Mapping
Workplace and Organizational Change

Yan Li

B.Arch., Southeast University, Nanjing, China
June 1998
M.Arch., University of Minnesota, Minneapolis, MN
June 2000

Submitted to the Department of Architecture
in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Architecture Studies at the
Massachusetts Institute of Technology
June 2002

Yan Li
School of Architecture and Planning
Massachusetts Institute of Technology

William Lyman Porter, FAIA
Leventhal Professor of Architecture and Planning
Massachusetts Institute of Technology
Thesis Supervisor

Julian Beinart
Professor of Architecture
Chair, Department Committee on Graduate Students
Massachusetts Institute of Technology

Mapping
Workplace and Organizational Change

Yan Li

Thesis Readers

Francis Duffy, CBE, PPRIBA
Founder and Chairman, DEGW
Former President of Royal British Institute of Architects
Visiting Professor in Architecture
Massachusetts Institute of Technology
Thesis Co-Supervisor

Thomas J. Allen
Howard W. Johnson Professor of Management
Senior Associate Dean
Sloan School of Management
Massachusetts Institute of Technology

Mapping
Workplace and Organizational Change

Yan Li

B.Arch., Southeast University, Nanjing, China
June 1998
M.Arch., University of Minnesota, Minneapolis, MN
June 2000

Submitted to the Department of Architecture
in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Architecture Studies at the
Massachusetts Institute of Technology
June 2002

Abstract

The current condition of global economy is evolving out of the ascendance of information technologies and the associated increase in the mobility and liquidity of capital. These phenomena have further propelled a corresponding change of previously national economic actors participating more actively in a complex global market. The complexities involved at different scales entail a new type of organizational structure and conceptual model which are based on dynamic perspectives to re-scale the existing strategic territories and spatial units. The intention of this thesis is to explore metaphor as a mapping mechanism in conceptualizing these unfamiliar realities. Particularly, the metaphors from nature, from living creatures and from existing physical forms and patterns are applied to find associated correspondences with these global phenomena. By mapping workplace and organizational change, the thesis attempts to construct a framework to visualize the new physical pattern and geographic distributions of global organizations to form a conceptual understanding of the complexities in the global economic activities.

Thesis supervisor: William Lyman Porter, FAIA
Title: Leventhal Professor of Architecture and Planning
Massachusetts Institute of Technology

Acknowledgements

I am deeply thankful to Professor William Porter for being my advisor during the two years of intellectual pursuit at MIT. He has provided me with both inspiration and guidance through the development of this thesis. His openness and insights have always been the key component in helping me clarify my interest and focus.

I also want to thank Professor Francis Duffy who supported this thesis enormously through awarding a Teaching Assistantship during the thesis semester on his workshop of workplace. I enjoyed the work and benefited greatly from this process. His efforts in getting contact with people at Sun Microsystem are greatly appreciated.

I want to thank Professor Thomas Allen at Sloan School of Management for the support of this thesis and the discussion around communication in workplace. He has provided me with good advice in the path of the thesis. I would like to thank Professor William Wheaton at the Center for Real Estate. His teaching and research on Urban Economics gave me the opportunity to gain insights and understanding of the topic.

Professor Starling Hunter and Professor Jun Pan at Sloan School of Management opened my horizons in the fields of strategic management and investment. I would also like to express my sincere thanks to them. Professor Hunter offered help on organizational theories and contemporary business strategies which were essential to the construct of the thesis. And Professor Pan helped me with the access to the data for analysis.

I would like to thank the School of Architecture and Planning for supporting my studies in the two years. I also want to express my gratitude to friends and colleagues in the larger MIT community who gave me successive support and encouragements, especially those students who have exchanged interesting ideas with me.

I would like to dedicate this thesis to Nan and my parents who have been so supportive all along and have given me so much strength to carry on.

A Global Fractal:
Mapping Workplace and Organizational Change


emergent global village
decentralization & new forms
of centrality
1
phenomena
tree and leaf vein
built mass
galaxy
organic forms
flocking
conceptual tool
metaphors from nature
2 metaphor
3 tool : fractal
mapping workplace and organizational change
Sun Microsystem: "iWork"
4 mapping
historical pattern & spatial distribution
Silk Road to interconnected global city
global city regions
Boston metropolitan area
nationalgeographic mapmachine
northeastern corridor
mapping internet
organizational structure
history: industrialization
human interaction
organizational change

Contents

1 Introduction

The current condition of global economy is evolving out of the ascendance of information technologies and the associated increase in the mobility and liquidity of capital. These phenomena have propelled a corresponding change of previously national economic actors participating more actively in a complex global market. Frank Moulaert in his book *Cities, Enterprises and Society on the Eve of the 21st Century* describes this transformation: "We have witnessed the emergence and crystallization of a global financial system in which national markets, physically separated and nationally regulated, function together as if they were all located in the same place at the same time." This transformation provides a dynamic perspective for participants in the global marketplace: a constant re-scaling of the existing strategic territories and spatial units to conceptualize the increasing diversity, intensity, and complexity of the world.

To form a conceptual understanding of this reality, an interesting experiment is to refer to the assistance of 'metaphor', not in the sense of its meaning in pure rhetoric, but in terms of its much broader power as a mapping process across different conceptual domains. Geroge Lakoff in his *Contemporary Theory of Metaphor* reveals that metaphor offers a mechanism through which we interpret conceptually of what is unfamiliar in terms of what we are familiar. The thesis tends to explore the mapping mechanism of metaphor as a tool in conceptualizing the emerging phenomena of global economic activities. It uses the metaphors from nature, the metaphors of living creatures, the metaphors of existing physical forms and distributions to build a mental construct of the unfamiliar reality, the reality of scaleable strategic resources and spatial distributions of workplace and organizational change.

Making sense of this complex reality with traditionalism or conventional tools of rationalism has become increasingly difficult. Jonas Salk used the geometry of Mobius Strip as a conceptual tool to explain the complexity. "Converging with itself, it symbolizes the structural kinship, the intimate relationship between subject and object, matter and energy, demonstrating the error of any attempt to bifurcate the observer and participant, universe and man, into two or more systems of reality." To unravel the complexities in different levels and at different scales, new sets of tools were gradually developed and added to our understanding in order to interpret the phenomena that used to be unexplainable. The Fractal geometry versus the Euclidean shapes, the Brownian motion

versus the Newtonian law are some examples of the new tools developed beyond the constraints of old principles and metaphors to help us conceptualize and quantify the current complexities across different scales.

