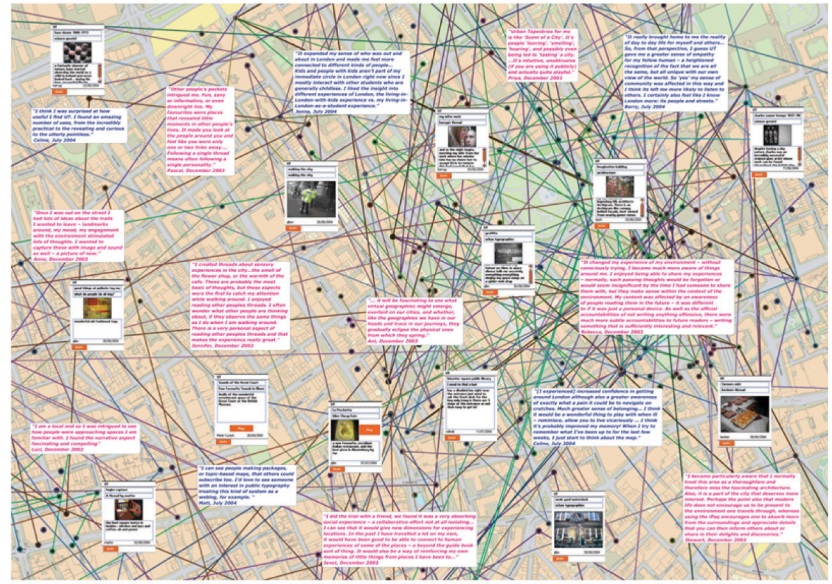


Fig. 2.9 [Above]
Murmur by Shawn Micallef and Gabe Sawhney. This sign indicates the availability of local stories and anecdotes accessible by mobile phone.

Fig. 2.10 [Below]
Park Walk Project by MDCN researchers Martha Ladly and Bruce Hinds. A guided outdoor mobile experience in Toronto's High Park.

through verbal story/information threads. The result is a network of places and content related by such things as their ability to act as nodes along a pleasant walk, their suitability for different lifestyles, such as the handicapped, their relation in a particular person's childhood memories, and etcetera. (Fig. 2.11) These may be searched or added to on the go via mobile communication. (Lane et al. 2005) The *TSG Toolkit* takes a more abstract approach to the creation of participatory hybrid real-space/virtual-network environments by drawing from the culture of urban community gardening. The toolkit consists of a TSG server, at least one open WiFi network, and a downloadable client application. It uses the propagation of WiFi access points in dense urban environments to define the geographical extents of a garden and to locate people within it through a process of triangulation with relation to signal strengths. Sound gardens are dynamic sonic environments that are interactive via mobile phone or PDA. Within them, people can 'plant' sounds in place either by uploading their own content or choosing from the client library. They can also 'prune' existing sounds by modifying their parameters. Each person hears a real-time audio mix specific to their location as they travel through and interact with a sound garden. This is orchestrated by a three-dimensional audio engine common to gaming environments. (Fig. 2.12) (Shepard)

Commercial public authoring applications have only very recently begun to arrive on the market, largely because of the proliferation of 'smart' phones. *Wikitude* offers information on places, natural formations such as mountains and rivers, buildings, monuments, and other points of interest worldwide via map view or augmented reality. (Fig. 2.13) What makes the application interesting is that it culls this information from *Wikipedia*, a robust and proven effective collaborative authoring application. It also allows for less formal geo-



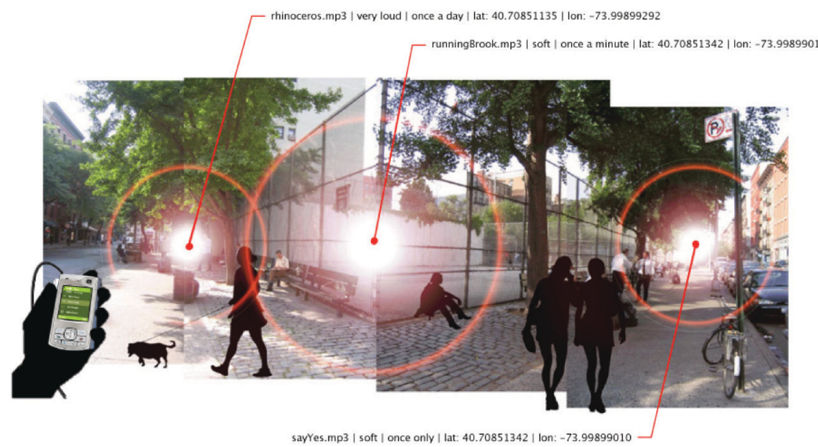


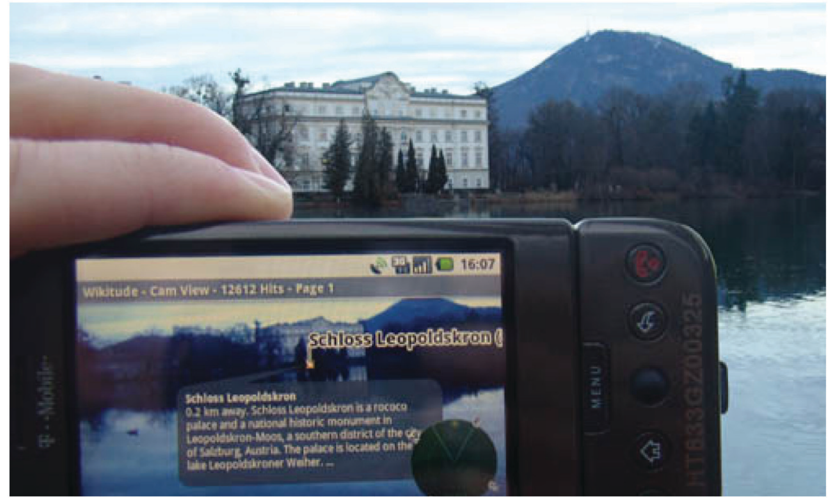
Fig. 2.11 [Above]
Urban Tapestries by Proboscis. A network of geo-tagged places and associated media linked via story/information threads, all accessible by mobile phone.

Fig. 2.12 [Below]
Tactical Sound Garden Toolkit by Mark Shepard. A kit for deploying user-created and managed dynamic sonic environments.

graphical annotation to points of interest via the *Wikitude.me* website. *Layar*, another augmented reality smart phone application, does not directly rely on the public for the content it displays. Instead it acts as a framework for third party developer layers, which may be turned on/off like layers in most image editing software. These, in turn, may (or may not) address the connections between people and/or place. For example, *Tweeps Around* is a layer for visualizing the location and timing of nearby 'tweets' from *Twitter*, an online microblogging application. (Fig. 2.14) This layer is particularly interesting because it allows people to see the shared 'thoughts' of people around them in real-time. These examples begin to show how different tools and frameworks may come together for inspired socio-spatial annotation and potentially even emergent collaborative action.

It is difficult to critique the above mobile experience design precedents because they are the result of varying artistic, commercial, and research related motivations. They were realized with different budgets, and most significantly, they were limited by the technologies available at the times of their creation. However, in a generalized criticism, we may consider their competence in articulating spatial and network social practices to the effect of affording human agency in urban space.

None of these projects realize the full potential of the intelligent socio-spatial agents through which they operate – they do not go to great lengths to integrate with natural human spatial behavior, nor do they take full advantage of the network properties inherent to mobile communication. The *Park Walk Project* exhibits some success defining group and place scale interaction. Its geo-located hotspots act as focal points in urban space. They encourage people to converge



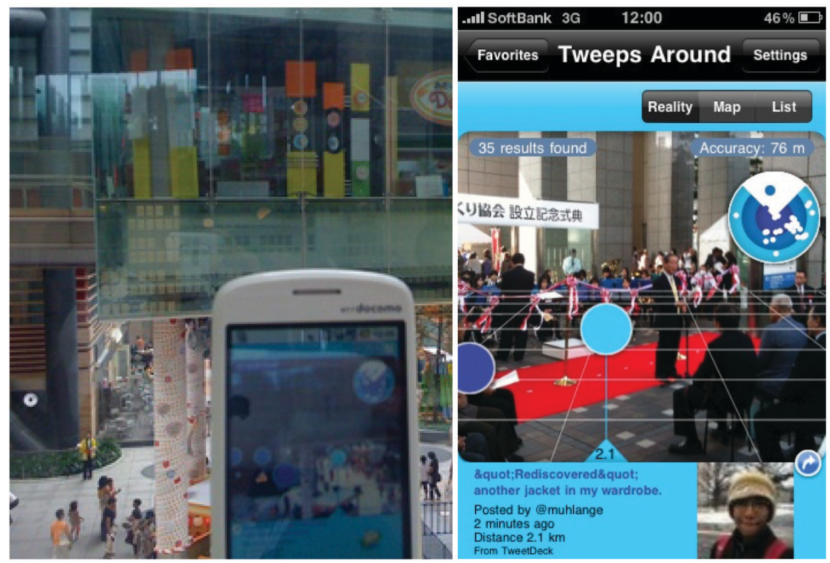


Fig. 2.13 [Above]
Wikitude, a commercial mobile phone application for point-of-interest public authoring and augmented reality with information culled from *Wikipedia*.

Fig. 2.14 [Below]
Layar, a commercial mobile phone application for managing a variety of third-party augmented reality data layers. *Tweeps Around*, a layer for visualizing *Twitter* data is shown.

to a casual social distance by way of their constrained size. Furthermore, the network of these nodes connects people in a shared experience at the scale of urban places. Similar success is evident with the *TSG Toolkit*. It gives definition to place scale social activities through the spatial limitation of sound gardens by way of WiFi accessibility. Such spatial definition is essential to the organization of persistent socio-spatial activity, and thus, human agency. However, these projects' spatial considerations are underdeveloped and they do not result in cohesive functionality through the multiple scales of the city. The other projects do not exhibit any relevant spatial considerations beyond geo-location.

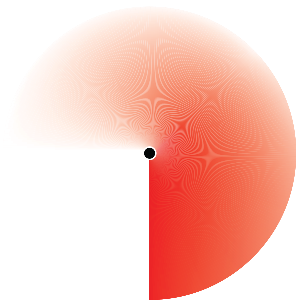
The network aspect of these projects is well used for the purposes of recording and organizing information, especially among the elaborate *Urban Tapestries* threads. However, the potential for directly and simultaneously engaging people in socio-spatial activity through these networks is largely overlooked. Projects like *Murmur*, *Urban Tapestries*, and the informal side of *Wikitude* merely encourage location-specific annotation of personal stories, opinions, and facts through message-board-like functionality. This may enrich places with history and information, and even be affective, but it does little to activate places in the present. Consider the variety of activities and subjects of conversation that naturally occur in urban environments. It is more productive to strengthen, interconnect, and build upon this non-specific social activity *in place* than it is to attempt to connect people *through place* with more restrictive programs. The *TSG Toolkit* recognizes this to some extent. The abstract nature and real time effect of the annotation it encourages shifts emphasis from the sound garden artifacts it produces toward the collaborative activity of managing these gardens. However, this abstraction also limits the specificity and variety of goals that may be pursued through the activity the project encourages. *Tweeps Around* of the *Layar* application has the potential to inspire an unlimited range of collaborative activities because of its openness. It brings the emergent phenomenon of 'ambient intelligence' inherent to *Twitter* use into the spatial realm. However, like a smart mob, it lacks the formal structure to guide this collaborative activity toward effective and consistent human agency.

All of the discussed mobile experience designs afford some degree of human agency in urban space. Their successes in this regard are limited by their effectiveness in giving persistent spatial definition to collaborative network activities, and by the balance they achieve between directive program and functional freedom with these activities. The model draws from these precedents' pioneering efforts to structure socio-spatial activities that have come about through the coupling of people and mobile communication devices. However, it recognizes that the innate power of this coupling is best leveraged through the most natural means of public collaboration. That is, through information management activities that do not exist parallel to, but extend naturally from regular socio-spatial practices at multiple scales.

Closing Remarks |

This chapter has outlined the three categories of the contemporary practical context of this thesis: collaborative Web 2.0, ubiquitous computing, and mobile experience design. The model situates itself within the field of ubiquitous computing, but in opposition to ubiquitous computing's largely semantic organization, which tends to benefit human-computer and computer-computer interaction most. The model favors social network construction for its potentially stronger alignment with human-human interaction. Web 2.0 applications and phenomena are exemplary of forward-looking designs for collaborative network interaction. The model reinterprets and extends some of these precedents' underlying architectures, which currently afford users agency online, into the spatial realm toward similar ends. Mobile experience design precedents suggest some of the ways this translation may be made, directly through people carrying mobile communication devices. However, the model does this in a way that extends naturally from regular socio-spatial activity rather than through some of the more restrictive program typologies that are common in mobile experience design.

The material presented in this chapter serves as a rough synopsis of the current state of the public authoring side of mobile experience design in the larger context of ubiquitous computing. It should aid the reader in critically evaluating the contributions of this thesis to these and architectural disciplines. The model and emergent architecture, which exemplify the critical standpoint of this thesis towards socio-spatial design, are developed in the following three research and design chapters.



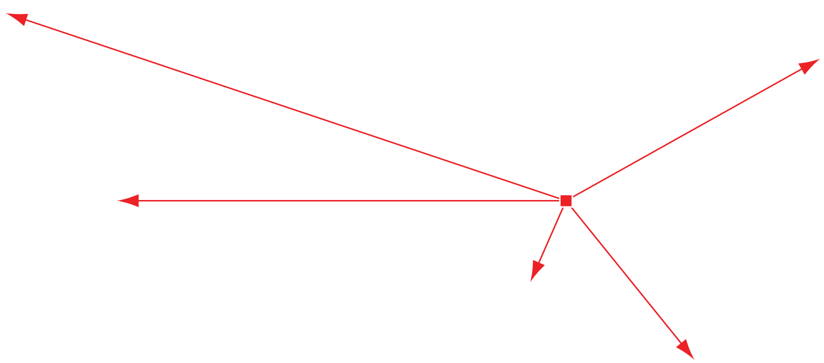


Fig. 3.1a
Spatial connections are localized; their extents are governed by the reach of elements in space.

Fig. 3.1b
Network connections are ubiquitous; they are non-spatial with potentially limitless extents in a network.

Chapter 3

Socio-Spatial Connection Extents: **Nodes/Clusters**

Chapter Introduction |

The research and design portion of this thesis will examine socio-spatial structures of people and their relations at the scales of groups, locales, and the city at large. These structures will be examined in two parts so that they may inform the model's design. This chapter will look at their defining elements. The following chapter will look at their connecting elements and show how the two parts come together. A final chapter will animate the model in time and illustrate how it brings about the emergence of socio-spatial human agency architecture.

Socio-spatial connection extents measure the scope of analogous, strong spatial and network connections. Spatial connections are localized; their extents are governed by the reach of elements in space. (Fig. 3.1a) Network connections are ubiquitous; they are non-spatial with potentially limitless extents in a network. (Fig. 3.1b) These connection properties define spatial connection territory and network connection identity.

This chapter will examine these properties of connection extents. It will begin by outlining how strong spatial and network connections articulate to define clusters, or nodes. It will show that these nodes are the most basic elements of socio-spatial structure. Next, it will examine them in the context of three different scales. The findings will inform how the model defines nodes in the emergent architecture.

Socio-Spatial Connection Extents |

This section will examine the broad properties of connection extents in naturally occurring social formations. It will focus on interactions among social places in an urban environment. First, it will show that all social formations have both spatial and network connection components. It will illustrate how strong spatial and network connections define clusters, or nodes. Next, it will show that socio-spatial structures are organized by hierarchical levels of these connection clusters. And lastly, this section will explain how connection extents – spatial connection territory and network connection identity – may be defined within this structure.

"All human social formations appear to exhibit (a) duality of spatial and transpatial, of local group and category." (Hillier & Hanson 2003, 42) For example, an individual hanging out with friends on the street is simultaneously a member of two different types of group, one spatial and the other categorical. He and his friends give rough spatial definition to a group territory by virtue of the space they occupy. They also portray a group identity, which is transpatially defined through their network relations. (Fig. 3.2) Social formations are organized by both spatial connections and network connections between people. Spatial connections give definition to their territory. Network connections give definition to their identity.

Socio-spatial structures consist of two types of elements: nodes, and connections between nodes. Nodes can either be singular, such as a person, or composed of a cluster of subordinate nodes such as with a group of friends. (Fig. 3.3a) Connections between nodes can

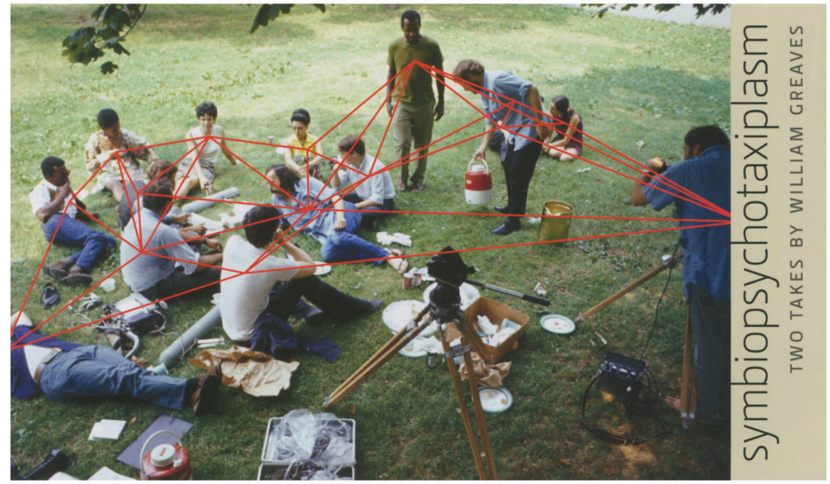
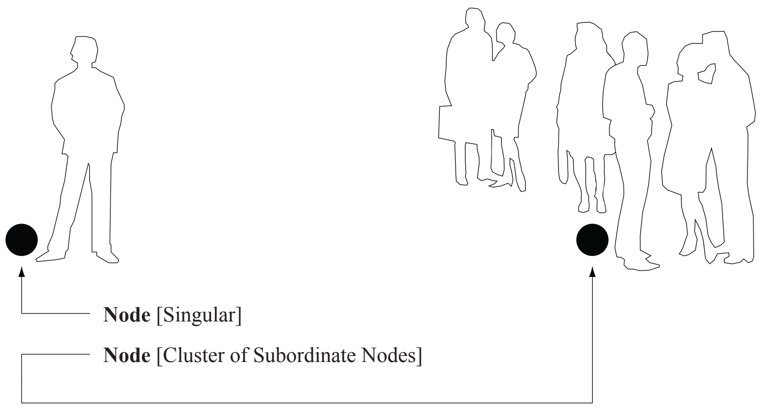


Fig. 3.2
A film DVD cover depicting a social formation composed of both spatial and network connections between individuals.

be of different strengths. The strength of spatial connections between nodes is relative to their proximity to one another. The strength of network connections between nodes is relative to the strength of their relationship. (Fig. 3.3b)

Strong spatial and network connections cause nodes to cluster together. This clustering is a natural phenomenon. People tend to form their strongest relationships with others who live, work, and play close by. Furthermore, they stay close to, and gather most often amongst family, friends, and others with similar interests. This occurs at all scales of social living. (Jakle et al. 1976, 93) As a result, there is significant overlap in peoples' relations with one another. Friends and collectives of friends network in triangles because of their close proximity. Any two nodes that share strong connections with one other local node are likely to come together and realize a strong connection



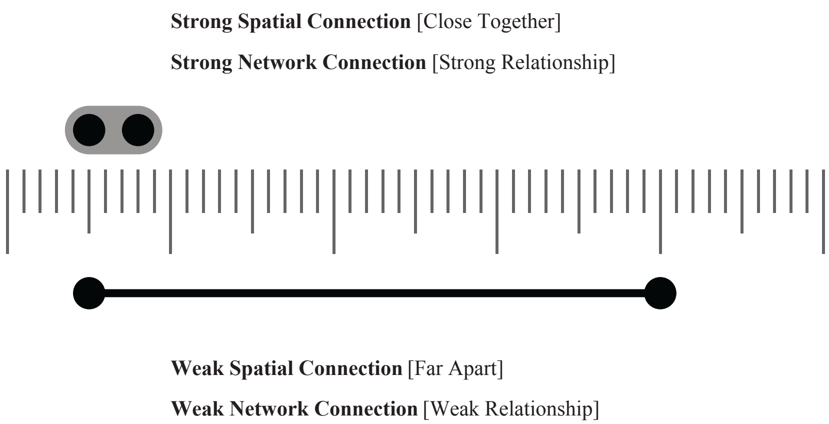


Fig. 3.3a
Nodes represent both singular entities and clusters of subordinate nodes.

Fig. 3.3b
Spatial connections vary in strength based on proximity. Network connections vary in strength based on relationship status.

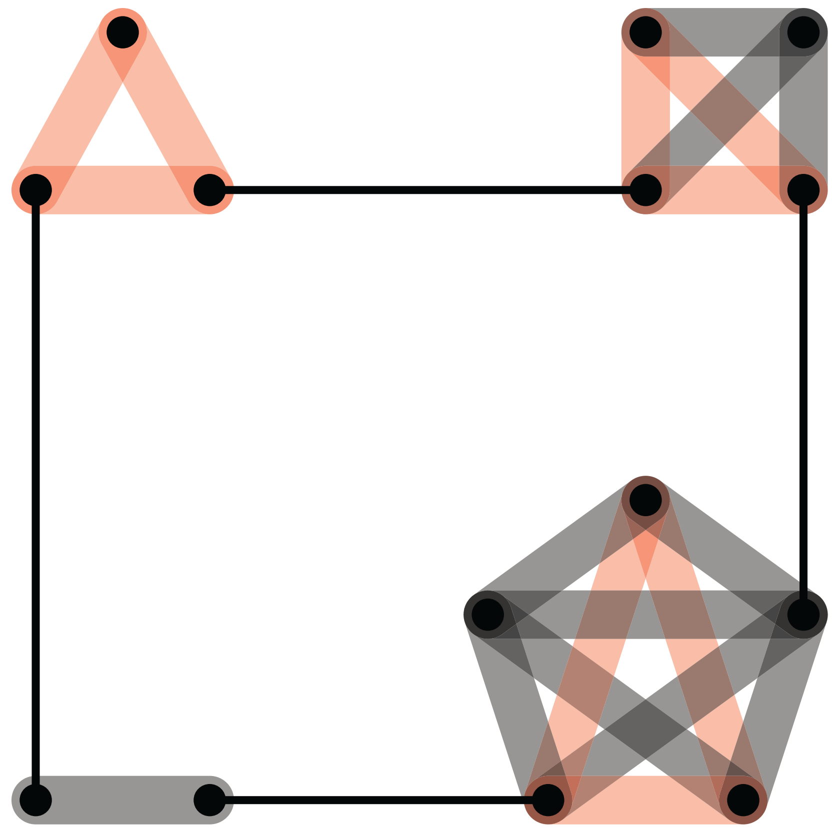
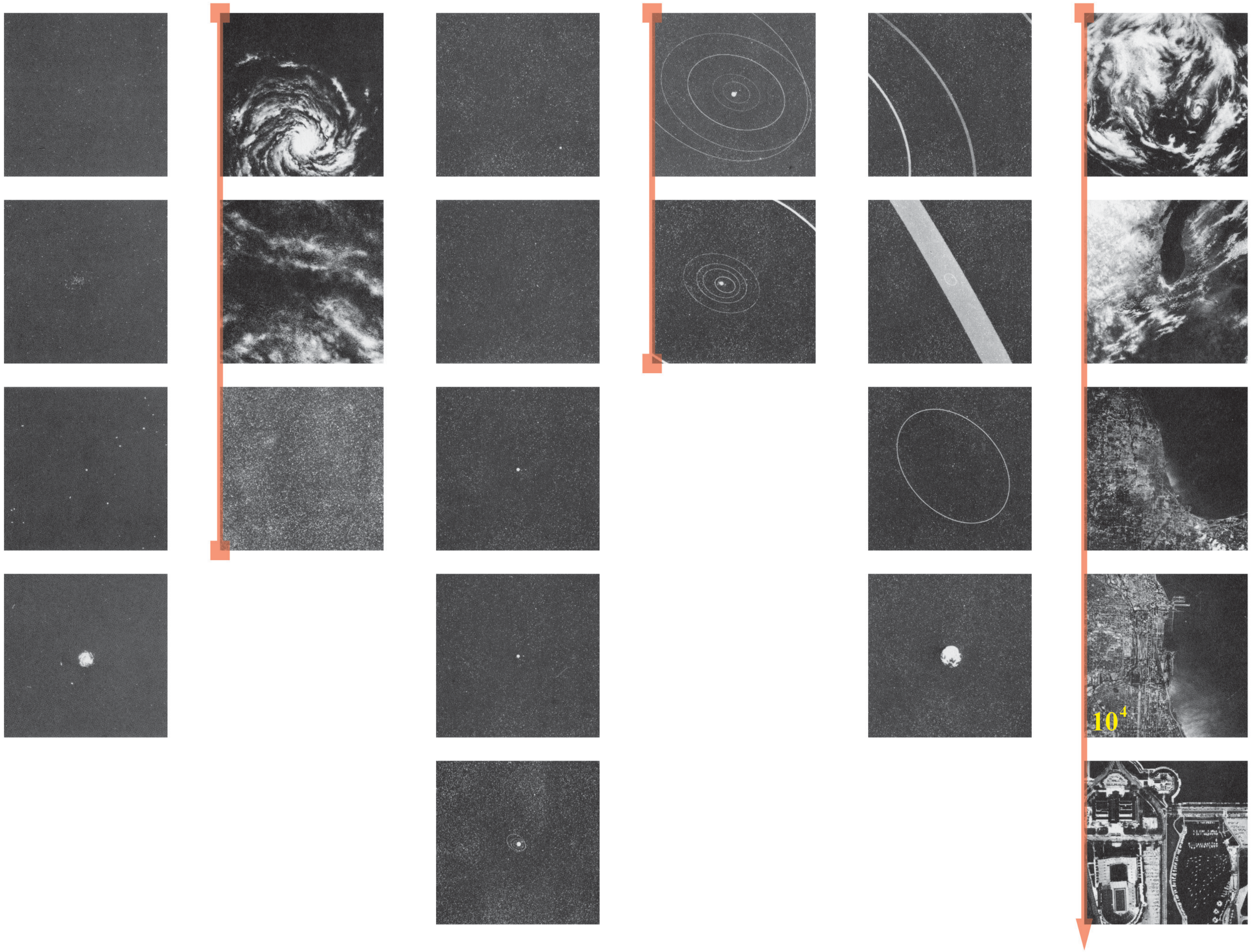


Fig. 3.4
Analogous spatial and network connection clusters, or *nodes*. These are the most basic elements of socio-spatial structure.

between themselves. This triangular relationship results in tightly knit networks. It is the essence of network clustering. (Buchanan 2002, 41-42)