The complexities in the global economic activities involve intensified competitions and encounters in various scales, for this reason, entail a new type of organizational structure and corresponding conceptual model. To construct a mapping process to reflect these organizational changes and the associated distributions of workplace is an important component for this new conceptual model, and more practically, an important recommendation for participants in the rapidly changing global market.

The emergence of open, networked relationships, less or non hierarchical organizations, decentralized operations, geographically dispersed centers and subcenters, temporary individual and team work spaces, and the related economic principles at Macro-Micro levels all marked as the major changes in the external environment for many organizations. These external changes demand future global players to make certain adaptations to rethink or reallocate their workforce and workplace strategically. Mapping the workplace across geographical locations and across time will help grasp this unfamiliar change and assist in constructing a conceptual platform for global organizations.

The thesis will examine the tangible impacts of globalization on workplace and organizations through mapping the historical patterns and physical distributions of the urban system, focusing on built mass, population and employment. It will then explore the less tangible dimension -- the mapping of the internet, of organizational structure and dynamic relationships in human interaction. In the end, a case of Sun Microsystem's "*i*work" as an example of organization restructuring and workplace redistribution will be analyzed.

2 Phenomena

Emerging Global Village
Decentralization and New Forms of Centrality
World City and Workplace

2.1. Emerging Global Village

The dawn of the 21st century is undergoing intense convergence of the diversity and complexity of the world. This condition of globalization is developing out of the intertwining worldwide fiber optics and celestial synchronized satellites of information technology. The associated increase in the mobility and liquidity of capital with this ascendance of information technology has marked as the key properties of the current phase of the world economy.[1]

The phenomena of mobility are not confined in the realm of capital market alone; the liberating effect of information technology implied an intensification of all kinds of cross-border economic and cultural processes - flows of information, capital, labor, raw materials, physical products, art pieces and tourists. This constitutes both planned and serendipitous encounters on a global scale. What used to take place primarily within the inter-state system or national states level, now increasingly spread and expand across national borders or political boundaries, linking those once segregated individuals and entities in a new system of simultaneous global network.

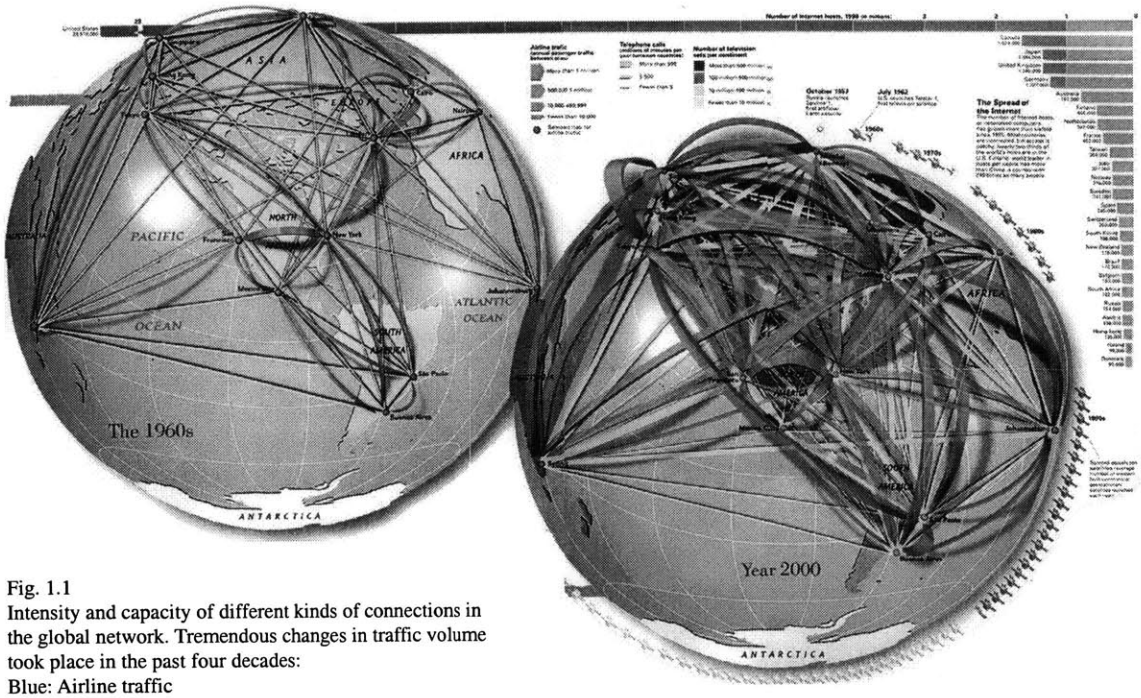


Fig. 1.1
Intensity and capacity of different kinds of connections in the global network. Tremendous changes in traffic volume took place in the past four decades:
Blue: Airline traffic
Yellow: Telephone calls
Brown: Television sets
Red: Internet hosts
Source: National Geographic. March, 1999.

It is in this context that I try to re-locate the emerging "global village", a concept well described by Marshall McLuhan in the late 60s. In his book *Medium is the Massage*, McLuhan articulated the impact of the emerging electric technology that superseded mechanization as "has overthrown the regime of 'time' and 'space' and pours upon us instantly and continuously the concerns of all other men. It has reconstituted dialogue on a global scale. Its message is Total Change, ending psychic, social, economic, and political parochialism. The old civic, state, and national groupings have become unworkable."[2] What McLuhan depicted then as the "global village" was an inventory of effects on our perceptions in a transition to the electronic age, the effects of "total involvement", of converging and linking distant and diverse individuals and entities, the effects of new technology as the medium we created to reshape and restructure the patterns of social interdependence. Ever since the book was first published, the level of speed and change brought upon by new technology has unexpectedly increased in exponential terms, correspondingly, the concept of 'the global village' and the associated perceptions have been continuously redefined and intensified in a new global system of information technology.

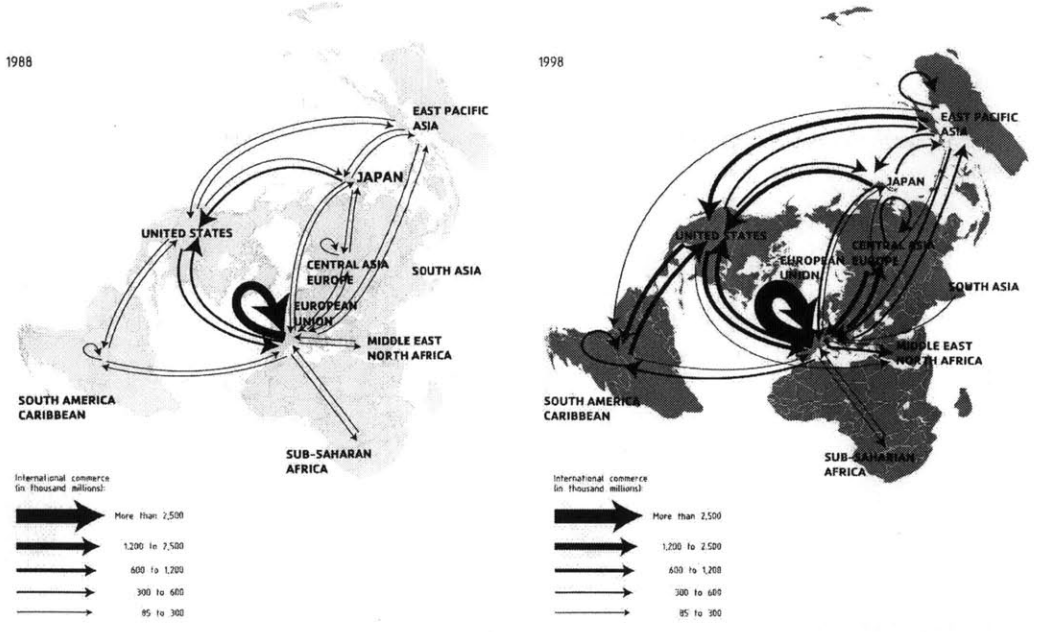


Fig. 1.2
International commercial exchange intensified everywhere.
Comparison of international commerce (in thousand million US dollars) between 1988 and 1998.
Source: Mutation, Rem Koolhass, based on data from World Bank.

In the global village today, we are experiencing a global oneness, an unprecedented convergence of multi-cultured diversity and multi-layered complexity propelled by latest technology and market economy. We have witnessed in recent years, a growing number of governments opting for or being pressured into privatization and deregulation, and opening up their national economies to foreign entities.[3] The 'United States' of the European Union, and the introduction of a single currency in Europe earlier this year were the latest evidences of this kind of opening and integration at the level of a continent. Those once physically separated and nationally regulated markets, as Frank Moulaert pointed out, in the crystallization of a global financial system, began to function together as if they were all located in the same place at the same time.[4]

These simultaneous happenings announce the obsolescence of the concept of segregated economic entities and spatial units, replacing them with networked global organizations, growing-scaled world enterprises, inter-penetrated trading nations and continent-scaled trading blocs. Consequently, the "**scales**" involved in the global economic activities poses new challenges and confusions.

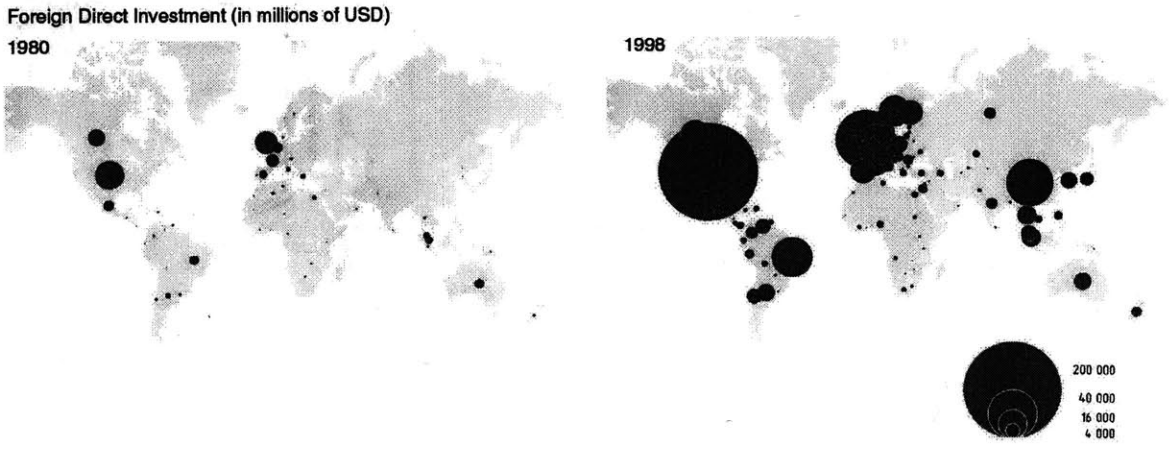


Fig. 1.3.
Comparison of the volumes in Foreign Direct Investment
between 1980 and 1998. (Also see Fig. 5.2, 5.3, 5.4 on Page 52.)
Source: Mutation, Rem Koolhass, based on data from World Bank.

On one hand, in the larger scale, we observe a global level of oneness, converging and assimilating existing differences; on the other hand, in the smaller scale, we see a local level of increased diversity and complexity, creating or introducing new varieties. The coexistence and the divergence of differences in both Macro and Micro levels foster individual organizations to have greater exposures and opportunities to confront the differences in the external environment. This has effectively encouraged previously national economic actors to participate actively in complex global markets, and demands a perspective of re-scaling the existing strategic territories and spatial units to conceptualize and articulate the complexity of the world.

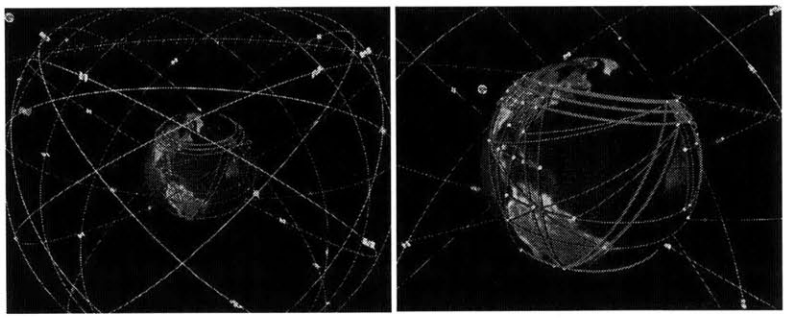


Fig. 1.4.
Intertwining worldwide fiber optics and celestial synchronized satellites transmit information in a global communication network and reconnect people in the networked cities to form a signle global urban entity.
Source: Architectural Record, page 71, March,2002.