There is similar clustering of nodes in space and through peoples' interconnecting networks. Spatial and network connections articulate in dynamic localized clusters of nodes. These are the most basic elements of socio-spatial structure. (Fig. 3.4)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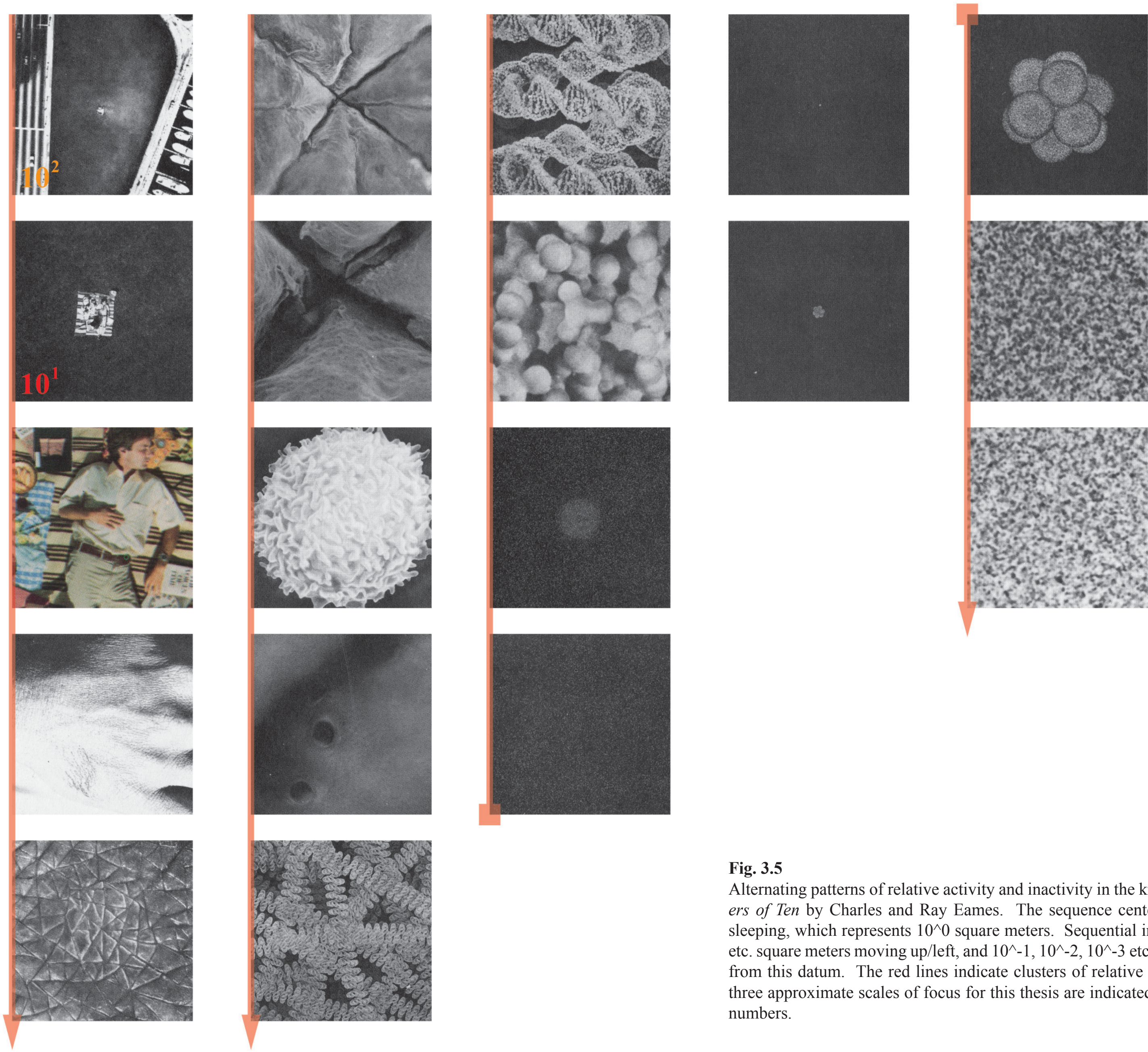


Fig. 3.5
Alternating patterns of relative activity and inactivity in the known universe, from the film *Powers of Ten* by Charles and Ray Eames. The sequence centers on the colour image of a man sleeping, which represents 10^0 square meters. Sequential images represent 10^1, 10^2, 10^3, etc. square meters moving up/left, and 10^-1, 10^-2, 10^-3 etc. square meters moving down/right from this datum. The red lines indicate clusters of relative activity within the sequence. The three approximate scales of focus for this thesis are indicated in red, orange, and yellow power numbers.

Weak spatial and network connections link nodes over longer distances and by weaker relationships than strong spatial and network connections. However, they are no less significant. They work with nodal clusters as part of a cohesive system to optimize socio-spatial structures. The nature of this optimization will be discussed in the following chapter.

Clusters of nodes are loosely organized. They can be singled out in space and identified in networks amongst other distributed nodes. However, clusters of nodes naturally occur in progressive self-similar levels. We must be able to identify them with relation to scale. People cluster in groups, which in turn cluster to form locales – local places of gathering – which cluster to form cities, and so on. These clusters extend like fractals, theoretically into infinity. Charles and Ray Eames pointed out similar alternating patterns of relative activity and inactivity extending out as far as the known universe and through the smallest observable scale in their short film *Powers of Ten*. (Fig. 3.5)

A hierarchical approach is necessary to frame our references to these clusters. This thesis will focus on three hierarchical *levels*, each representing the scale of a dynamic cluster formation while also recognizing the scale of its parts: the group level of individuals, the locale level of groups, and the city level of locales. Each may be considered from the perspective of the collective whole or from that of its individual elements. (Fig. 3.6) This allows us to roughly qualify spatial connection territory and network connection identity together for different levels of socio-spatial structure.

At each level a number of nodes define analogous spatial and network clusters. The spatial collective of these nodes suggests the

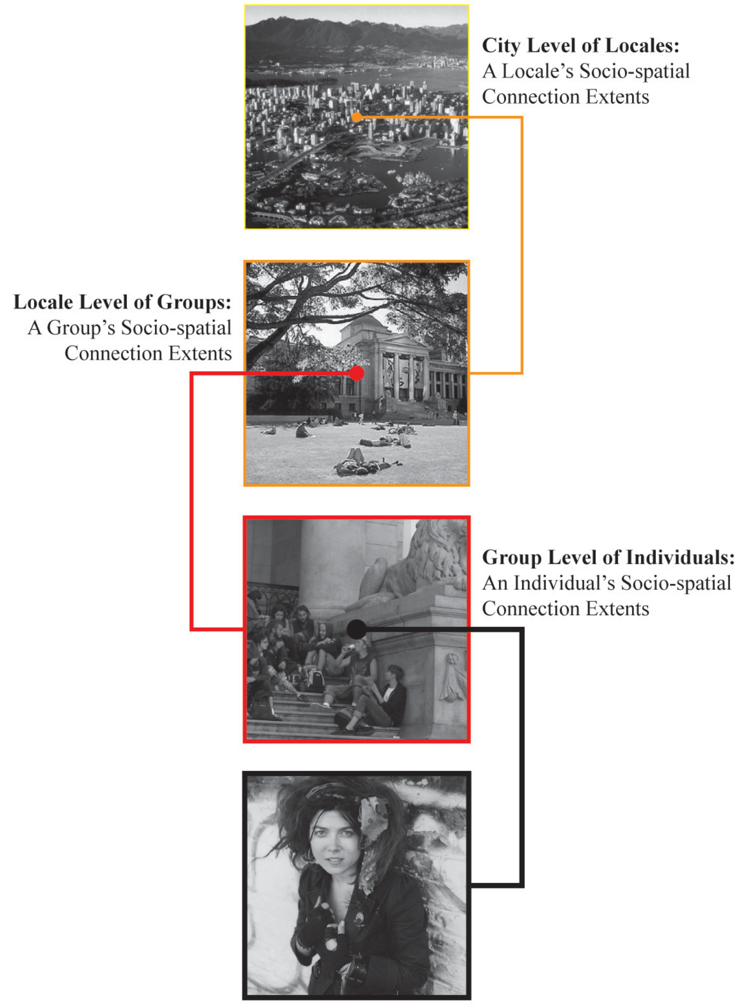


Fig. 3.6
The three hierarchical *levels* of focus in this thesis. Each represents the scale of a dynamic cluster formation, while also representing the scale of its parts.

territory of the formation. The network relationships between these nodes associate them together as one and suggest the formation's identity. Together, the territory and identity of the formation represent the immediate social environment of any of its individual nodes. We will refer to this as their *socio-spatial connection extents*. This relationship gives definition to socio-spatial structure at every scale.

Socio-Spatial Connection Extents in Context |

This section is composed of three parts. Each part will examine the qualities of socio-spatial connection extents in the context of a particular scale. These will inform the model's design. A function for defining socio-spatial nodes will be outlined for each scale. It will focus on node territories. All node identities will be defined in the model by online media expressed in some way through subordinate nodes.

The scales are part of a progressive hierarchy inherent to regular socio-spatial structure. They are named by their hierarchical levels; the group level, the locale level, and the city level. Each represents a cluster composed of the nodes, or clusters, of the last. They are presented in an artificial context loosely based on my experiences in a number of Canadian cities. The specifics of this context are irrelevant beyond providing a realistic setting in which to outline the model, and later to illustrate the emergent architecture.

Nodes can be *associated* or *unassociated* at each level of the model. The model defines nodes, or clusters, of subordinate *associated* nodes. Associated nodes will be depicted with a coloured outline that represents their formation; red for groups, orange for locales, and yellow for cities. Such nodes function within the levels at least up to and including the one they exist in as a cluster. Nodes that are not part of these clusters are *unassociated*. They only function within the levels up to and including the one they exist in individually.

Group Level |

The socio-spatial connection extents of individuals, at the group level, are influenced by their proxemic behavior. Each individual must balance their need for personal space and their desire for comradeship in forming a group cluster. The specifics of this balance inform the nature of node definition at this level in the model.

Anthropologist, Edward T. Hall suggests that there are four zones of proxemic perception, each with a close and far phase: intimate, personal, social, and public. They stretch from the point of touch to a distance greater than twenty-five feet. The social distance and the thresholds of personal and public distance at either end are particularly relevant to this thesis. (Fig. 3.7) The social distance consists of a close phase of four to seven feet, and a far phase of seven to twelve feet of separation between people. Impersonal business such as discussion at social gatherings occurs at the close phase. Discussion is more formal at the far phase. The differences in business conducted between these phases are primarily determined by the audibility of peoples' voices and the ease of maintaining visual contact. The threshold between the social distance and the shorter personal distance (one and a half to four feet) relates with the potential for two people to touch with outstretched arms. It is the protective area of personal space and the limit of physical domination. The distances people leave between themselves in this zone are indicative of their relationship or the way they feel about one another. Subjects of a personal nature are usually discussed here. The threshold between the social distance and the longer public distance (twelve to more than twenty-five feet) is where space gains the potential to screen people from one another. People may feel comfortable in choosing not to interact at this distance. It is

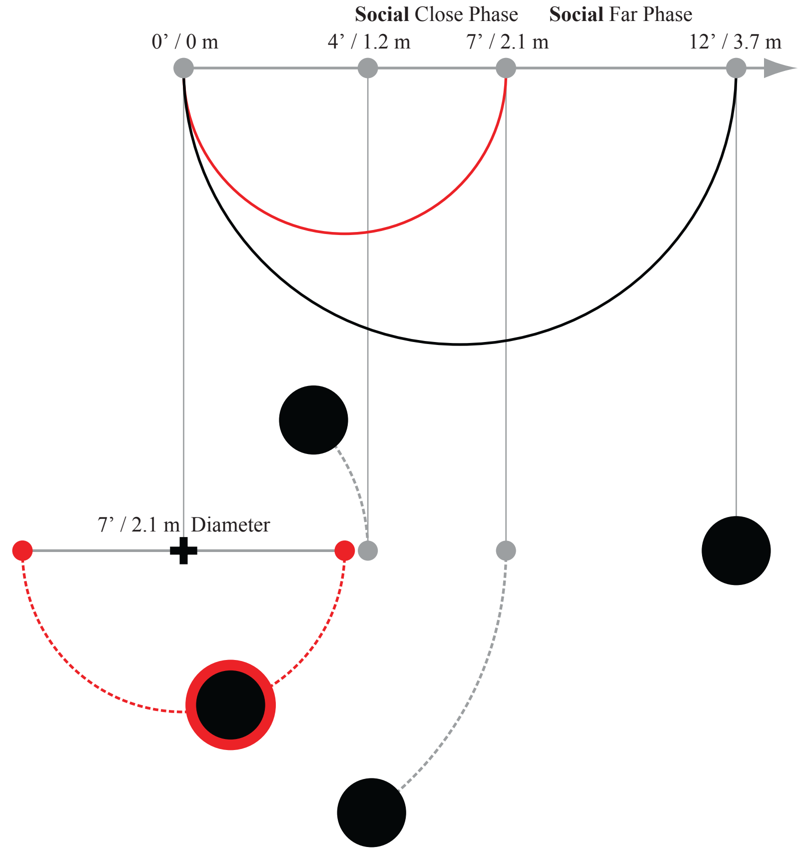


Fig. 3.7
Scale | 1:50
Measurements of the social distance, as defined by Edward T. Hall. These distances are measured from an arbitrary point, "+", to a number of nodes, which represent individuals. The red arc depicts the diameter of a circle that represents the extent of the close phase of the social distance. The black arc depicts the diameter of a circle that represents the extent of the far phase of the social distance.

generally reserved for formal business. (Hall 1966, 110-120)

Proxemic behavior is learned, it varies between individuals, cultures, and situations. Within a culture, people share customs – they behave similarly in certain situations. However, the specifics of an individual's upbringing and environment ultimately make him or her unique. What remains constant is the struggle for balance between individual comfort and group comradeship. Schopenhauer alludes to this phenomenon in his porcupine fable: a group of porcupines huddle together for warmth, but in doing so they poke one another and have to separate again. Their situation leaves them perpetually searching for a comfortable balance between the two conditions. (Sommer 1969, 26) Individual concepts of personal space and this struggle for balance make every group formation unique.

The model defines group node territories based on measures of the social distance. Group nodes may be created on location where two individuals come to rest within the close phase of the social distance (7'). This area restriction ensures that nodes are only created where a social connection strong enough to warrant such close proximity has occurred. However, the area is large enough to comfortably accommodate any type of casual encounter.

The active area of a group node is restricted to a circle with a diameter the length of the far phase of the social distance (12'). This restricts groups to a size suitable for everyone to be within social range of everyone else. The amount of personal space available to each individual is inversely proportional to the number of active individuals. This factor encourages excessively large groups to reorganize into more manageable smaller groups. (Fig. 3.8)

The active area of a group node is mobile around the co-ordinate point of creation within a circle twice the diameter of the far phase of the social distance (24'). It automatically adjusts its position within this area to accommodate newly arriving individuals. New connections are made when people come to rest within this area. This function also allows groups the flexibility to adapt their formation to changing site conditions, such as those of light and shadow. The close phase core of the group node is fixed in place. Its size dictates the necessary separation between separate group nodes. Only the portions of active areas outside these cores are permitted to overlap. (Fig. 3.9) Group nodes disappear when their active members depart. However, a memory of their co-ordinate of creation is retained for the purposes of locale node definition.

The model defines group node identities based on the co-operative contributions of everyone. Each individual of a group is capable of sharing web media and functionality with the others. This will be described in greater detail in the next chapter. This media represents groups in the wider networks of the model. Individuals who contribute the most will naturally hold the greatest influence over their group identity in the model.

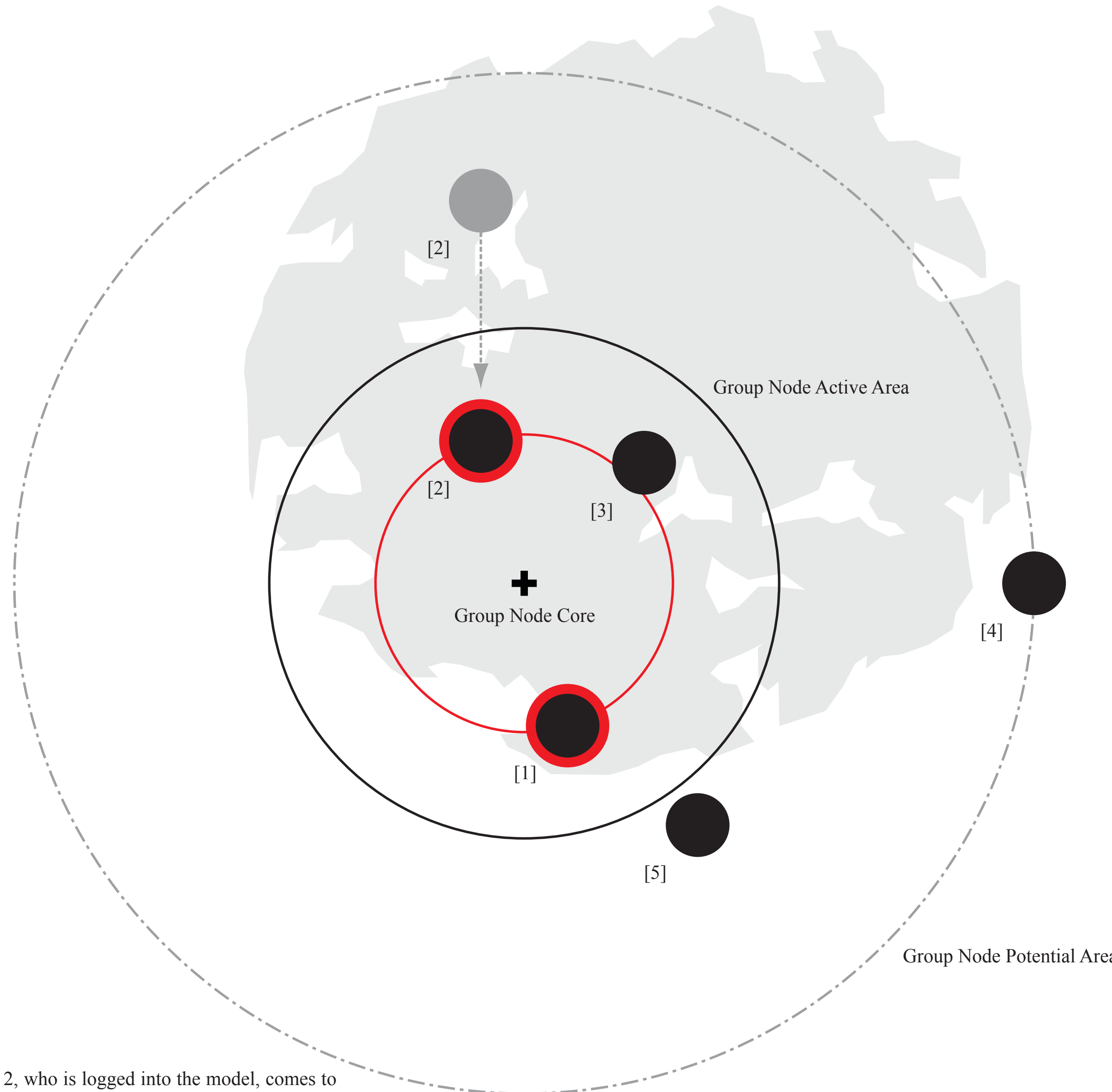


Fig. 3.8
Scale | 1:50
The creation of a group node of individuals. Person 2, who is logged into the model, comes to rest within range of person 1, who is also logged into the model. They decide to create a group node. Associated individuals who define this group node are depicted with a red outline. Persons 3, 4, and 5 are not logged into the model.

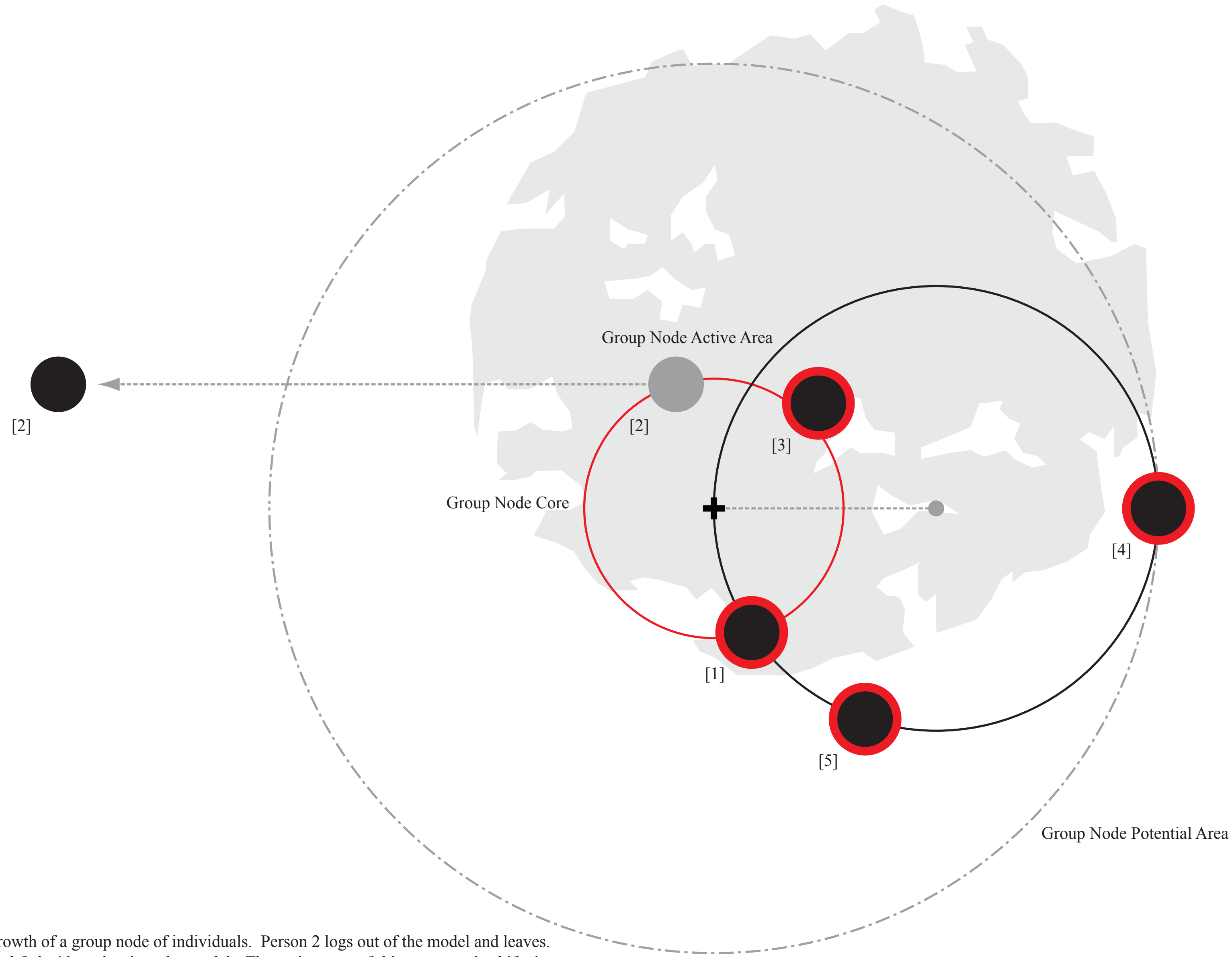


Fig. 3.9
Scale | 1:50
The dynamic growth of a group node of individuals. Person 2 logs out of the model and leaves. Persons 3, 4, and 5 decide to log into the model. The active area of this group node shifts its maximum distance to include everyone within range. Associated individuals who define this group node are depicted with a red outline.

Locale Level |

The socio-spatial connection extents of groups, at the locale level, are influenced by local territorial activity. Each group must co-exist with others in a shared context. The specifics behind this co-existence inform the nature of node definition at this level in the model.

Groups of people cluster together at the locale level to partake in the experiences associated with different types of places. They go to cafés, for example, to take a break or to meet socially over coffee. Parks on the other hand are associated with play, exercise, and relaxation. A quaint street that draws its character from nearby shops and restaurants can also provide a distinct experience. "Places serve as symbols of expected satisfaction or stress and are stereotyped according to the people who usually occupy and control them, the activities that usually occur in them, and the nonhuman objects that are associated with these activities." (Jakle et al. 1976, 37) People and their behavior, then significantly influence place identities. Conversely, places stereotype the kinds of people found in them. The relationship is such that people and places interact symbiotically to validate and reinforce one another's identities.

Spatial expanses serve to locate locale clusters of groups. People and groups of people disperse themselves evenly in open areas. They possess and defend territories like individuals hold personal space. The density of people determines the separation between group territories, and even the size of territories themselves in crowded conditions. (Fig. 3.10) However, groups' territorial choices are influenced by the qualities of an area and the elements among it. Benches and steps, for example, locate groups because of the resting places and tiered social setting they provide. Areas in shadow or off the beaten track stereotypically locate groups who want to keep a low profile. Large grassy expanses on the other hand allow people to play and sunbathe with the public's attention. Such distinct spots are often controlled by groups who frequent the locale regularly. Infrequent visitors are responsible for the more ephemeral dimensions of a locale cluster. Temporary or impromptu events also offer variance to the social formation. Different combinations of groups ultimately arrange their own cluster formations depending on the territories they assume among a locale.

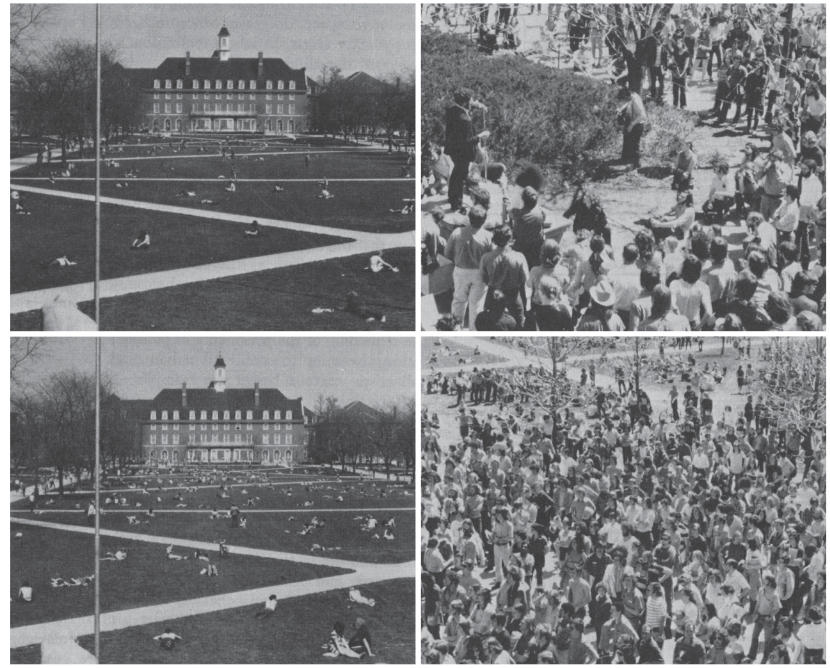


Fig 3.10
The even distribution of groups in a locale, and their territories with relation to crowding.

The model defines locale node territories based on the regularity of spatial usage. It is a two-stage process. First, clusters of geographical co-ordinates representing recently expired group nodes are identified. Each of these clusters serves to locate a locale node and to determine its general area. (Fig. 3.11) Locale nodes will emerge in planned expanses such as parks and public squares where groups regularly gather in close proximity. They will also more rarely emerge in dimensions that do not reflect cohesive spatial planning, but happen to support well frequented spots in close proximity nonetheless. The second stage identifies active group nodes in close proximity to the clusters already identified. This process serves to fill out the locale node. It also validates or invalidates assumptions regarding cluster dimensions that were made in the first stage. (Fig. 3.12) These two stages function together continuously to define and monitor locale nodes that represent well used areas.

The model defines locale node identities based on the most pervasive group node contributions. Group nodes are capable of viral media sharing within a locale. The structure that facilitates this will be described in greater detail in the next chapter. Locales identify themselves within the wider network of the model by way of the media most actively shared through their groups. The more tightly knit regular groups will naturally hold the greatest influence over their locale identity. No predetermined classification influences the content or type of media that people may share. There is also no form of censorship. Instead, it is expected that locale network identities will develop naturally with some relation to the immediate physical and cultural context. Social responsibility in a real space setting will keep content acceptable. “Each participant has a ‘vested interest’ in maintaining the symbolic meaning of the place, for if a place stereotype is destroyed, no one will be able to obtain the full measure of satisfaction that he seeks there.” (Jakle et al. 1976, 38)

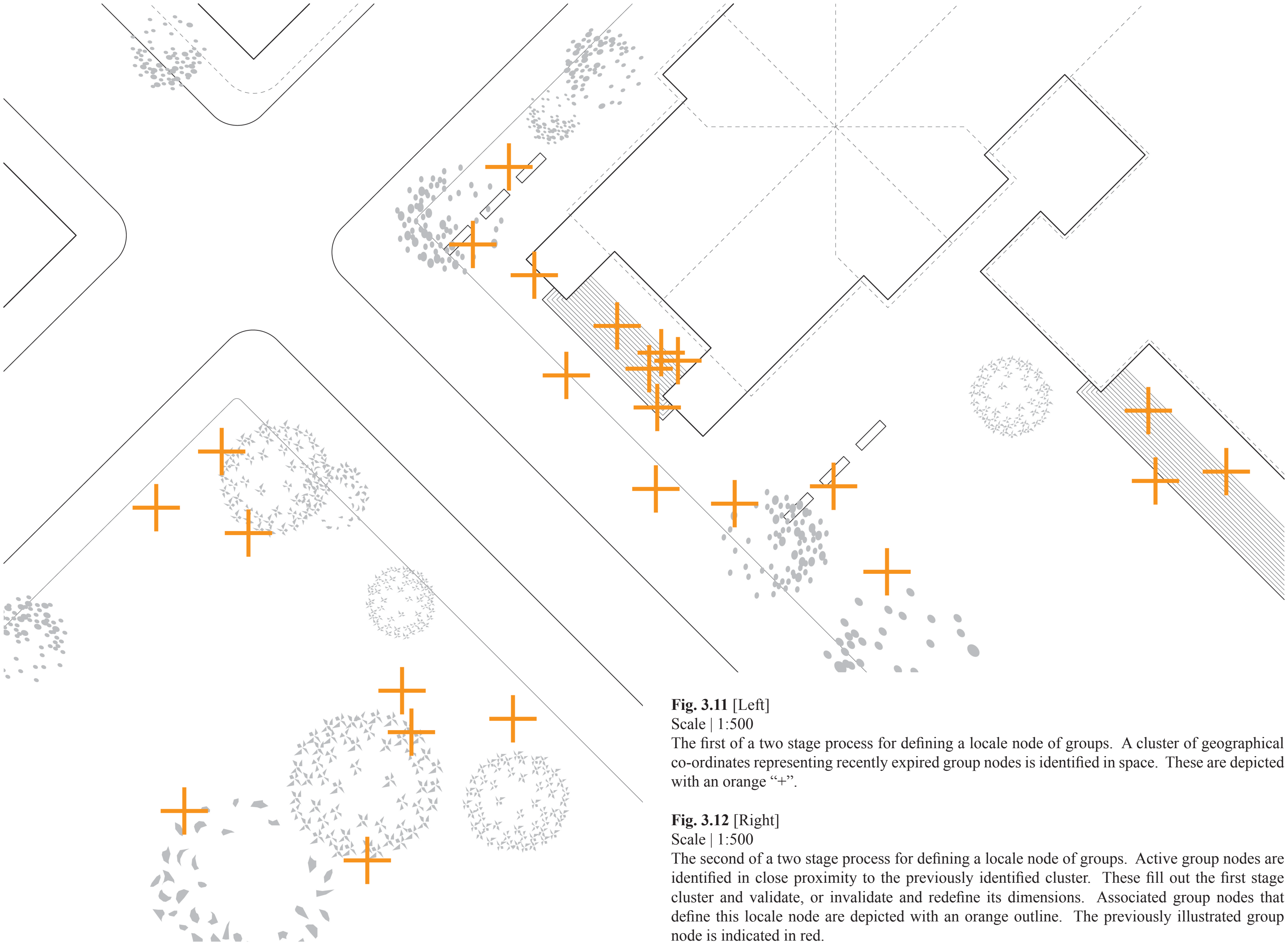
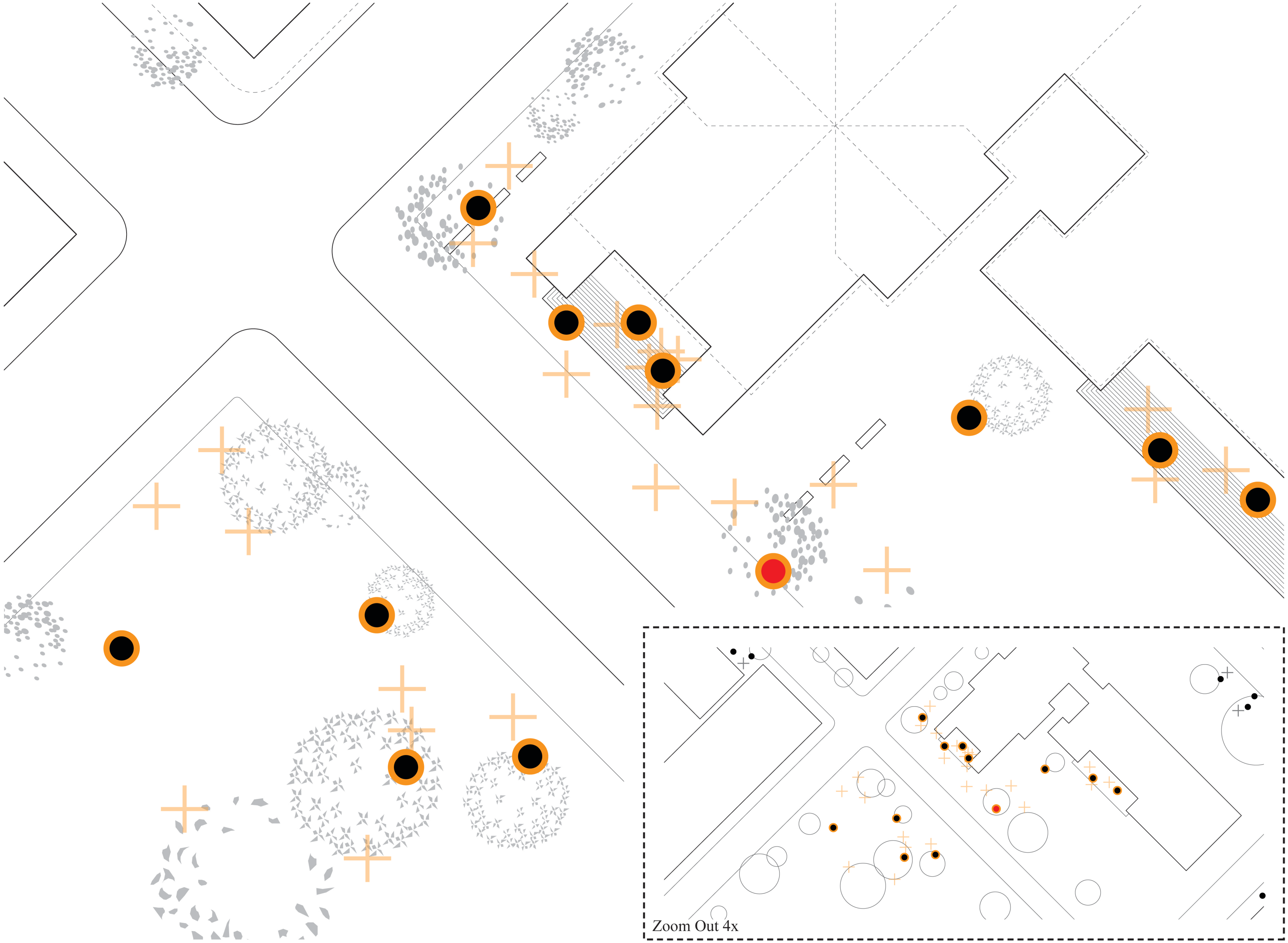


Fig. 3.11 [Left]
Scale | 1:500
The first of a two stage process for defining a locale node of groups. A cluster of geographical co-ordinates representing recently expired group nodes is identified in space. These are depicted with an orange "+".

Fig. 3.12 [Right]
Scale | 1:500
The second of a two stage process for defining a locale node of groups. Active group nodes are identified in close proximity to the previously identified cluster. These fill out the first stage cluster and validate, or invalidate and redefine its dimensions. Associated group nodes that define this locale node are depicted with an orange outline. The previously illustrated group node is indicated in red.


Zoom Out 4x

City Level |

The socio-spatial connection extents of locales, at the city level, are influenced by their interrelationship in the day to day lives of individuals. Locales support one another and together, they give cultural diversity to the city. The specifics of this relationship inform the nature of node definition at this level in the model.

Action space refers to an individual's "total interaction with and response to (their) environment." (Jakle et al. 1976, 92) All the places and networks within which a person operates, as well as the ones they merely cognize, comprise their action space. The city cluster of locales consolidates all the necessities for living and a range of amenities. Many people rarely need to leave the city. A portion of it may thus roughly represent an individual's total potential social and spatial environment – their action space.

Populations tend to segregate and arrange themselves in urban areas based on three general dimensions: economic status; family status; and ethnic status. (Fig. 3.13) Economic status defines separate high, middle, and low income sectors with radial divisions around the central business district (CBD). These divisions are thought to be generated by transportation infrastructures and the shores of lakes and rivers. Such elements typically run through CBDs and influence adjacent land use and value. Family status sorts itself in concentric rings of increasing family age and size extending outward from the CBD. This is largely caused by immigrant groups who enter near the center of the city and gradually move outward as they assimilate and the city grows and develops. Ethnic status defines clusters in the city where people of similar background group together. (Jakle et al. 1976, 192-193) The spatial sorting of urban populations among these

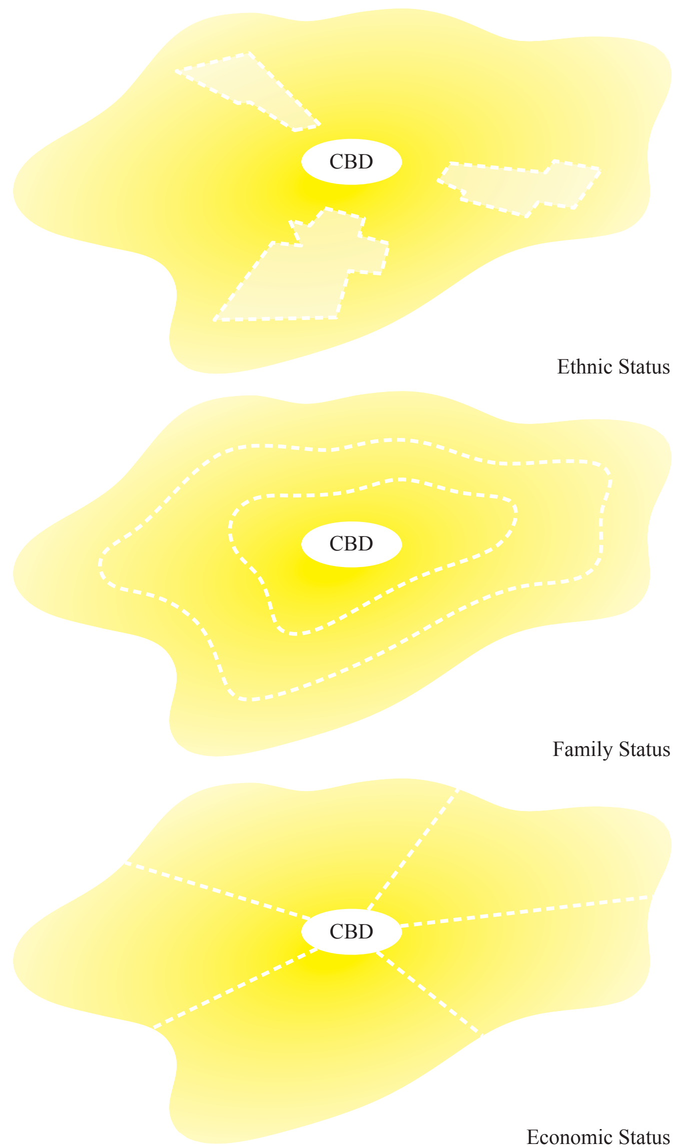


Fig. 3.13
The three general dimensions of urban areas.

dimensions influences not only the areas in which people live, but also where they work, shop, and the locales in which they gather to socialize. Consequently, people among the same dimensions share similar action spaces, while people among different dimensions have separate action spaces.

These three basic dimensions are generalizations and are not mutually exclusive. The intermingling of people between them is greatest in what Ray Oldenburg refers to as *third places* – public settings outside the first and second places of home and the workplace. Here, people meet on neutral ground and socialize in good company. Third places are "open to all and (lay) emphasis on qualities not confined to status distinctions current in the society." (Oldenburg 1999, 24) The varying action spaces of an urban population overlap in the city's many social places. This overlap is likely greatest among the CBD, where activity is concentrated. Different dimensions of people intermingle there out of convenience and necessity.

The model defines city node territories based on the overlapping action spaces of an entire population. This process is similar to the two-stage process that defines locale nodes, but it references different data. The first stage identifies a cluster composed of locale nodes with the greatest diversity of ties to other locales with regard to distance and direction. This would include only the most popular recreational grounds, cultural and civic destinations, shopping areas, and etcetera. Like at the locale level, this cluster serves to locate the city node and to determine its general area. (Fig. 3.14) City nodes will emerge in the downtown cores of metropolitan areas, where the greatest diversities of people converge to take advantage of city amenities. The second stage identifies less diverse locales in close proximity to the cluster already identified. Like at the locale level, this serves to fill out the city node and to reinforce the first stage of city node definition. (Fig. 3.15) These two stages function together to define and maintain diverse city nodes.

The model defines city node identities based on a dynamic collection of current media contributions out of every locale as deemed significant by the city population at large. Locale nodes broadcast this media online for everyone actively participating within the locale and those simply viewing from the home or workplace. This function will be outlined further in the next chapter. Every locale contributes to the diverse character of the city. However, those that most actively represent the interests of its population will have the greatest influence over its identity in the model.

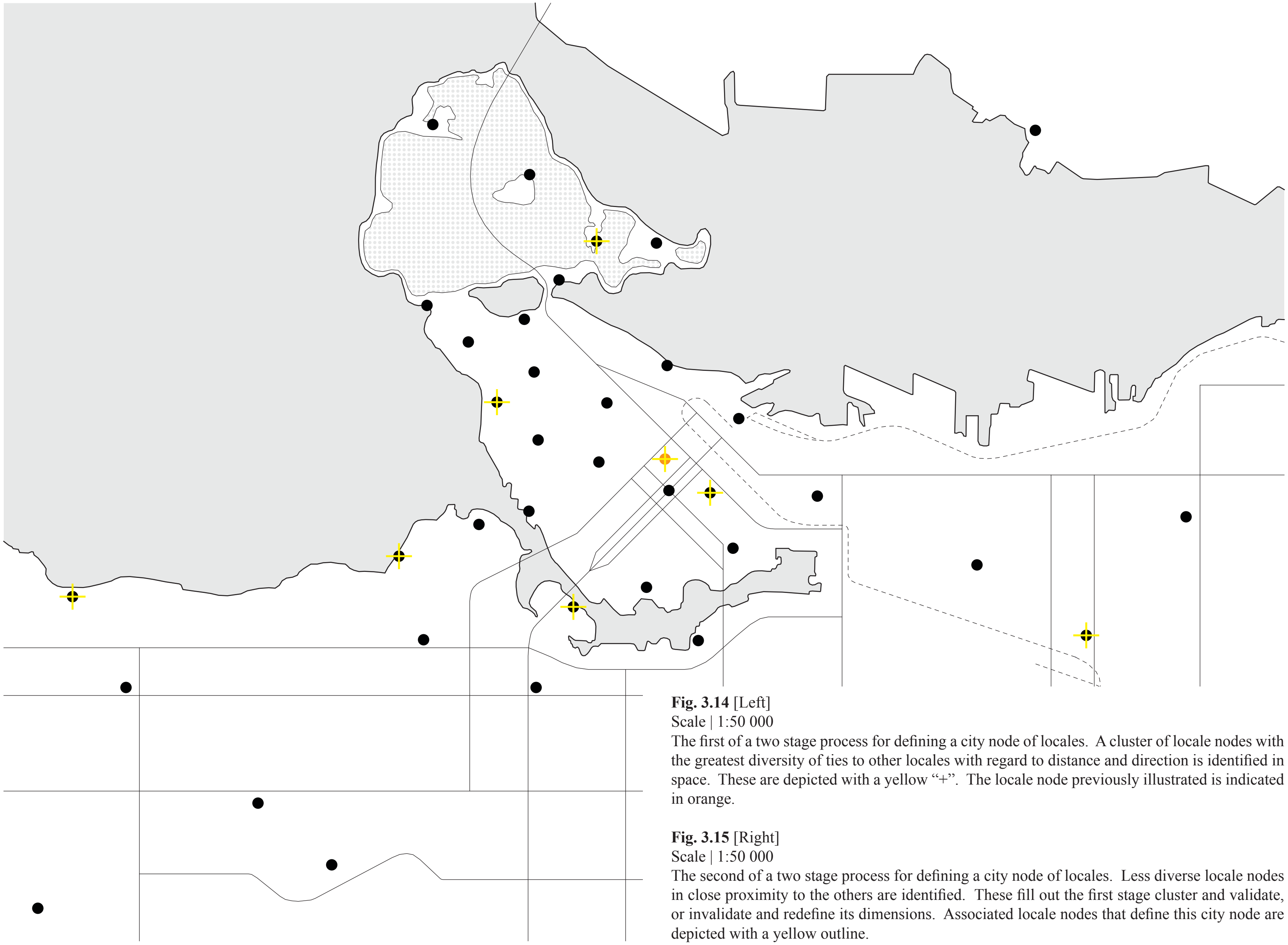
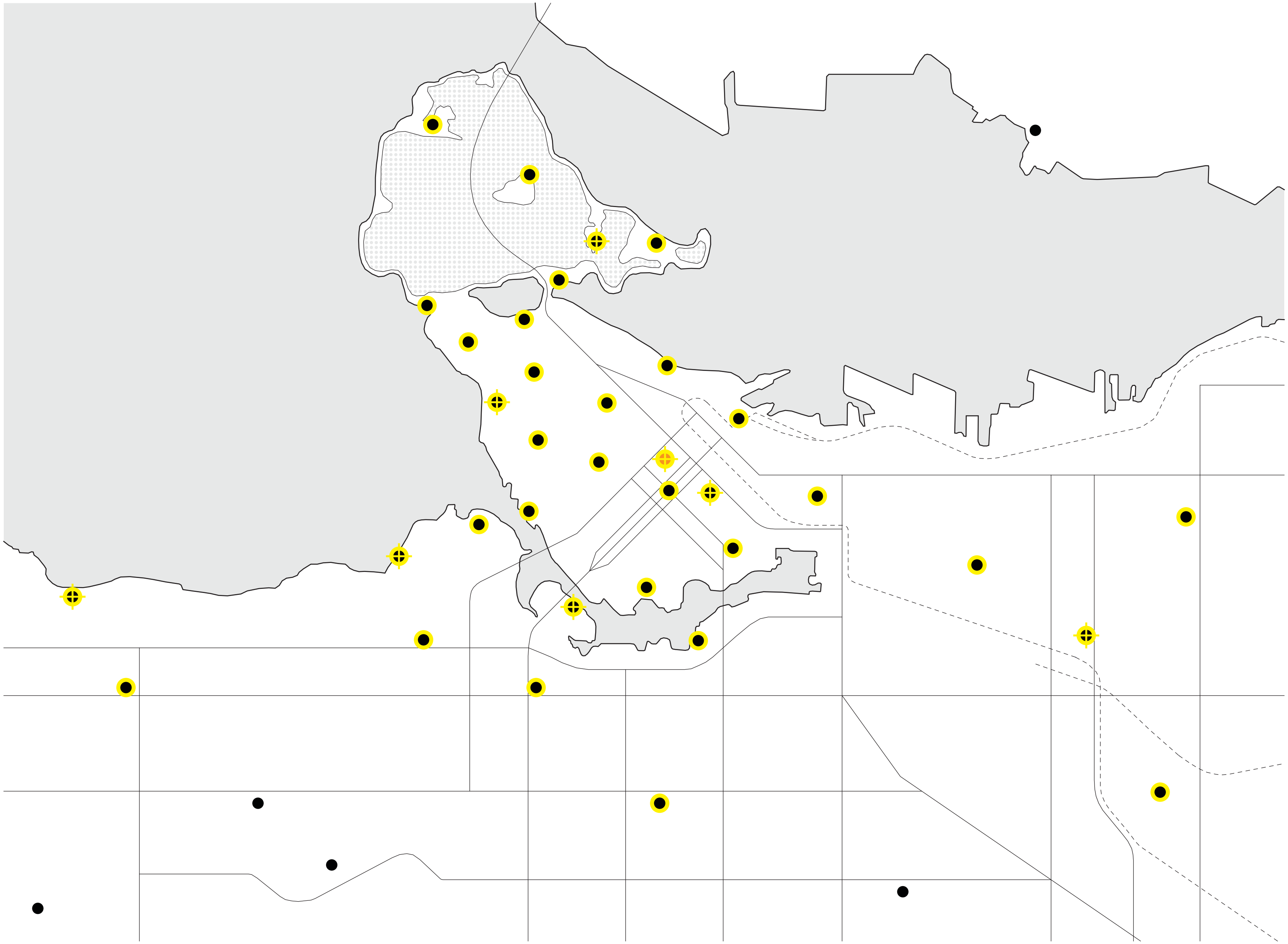


Fig. 3.14 [Left]
Scale | 1:50 000
The first of a two stage process for defining a city node of locales. A cluster of locale nodes with the greatest diversity of ties to other locales with regard to distance and direction is identified in space. These are depicted with a yellow "+". The locale node previously illustrated is indicated in orange.

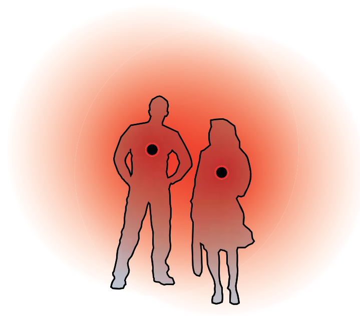
Fig. 3.15 [Right]
Scale | 1:50 000
The second of a two stage process for defining a city node of locales. Less diverse locale nodes in close proximity to the others are identified. These fill out the first stage cluster and validate, or invalidate and redefine its dimensions. Associated locale nodes that define this city node are depicted with a yellow outline.



Conclusion |

Socio-spatial connection extents are difficult to define. However, an attempt has been made here to show that analogous strong spatial and network connections articulate in clusters. These clusters are the best means for expressing territories and associated identities. The model uses them to define nodal elements of the emergent architecture in space, and to give these same elements identity in local and distributed culture. They are this architecture's socio-spatial foundation.

Additionally, an attempt has been made to show that socio-spatial connection clusters, or nodes, exist naturally in a hierarchy. The model supports this hierarchy so that the emergent architecture may evolve from its structure. The contextual studies of socio-spatial connection clusters at the group, locale, and city levels have made it possible to establish basic functions for identifying relevant and relative cluster formations from simple geographical data points. What is more, they offer some insight into the nature of the emergent architecture in action, since it extends from regular social activity in outdoor urban space.



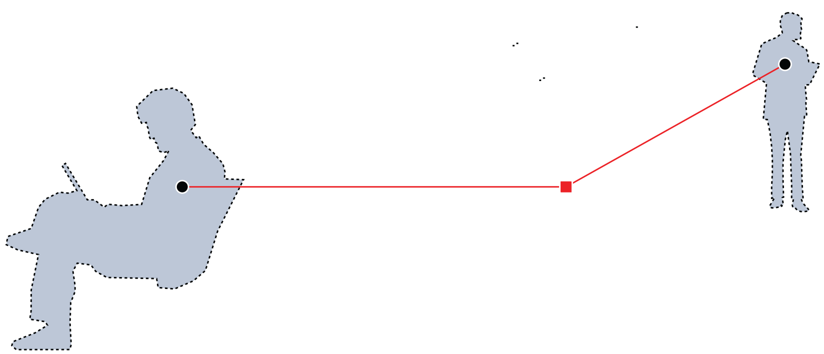


Fig. 4.1a
Spatial connections are co-present; their integrity depends on the co-operative displacement of space.

Fig. 4.1b
Network connections are distributed; their integrity depends on the mediation of divided elements in a network.

Chapter 4

Socio-Spatial Connection Integrity: Small World Networks

Chapter Introduction |

The previous chapter began looking at natural socio-spatial structures of people and their relations. It focused on clusters, or nodes, which are composed of strong connections. This chapter will look at weak ties, which connect disparate and far separated (relative to the scale of focus) nodes in socio-spatial structure.

Socio-spatial connection integrity measures the cohesion of a structure and the effectiveness of its connections. Spatial connections are co-present; their integrity depends on the co-operative displacement of space. (Fig. 4.1a) Network connections are distributed; their integrity depends on the mediation of divided elements in a network. (Fig. 4.1b) These connection properties suggest the active integrity of weak ties. Weak ties in turn are essential to the structural integrity of social formations.

This chapter will examine these properties of socio-spatial connection integrity. It will begin by outlining the significance of weak ties, illustrating how they facilitate the natural development of the most efficient network topology, the small world network. Next, it will examine the active integrity of weak ties and the structural integrity of social formations in the context of three different scales. These levels of socio-spatial structure will be compared and contrasted to related collaborative web architectures. The findings will inform how the model may best network the emergent architecture at each level, and as a whole, for collaboration amongst nodes.