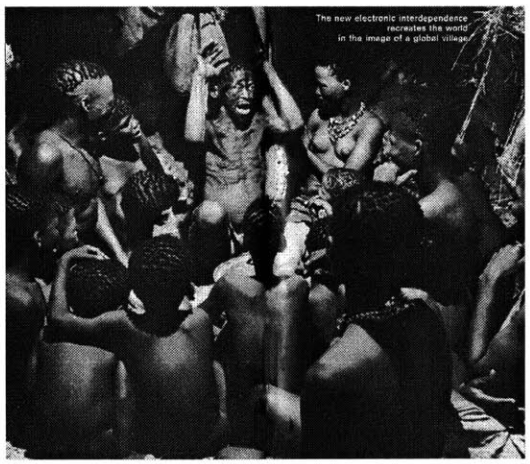


Fig. 1.5.
"The new electronic interdependence recreates the world in the image of a global village."
Source: *Medium is the Massage*Marshall McLuhan, *1967.*

2.2. Decentralization and New Forms of Centrality

The geographic dispersal of strategic territories and the decentralization of spatial units in the emerging global economic activities has modified our conception of centrality and also questioned the very continuity of it. Throughout the recorded history, centrality in terms of demographic, economic, technological, cultural and political has been largely associated with the physical concentrations within cities. (Fig. 1.12) The ancient civilizations of Mycenae, Egypt are among the first few to have notable concentrations and build cities around palace economies. These ancient cities served as the economic nerve centers for surrounding agricultural societies. At the center, it was a functional and symbolic pyramid of economic and political power - a citadel, in which agricultural goods, domestic and exotic commodities were accumulated and re-distributed in various kinds of trades. However, little contact or understanding, as some archeological evidence suggested, was well developed among some neighboring cities and palace economies, primarily because of their limited transportation and the fact that any single economy was large enough to sustain itself without overlapping with another economy. As a result, systems of communication, craft, architecture, and burial customs often evolved in relative isolation.[5] The centrality of these ancient cities had very restricted scopes and influences. This condition has changed as cities transformed through successive agricultural and industrial revolutions that provided cities with the necessities and the possibilities to connect remote points of production , consumption and recreation. In this process, the centrality was reinforced and started to take on new forms.

Today, some 5000 years later, the world is developing a global system of communication with fiber optic and celestial synchronized satellites. Information technology, with its dematerializing nature, has provided the potential of large-scale geographic dispersal for various organizations, especially those with functions that are not necessarily located in highly concentrated areas. (Section 5.3.) This seems to let us believe that the effects of decentralization will eventually reduce the centrality that used to be dominant in the central cities. But what we have observed in the recent years are the increasing population density and employment opportunities, escalating physical agglomerations and capital accumulations, expanding transportation systems and financial networks, all of which still strongly associated with the central cities. (See details in section 5.3.) This continu-

ous concentration in the sharply growing global economic activities is largely because of the comparative advantage of **scale economy** [6] that historically inherited in the central cities to provide the intensity and diversity of expertise in large-scale production, consumption and regulations for economic growth.

The coexistence of geographic dispersal and territorial/non-territorial concentrations at the metropolitan, regional, national and international level associated with the globalization process established the foundation of a new logic for agglomeration and new forms of centrality.

The new logic for agglomeration is one encompassing decentralized spatial units as an extended version of centrality, the spillover from previous urban or business centers that gradually grow into interconnected networks of sub-centers with complex economic activities. (detail in section 5.3.) This includes both territorial and non-territorial concentrations of specific geographic control sites that represent the new centrality in at least the three following forms:

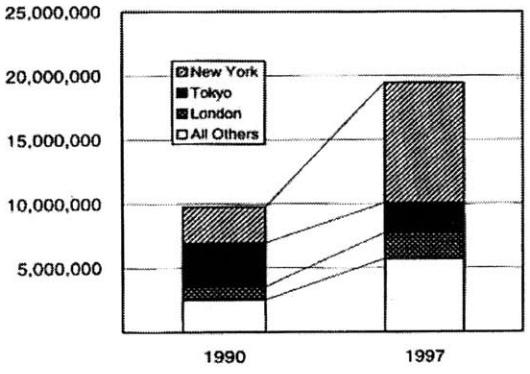


Fig. 1.6. (Left)
Concentration of Capital:
Share of world stock market value (in Millions USD) in '90 and '97. Mostly concentrated in New York, Tokyo, London.
Source: Meridian Securities Markets, World Stock Exchange Fact book '98.

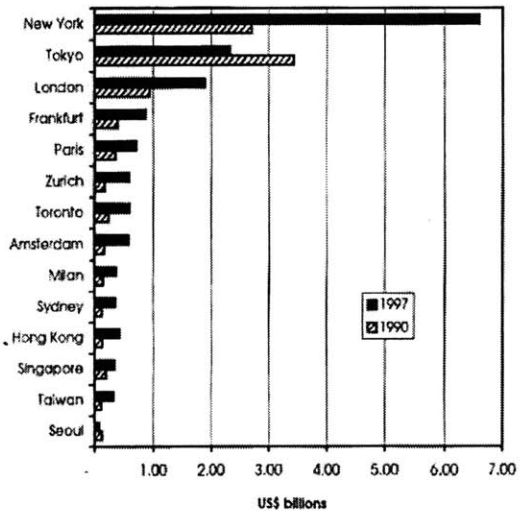


Fig. 1.7. (Right)
Cities ranked by stock market value in '90 and '97. (US$ billions)
Source: Meridian Securities Markets, World Stock Exchange Fact book '98.