Socio-Spatial Connection Integrity |

This section will examine the properties of socio-spatial connection integrity in natural social formations. First, it will introduce weak ties and show how they connect nodes in a network. It will suggest that there are different types of weak ties with different active integrities relative to the scale of focus. Next, this section will illustrate how weak ties enable the natural development of cohesive and highly efficient small world network geometries. It will show that small world networks are essential to all types of interactions and relationships. Lastly, it will illustrate how small world geometries assist the integrity of socio-spatial structures.

The previous chapter showed that strong spatial and network connections create clusters, or nodes, at different scales. Friends, family, and other divisions of people share similar patterns of spatial activity, and their network connections overlap considerably. These clusters are relatively confined social environments. Information, like gossip, that is released into them tends to loop along the same paths.

Weak ties are the most effective connections between these clusters. They enable information to ramify exponentially through a network. Weak ties consist of weak spatial and network connections – the opposite of socio-spatial clusters. They represent the connections between disparate nodes within and through all hierarchical scales, or levels. They connect distant or entirely separate social worlds. (Fig. 4.2)

Socio-spatial clusters exist simultaneously in many hierarchical levels. Different clusters such as those of groups, locales, and

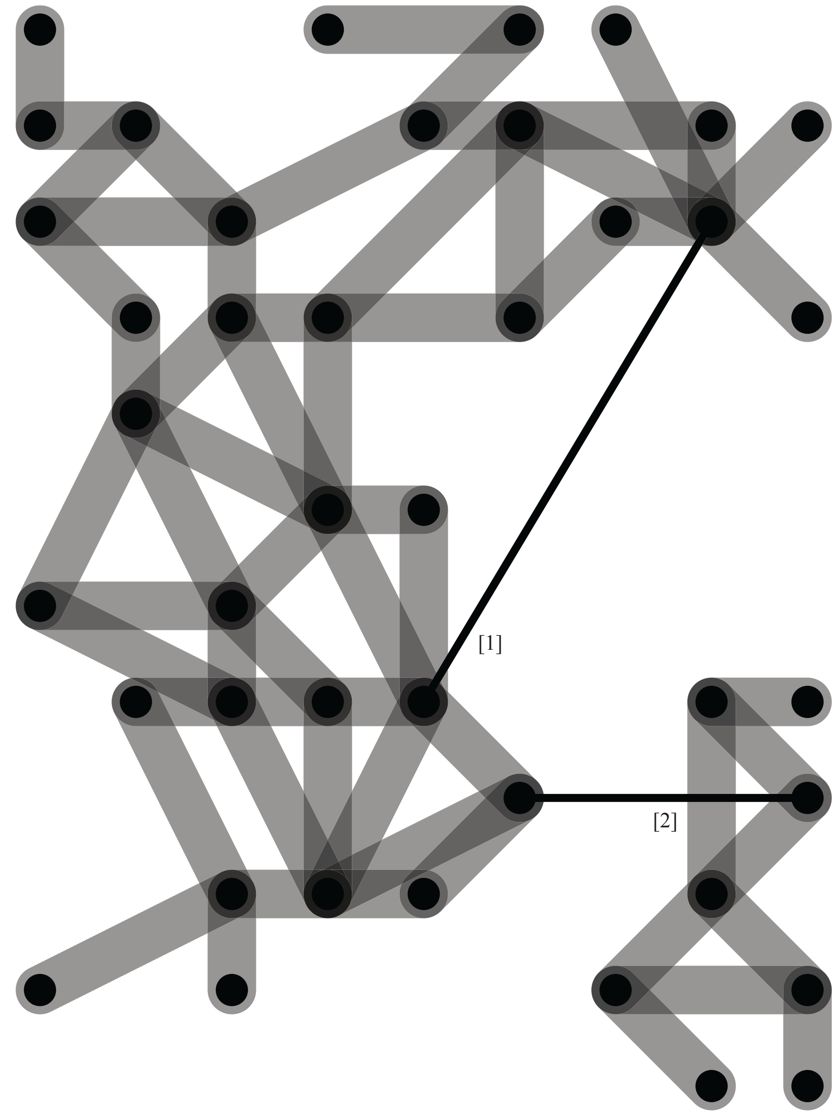


Fig. 4.2
Weak ties connect distant [1], or entirely separate [2] social worlds.

cities may be identified depending on the scale of focus. The strength of network ties, which both form and connect these clusters, is also relative to scale. We will use the term *weak ties* to refer to the weakest ties, or the ties connecting the most disparate nodes, at any scale.

Weak ties are a significant feature of small world network topologies. This chapter will examine them with relation to network structure and function. However, we must also evaluate their integrity in action for the benefit of the model. We will refer to this as their *active integrity*.

Though usually referred to as strictly a network component, weak ties may be created by, or activated through either a spatial or network connection, or some combination of both. This depends on the scale. It usually involves one person traveling to engage in spatial connection with another, or a network connection between people via electronic communication. Spatial connections are inherently better for social cohesion. However, network connections have greater reach, speed, and flexibility. (Fig. 4.3)

This thesis defines the active nature of weak ties in the model in terms of the circumstances that normally affect such activity at each level. However, the thesis also augments this definition with functionality inspired by collaborative web architectures. This preserves some of the inherent benefits of these conditions while also improving network cohesion and the efficiency and integrity of connections at every level.

The structural significance of weak ties has only recently been documented. In the June 4, 1998, issue of *Nature*, mathematician Duncan Watts and his doctoral advisor at Cornell University, Steve

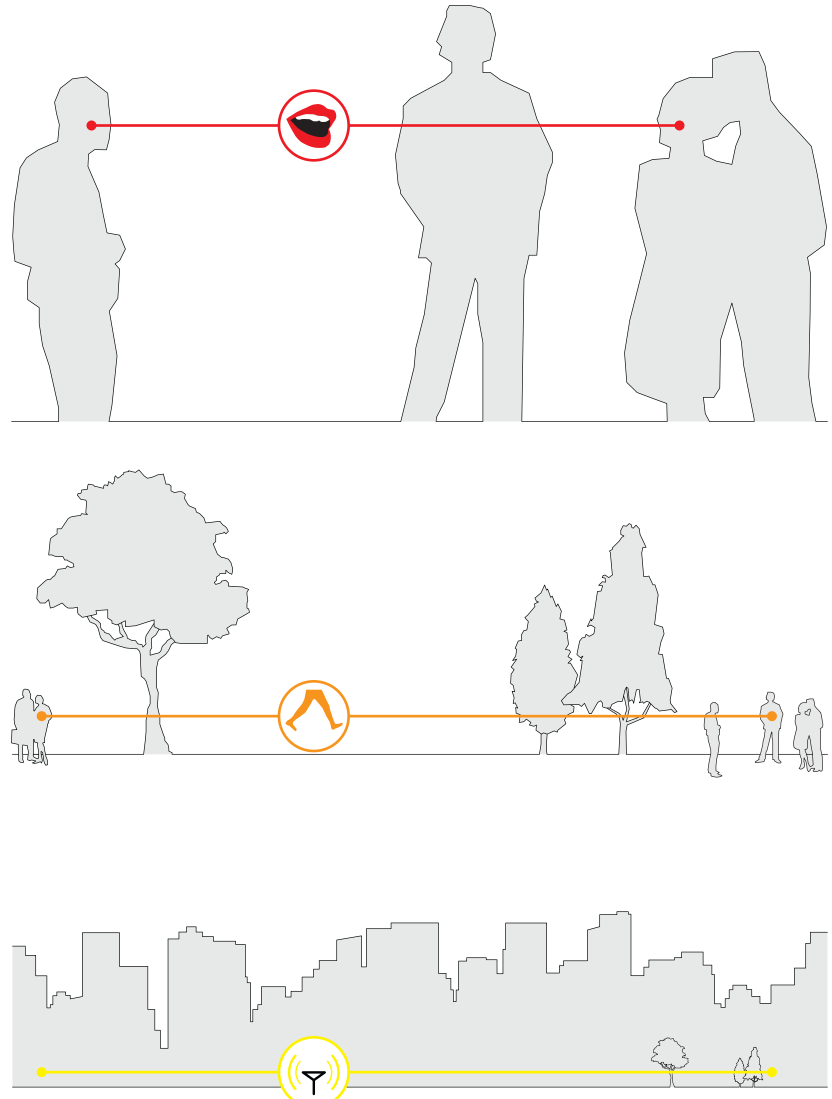


Fig. 4.3
Weak ties and the typical means for *activating* them at the three levels of focus: verbal and gesture interaction at the group level; personal mobility at the locale level; and electronic communication at the city level.

Strogatz published a paper on small world networks. They discovered that the random rewiring of just a few ties in an otherwise ordered network drastically improves its architecture.

The ordered ties in this model represent strong local ties. Each node is connected to a number of those in closest proximity. These connections are redundant so the network is highly clustered. (Fig. 4.4a) Watts and Strogatz experimented with this structure. They found that the degree of clustering within the network is barely affected by the act of randomly rewiring a few of the nodes. However, the degree of separation – the average number of links required to connect from one side of the network to another – decreases dramatically. The random ties act as long distance weak ties, efficiently connecting disparate clusters of nodes. This is one type of small world network. We will refer to it as *egalitarian* – most nodes have a similar amount of strong local ties, and few have one or two long distance weak ties. (Buchanan 2002, 48-60) (Fig. 4.4b)

There is also an *aristocratic*, or in technical terms, a *scale-free* variety of the small world network topology. It differs in structure from the egalitarian variety, but exhibits the same properties of being highly clustered, while maintaining a very low degree of separation. (Fig. 4.5a) The distribution of its ties follows a power-law pattern. That is, each time the number of links doubles, the number of nodes with that many links decreases by a constant factor. (Fig. 4.5b) This results in hierarchies of nodal hubs relating to the number of links they support. We will refer to these special nodes as *connectors*. At the top of the hierarchy, very few connectors support many links; at the bottom, very many nodes support few links.

Most small world networks naturally arise out of the *rich get*

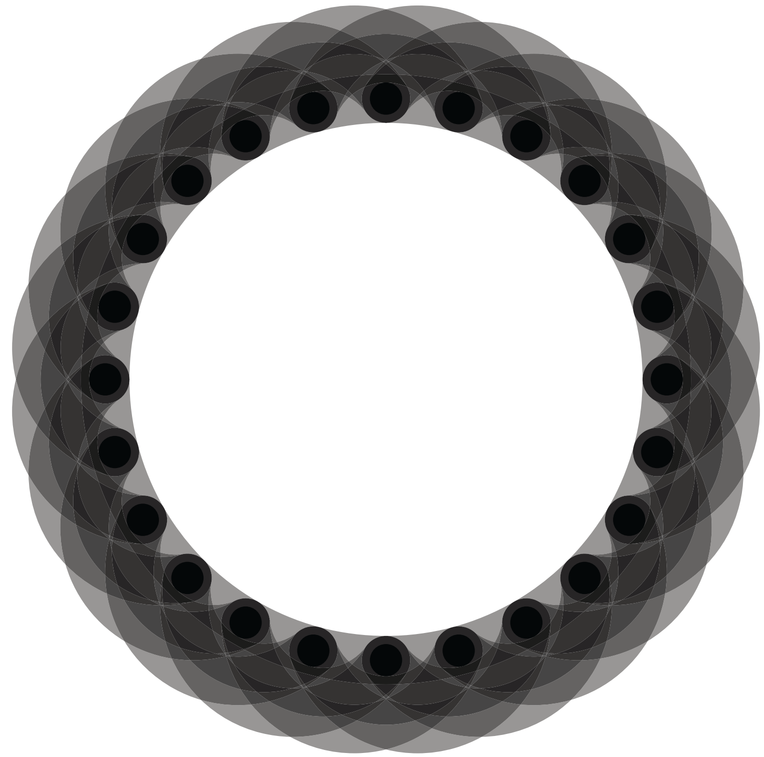


Fig. 4.4a
A highly clustered ordered network. Each node is connected to a number of those in closest proximity via strong local ties.

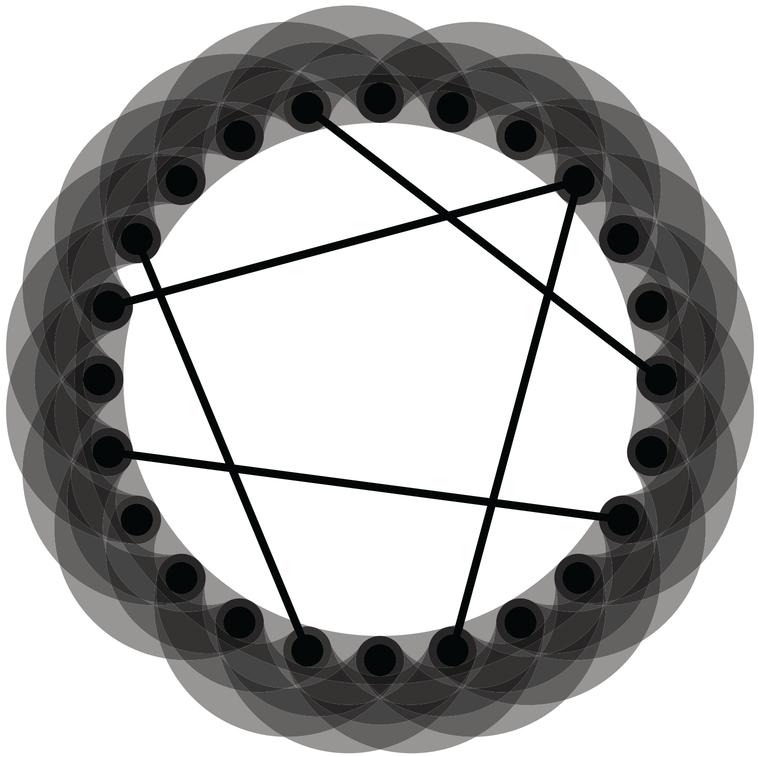


Fig. 4.4b
The same network from Fig. 4.4a, but with five nodes randomly rewired. This is an egalitarian small world network – most nodes have a similar amount of strong local ties, and a few have one or two long distance weak ties.

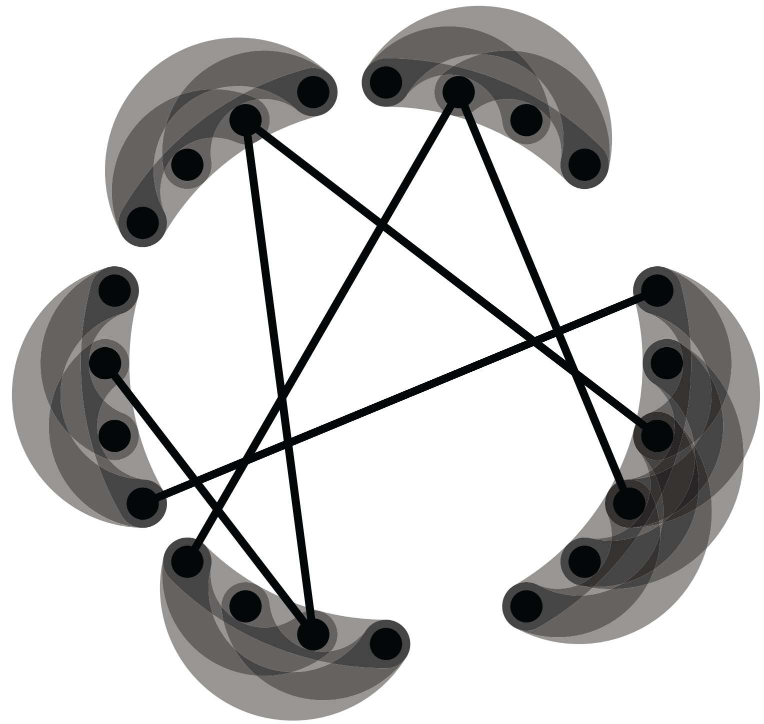


Fig. 4.5a
A scale-free small world network. The distribution of its ties follows a power law pattern – each time the number of links doubles, the number of nodes with that many links decreases by a constant factor.

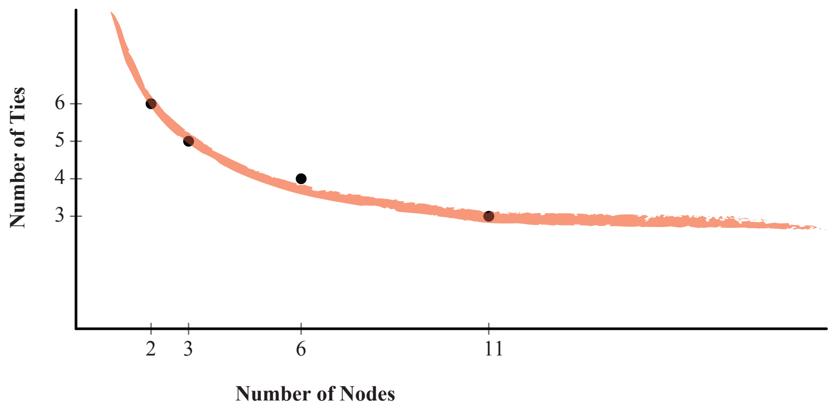


Fig. 4.5b
A power-law graph of the nodes and ties making up the network in Fig. 4.5a. The power-law curve is recognizable by its long, fat tail.

richer phenomenon as the scale-free variety. The distribution of new ties amongst nodes in a network is rarely random. Accessible nodes with the most links are favored. Consider the worldwide network of connecting commercial flights. Airports with the most existing connections are most likely to acquire new connections because of their ability to extend these new connections elsewhere. Airports with fewer connections attract fewer new connections, but still more than those with fewer connections still. Connectors emerge in a power law to create a scale-free network.

Egalitarian networks evolve from scale-free networks that limit the growth of connectors. This limitation is often a factor of crowding. Consider the worldwide commercial flight network again. Though this network probably started out scale-free, recent studies show that it now tends more toward the egalitarian variety. The most popular airports are so crowded and tightly scheduled that small inconveniences such as poor weather can compound into significant delays across the board. For this reason, it is beneficial for many to make connecting flights through smaller airports. Less connected hubs have grown to accommodate more links and the network has evolved to distribute traffic more evenly. (Buchanan 2002, 121-125)

Jane Jacobs touched on the significance of weak ties and small world networks in her book *The Death and Life of Great American Cities*. She recalls a game she played with her sister as a child. They would pick two wildly dissimilar individuals and compete to discover the shortest possible chain of people through whom a message could be sent between them by word of mouth. The game was eventually foiled when the two began employing a Mrs. Roosevelt character in the middle of their chains. "Mrs. Roosevelt made it suddenly possible to skip whole chains of intermediate connections. She knew the most unlikely people. The world shrank remarkably." (Jacobs 1961, 134-135) In fact, any two people of the world's population of roughly 6 billion can be connected in about six links because the worldwide network of social relations is a small world.

The small world geometry is essential to many of our most significant infrastructures. Systems of roads and railways, as well as those of electric power grids are egalitarian networks. The physical network of computers and transmission lines that form the Internet is scale-free. (Fig. 4.6) So is the digital network of the World Wide Web. What's interesting is that these networks were not planned, but evolved this way. The rich get richer phenomenon guided their development and evolution. Nature too, has stumbled upon the small world geometry through natural selection. The neural network of the human brain is egalitarian. (Buchanan 2002, 125) The food web is a scale-free network by way of its predator-prey relationships. The small world geometry is the natural model of efficiency and integrity

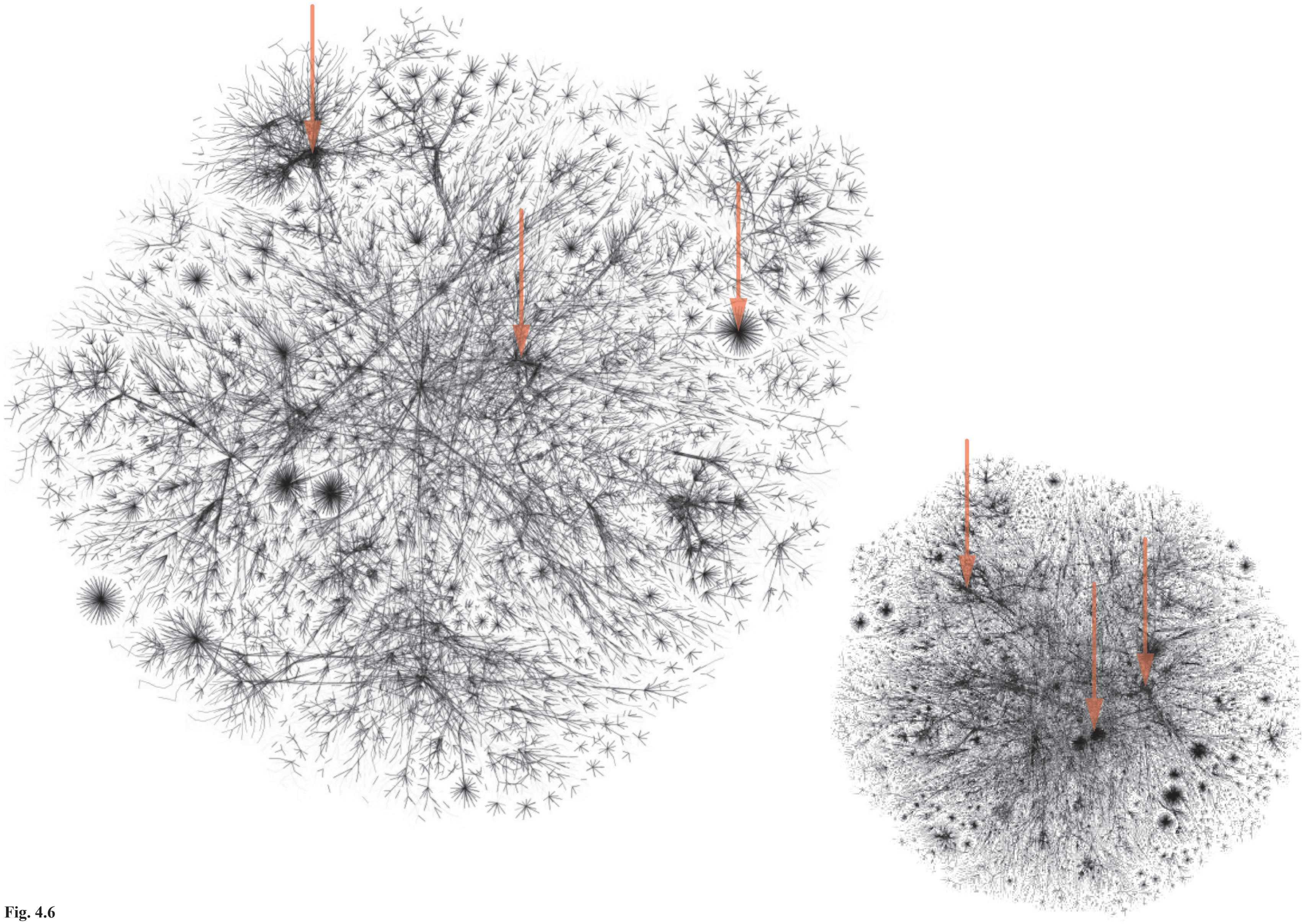


Fig. 4.6
A partial map of the Internet [left] and a map of the World Wide Web [right]. Note the hierarchies of connector nodes, or hubs, that make up these scale-free networks.

for almost any complex network of interactions or relationships. Even the structure of human language follows this pattern. (Csermely 2006, 219-24) It is "a new geometrical and architectural idea of immense importance." (Buchanan 2002, 60)

Various network geometries are appropriate for different purposes. The same principals that make small world geometries highly efficient also make them vulnerable to targeted attack. Small world networks rely strongly on a few important connectors. The removal of just these nodes causes the network to fall to pieces. (Fig. 4.7a) However, the small world geometry is ideal for purposes that do not face 'intelligent' attack. Natural failure is likely to chance upon some of the many redundant nodes in a small world network rather than upon the fewer major connectors. (Fig. 4.7b) Small world networks fall apart gracefully. They usually remain completely intact as nodes are removed randomly one by one. Random networks, on the other hand, tend to shatter suddenly into collections of isolated subnetworks as nodes are removed. For this reason, the small world geometry is the most resistant to natural decay.

The model encourages a scale-free small world network structure in the emergent architecture. This extends from, augments, and improves the socio-spatial structures people naturally develop in urban environments. It is particularly supportive at the locale level. The natural active integrity of weak ties between groups there is poor. This negatively affects the integrity and efficiency of the city socio-spatial structure as a whole. The model enhances the natural active integrity of weak ties at each level and supports the city small world structure.

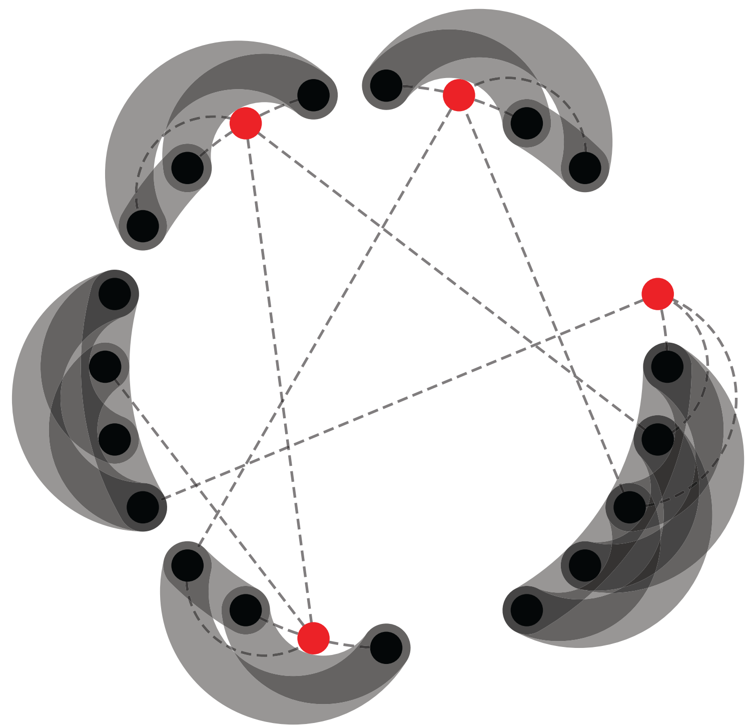


Fig. 4.7a
A scale-free network under intelligent attack. Connector nodes are targeted (red) and the resulting destruction leaves the network fragmented. Destroyed ties are indicated by dashed lines.

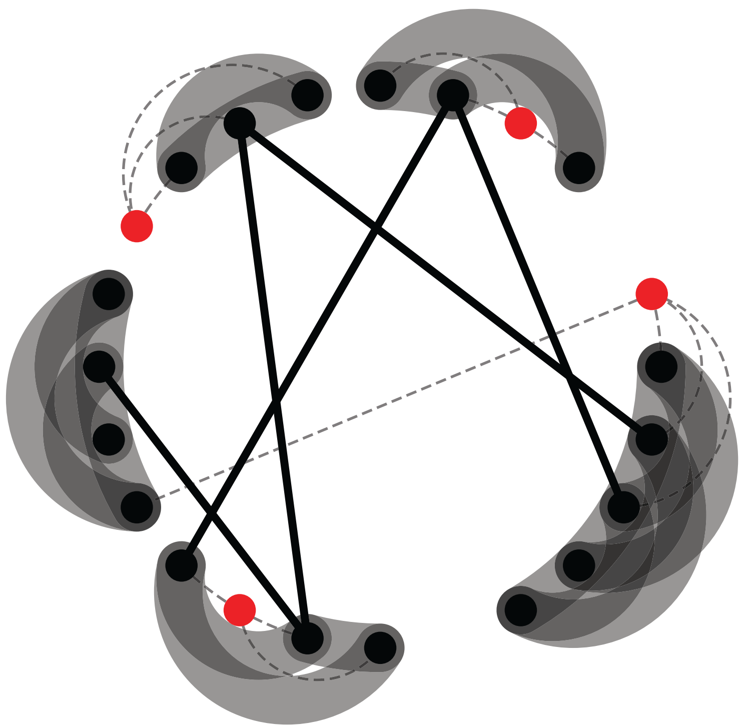


Fig. 4.7b
A scale-free network undergoing natural decay. This is simulated by randomly removing nodes (red). Abundant low-level nodes are hit the hardest. The resulting destruction leaves the network largely intact. Destroyed ties are indicated by dashed lines.

Socio-Spatial Connection Integrity in Context |

This section of the chapter is composed of three parts. Each part will examine the qualities of socio-spatial connection integrity in the context of a particular scale. This will involve an analysis of both the active integrity of weak ties and the integrity of socio-spatial structure at each level of focus. The functions of a few relevant web architectures will be compared and contrasted with these analyses. All this will inform the model's design. Functions for connecting nodes in a scale-free structure will be outlined at each level.

Group Level |

Socio-spatial connection integrity is best at the group level because of the rich and immersive nature of verbal and gesture interaction. Individuals of a group achieve social cohesion through ritual use of these co-present practices. This scenario and a comparative web architecture, the wiki, inform how nodes are connected at this level in the model for optimum structural integrity.

We will consider weak ties at the group level to connect the most poorly acquainted individuals. They are activated through verbal and gesture interaction. This is predominantly a spatial, rather than a network practice given that it is unmediated and in close range. People must co-operatively organize themselves in space and be attentive to one another. This enables immersive connections with high active integrity.

Group socio-spatial structures are typically tightly knit throughout. Everyone is well connected, so long as they actively participate in the group interaction. We will refer to the structure of group networks as egalitarian. (Fig. 4.8) This rich co-present group scenario allows for the development of social cohesion through ritualistic interaction. "It is the function of ritual to ensure that a sense of the collective arises from the interaction of individuals. (Ling, 2008, 47) Furthermore "…it is the job of the participants to not only fall into the mood of the session, but also participate in engineering it." (Ling 2008, 87) People use ritualistic devices to enter into, maintain, and exit group social situations. Greetings, for example, set the mood of conversation; head nods and light responsive utterances inform others that one is listening; proper management of glances can guide the flow of interaction, and even have an effect on its tone. This simple behavior allows individuals to give themselves over to the collective and develop a common sense of identity.

The mobile communication device has a varied role in group scenarios. It is most commonly thought to disrupt them. Indeed, an externally made or received phone call or text message breaks the flow of interaction. The involved individual must balance his or her attention between those present and the networked participant. With a phone conversation, both participants face the task of finding a common conversational tone and character that is sensitive to the scenarios at either end of the line. This is difficult to anticipate and can put strain on either, or both groups. Those present, but not engaged in the phone conversation have to adjust their behavior for the situation as well. However, the mobile device also has positive qualities in the group scenario. It can augment situations with shared personal or online media. It is also capable of bridging awkward moments through its functionality. "Glancing at the telephone or quickly checking for new messages can be a 'break' from the mutually focused activity of the co-present conversation." (Ling 2008, 97)

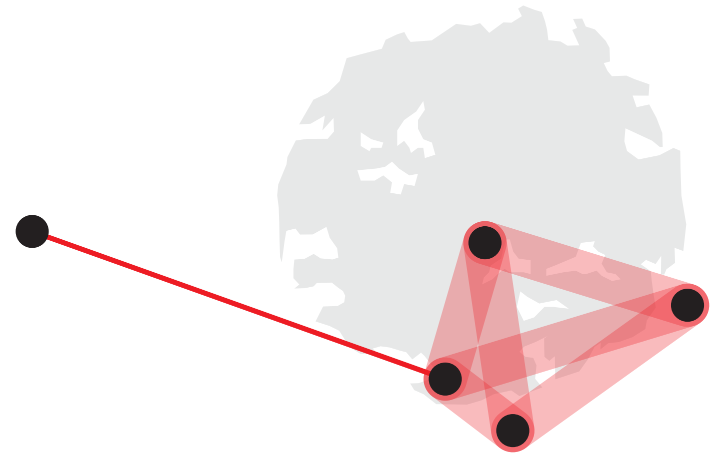


Fig. 4.8
An example of a group level highly redundant socio-spatial structure.

The wiki is a collaborative web architecture that approximates the co-present nature of the group scenario online. It is more than just a one-way expanding document. The wiki allows people to edit one another's work in a circular process. New wiki structures such as the one inherent to *Google Wave* even exhibit contributors' progress in real time. They function similar to how multiple people might interact with a shared object in co-present space.

The model functions through people's mobile communication devices. Each individual's mobile device acts as a portal into the model's network environment. This portal consists of three windows:

personal, for private, entirely open web surfing; *group*, for group level collaboration; and *locale*, for a directory of everything at the locale level.

The group level of the model is designed to connect each individual with every other within their group. Its functions extend from the nature of regular co-present group scenarios with augmentation inspired by wiki web architectures. It enables individuals to alternately lead wiki collaboration as an extension of their regular conversation. In effect, these individuals become group level connector nodes for the period they direct the collaboration. (Fig. 4.9a)

The group window is a collaborative wiki authoring and viewing environment similar to *Google Wave*. Every individual in the group can interact within it via their mobile devices in real time. It simply supports hypertext on the *main page*. However, the links are a means for associating any imaginable media content and native or independent applications sourced from the internet or the individual's mobile device. Group members can assemble simple data documents, or fully functioning 'programs' to be used by themselves, other groups within the locale, and anyone else among the city, or worldwide. These 'programs' operate via three sources: the automated functions of native and online applications (wikis, forums, chat, video and audio streaming, games, polls, monetary transaction processing, etcetera); manual control by group members, who might act as media jockeys, for example; and distributed collaborators within the locale and worldwide. The creative combinatory potential is limitless. The regular text of the group main page is for giving context to the links and instruction on how to use them together, as well as for giving character and identity to the associated group node. Each wiki also requires a title, which will represent the group node in locale and city level lists. (Fig. 4.9b)

The group node and its publicly organized functions form the basis from which the entire model extends. It is designed to accommodate individual involvement on a sliding scale. People may simply use it as a social break and to augment conversation with shared media (and consequently publish a real-time public record of their conversational topics). On the other end of the scale, the group node may be used to stage small-scale, or elaborate functions or events meant to be experienced locally, online, or as a combination of the two. In any case, the group node aids in the development of social cohesion among individuals.

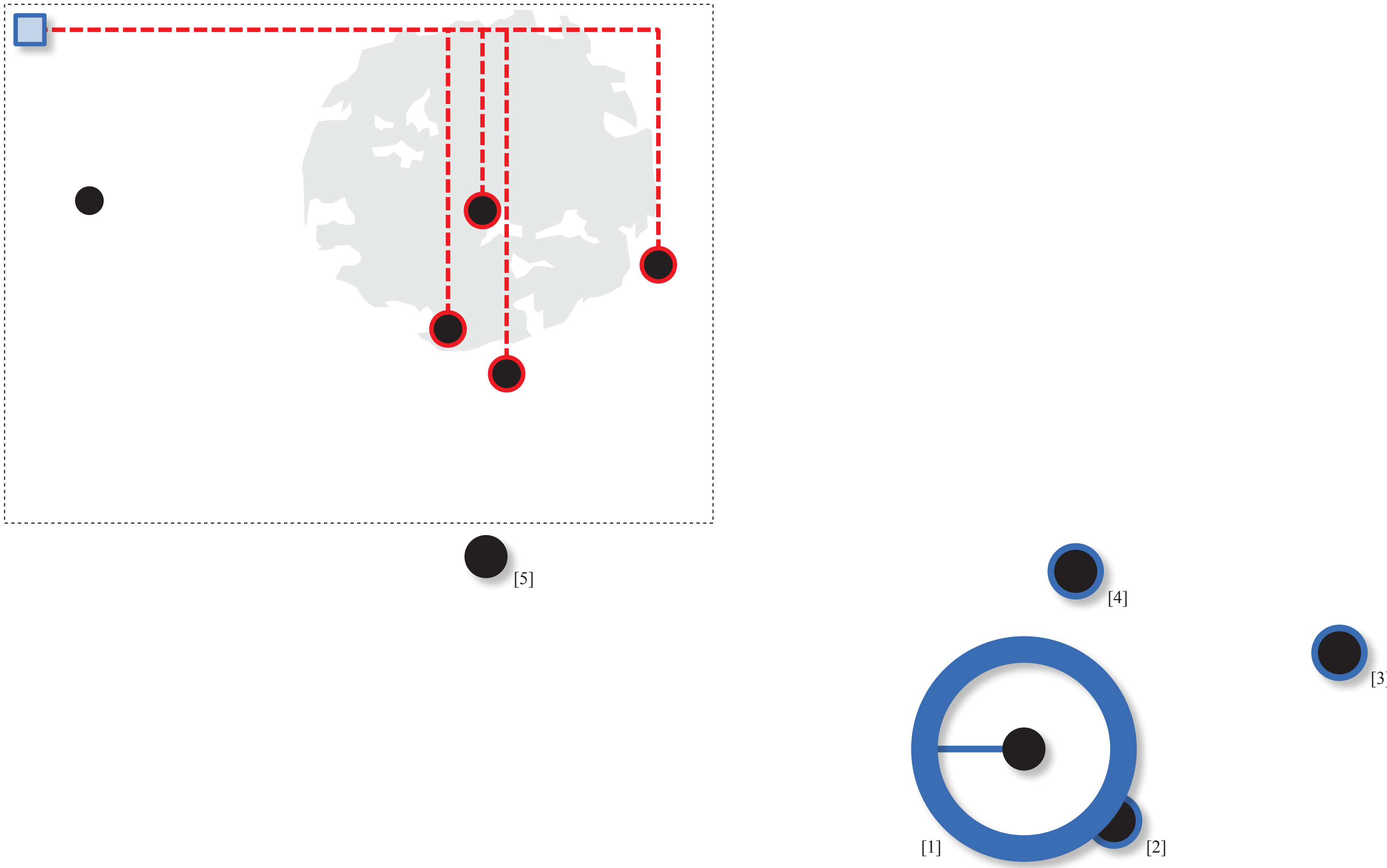
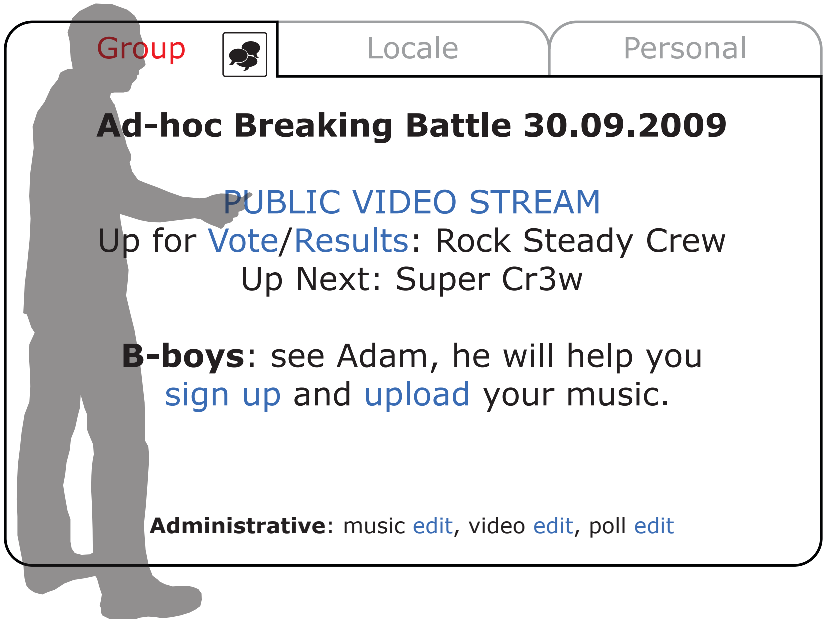


Fig. 4.9a
The model connects each individual with every other in their group. Associated nodes in the model are illustrated in blue. The size of each blue nodal outline indicates the degree to which that node is currently a connector in the group network. This status is determined by who is leading and contributing to the group interaction.



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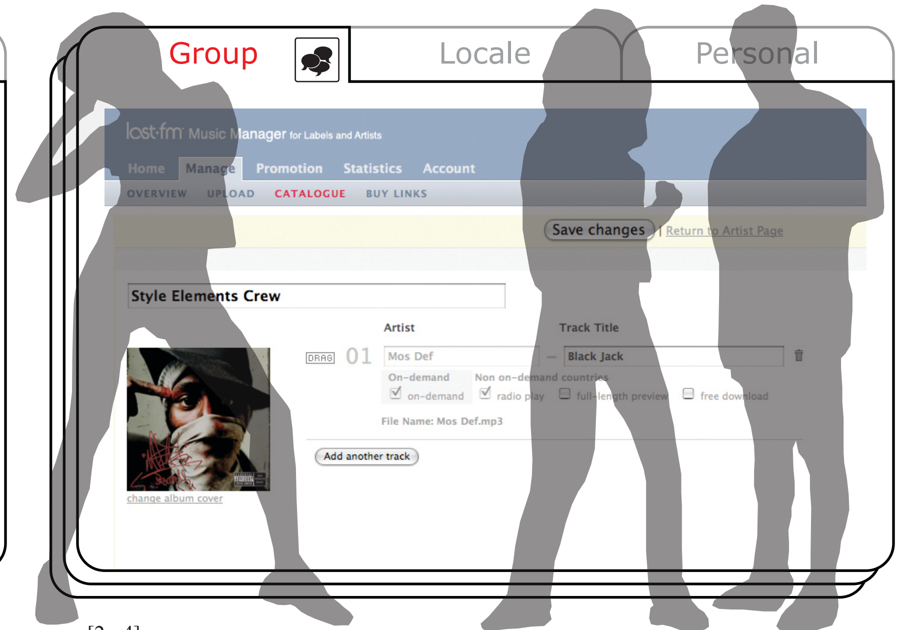

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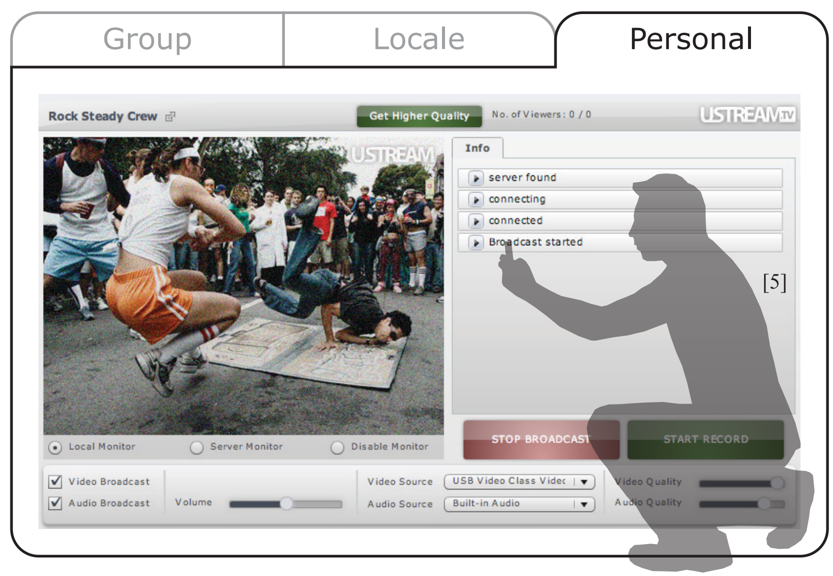


Fig. 4.9b
A group node ad-hoc break dancing event. Adam [1] assists three b-boys/girls [2 - 4] in signing up for the event and uploading their music via third party online applications linked through the group node wiki. Adam manages all aspects of the event through the group wiki and through co-present interaction. The music plays through speakers plugged into his mobile communication device. Another individual [5] films the event on his phone. Though he is currently outside the group node range and unassociated with the model, he streams his video live through a third party online application, which is linked through the group wiki and available for anyone to view.

Locale Level |

Socio-spatial connection integrity is poor at the locale level. The process of activating connections is complex at this scale because separate groups in urban space are not typically acquainted. The impersonal nature of contemporary urban spaces and their lack of socially directive qualities compound the problem. These factors, and a comparative collaborative web architecture, the forum, inform how nodes are connected at this level in the model for optimum structural integrity.

Weak ties at the locale level connect the most disparate groups. They are best activated by the combination of an individual's personal mobility, which is used to traverse the space between groups and through verbal and gesture interaction, like at the group level. We have already discussed the logistics of co-present interaction, a spatial component of this process. The addition of a network component, connecting between groups, adds considerable complexity. One must cross a distinct social boundary, the group territory, in order to activate the connection. The complexity of this undertaking gives weak ties at the local level poor active integrity.

Locale socio-spatial structures have the potential to be exceptionally cohesive considering that separate groups have all converged to engage in similar activities. Nonetheless, they are typically very fragmented. (Fig. 4.10) This stems from group territorial activity. "The human being is the connecting creature who must always separate and cannot connect without separating." (Simmel 1997, 171) People make sense of things by separating them into groups, through which they draw distinctions and order relations. This holds true even for people themselves. Groups define themselves and enhance their

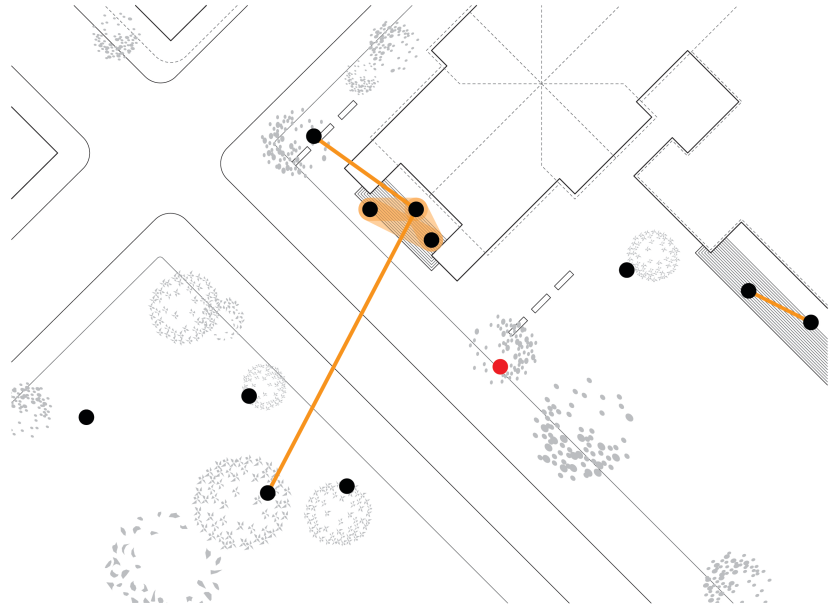


Fig. 4.10
An example of a locale level fragmented socio-spatial structure.

own physical and cognitive cohesion through distance and spatial separation. To cross these boundaries is to challenge the social order of the locale. This behavior is acceptable, or even encouraged in some places, but discouraged in most public urban areas.

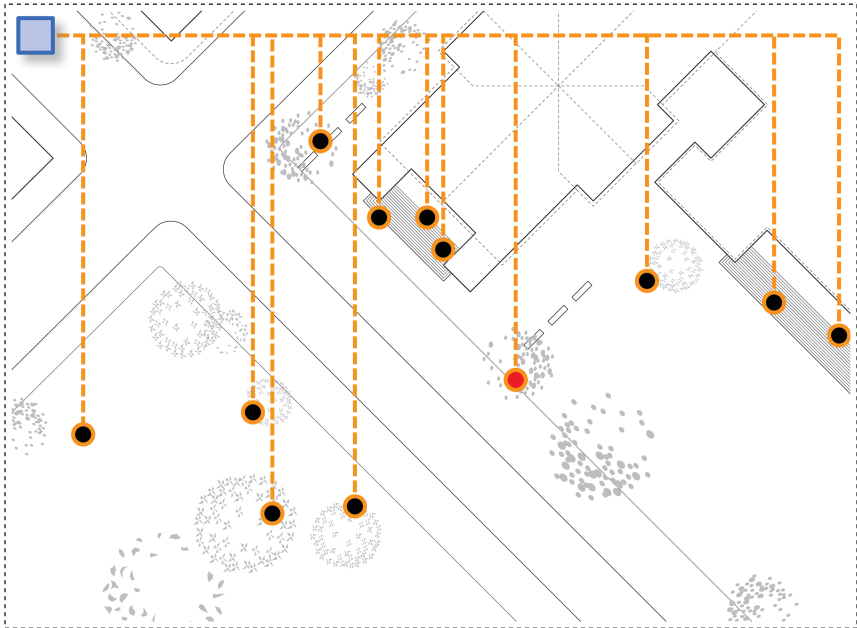
Social cohesion can be high in places that are typically identified with social exchange such as cafés, bars, hair salons, and other *third places*. This is especially true of schools, neighborhood community centers and club facilities, where the same people meet regularly. These places are only semi-public. Their purposes and the intentions of people there are well defined. This helps to alleviate the stress of crossing social boundaries. Street areas, and public parks or squares on the other hand, are theoretically open to everyone. This is problematic because, as critics like Richard Sennett have pointed out, individuality has won out over collectivity in modern times. "At the level of subjectivity the cult of privacy has 'raised claustrophobia into an ethical principle' as the work of the self and the drama of intimacy assume the centre of moral life." (Tonkiss 2005, 73) The reality of urban public spaces is that they are organized through forms of control and exclusion. "Public policing, private security, social aversion, hostility or harassment, codes of consumption and conduct interact in various ways to determine both the rules of access to public space and the exclusion zones of the private." (Tonkiss 2005, 72) These impersonal forces degrade the communal atmosphere of public space. Separate groups perceive one another as a nuisance, or threatening, rather than welcoming. This magnifies the complexity of activating connections between groups and the potential integrity of the socio-spatial structure is compromised.

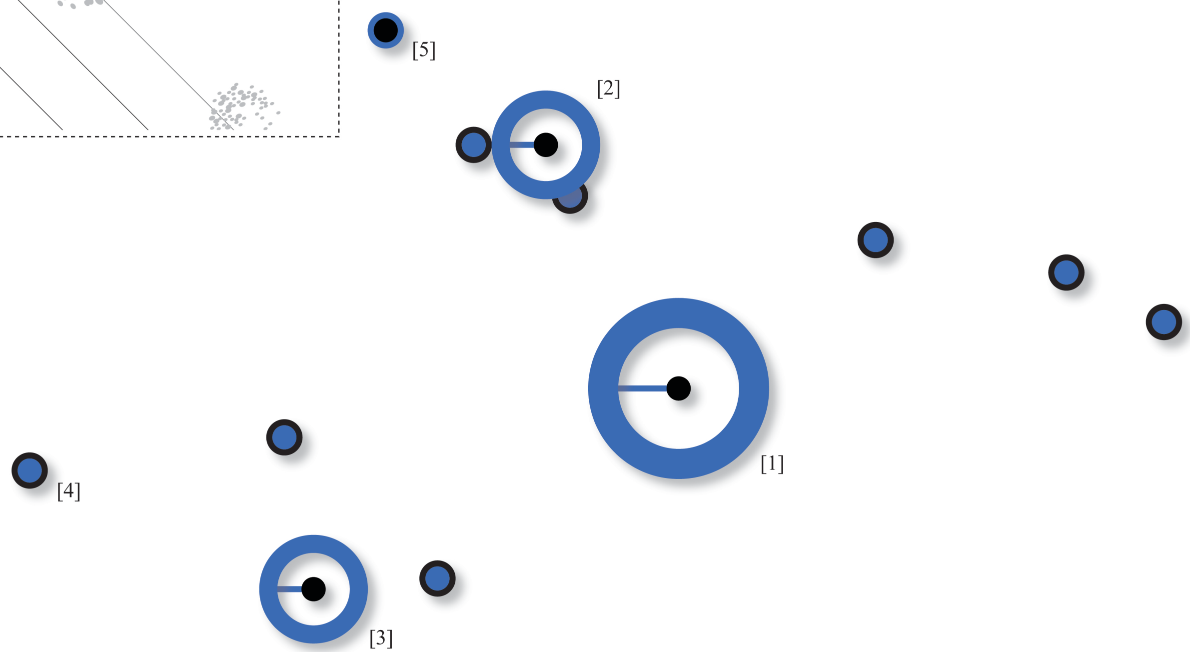
Mobile communication devices can connect many people and help them organize themselves in opposition to external forces, restrictions, or authorities. Howard Rheingold refers to this phenomenon as a *smart mob*. Smart mobs leverage both the spatial authority and the network intelligence of crowds for different purposes. For example, on November 30, 1999, demonstrators loosely organized themselves to disrupt the World Trade Organization meeting in the 'Battle of Seattle' through a network of mobile phones, radios, police scanners and portable computers. "The Direct Action Network enabled autonomous groups to choose which levels of action to participate in, from nonviolent support to civil disobedience to joining mass arrests – a kind of dynamic ad hoc alliance that wouldn't have been possible without a mobile, many-to-many, real-time communication network." (Rheingold 2002, 158-161) On the other end of the scale, smart mobs can also facilitate surreal public performances such as massive urban pillow fights organized by social art groups. Mobile communication devices allow people to network together and overwhelm the prescribed order and meaning of urban places. This form of human agency has the power to strengthen social cohesion at the locale level.

The internet forum is the best structural precedent for organizing the many separate group nodes of a locale online. It is a list of related group discussions that are prioritized by their current level of activity. The newest and most active discussions hold the best positions at the top of the list, while the older and less active ones sink to the bottom. This simple function keeps people abreast of the latest activity. The locale level scenario is similar in that people can see and hear the separate groups and their activity levels. However, the organization of this information in the forum is more refined.

The locale level of the model is designed to potentially connect each group with every other that make up a locale. This facilitates the development of locale level connector nodes. (Fig. 4.11a) The local level's functions extend from the nature of regular locale scenarios with augmentation inspired by web forum architectures. Group nodes are considered to be flexible parts of a cohesive locale structure, not separate entities. We have already shown that they consist of a spatial area and a network *wiki-like* component.