First, Central Business Districts. Profoundly reconfigured by information technology and global economic encounters, existing physical central business districts in major international business hubs remain to perform as important central strategic sites for the leading industries and international companies for command, control and service purposes. (Friedman / Wolff) This has further reinforced the concentration of capital flow in these existing world cities, such as New York, London, Tokyo, Frankfurt. (Fig. 1.6, 1.7)

Second, Metropolitan Hubs and Regions. The centrality expressed by major ancient cities has gradually extended into centrality of metropolitan areas and their surrounding regions through dense nodes and connections of intense business activity. In the case of Memphis (below), the large metro area stretchs

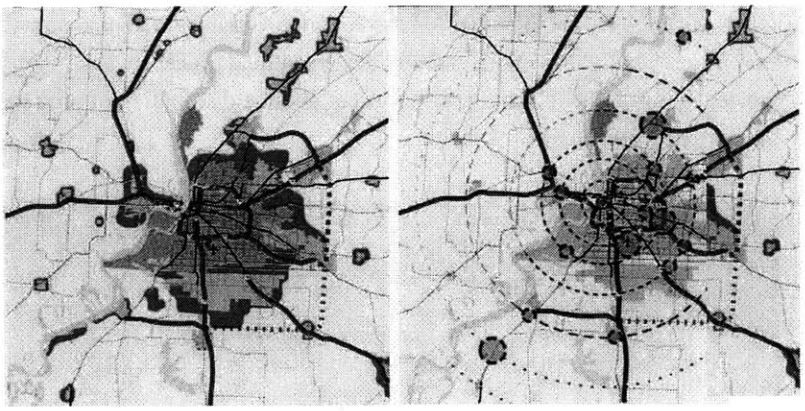


Fig. 1.8. Memphis.
Economic activities draw smaller towns and subcenters into the urban orbit to form a larger metropolitan region. The overall organic growth pattern of these satellite towns and sub-centers represents the decentralized economic activities and reinforces the centrality as a region.
Source: Architectural Record, Page 72, March 2002.

hundreds of miles into sub-centers aligned with public transportation system in the surrounding region. The organic growth pattern is a representation of the decentralized economic activities and a reinforcement of the centrality as a region. Those surrounding nodes and sub-centers with intense business activities rely on both the new system of information technology, as well as the conventional transportation and communication systems, rapid rails, highways and airways connecting existing strategic sites, thus maximizing the exploitation of the existing connectivity and infrastructures.

Third, Centrality developed in virtal space. The centrality emerged in the digital space and electronic networks via intense economic and cultural activities

inside and outside of the major global cities. These networks constitute a new horizon of control and management, a new kind of centrality at the global level spreading out instantaneous signals. When looking back at the rise and fall of many technology companies in the last couple of years, it is striking how often management theories failed. Digital media have not only brought new ways of dealing with informaiton, they have changed the place of business. (Mats Bjorkin, 2002) The traditional concept of centrality focused on the physical presence of companies, which was often expressed through historical and emerging powerful finacial and business centers, such as New York, London, Tokyo, Hong Kong, Zurich, Amsterdam and so on. However, as techonology enables the new centrality in the virtual space, a small company outside the financial centers can easily become global and might have strong central power as well.

Understanding the phenomena of decentralization and recognizing the new forms of centrality are essential for current or potential international organizations, especially those with globally dispersed field offices to make strategic decisions on the allocation of resources and the distribution of physical and virtual workplaces.

Fig. 1.9.
Trading floor in New York Stock Exchange.
An extreme condition of strong urban agglomeration and centrality:
High concentration of people, information, capital flow and physical facilities.
Source: *Mutation*, Rem Koolhass.

2.3. World City and Workplace

The coexistence of spatial dispersal and global integration has created new strategic roles for major cities around the world. These cities are now interlaced in a global market of industrial production, exchange, culture, manufacturing, and financial management. Among these cities, New York, London and Tokyo are the leading command centers. They are considered 'world cities' because of their dominant strengths and power globally. In her book *The Global City, New York, London, Tokyo(1991),*Saskia Sassen described and analyzed the massive and parallel changes of these three cities in their economic base, internal dynamic, spatial organizations and social structures in the situation of global processes. In the second edition of this book, the research of "the global city" extended to a much wider range of cities encompassing Paris, Frankfurt, Hong Kong, Sao Paulo, Mexico City and so on.

The "world city" or "global village" is a representation of this vast network of cities and their sub-centers that girdle the world so intertwined that they unite existing cities in a single global urban entity. In this networked entity, virtually all cities would eventually become enmeshed in the complex world economy, even though most of them currently function at a national or regional rather than a global scale. [7] In this vast network, the borders between a company and the outerworld, between company and company have been blurred; (section 5.3.7.) while information and business networks have become more important than individual units. Global organizations, in this case, need to develop corresponding strategies and appropriate organizational structures to locate their tangible and intangible assets both physically and virtually in the global network.

This overlapping network of cities and information constitute the basis for today's workplace. Information technology provided the possibility of dematerialization, hyper-mobility and geographic dispersal, enabling more people to work at home, to work in distant spatial units. At the same time, we have also seen the sharply rising density and intensity of certain workforce, physical facilities, infrastructure, related services still embedded in central cities. This indicated at least two facts about the distribution of workplace:

1. The territorial dispersal of current economic activities create a need for expansion of complex central control and management which still locate in many central cities. [8] The physical workplaces, especially the headquar-

ters of international organizations in these cities will remain to be the prevailing strategic sites. The reason is that these cities have the depth and diversity of expertise to serve vast and diverse global markets (manufacturing, finance, accounting, law, education, R&D, health care, culture, arts, sports, and recreation); and equally important, these cities provide the best global connectivity (air, rail, road, water, telecom, radio, TV, people). [9]

2. Advanced information industries require a vast physical infrastructure containing strategic nodes with hyper-concentrations of facilities. [10] They usually have a work process that is at least partly place-bound because of the combination of complex resources it requires, even when some of the outputs of a spcecif company or industry are hyper-mobile or virtual.

Census data such as demographic and employment statistics (see details in section 5.3.) are clear evidences of intense agglomeration and employment in the global city centers as well as their surrounding multi-centered regions. One distinctive feature of the distributions of both physical and virtual workplaces is that they are closely tied to the demographic and employment patterns in those regions. (See Fig. 5.24-5.26 on page 68, 69.)
To **visualize these distribution patterns** will allow us to re-capture the changes in **geography of workplace and organizations,** and to further re-capture the cross-border flows of goods, capital, information and people.