Individuals who have defined a group node may either create and associate a new wiki to their area, or they may associate an inactive or an already active wiki from the *locale level list* to their area.

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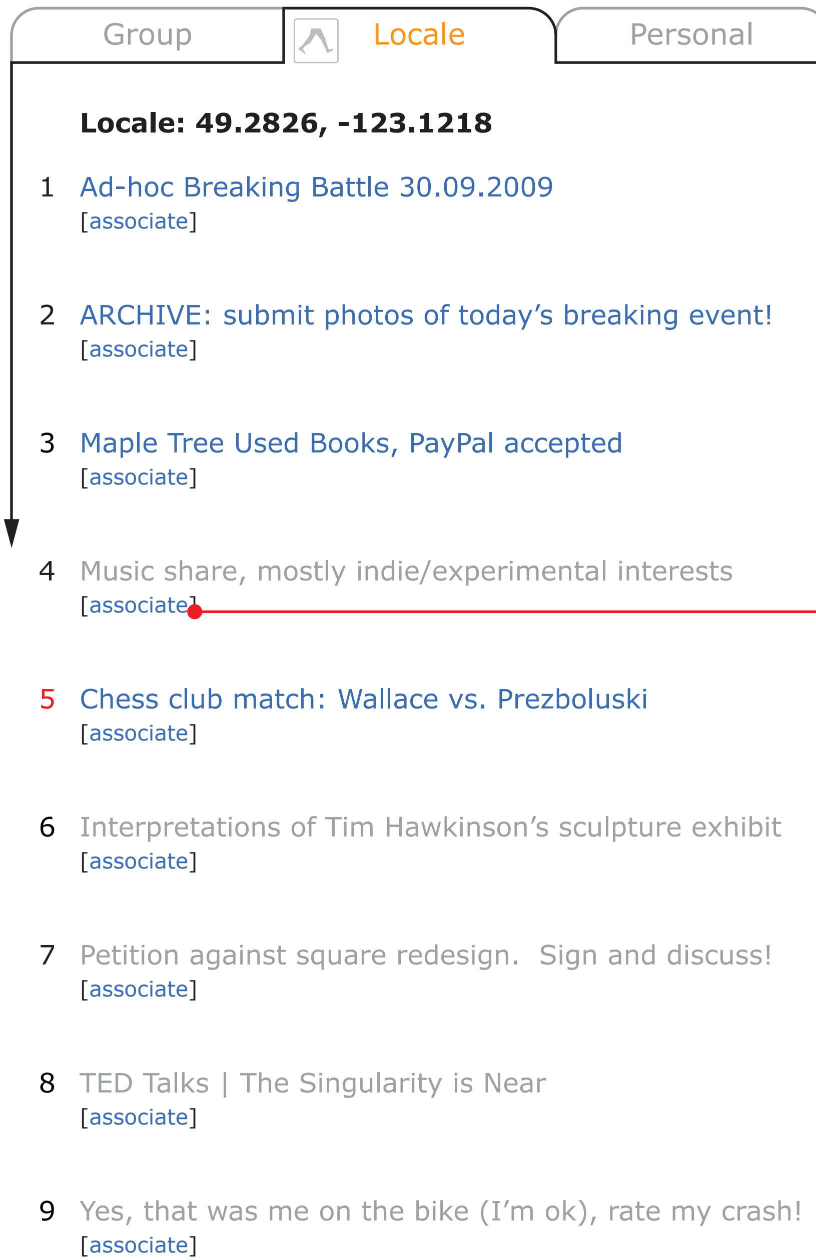


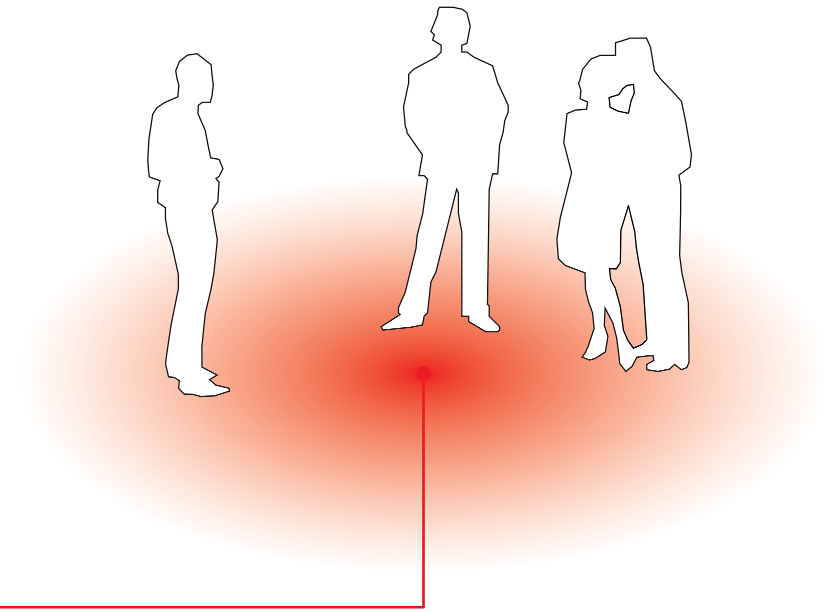


Fig. 4.11a [Left]
The model potentially connects each group with every other that make up a locale. Associated nodes in the model are illustrated in blue. The size of each blue nodal outline indicates the degree to which that node is currently a connector in the locale network. This status is determined for each individual node by the number of other nodes that associate its wiki to their area at any given time. The inverted nodes in the diagram depict those that have associated another node's content.

Fig. 4.11b [Right]
A locale level list of group wikis organized by activity level. The more activity a wiki receives, the more prestigious its position on the list, and consequently, the more continued attention it attracts. This *rich get richer* scenario aids in the development of a locale level scale-free socio-spatial structure (as illustrated through hierarchical levels of connector nodes in Fig. 4.11a).

Wikis are associated to group node territories simply by clicking the "associate" link. Already active wikis are listed in blue, while inactive wikis are grayed out. Private groups are indicated by a red number, as with #5.

The first two of those options will give them full editorial control of their wiki. The third option, to associate an already active wiki, allows the group to view and interact with the content of the wiki, but not to edit the wiki itself. This is significant in that it enables any number of separate groups to effectively collapse the space between them and connect through a single networked environment. Editorial control of the wiki remains with the group who first associated it to their node. Such groups of people, their territories, and their networked wikis together act as socio-spatial connector nodes.

The locale level list appears in the locale window of an individual's mobile device. It is viewable in two formats; organized by activity level, and organized spatially. The first format lists all wikis associated with the locale, with inactive wikis grayed out. They are prioritized by their levels of activity, similar to an internet forum. A wiki's activity level is determined by the number of group nodes who associate it to their area, both as operators and as viewers in a period of time. (Fig. 4.11b) This can have a viral effect. The *rich* wikis – those high on the locale list – will get richer as their position encourages more people to view them. The *poor* wikis will inspire less interest as they descend the list. The spatially organized format orders nodes in the locale list based on their proximity to the individual viewing the list. This makes it possible for people to easily associate wikis from the list with groups of people among the locale for navigational purposes. (Fig. 4.12) Active groups that have associated another group's wiki are listed, but grayed out. Inactive wikis are not listed in this viewing format. Wikis persist in the locale level of the model, even after the individuals of the group have parted ways. This will be discussed further in the next chapter.

Lone individuals do not have a group node to which they may associate an existing wiki. However, they may still create a new wiki in a *pseudo group node*. This wiki is *almost* like any other in the locale; it may be found in the locale list, and group nodes may associate it to their area and interact with it normally. The difference is that it only persists if another individual connects with the lone individual in the pseudo node to create a regular group node. People may also engage with one another in a pseudo node without triggering this transformation if the wiki author does not want the wiki published to the locale. This pseudo node has the ability to associate only the creator's wiki – no other – but otherwise functions normally. Its purpose is mainly to assist lone individuals who wish to provide a service to passersby.

Lone individuals may also view the locale level list from anywhere within a locale in order to choose a group to join. A function that allows group nodes to designate themselves as either public, which is default, or private, alleviates any potential social anxiety associated with this process. Private groups are indicated by a red number beside their wiki in the locale list. Private group nodes simply do not associate new individuals who are within range. This function allows people to easily recognize which groups are welcoming, and which are not.

These functions allow the public group node to act as an amenity like a bench, a fountain, or a source of light or shelter. It is a point of convergence for people in space. The shared operation of a wiki from within the area of a group node encourages collaboration between strangers and intermingling between groups with the express purpose of increasing the social cohesion of locales.

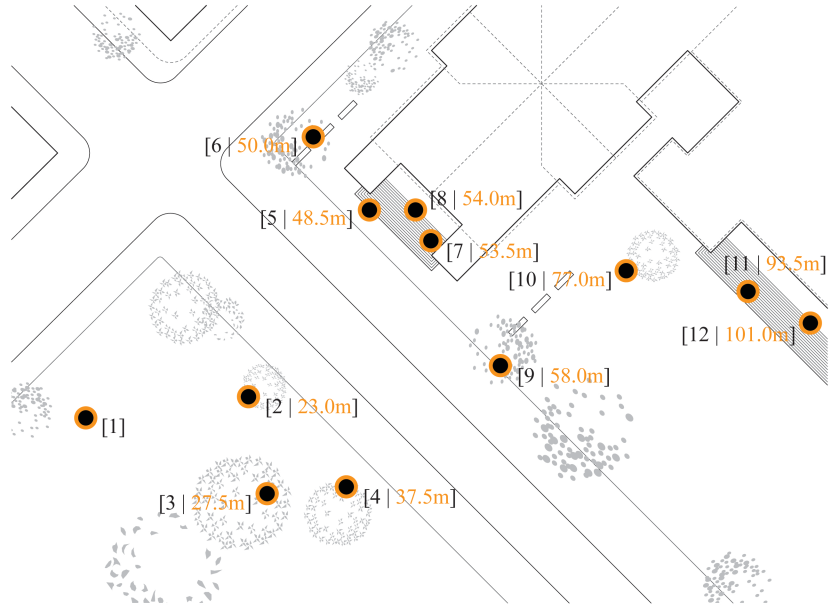


Fig. 4.12
A locale list of group nodes organized spatially. Nodes are ordered based on their proximity to the individual viewing the list. Active nodes are listed in blue. Nodes that have associated another node's wiki are listed, but grayed out. Inactive wikis are not listed.

City Level |

Socio-spatial connection integrity is good at the city level. The overlapping action spaces of an urban population connect locales in a robust small world network. Unfortunately this is spoiled by the lack of locale level constituent connections, as discussed above. Contemporary society is characterized by more individualized nomadic networks. It is easier to activate trans-metropolitan network connections via mobile communication than it is to personally activate connections amongst strangers or weak acquaintances in urban space. This scenario and a comparative web architecture, the web feed, inform how nodes are connected at the city level in the model for optimum structural integrity.

Weak ties at the city level link disparate or far-separated locales by way of the individuals who visit them. These ties are best activated through person-to-person mobile digital communication among friends, family, or acquaintances. "With marginal exceptions, all other [sic] forms of mediated interaction pale in comparison to the power of co-present interaction. That said, mediated interaction is also a form of contact through which social bonds can be nurtured." (Ling 2008, 118) There is enough emersion and freedom of expression in conversational and textual interaction via a mobile phone to facilitate ritualistic behavior. This includes such practices as rhythmic utterance/laugh cycles in conversation and the emotive use of characters and intentional misspelling and short-forming of words in text messages. These practices help people build social cohesion and a common sense of identity through disembodied interaction. Mobile phone interaction is a network practice with fair active integrity, despite its mediated nature.

City socio-spatial structures are robust with a diversity of strong and weak connections, the poor integrity of the locale level notwithstanding. People have strong connections with places including and nearby to where they live, work, and recreate, and weak connections with other distant areas they visit less frequently. We have already loosely referred to these places together as an individual's action space. The overlapping action spaces of a city population constitute a small world network, which appears to be scale-free. Places emerge as hubs of different strengths based on their popularity and their ability to draw visitors from greater and greater distances. These hubs connect to nearby locales with a few strong ties and to one another and other distant areas with many weak ties. (Fig. 4.13) People and their mobile devices activate the connections of this network.

The central unit of contemporary society is no longer the community, as it has been in the past, but the individual self. "The deconstructive approaches of post-structuralism, feminism, queer theory and postcolonialism show how the traditional pointers of identity such as class, gender, age, nation and ethnicity are being questioned and loosened, providing new opportunities for individual autonomy." (Chambers 2006, 93) Furthermore, "Evidence suggests that young people rely more on friends in a nomadic way, by transcending the kinds of social networks shaped by geographically bounded communities." (Chambers 2006, 99) Individual urban nomads use contemporary ICTs to network and interact in new and more flexible ways. Mobile communication devices enable people to organize co-present gatherings and to support strong ties before and after they are activated. Perhaps more interesting though, is the effect they have on weak ties; they enable everyone to remain continually connected, everywhere. "…One could imagine each (mobile phone) user becoming

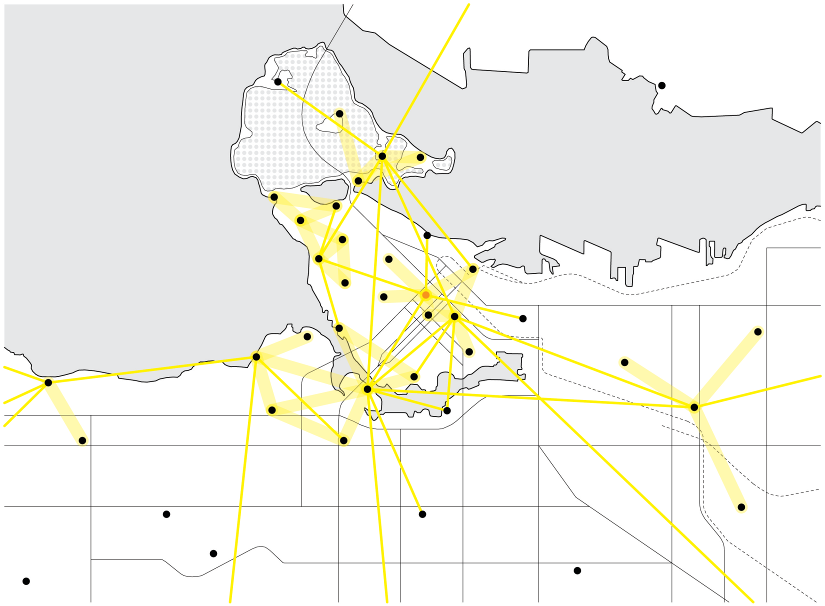


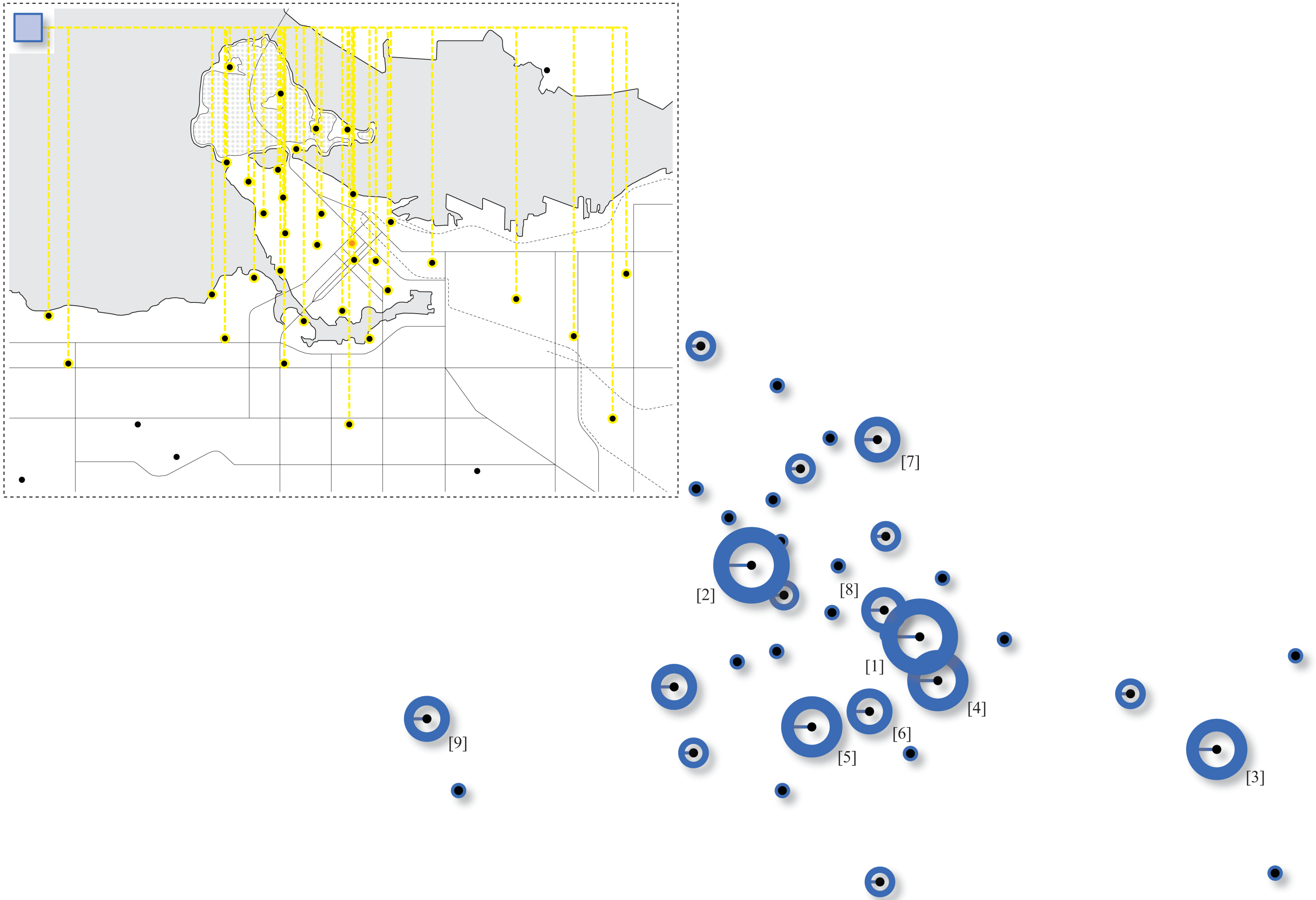
Fig. 4.13
An example of a city level scale-free socio-spatial structure.

a broadcasting station unto him or herself, a node in a wider network of communication…" (Rafael 2002, 157) Ubiquitous communication networks connect a city's locales through the interactions of its population. However the lack of a city-wide organizational structure for this communication, and the poor integrity of the locale socio-spatial structure in particular prevent this phenomenon from reaching its full potential.

The web feed is an interesting structural precedent for organizing the activity of locales at the city level. Web feeds such as *Google Reader* publish summarized text and metadata such as publishing dates and authorship of frequently updated web media from all over in a single document. They are beneficial to both publishers and readers because they syndicate content automatically. Web page publishers effectively broadcast massive amounts of data online, similar to the scenario of ubiquitous mobile phone users in the city. The ways in which web feeds aggregate and restructure web media offer some insight into how mobile phone interaction may be organized for the benefit of the urban population at large.

The city level of the model is designed to connect every locale with every other area of a city, and to one another indirectly. (Fig. 4.14a) Its functions extend from the nature of regular city socio-spatial structures with augmentation inspired by web feed architectures. The model manifests as a desktop web application at this level. It is intended to be accessible not primarily from within the locales themselves, but from all other areas of the city, such as homes and workplaces. This allows anyone to choose the degree and type of engagement they wish to have with the model, and to do so from anywhere. It ensures that the whole urban population is involved and organized from the bottom-up.

The city level desktop web application is a list of links to every associated locale in the model. Each listing consists of the longitude and latitude of a locale, which can be mapped, and the title of its current most active group node wiki. These locale listings are dynamically prioritized based on the city-wide popularity of the subject matter to which their group wikis best relate. This is achieved by comparing the particular group wikis of each locale to a *level of interest model*. This level of interest model prioritizes all subject matter written and linked in the model based on repetition and association. Group wikis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City Level List

1 “No offshore drilling,” says mayor
49.2794, -123.1163 [map]

2 CELEBRITY WATCH: Rachel McAdams eating lunch!
49.2875, -123.1419 [map]

3 Okanogan wildfires still raging, taking homes
49.2736, -123.0700 [map]

4 Canucks Fend Off Flames in Shootout!
49.2774, -123.1138 [map]

5 Granville Market Fall Festival: Build a Birdhouse
49.2711, -123.1338 [map]

6 Google Wave now in beta, best thing since sliced bread
49.2731, -123.1245 [map]

7 Interactive Tours Presents: Nine O’clock Gun
49.2999, -123.1222 [map]

8 Ad-hoc Breaking Battle 30.09.2009
49.2826, -123.1218 [map]

9 Sunny, 26 °C - Indian summer beach v-ball tourney
49.2725, -123.1946 [map]

Next

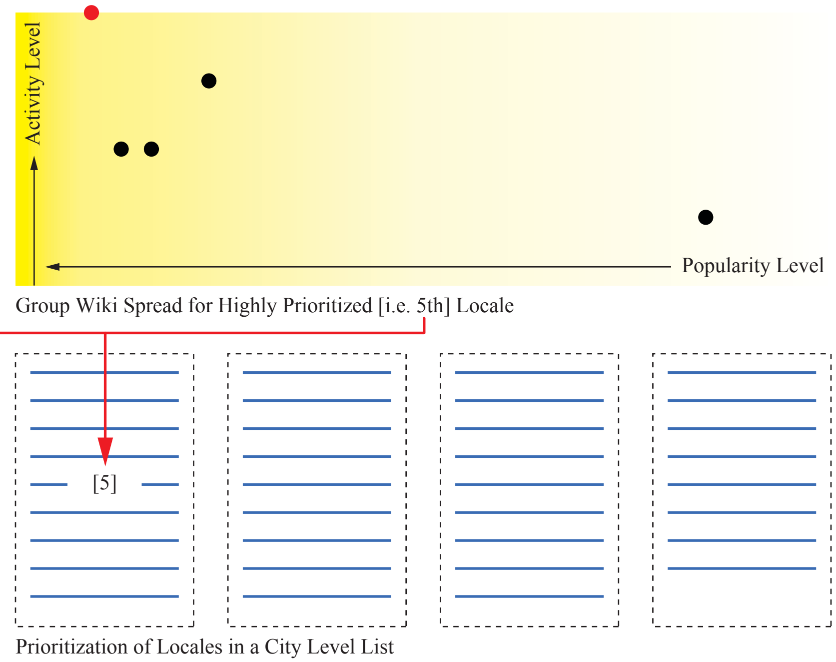


Fig. 4.14a [Left]
The model potentially connects each locale with every other area of the city, and to one another indirectly. Associated nodes in the model are illustrated in blue. The size of each blue nodal outline indicates the degree to which that node is currently a connector in the city network. This status is determined by the number of people who interact with each locale virtually through the city level list at any given time.

Fig. 4.14b [Right]
A city level list of locales, each represented by their most active group wiki. Locales are dynamically prioritized on the list based on the city-wide popularity of the subject matter to which their group wikis best relate.

The yellow gradient represents a model of the degrees of popularity of all subject matter written and linked in the social interaction model, organized from most to least popular. A locale’s particular group wiki spread in comparison to this model, with the activity levels of wikis considered in the equation, determines its dynamic ranking in the city level list. These functions aid in the development of a city level scale-free socio-spatial structure (as illustrated through hierarchical levels of connector nodes in Fig. 4.14a).

with high popularity rankings based on comparison with the level of interest model positively affect their locale's position on the city list. Group wikis with low popularity rankings have a negative effect. Furthermore, the activity level of each wiki indicates the degree of this effect, whether positive or negative – high activity returns a greater effect, while low activity returns a lesser effect. (Fig. 4.14b) These functions together ensure that locales, each represented by their most engaging group subject matter and activities, are presented to a city population based on likely interest levels.

The links in the city level list lead to the locale lists they represent. From there, users can engage with the media and functions organized by each and every group, just like from within the locale itself. Locale accessibility is thus virtually extended in the model. This function, along with locales' own territories and the people who pass through them allow them to act as socio-spatial city level connector nodes. These connector nodes attract different numbers of users based largely on their position on the city level list, which is a function of their popularity. This *rich get richer* feedback relationship is designed to result in a scale-free small world structure.

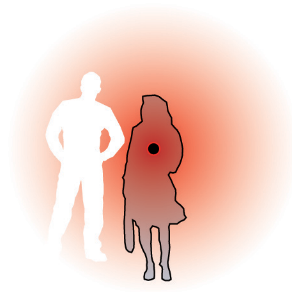
The prioritizing of subject matter based on the city's collective interest in it allows the urban population to report and engage with the news and activities they feel are the most significant. Furthermore, linking this material through active groups aids locales in developing an identity based on the interests of the people who frequent them, and it attracts like-minded individuals or challengers to these areas. All these functions together allow the model to function like a dynamic public newspaper that not only reports, but also creates the news.

Conclusion |

This chapter has shown that the integrity of socio-spatial structures must be considered both on the whole, and also in part. A Structure's integrity is directly dependant on the active integrity of its connections. The integrity of weak ties in particular is significant because they are responsible for connecting through disparate and far-separated nodes. They enable the small world topology, which is highly efficient and resistant to natural processes of decay. The scale-free variety of the small world topology is ideal for the model because it evolves naturally.

Further, this chapter has shown that the social structure of urban populations, like many other systems of relations, naturally evolves into a small world. Socio-spatial connection integrity is generally good, except for at the locale level. However, cities lack a program for managing these connections and optimizing their integrities. The result is that connections between locales activated via mobile phone largely disrupt rather than enhance social cohesion among the groups through which the connection is made. Furthermore, there are few provisions for encouraging groups to interact in public space. This works against the robust city level small world network that naturally connects locales.

This information has made it possible to develop a model that supports city socio-spatial structures. The model does this in two ways: it boosts the active integrity of connections at each level of focus; and it facilitates the emergence of connectors in scale-free structure. The dynamic prioritizing of nodes in both the locale and city level lists in particular encourages the emergence of connectors through the *rich get richer* phenomenon. It does this simply by making the most active and relevant nodes most accessible. This, and the dual means of connecting into the model (from within locales and from home) give the model much of its complexity. The model's rigid hierarchical design is merely a framework. Dynamic, scale-free, socio-spatial architecture emerges from within it.