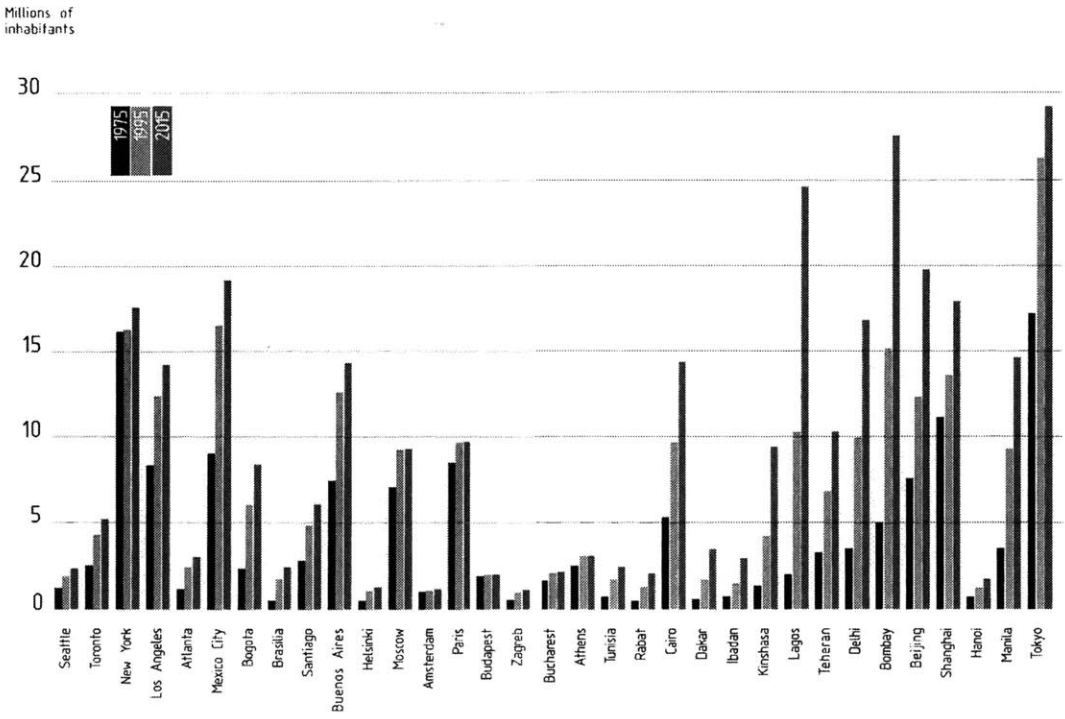
Fig. 1.10. (Left)
Oxegen Media Office. New York, NY. Adaptability is celebrated in the office through highly mobile furniture which facilitates the project-by-project process.
Source:On the Job: the American offices.

Fig. 1.11. (Right)
Working at home and working in distant places. Marketing images of Microsoft Windows XP.
Source: Microsoft.

Urban Agglomeration (UA)	*Total Number of UA*	*Total Percentage Residing in UA*
China	49	10.9
United States	35	38.3
India	30	9.4
Brazil	14	33.2
Germany	13	40.9
Russian Federation	13	19.1
Pakistan	8	17.3
South Africa	8	29.8
Japan	6	37.8
Republic of Korea	6	52
Australia	5	58.1
Indonesia	5	8.5
Iran (Islamic Rep. of)	5	19.4
Turkey	5	25
Ukraine	5	15.6
Canada	4	35.7
Colombia	4	34.8
Italy	4	19.5
Mexico	4	27.2
United Kingdom	4	23.4
Argentina	3	40.9
Bangladesh	3	10.5
Egypt	3	23.5
France	3	20.8
Poland	3	17.4

Fig. 1.12.
Percentage of people living in urban areas in countries with highest urban agglomerations
Source: The global city, New York, London, Tokyo. Saskia Sassen. Based on data from theUnited Nations.

Fig. 1.13.
Concentration of People:
Historical records and projections of urban inhabitants in major world cities. (Number in millions)
Source: Mutation. Rem Koolhass, based on data fromWorld Bank.



Endnotes

1. Sassen, Saskia. *"The Global City, introducing a concept and its history." Mutation*. Barcelona : Actar, 2001.
2. McLuhan, Marshal. *The Medium is the Massage, An Inventory of Effects*. Rev. Ed. San Francisco: Hardwired, 1997.
3. Sassen, Saskia. *"The Global City, introducing a concept and its history." Mutation*. Barcelona : Actar, 2001.
4. Moulaert, Frank and Allen Scott ed. *Cities, Enterprises and Society on the Eve of the 21st Century*. London: Wellington House, 1997.
5. Fagan, Brain, *People of Earth*. London: Wellington House, 1997.
6. Lever, W.F., *"The Post-Fordist City", Handbook of Urban studies*. London: Sage Publications, 2001.
7. Sassen, Saskia. *The global city : New York, London, Tokyo*. Princeton, N.J. : Princeton University Press, 1991.
8. Ibid.
9. Gallis, Michael and James Russell. *"World City: Why globalization makes cities more important than ever."* Architecture Record, page 72, March, 2002.
10. Sassen, Saskia. *Cities in a world economy*. Thousand Oaks, Calif.: Pine Forge Press, 2000.

Bibliography

Bjorkin, Mats. *Re-mapping the Cash Flow: Digital Media and Corporate Communication*. Working Paper, Gothenburg University, Sweden. March, 2002.

Gallis, Michael and James Russell. *"World City: Why globalization makes cities more important than ever." Architecture Record. March, 2002*

McLuhan, Marshal, *The Medium is the Massage, An Inventory of Effects*. Rev. ed. San Francisco: Hardwired, 1967.

Koolhass, Rem, et al. *Mutation*. Barcelona : Actar, 2001.

Koolhass, Rem. *Delirious New York*. New York, NY: The Monacelli Press, Inc., 1994

Sassen, Saskia. *Cities in a world economy*. Thousand Oaks, Calif.: Pine Forge Press, 2000.

Sassen, Saskia. *Globalization and its discontents: [essays on the new mobility of people and money]*. New York : New Press, 1998.

Sassen, Saskia. *The global city : New York, London, Tokyo*. Princeton, N.J. : Princeton University Press, 1991.

3 Metaphor

Metaphor as Conceptual Tool
Mappings in Metaphor
Metaphors in Nature

3.1. Metaphor as the conceptual tool

The phenomena we observed in the globalization process brought tremendous changes to the development of new urban/regional forms and had profound consequences on a variety of organizational structures (detail in 5.2.). This scale of transformation and developing patterns are almost beyond our control and comprehension. To form a conceptual understanding of this reality, an interesting experiment is to explore the metaphorical meanings in these physical distributions of organization and workplace through the analysis of their correspondences and differences with similar forms and distributions in nature.