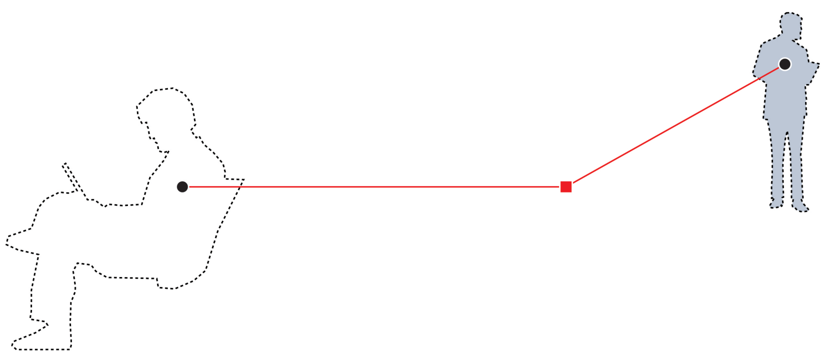


Fig. 5.1a
Spatial connections are temporal; their flexibility is governed by the timing of elements in space.

Fig. 5.1b
Network connections are persistent; they are coherent in time.

Chapter 5

Socio-Spatial Connection Flexibility: Emergent Dynamics

Chapter Introduction |

This chapter diverges from the previous two research and design chapters, which developed the model through three hierarchical scales, or levels, of socio-spatial study. It attempts to animate the model in time. This will be done in relation to the emergent properties of socio-spatial human agency architecture.

Socio-spatial connection flexibility measures a socio-spatial structure's ability to dynamically self-organize through emergent dynamics in the process of spatial and network connection articulation. Spatial connections are temporal; their flexibility is governed by the timing of elements in space. (Fig. 5.1a) Network connections are persistent; they are coherent in time. (Fig. 5.1b) In active combination, these connection properties may bring about the emergence of flexible temporal persistence, or adaptability, through self-organization in a socio-spatial structure. Such a structure may be capable of evolving and affording human agency.

This chapter will examine these properties of socio-spatial connection flexibility. A methodology for emergence in complex systems will be outlined with particular attention to self-organization through feedback relationships. Next, this chapter will illustrate how such relationships between the temporal qualities of socio-spatial connections enable morphodynamic and teleodynamic flexibility in the emergent architecture. Finally, it will show how the architecture affords human agency in urban space.

The previous chapter illustrated the small world topology and showed that the scale-free variety of this structure appears to underlie socio-spatial systems of people and the relations between them. However, the dynamic properties of this structure and the ways in which they are useful to the model have yet to be addressed. These things are best understood in terms of emergent dynamics. Emergent dynamics attempt to account for the spontaneous appearance of unprecedented orderliness in nature. The concept of *emergence* is exemplified in the phrase, 'the behavior of the whole is greater than the sum of its parts'. Emergentists attempt to understand this aspect of 'greater' in complex systems.

According to the second law of thermodynamics, closed physical systems tend to progress in the direction of increasing entropy, which involves energy dispersal towards a state of equilibrium. This leads to a loss of the differentials required for work. Consider an example in which two children place their personal collections of marbles in a shared bag. These separate clusters of marbles will tend to progress to a mixture if the bag is shaken. This mixing process is thermodynamically irreversible. (Fig. 5.2) No one would expect that the children could ever subsequently reach into the bag and simply remove their separate collections of marbles. This process is similar to the way in which nature, being unbiased, continually shuffles through the potential arrangements of things. There are vastly more potential arrangements that are 'messy' than there are those that are ordered. Thus, highly regular arrangements are very rarely sampled spontaneously and such an occurrence tends to become progressively less likely over time. (Deacon 2006, 111-13) How then, do we explain the existence of complex structures and relationships everywhere in nature?

Terrence W. Deacon, a professor of Anthropology at the University of California, Berkeley hypothesizes that complex "emergent phenomena grow out of an amplification dynamic that can spontaneously develop in very large ensembles of interacting elements by virtue of the continuing circulation of interaction constraints and biases, which become expressed as system-wide characteristics." (Deacon 2006, 124). To expand this, with reference also to the work of George F. R. Ellis, a professor of applied mathematics at the University of Cape Town, emergent phenomena are enabled by the simultaneous circular operation of bottom-up, same-level, and top-down action. This circularity allows constraints and biases in the dynamics of constituent bottom-up *interaction* to reinforce one another iteratively throughout an entire system and manifest higher-level regularities in *form*. These higher-level regularities exhibit top-down influence on constituent properties and dynamics even though they themselves are generated by constituent interactions. (Deacon 2006, 124) (Ellis 2006, 82-4) Same-level *self-organizing* features emerge from this amplification dynamic. (Fig. 5.3) This dynamic is capable of promoting a spontaneous increase in order under certain conditions that curiously rely on the flow of energy provided by increasing entropy (disorder). This is because "these spontaneous ordering features…are not so much regularities of structure as they are regularities in the dynamics of a process, though it may also leave a structural trace." (Deacon 2006, 118)

Emergent dynamics may be discussed in three categories, which correspond to increasingly complex emergent phenomena.

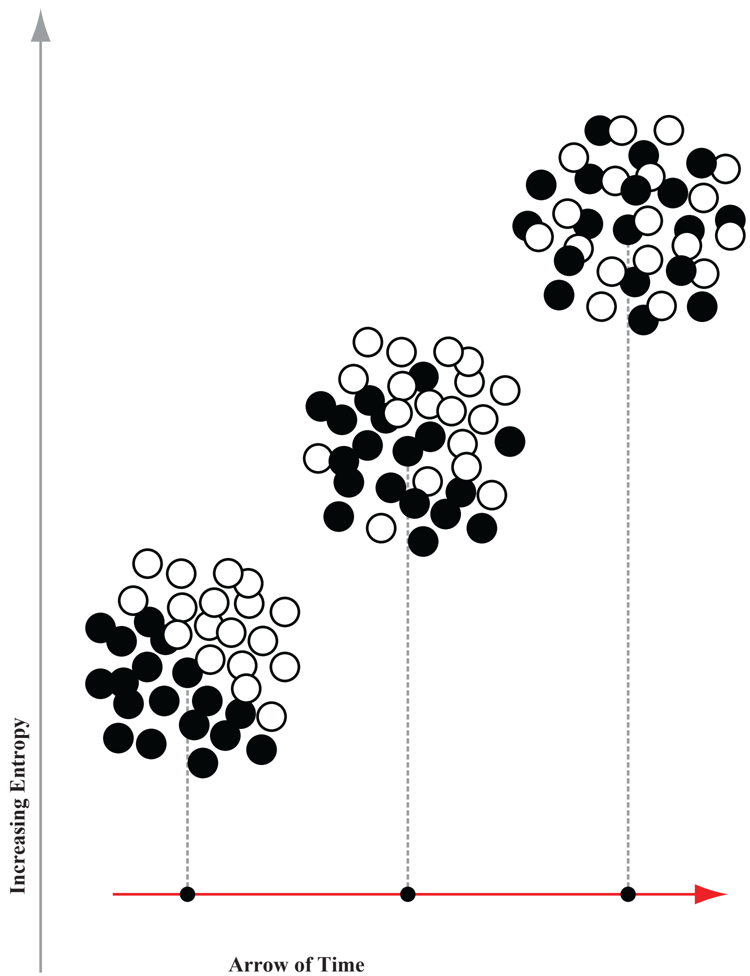


Fig. 5.2
Two collections of marbles mix in a bag. This illustrates the increasing entropy of the system in time. The mixing process is thermodynamically irreversible. The entropy of this system may only decrease with the application of a particular type of work energy to the system from an external source, as by hand sorting.

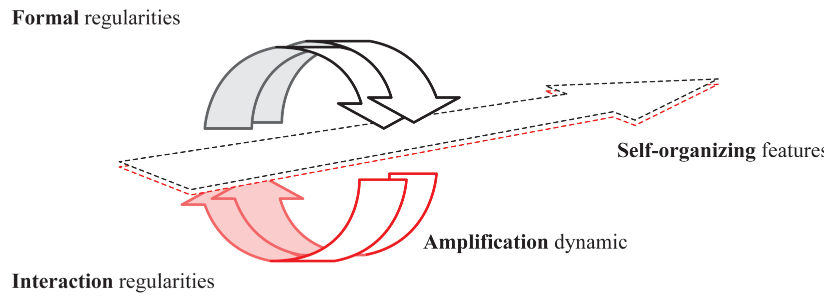


Fig. 5.3
Correlated lower-level interaction regularities and higher-level formal regularities reciprocally reinforce one another in a system. This amplification dynamic leads to self-organizing features.

First-order emergence, or *thermodynamics*, may be understood as the physical dispositions of material systems. As a system progresses towards equilibrium, the unique features of constituents, such as the charge, orientation, momentum, etcetera of molecules, distribute themselves in such a way as to cancel one another in aggregate. Shape parameters affect the pattern of the average interaction, which simply extrapolates from micro to macro as a higher order state. For example, the relational properties of molecules are responsible for liquid properties such as laminar flow, surface tension, and viscosity. Equilibrium thermodynamic processes do not involve the amplification dynamic discussed above because there is no correlation between the lower-level interaction dynamics and the emerging higher-level formal regularities of the system. Non-correlation is the overwhelmingly likely condition in any system of components with variable properties. However, sometimes constituent properties interact in such a way as to amplify, rather than cancel out perturbations in a system. (Deacon 2006, 126-31)

Second-order emergence involves the self-organizing amplification dynamic outlined above, which Deacon refers to as *morphodynamics*. A classic example of morphodynamics is the formation of Bénard cells in a heated liquid. A shallow, level volume of water will spontaneously self-organize into a structure of regularly spaced hexagonal convection cells with the application of uniform heating from below. (Fig. 5.4a) This phenomenon depends on the amplification effects of first-order non-equilibrium thermodynamic processes. Water molecules settle into a higher-order stable liquid state, while simultaneously, constant heating perturbs these regularities, resulting in chaotic conditions. Hexagonal cells of hot-rising and cool-descending liquid self-organize so the system may maintain even convection throughout the liquid volume. (Fig. 5.4b) This particular dynamical organization is self-amplified with respect to others because it is geometrically ideal for heat dissipation by moving liquid; it allows for the most even and dense distribution of regions of constant size on a surface. In a sense, the thermodynamic instability of other potential regular and irregular patterns of convection 'push' the system toward this particular dynamical order as they are 'selected against' in a process analogous to Darwinian natural selection. (Deacon 2006, 130-1)

Third-order emergence, or *teleodynamics*, is to morphodynamic processes as second-order emergence is to thermodynamic processes. It involves the amplification of reciprocally reinforcing morphodynamic relationships, which in turn, as we have learned, are based on the amplification effects of non-equilibrium thermodynamic processes. (Fig. 5.5) This relationship is the basis for the selection logic of evolution. It enables the redundant sampling of historic higher-order states of a system into current lower-order dynamics, which lead to future states. Systems of such complexity thus exhibit some

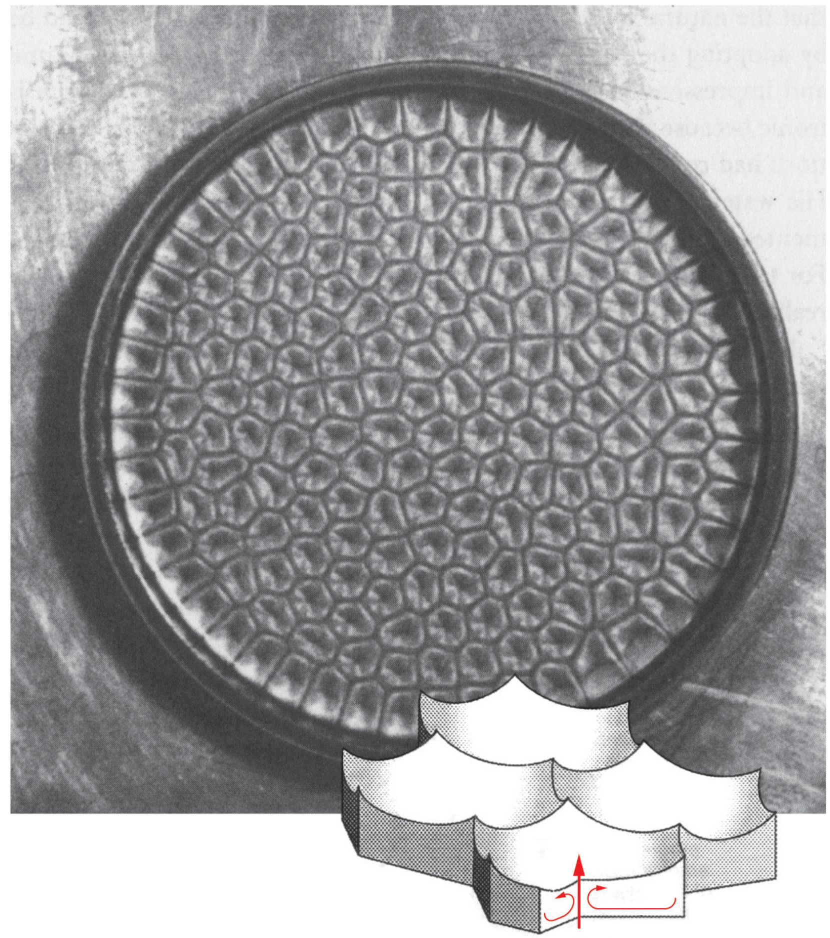


Fig. 5.4
Bénard cell dynamics. A shallow, level volume of water will spontaneously self-organize into a structure of regularly spaced hexagonal convection cells with the application of uniform heating from below.

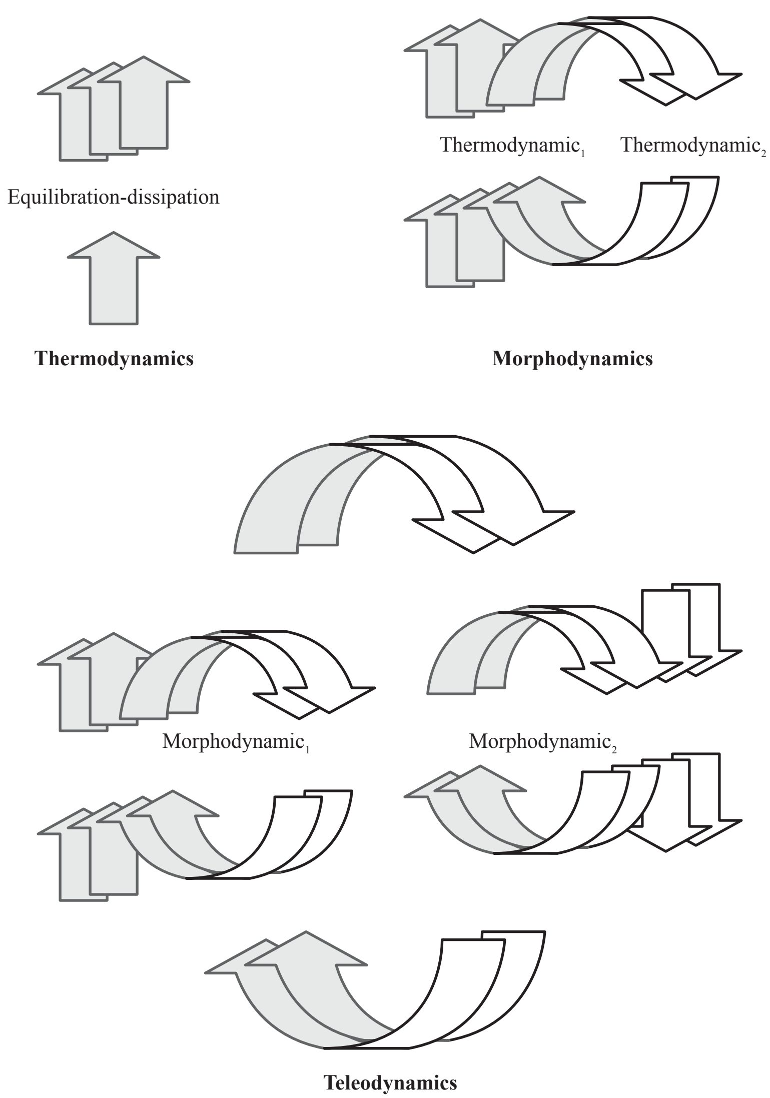


Fig. 5.5
A diagram illustrating how higher order modes of dynamics are composed of and dependant on lower order modes. The straight arrows abstractly represent directions of physical change from an antecedent to a consequent condition. The cyclic arrows abstractly represent changes in conditions that reciprocally promote the repeated production of specific thermodynamic or morphodynamic processes. (Deacon 2006, 147)

form of 'memory.' Discreet lineages may develop simultaneously or out of synch and remain linked by an unbroken heritage of dynamic structures and relationships. This memory allows every morphodynamic relationship throughout the course of time to become a potentially amplifiable condition contributing to future relationships. This phenomenon can be seen in the evolution of organisms, which often diverge from, and convergence back towards some reference state. Teleodynamics may be considered the self-organization of self-organizing dynamics. (Deacon 2006, 137-46) "This linkage by form, rather than by shared specific material or energetic substrate (as with morphodynamic processes), allows for a much vaster domain of amplification. Distant separation in time and the disruption of energetic continuity are not barriers." (Deacon 2006, 139)

This thesis employs these emergent dynamics because the model represents a dynamic complex system. Autonomous intelligent individuals construct and continuously mould the architecture under their own free will. This gives it real-time *flexibility*. However, unbeknownst to them, power law morphodynamics inherent in their natural socio-spatial interaction behavior (among many other things) generate the architecture's underlying structure. This is the source of the architecture's *adaptability*. The model brings countless social dynamics among a population together in a persistent teleodynamic relationship. This gives the emergent architecture *evolutionary* properties.

Emergent, Socio-Spatial, Human Agency Architecture: Baldwin Street |

This section of the chapter is composed of three blended parts, which allow an extension of Deacon's methodology for emergence in complex systems to be incorporated into the model. Each part will focus on one of three flexible qualities of the architecture: morphodynamics, teleodynamics, and human agency. However, these qualities are not confined to be fully developed within their part of this chapter section. They will blend and expand in a continuous, cohesive series of images that animate the model through selected expressions of the emergent architecture in a demonstrative scenario. The architecture will be dynamically rendered in an actual setting – Baldwin Street in downtown Toronto – in a move away from the diagrammatic development of previous chapters toward a realistic expression.

Morphodynamics |

This thesis has already shown that people naturally connect in clusters, both in space and through network relations. Furthermore, weak ties between people and places connect these clusters in a small world socio-spatial structure, which appears to be scale-free. This natural structure underlies the emergent architecture. It is highly *adaptable* in the sense that it self-organizes in a similar fashion in different and changing conditions. This is because the structure is a trace product of the regularities in power-law morphodynamic processes.

Consider the movement of people in space. If we remove their individual agency from this picture, we might expect them to settle into a stable higher order state, similar to how water molecules achieve equilibrium in a liquid state. This illustrates the thermodynamic tendency for the entropy of this system to increase. Of course, this is not the full picture – individuals possess agency. In order to focus on properties of form, let's abstract this agency into a bias toward connection. The constant application of energy to this system by way of people's natural tendency to connect perturbs higher-order regularities incessantly so that bias comes to dominate over distributive tendencies. Power law morphodynamics result from the amplification effects of these first-order, non-equilibrium, thermodynamic processes. This facilitates the emergence of scale-free socio-spatial structures.

Natural socio-spatial connections are temporal in space, but persistent in networks of relations. That is, people connect socially in space, but must eventually part, leaving only their relational connection to persist. The same is true of people's connections with places, and even hang-out areas within these places. Thus, social connections build on one another despite continually breaking apart and reforming in space. As described in the previous two chapters, they take form in dynamic clusters, and the *rich* clusters get *richer* in a power law. As an aid to imagining this phenomenon, consider the following *diffusion-limited aggregation* 'game'. The process starts with a lone molecule. Successive molecules are allowed to wander in from a random direction, along a random path. If a molecule collides with the original one or another attached to it, it sticks and contributes to a cluster. If it misses, it does not. Arms quickly emerge and act as screening obstacles for subsequent molecules so that longer arms get longer faster than shorter ones. This simple process consistently yields similar fractal structures of branching arms with self-similarities reflected in a power-law. (Fig. 5.6) (Buchanan 2002, 103-5) It is not difficult

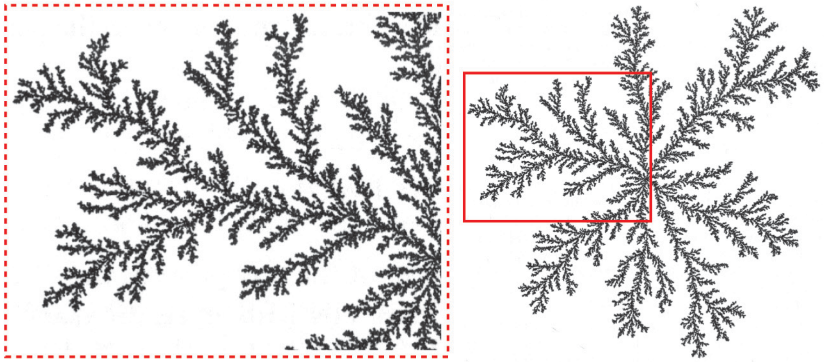


Fig. 5.6
A cluster formed by the process of *diffusion-limited aggregation*. Its self-similarity is reflected in a power law. That is, in counting the number of branches of various sizes, every time you decrease the size of the branch by a factor of two, the number of such branches would increase by a factor of about three. (Buchanan 2002, 103-5)

to imagine similar processes in the dynamic growth and decay of hierarchical levels of socio-spatial connection clusters, like those of the group, locale, and city. The scale-free socio-spatial structure of connections is self-amplified with respect to all other potential formations because it is the most efficient to form as connections build, and the most resistant to decay as connections break apart – in a word, it is the most stable.

This process, by which scale-free structures self-organize, may be considered a type of adaptability in space. Power law dynamics in the growth and decay of connection clusters consistently leave a dynamic scale-free structural trace. This phenomenon is the basis for the model's functions and the emergent architecture's dynamic structure. It ensures that the architecture takes form, adapts to changes in environmental conditions, and also decays, gracefully. As illustrated in the *Socio-spatial Connection Extents* chapter, the structure builds from the bottom-up. Group nodes are encouraged to develop separately before they are unified in locales, which in turn only define a city node once they reach appropriate concentration and maturity. Once a locale is defined, group wikis associated with it are as mobile as the groups of people who us them. This enables the structure to adapt to changing spatial conditions such as with private and public events. Even the failure of whole locale nodes does not affect the integrity of the city socio-spatial structure. This occurs slowly, with the intermediate condition of groups loosing their locale status and operating autonomously with the potential to rebuild. All this is considered part of the process by which the architecture self-organizes.

The sequence of images that will animate the model through selected expressions of the emergent architecture in a demonstrative scenario, henceforth called the emergent sequence, begins by showing part of a natural ephemeral socio-spatial structure. The model has not yet been introduced into the scenario. This structure consists of groups of people in a number of popular hang-out spots in close proximity that, alongside others, will come to define a locale. The adaptive qualities inherent to this structure and later employed in the emergent architecture may be seen through the changing activity among the three initial spots of interest throughout the sequence. The activities depicted in these first three frames of the emergent sequence are simultaneous in time.

Fig. 5.7
Groups of people wax and wane throughout a spring day among numerous hang-out spots on Baldwin Street in Toronto. This is one of them. Places among this locale with lots of people will attract more, and if/when places close to the public, people simply group elsewhere. Thus, the structure of people dynamically adapts to the situation.

Fig. 5.8
Many of the people meeting in groups along Baldwin Street are regulars, while others visit the area infrequently, and still others have come across the locale for the first time. Between them are a multitude of connections to other people and areas of the city. Regulars likely have the most overlapping connections, while less frequent and new visitors likely connect to more distant areas of the city and more disparate dimensions of the population. Together they form a city-wide (and larger) small world socio-spatial structure.

Fig. 5.9
As discussed in the previous chapter, a lack of active connections between individuals and groups among locales limits the connective effects of a city socio-spatial structure. Additionally, the content of any social connections actually made is transient – conversations are lost to the air, and social activities resolve in time, likely without a trace.

Teleodynamics |

This thesis has already illustrated how the model supports city socio-spatial structures: by boosting the active integrity of connections at each level of focus; and by facilitating the emergence of connectors in a scale-free structure. This enables an entire population to connect and collaborate toward diverse ends of their own initiative in urban space. Furthermore, the model gives persistence to the forms and functions of socio-spatial connections made through this collaborative activity. These constantly *evolve* toward socio-spatial human agency architecture through teleodynamic processes.

The model introduces a significant shift in the temporality of connections made through natural socio-spatial activity. As illustrated in the *Socio-spatial Connection Extents* chapter, the co-ordinate locations of group interactions are recorded and used to define the spatial dimensions of locales, among other things. The *Socio-spatial Connection Integrity* chapter illustrates how people may translate the content of their interactions into wiki documents or 'programs'. All this data persists through emergent architecture, where it would otherwise be lost. Thus, socio-spatial connections may build and evolve in the model's hybrid real-space/virtual-network environment.

The previous *Morphodynamics* sub-section showed how the scale-free geometry emerges from power law dynamics in socio-spatial interaction. The model reinforces this process by giving temporal persistence to the spatial data of connections where they are made. It also enables another power-law-based morphodynamic process to occur – the building and networking of wiki content. Groups among a locale will tend to associate the more popular wikis to their nodes more frequently. It follows that these wikis will likely also expand and evolve their content faster. These two morphodynamic processes have a reciprocally reinforcing relationship. As people connect through the model and consequently build and evolve human agency architecture, this architecture acts as a catalyst in the recursive process by appealing to more people and encouraging their involvement.

Deacon refers to this dynamic as *self-similarity maintenance*. (Deacon 2006, 138) Consider the system of the model and emergent architecture as a whole, involving an entire city. Countless reciprocally reinforcing morphodynamic processes supported by the model continually define and redefine the spatial territories and network identities of the emergent architecture and all levels of its constituent parts. This embedded circular dynamic of circular dynamics facilitates the development of discrete nodes and lineages within the architecture, which are nonetheless linked by unbroken continuity of changing structure and relationships. The architecture evolves as the system cycles through variants of these processes with respect to contextual regularities. Past and/or present states of the architecture are amplified when they happen to fit well with the context in terms of the specific areas where people gather and the interests of these people. Uncorrelated relationships are 'selected against', while the more contextually fitted variants are preserved. The model employs teleodynamics so the emergent architecture may continually evolve towards this 'ideal fit', where people can most efficiently engage with it in the locales they frequent, and in the ways that interest them most. (Deacon 2006, 137-46)

The emergent sequence continues with the immediate introduction of the model into the scenario. This section of the sequence focuses on the emergence of socio-spatial human agency architecture and its early stages of evolution. A locale territory settles into semi-regular definition and several well fitted group wikis begin to define its identity. This increases social cohesion among the locale and gives it significance in the larger socio-spatial structure of the city. The time between each of these five frames ranges from a week to a few months.

Group nodes/wikis are represented in the renderings as a circular node below three vertical bars. These bars, from left to right, abstract the relative number of locale, group, and city level connections associated with this node. Pseudo group nodes are indicated with a red dot and group nodes that have associated another group's wiki are indicated with an inverted (white) dot. Relative connection strength is indicated by line thickness as it has been in past diagrams. Dotted lines vary in meaning with each rendering, but usually represent an indirect connection.