The reason I refer to 'metaphor' is not solely because of its meaning in pure rhetoric, but more because of its strength as a mapping process across different conceptual domains. Metaphor has its long history strongly associated with language. Aristotle considered the relationship between metaphor and language in the purpose of communication. His views were largely based on the use of metaphors in Poetics and Rhetoric, which are still very influential today. He believed metaphors to be implicit comparisons following the principles of analogy, but metaphors were not really necessary, or primarily ornamental in function. [1] He also urged a distinction between definitions and metaphors, pointing out the ambiguity and obscurity inherent in the latter. [2]

The existence of ambiguity and obscurity was later re-considered as conceptual incompatibility (between the topic and the vehicle) and it has been explored and developed into a more contemporary perspective of metaphor. This perspective considers metaphor not simply as a figure of language but a basic foundation of our thought and mental functioning. We constantly use metaphors in our speech, our thinking, our fantasies, and our dreams even without noticing it. [3] In our daily speech, for example, we are "stuck," this relationship is "going nowhere," he is "spinning his wheels," we irresistibly use these metaphors to describe complicated and abstract notions based on those concepts and experiences from more familiar situations.

Geroge Lakoff in his *Contemporary Theory of Metaphor* reveals that metaphor offers a mechanism through which we interpret conceptually of what is unfamiliar in terms of what we are familiar. "It is a cross-domain mapping in

the conceptual system, a mechanism or a conceptual tool (of thought and reason) for people to understand a relatively abstract or inherently unstructured domain in terms of a more concrete, more highly structured domain." 4 Metaphor as the conceptual tool provides the opportunity to recapture the correspondence from the 'source domain' (more comprehensible) to the 'target domain' (less comprehensible) in a mapping process. Lakoff used the very familiar metaphor 'Love is a journey' to describe this process, a mapping from 'journey' (source domain) with more comprehensible characteristics to 'love' (target domain) which is much more abstract in nature.

3.2. Mappings in metaphor

Since the mapping process of metaphor is not merely a phenomenon of communication, but more of a representation of our mental functioning as we comprehend and conceptualize unfamiliar situations, it is quite important to explore the characteristics of mappings to constitute a more solid understanding of why the situation of physical distributions of workplace can be revealed in a process of mapping other familiar forms. In the following text, I would like to discuss the mappings in two common kinds of metaphors: language metaphor and picture metaphor which are quite interrelated in various cases.

In the classical theory of metaphor which mainly focused on language, the word "metaphor" was defined as a novel or poetic linguistic expression where one or more words for a concept were used outside of their normal conventional meaning to express a "similar" concept. [5] In this set of reasoning, the mapping process was an illustration of the "similarities" between concepts beyond their ordinary use. Opposing views in more contemporary theories of metaphor revealed the "differences" or "the conceptual incompatibilities" between these concepts as the key to metaphor. Michael Reddy showed in his extensive early research: "the locus of metaphor is **thought, not language,** that metaphor is a major and indispensable part of our ordinary, conventional way of conceptualizing the world, and that our everyday behavior reflects our metaphorical understanding of experience." [6] Then, the mapping process of metaphor was re-discovered as the illustration of conceptual correspondences and disparities between two concepts in ordinary everyday language, not just in poetic expressions.

In language, this cross-domain conceptual mapping of metaphor unveils the "similarities" and "differences" between two domains. For example, the hidden logic of "love is a journey" well explains why the word "journey" is used to describe "love", why the reason of the former is used to reason the latter, and why the former in essence is **not** the latter. (Metaphor itself is not a proposition).[7] Finding the answers to these questions reveals the meaning and structure of mapping, at the same time, extends our understanding of the concepts in both domains as well as the relationship between the object and the vehicle. This provides a general inquiry of metaphor. Similar strategies can be applied to the analysis of picture metaphors.

The mapping process of pictorial metaphor is particularly well represented in memories or dreams where visual-spatial imageries flow freely in less restricted mental activities.

> I was walking on a narrow mountain path with steep drop-offs on either side; it seemed kind of dangerous; the path was foggy; I could not see ahead very well. There was a large, shadowy figure walking with me; I was not sure whether this figure was good or evil. 8

This is one of the typical descriptions of dreams reported from patients in psychoanalysis. It portrays a "particular part of life as a potentially dangerous journey," a pictorial metaphor stating the similarities across two conceptual domains, life and journey. The mapping process occurs in a situation when the function of language is not activated, though the patient tells the story by words in a purely descriptive way when he/she is in the state of waking. Ernest Hartmann in his book *Dreams and Nightmares* argued that "Dreaming is often an **explanatory metaphor** using visual-spatial imagery to express the state of one's mind." The mapping process of this pictorial metaphor, in his mind, "is very similar to what we do when we speak of life metaphorically as a road, a plant, a tree, or a fire, or speak of love metaphorically as a journey. We try to explain something important but difficult or problematic in terms of something simpler; we especially try to explain it in terms of a visual image." 9

In dreams or memories, the mapping process across two conceptual domains reveals our picture-based metaphorical understanding of abstractions or emotions. Everyday abstract concepts like time, states, change, causation, and purpose are mapped onto other forms of more comprehensible concepts or related experience, often in a visual language.

The thesis attempts to explore the use of visual images as explanatory metaphors to help us conceptulize the unfamiliar complexities in the emerging global economic activites which are rather abstract and dificult to comprehend through conventional tools or language.

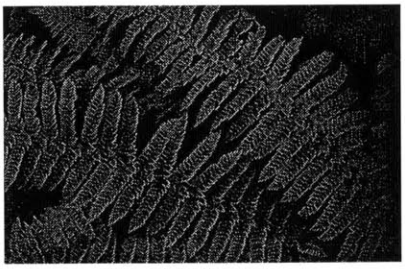
3.3. Metaphors in nature

The organic forms and the biological processes of living creatures and communities are somewhat more familiar realities that have been visible in our everyday life and have been rigorously studied for several thousand years. Even though some of the internal mechanisms in such forms or processes leading to the external familiar phenomena are still unknown or quite unfamiliar to us, our comprehensions of very abstract concepts or more unfamiliar realities can often be greatly improved when we referred to these organic forms and biological processes. This section intends to use the metaphors from nature as the foundation in mapping the structures of organizations and the distribution patterns of human inhabitation.

Three basic aspects of metaphors from nature will be addressed: *structure, aggregation and adaptation.*

Structure:

Tree and leaf veins – One kind of natural form that is usually applied in representing hierarchical structures or systems. The clarity within the tree structure relies on its way of connecting the main level and its sub-levels. There is no ambiguity in cross-level hierarchies and no direct relationships among different sub-level elements. Its implications can be found in various disciplines especially those systems organized according to clear rules or hierarchies. However, when it comes to a system with dynamic input or complex connectivity among sub-level units, the tree metaphor starts to lose its appropriateness.