Fig. 5.10
We return to a previous state of a group on Baldwin Street (depicted in fig. 5.7), now introducing the model into the scenario. An individual spots an unusual bird. Out of curiosity, the two friends attempt to identify the bird via a mobile internet query. They post a link to the results in a group wiki, thus defining a connection/node through the model. The location and content of the interaction between these two individuals now persists in the beginnings of emergent architecture, as opposed to being lost to passing time.

Fig. 5.11
Weeks and many more connections later, multiple spots of regular activity dynamically define the spatial extents of a locale node, which encompasses a portion of Baldwin Street. A wiki largely managed by staff of Around Again Records begins to make a significant inward connection as a local 'radio station' that broadcasts the music and ambient noise of the store. The wiki is regularly associated to other areas of the locale and the same synchronized audio may be heard through portable speakers, restaurant audio systems, and in headphones all around.

State 1: Two individuals spot an unusual bird. One of them identifies it out of curiosity via an internet search. He records a link to relevant Wikipedia data in a group wiki.
State 2: Locals record a second sighting down the street a few days later.
State 3: Weeks later, cycling bird enthusiasts discover the "unusual bird" wiki while passing through the locale. Excited, they search for the nest and find it! The bird was incorrectly identified, but a rare sighting nonetheless. The cyclists correct the wiki and note the location of the nest for the benefit of other enthusiasts.
State 4: The nesting birds remain a minor local attraction throughout the season.

Fig. 5.12
The initial 'unusual bird' wiki sees enough activity to maintain a relatively popular status on the locale level list throughout the season. The wiki evolves into a record of local fauna and flora, with the unusual bird remaining the highlight due to ongoing developments regarding its condition, and breaking news of its nest, mate, and young.

Fig. 5.13
A lone individual challenges the Baldwin Street restaurant patio lunch crowd to a game of chess. This is done via a pseudo node (red) linking an online chess game application and a chat application. Three separate groups among the locale collaborate, but fail to topple the challenger. After the game, one of the collaborators agrees to a rematch in person with the support of the original distributed groups of collaborators via the same wiki. This co-present connection transforms the pseudo node into a legitimate group node and the wiki is recorded in the model.

Fig. 5.14
The 'around again' wiki begins to make a significant outward connection into the city and abroad. People listen to the 'radio station' at home, at work, and it is even played in some business locations. Locals and visitors have evolved the wiki to include other music related features, such as a portal for music file-sharing. This activity starts to define a popular hang-out spot across the street. Note: group 1-A (white) is associating the wiki, while group 1, which associated it first, retains editorial control of the wiki.

Human Agency |

'Human agency', in the context of this thesis, refers to people's ability to transcend the regular structure, function, and meaning of urban place through their own dynamic organization. This is the essence of the emergent architecture. It relies on *real-time flexibility*. In order to understand the relationship between these qualities of the architecture, let's ask with reference to Ellis's work: 'Why is the architecture flexible?' and answer in three dimensions:

- In *bottom-up terms*: because, as illustrated earlier in this chapter, power law dynamics give the underlying structure dynamic stability. In other words, physics underlies higher-level functioning.
- In terms of a *same-level explanation*: because people use the model by their own free will, thus defining the emergent architecture in real-time with the flexibility of their own actions. They do this for want of the agency the flexible architecture affords them in urban space.
- In terms of a *top-down explanation*: because the model is designed to bring about the emergence of flexible power-law-based architecture that is defined by the free actions of people.

All three of these explanations are true and necessarily simultaneously applicable. The higher-level explanations are dependant on the existence of the lower-level explanations, yet they are not reducible to them. Furthermore, the lower-level power law dynamic consistently results in a structure that may be exploited by the higher-level design state. Thus, higher-level design activity may coordinate lower-level power law activity so that top-down action occurs and effects same-level action – that is, so people may take advantage of the power law dynamic as per the model's design in order to define flexible emergent architecture. (Ellis 2006, 82-4)

As previously discussed in this chapter with reference to Deacon's work, this type of relationship allows for same-level and inter-level negative and positive feedback loops. The real-time flexibility and human agency associated with the emergent architecture are involved in such a loop. The model brings people's dynamic socio-spatial structures and their social wills into direct relation in persistent architecture. Individuals act through the architecture for the agency it affords them in urban space, thus giving it flexibility. The architecture affords this agency in the form of spatial authority and network intelligence by giving persistent organization and direction to people's social formations and collaborative activities. The architecture's dynamic qualities are essential to this. They allow it to remain flexible with socio-spatial activity in real-time, to adapt to changing urban conditions, and to evolve with the city and its population.

The emergent sequence reaches its climax and concludes by animating the model in action among a 'well developed' locale. This last section of the sequence features an event that highlights some of the various types of interpersonal, interarchitectural, and intercontextual engagement that the model makes possible, and through which the emergent architecture affords human agency. The activities depicted in most of these five frames take place in a single day.

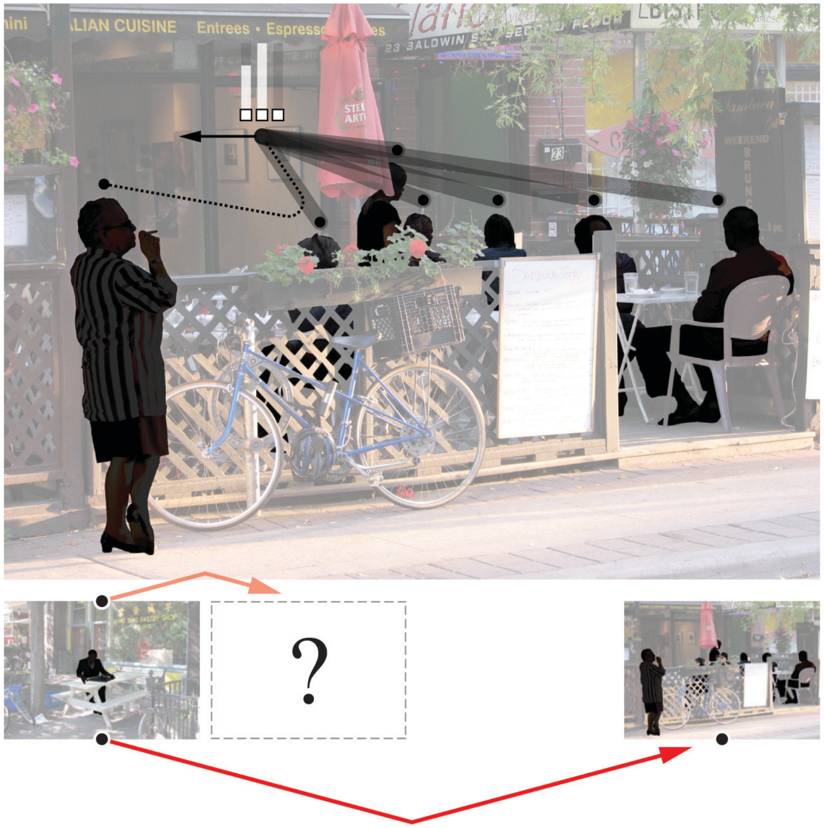


Fig. 5.15
A partial past state of the locale (involving the chess match – fig. 5.12) was long forgotten. However, the wiki was later discovered by an individual browsing through the locale list history. Intrigued by how it activated collaboration between Baldwin Street restaurant patios, the individual revived the wiki in a new form. This time the wiki went viral among the locale and it now blooms as an 'intra-patio network' for discussion of food, art, and culture, and occasional inventive collaborations like the chess match. This rendering also illustrates how an individual without a mobile communication device may form an indirect connection with the model through other active users. In this case, a woman who has recently moved to Toronto from Vancouver shares her opinion on a YouTube news segment video about aboriginal protests at the 2010 Olympics shown to her by active users with whom she is conversing.

Fig. 5.16
A small public music festival on Baldwin Street has been planned via the 'around again' wiki and is now underway. Due to the popularity of the wiki among the locale and references to the event city-wide, the 'around again' wiki has temporarily shot up the city level list. This informs Toronto's population of the event and attracts people to the locale. Regulars and newcomers alike find their way to the record shop, which acts as the festival's hub. The model allows them to collaboratively promote, organize, manage, and enjoy the festival's events (such as live shows, music lessons, and interviews, etcetera) throughout the locale.

Fig. 5.17
This is the music festival's main attraction, a battle of the bands. An assistant manages one band's biography, online music sales, and show booking via a pseudo node while they perform. Meanwhile, a group enjoys the band, while simultaneously collaborating with an interview elsewhere in the locale. A woman on a bike who is currently unassociated with any node captures and uploads photos of the event to a Flickr page linked through the 'around again' wiki.

Fig. 5.18
One individual manages an interview pseudo node/wiki for the event. He sets up a discussion forum through which the audience, other groups among the locale, and people city wide (and globally) collaborate in feeding him questions and discussion topics for the bands being interviewed. This format results in a dynamic discussion that is at once intimate, varied, and well informed. The bands' responses are broadcasted aloud and fed back into the wiki in real time via streaming audio.

Fig. 5.19
The emergent sequence of renderings leaves off where it began, in an intimate co-present situation. A couple on a first date mix conversation with checking the locale list for updates. This activity bridges down-time in the conversation and acts as a 'break' from the mutually focused activity of co-present interaction, similar to the ritualistic device of attending to one's beverage. They associate the 'intra-patio network' wiki to their node and join a discussion spurred on by a recently posted link to an article in the New Yorker. They bounce opinions off one another before collaboratively commenting, which increases the cohesion of their engagement.

Base Socio-Spatial Connection Essence: A Comparative Study |

The thesis proposal and *Murmur*, a highly successful, location-based, mobile phone documentary project previously introduced in the *Contemporary Practical Context* chapter (p. 18), both connect people, places, and information. This section compares these two projects in an attempt to reveal the essence of these connections at their base levels. (Fig. 5.20) This will aid in differentiating the proposal from most mobile experience design projects geared toward public authoring, of which *Murmur* is exemplary.

Murmur

1. The connection is of a personal nature. It involves human-computer interaction to mediate a one-way relationship between a storyteller and a listener.
2. The connection is made through an audio narrative.
3. The connection is fixed in the psychogeographic space of the narrative.
4. The connection between storyteller and listener is asynchronous. The content and location of the connection are static in time.
5. The connection links people with situated (historic) stories.
6. The connection involves a top-down editorial approach to public authoring.

Model and Emergent Architecture

1. The connection is of a public nature. It augments co-present human-human interaction and invites outside, network collaboration.
2. The connection is made through any/all types of internet media and application functionality.
3. The connection is at a dynamic point of convergence between a group, a place, a city, and local and global information and communication networks.
4. The connection may be made synchronously, asynchronously, or in any combination of the two between all parties. The content and location of the connection evolve in time.
5. The connection affords hybrid human agency.
6. The connection involves a bottom-up self-organizing approach to the creation of socio-spatial architecture.

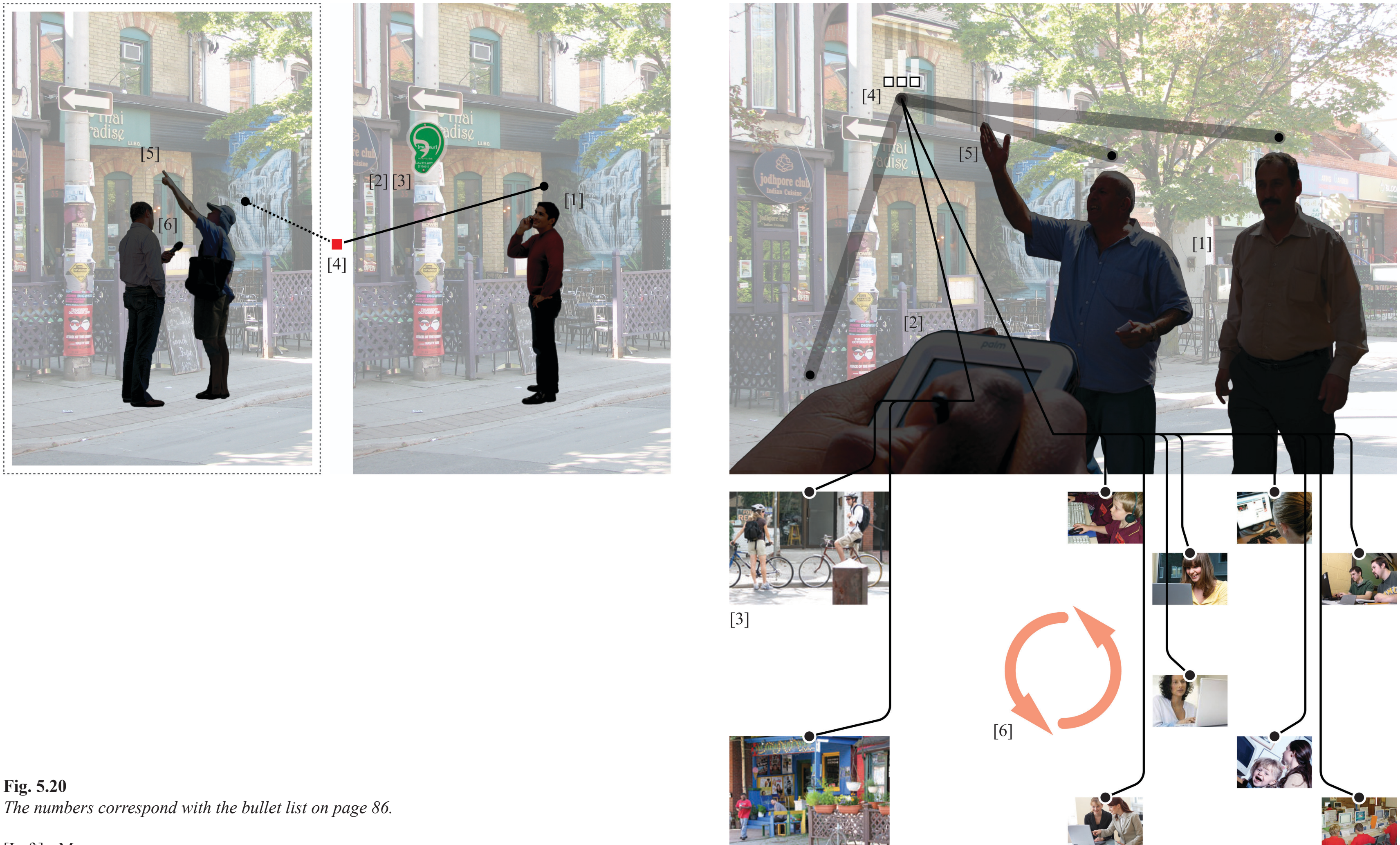


Fig. 5.20
The numbers correspond with the bullet list on page 86.

[Left] - Murmur
An expression of the base socio-spatial connection of the *Murmur* project. In the left panel, *Murmur* project personnel record people's personal stories in situ. These are edited, and hosted on a server. A physical sign is erected in place to indicate and give public access to the recording. In the right panel, a pedestrian phones the number listed on the sign to listen to the recording.

[Right] - Model and Emergent Architecture
An expression of the base socio-spatial connection of the proposal. An emerging public demonstration is illustrated.

Conclusion |

This chapter has animated the model in time with reference to concepts of emergence. It has shown that the flexibility of complex socio-spatial structures is inherent in the dynamics by which they take form. Power law morphodynamic processes in socio-spatial interaction consistently achieve dynamic stability in a scale-free structure. However this structure is naturally ephemeral in space.

The model encourages and gives persistence to the forms and functions of collaborative social activity in urban space. These are flexible in real-time with the people acting through the model. Power law dynamics usher their development into adaptive socio-spatial architecture. This architecture continually evolves towards an 'ideal fit' with the people who act through it and the places where it emerges in order to afford human agency.

The emergence studies of this chapter have not only aided in the model's design; they also have brought to focus the significance of the relationship between the model and emergent architecture. The model has been designed to direct the emergence of dynamic, socio-spatial, human agency architecture. However, in practice the various manifestations of this architecture among different scenarios would, in turn, bring to light oversights and inefficiencies in the model's design. These would be ironed out through a continued process of informed trial and error updates. This fine tuning is possible because the model is driven by a set of easily modifiable computational functions. Thus the model and emergent architecture evolve together as a dynamic system.

Chapter 6

Conclusion |

This thesis set out to address the disparity between spatial and network social practices in the basic human experience of the contemporary city with a human agency architectural design proposal. It looked primarily to Web 2.0 applications and phenomenon for a structure suited to collaborative network interaction. Mobile experience designs were explored for a means of grounding these network practices in space, directly through individuals carrying mobile communication devices. The proposal situated itself within the field of ubiquitous computing, but in opposition to ubiquitous computing's largely semantic organization, in favor of social network construction instead. The solution to the thesis problem took the form of a socio-spatial interaction model / emergent architecture couple. This proposal introduces a greater than normal degree of separation between the architect and the realization of his/her design and gives significantly more power to the architecture's 'users'. Through the model, people may organize themselves, their relations, and activities in dynamic socio-spatial architecture that makes essential connections between urban public place and global information and communication networks. The architecture affords much needed human agency by virtue of the privileged positions it gives people in both its own emergent process, and consequently in the social, spatial, and cultural contexts of the contemporary city at large.

The greatest challenge in developing the model was setting constraints and conditions by which architecture composed solely of people, information, and connections could be defined and evaluated.

It had to have: definite spatial and identifiable network *extents*; cohesive structure with fine *integrity*; and all this had to have sufficient *flexibility* to be dynamic with the flows of people, to adapt to shifting environmental conditions, and to evolve with the city and its population in time. The details of these constraints were largely arrived at through research grounded in emergence and sociology, specifically the studies of human spatial behavior and social network structure. The main body of the thesis outlines these developments.

In summary, it was discovered that people naturally connect in small world socio-spatial structures of clustered strong connections linked by weak ties. These appear to be scale-free. By extending the model's design from this natural organization, it was possible to define socio-spatial extents at different levels, namely the group, locale, and the city, by way of clusters of subordinate nodes composed of people in spatial and network association, in a hierarchy.

The scale-free network topology naturally has great structural integrity. However, it was discovered that weak ties, arguably the most significant element of this topology with regards to integrity, are not always well activated in complex socio-spatial systems, particularly at the locale level. Thus, it was important that the model boost the active integrities of weak ties at each level of focus. This was accomplished by amalgamating regular and internet inspired modes of interaction in the model to break through social barriers. Significant connectors are also encouraged to emerge in the model's networks through a *rich get richer* means of presenting information and activity through the hierarchical levels of the model.

The model gives persistence to people's natural socio-spatial formations and activities through the emergent architecture. Thus, it was important that this architecture remain as flexible as the people who define it, and in the same manner. For this reason, the model employed Terrence W. Deacon's methodology for emergence in complex systems for all matters to do with its flexibility. This allows the emergent architecture to dynamically self-organize through socio-spatial activity and to continually evolve towards an 'ideal fit' with urban places and populations.

This thesis' main contribution to architecture and ubiquitous computing disciplines is the way in which it brought research regarding the natures of spatial and network social connections together in the above constraints and conditions for defining emergent socio-spatial architecture. The model offers a foundation from which these two disciplines may merge and evolve together with the social well-being of people in the city as the central concern. It is meant to exemplify, in broad strokes, one manner by which programmers may weave information through urban environments, and by which architects may design dynamic interaction structures, with the simultaneous and complementary goal of affording human agency in the streets, parks, and squares of contemporary cities.

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Glossary of Terms |

This thesis employs some new and appropriated vocabulary. This list consists of terms commonly used in this thesis with reference to complex, abstract, and original entities, processes, phenomena and etcetera. Italicized words in the term descriptions are defined, themselves, in this list. Please cross-reference where appropriate.

Active Integrity:

Active integrity is a measure of the effectiveness of a *spatial connection* and/or a *network connection* (esp. a *weak tie*) in action, with regards to its own potential ability to enhance social cohesion. For example, the effectiveness of a co-present connection activated through verbal and gesture interaction, with regards to its potential for enhancing group cohesion.

Connector Node:

A connector node is a hub in the *scale-free network* topology. Connector nodes support many *weak ties* that link distant or entirely separate social worlds.

Emergence:

Emergence is a term used to describe the spontaneous appearance of unprecedented orderliness in nature. The concept is exemplified in the phrase, 'the behavior of the whole is greater than the sum of its parts'. Emergent *morphodynamics* and *teleodynamics* inform all aspects of flexibility in the thesis proposal.

Emergent Architecture:

Emergent architecture is one part of the thesis proposal. It is a *socio-*

spatial form of architecture that *emerges* from a *socio-spatial interaction model* (the other part of the thesis proposal), based on *morphodynamic* and *teleodynamic* processes.

Human Agency:
Human agency is the capacity for human beings to make choices and to impose these choices on the world. In this thesis, it stands in particular contrast not only to natural forces, but also to government and private industry authority (esp. in urban space), and deterministic forces of *ubiquitous computing*.

Mobile Experience Design:
Mobile experience design is a branch of *ubiquitous computing* that focuses on the design of experiences that take advantage of the coupling of people and mobile communication devices. The thesis proposal is a mobile experience design in this respect.

Morphodynamics:
Terrence W. Deacon, a professor of Anthropology at the University of California, Berkeley hypothesizes about morphodynamics, or second-order *emergence*. He explains morphodynamics as non-equilibrium *thermodynamic* processes that tend to converge to a stable pattern by way of a *self-organizing* recursive circular relationship between constituent interaction dynamics and trace structural properties. Morphodynamic processes are the basis for real-time flexibility and adaptability in the thesis proposal.

Network Connection:
A network connection is a type of connection that occurs in virtual networks (electronic and social) and exhibits the qualities of being ubiquitous, distributed, and persistent. Network connections also exist in real networks, such as within a network of streets, but here they do not exhibit the degree of flexibility characteristic of connections in virtual networks. For this reason, this thesis primarily recognizes network connections as a virtual network phenomenon.

Network Connection Identity:
A network connection identity is related with a *node*, or cluster, and its *spatial connection territory*. It is a network association of all the cluster's constituent parts, which unifies them under a specific category or identity.

Network Social Practices:
Network social practices are social activities that consist primarily of *network connections* in virtual networks.

Node (Socio-Spatial):
Traditionally, a node is a non-dimensional point of connection in a network. In this thesis, a node is either a single individual in space with a mobile network connection, or a cluster of subordinate nodes, like a group of such individuals in strong spatial and network association. This thesis identifies three levels of relative cluster formations, or nodes, in a hierarchy: the group level of individuals, the locale level of groups, and the city level of locales.

Power Law:
A power law is a mathematical relationship between two quantities, where the number or frequency of an object or event varies as a power

of some attribute of that object, like its size. Power law *morphodynamics* result in a 'rich get richer' phenomenon, which is the basis for the natural formation of *scale-free networks*. The power law relationship is essential to the underlying structure of the thesis proposal and all matters to do with its flexibility.

Scale-Free Network:
Scale-free networks are a variety of the *small world network* topology. They have a high degree of clustering, yet a relatively low degree of separation, which is the average number of links required to connect from one side of the network to another. The distribution of ties in a scale-free network follows a *power law*, with few *connector nodes* supporting many links, and many regular *nodes* supporting few links. *Connector nodes* are largely responsible for the network's low degree of separation. The scale-free network topology is the underlying structure of the thesis proposal.

Self-Organization:
Self organization is the process by which the internal organization of a system increases in complexity without influence from an external source.

Small World Network:
A small world network is a network topology with a high degree of clustering, yet a relatively low degree of separation, which is the average number of links required to connect from one side of the network to another. *Weak ties* are essential to this low degree of separation. The world's population, connected through social relations, is an example of a small world network. Any two people can be linked by about six degrees of separation.

Socio-Spatial:
Socio-spatial refers to a social (network) and spatial hybrid condition.

Socio-Spatial Connection Extents:
Socio-spatial connection extents are a measure of a *socio-spatial* structure's *spatial connection territory* and *network connection identity*.

Socio-Spatial Connection Flexibility:
Socio-spatial connection flexibility is a measure of a *socio-spatial* structure's ability to dynamically *self-organize* through *emergent morphodynamics* and *teleodynamics* in the process of *spatial connection* and *network connection* articulation.

Socio-Spatial Connection Integrity:
Socio-spatial connection integrity is a measure of the cohesion of a *socio-spatial* structure and the effectiveness of its connections based on their *active integrities*.

Socio-Spatial Interaction Model:
A socio-spatial interaction model is a set of constraints and conditions for *socio-spatial* interaction designed to bring about the *emergence* of a particular form of *socio-spatial* architecture through *morphodynamic* and *teleodynamic* processes. The thesis proposal is a *teleodynamic socio-spatial* interaction model for *emergent human agency* architecture.

Spatial Connection:
A spatial connection is a type of connection that occurs in real space and exhibits the qualities of being localized, co-present, and temporal. Spatial connections also exist in virtual space, such as within video game environments, but here their qualities are not consistent; they can be authored to act in any way a programmer wishes. For this reason, this thesis primarily recognizes spatial connections as a real space phenomenon.

Spatial Connection Territory:
A spatial connection territory is the spatial area a *node*, or cluster, occupies. It is defined by the spatial collective of the subordinate parts of a cluster formation, which are associated together by *spatial connections*.

Spatial Social Practices:
Spatial social practices are social activities that consist primarily of *spatial connections* in real space.

Strong Connections:
Strong connections are strong *spatial connections* and/or strong *network connections*. The strength of the former is based on proximity; the strength of the latter is based on relationship status. Strong connections naturally link the constituent parts of *nodes*, or clusters, with high redundancy, thereby creating relatively confined social environments.

Teleodynamics:
Terrence W. Deacon, a professor of Anthropology at the University of California, Berkeley hypothesizes about teleodynamics, or third-order *emergence*. He explains teleodynamics as the stochastic amplification of reciprocally reinforcing *morphodynamic* relationships, or the *self-organization* of *self-organizing* dynamics. Teleodynamic processes are the basis for evolution in the thesis proposal.

Thermodynamics:
Terrence W. Deacon, a professor of Anthropology at the University of California, Berkeley hypothesizes about thermodynamics, or first-order *emergence*. He explains thermodynamics as a process by which the unique features of interacting elements distribute in such a way as to cancel one another in aggregate, leading to a higher order average state.

Ubiquitous Computing:
Ubiquitous computing is an emerging urban phenomenon that involves the thorough integration of information processing into everyday objects and activities toward the *emergence* of sentient cities. This thesis proposal positions itself within the broad context of ubiquitous computing, but in opposition to ubiquitous computing's largely semantic organization, in favor of social network construction instead.

Weak Ties:
Weak ties are weak *network connections*. Their strength is based on relationship status. Weak ties naturally connect between *nodes*, or clusters, thereby linking distant or entirely separate social worlds. They are a significant feature of the *small world network* topology.

Wiki:

Traditionally, a wiki is a collaborative web authoring architecture that allows anyone to create, edit, revert to a prior state of, or add to a document. In this thesis, a wiki is also the network authoring environment associated with group level *nodes* in the thesis proposal.