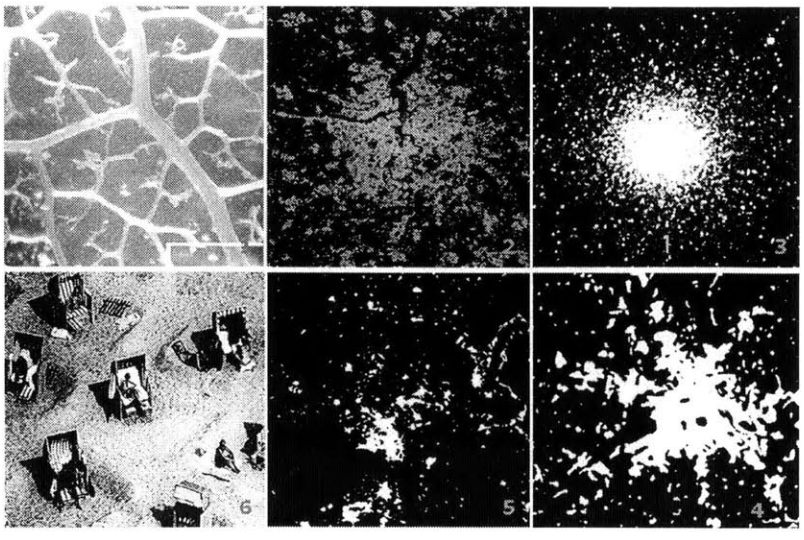
Self-similarity across different scales is another significant feature in the tree/leaf vein metaphor. It is well represented in the image on the left (Fig. 3.1.). The overall shape of the fern is similar to that of each leaf on the fern, as well as that of each small branch on the leaf. This also exists in many other natural forms. (Fig. 3.2) The quality of self-similarity can go beyond the specific form which is expressed in the tree metaphor. It can apply to other systems which are less hierarchical or without hierarchy at all.

Fig . 3.1. (Above)
The natural forms of fern.
Source: National Geographic. March, 2000.

Aggregation:

In the images below, (Fig.3.2) the forms of spatial distributions in the natural and built environments introduce the interesting similarities among natural objects and human interventions. The process of aggregation and growth across time as systemic effects manifest the possibility of similar underlying logics in the formations of both natural and human settings. In the image of population density of London and the Hercules constellation, the similarities, at least in the two dimensional projections, raise the question of whether there have been very similar forces or parallel mechanisms that have shaped the urban forms and the celestial spatial distributions. A complete scientific inquiry of this issue is maybe beyond the scope of the thesis, but the fundamental understanding of gravity, aggregation, center and periphery might help draw interesting connections and extend our understandings of both happenings. The metaphorical correspondences, in this case, would establish a starting point in revealing the internal mechanisms by asking the questions of how and why they have similar appearances, how and why they are different, whether their similarities and differences come from the same system of reasoning, or from quite distinct internal logics.

Fig. 3.2. Forms from natural and built enviornment. *Source*:
1. Microscopic view of leaf vein 2. Population density in London
3. Nebula of Hercules constellation 4. Built mass in Berlin
5. Satellite night image of Europe 6. Hazardous occupation on beach



Adaptation:

A very important factor to distinguish a living system is its ability to adapt in the changing external environment. In order to adapt to the changes more effectively, living creatures usually choose to stay together as groups. Flocking birds, schooling fish, herding sheep and foraging ants are some illustrations of the pack behaviors in the living community. Many species of fish actually spend their entire lives in schools from the moment they are born. The major reasons that they are traveling as a school are based on the logics of overall/ individual safety, effectiveness of food hunting and easiness in protecting their own domains, all of which are based on group adaptations to the changing conditions. 10

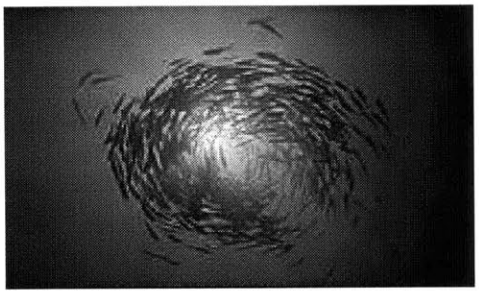


Fig. 3.3. Schooling fish.
Source: http://www.oceanic impressions.com/schooling.htm

Successful mapping programs designed by computer scientists have attempted to simulate the pack behavior by setting certain simple rules for the movements of individual units in the pack. Craig Reynolds of the Los Angeles Symbolics Corp. developed a computer simulation that captures the essence of flocking birds, herding sheep, or schooling fish in 1986. It is a screen full of moving objects, called boids (or bird objects), which obey three basic rules. The first rule ensures the necessary separation, while the second two rules produce the cohesion and alignment of the flock:

1. Attempt to maintain a minimum distance from all other Boids and objects on the screen.
2. Attempt to match speed with other Boids in the neighborhood.
3. Attempt to move to the center of the Boids in the neighborhood. 11

Richard Dawkins in *The Selfish Gene* proposed that pack behavior follows the same rules as those of boids.

> "A simple strategy for a predator is to chase the closest prey in its vicinity. This is in order to reduce the amount of energy that it must expend. The strategy for the prey then is to keep as far away from its predators as possible. If predators only attack the closest prey, then all of the others should be safe. Each prey can be considered to have a "domain of danger" surrounding it. A

> lone individual would have a rather large domain of danger while each individual in a pack would have a small domain of danger around it. The strategy of the prey then is to reduce its domain of danger as much as possible. This is accomplished by creating a pack, where each individual tries to reduce his own domain of danger. But, because those on the edges of the pack have a larger domain of danger than those in the center of the pack, those on the edges try to move inward, thus pushing those on the inside outward."[12]

Just like real schools and flocks, the units can get back together after acrossing barriers, flowing around walls or avoiding attacks, even though no such command was given at the system level.

Another example is Resnick's *StarLogo* developed at the Media lab as an experiment to examine the decentralized, self-organizing systems such as turtles, termites and traffic Jams. Its simulation on the termites collecting wood chips intended to model the behaviors and interactions of elements in a distributed system. The user can experiment with the parameters of the systems, observing how certain factors can change the outcome. It shed light on how organizations can emerge from components without the direction of a central coordinator. [13]

This becomes one of the most distinguished implications of this kind of research-- very complex system behaviors can be formed by very simple rules applied locally. Local interactions between individuals that follow simple rules may - on a much larger scale - induce very complex global system behaviors or intricate group patterns.

The metaphors of the adaptive qualities of living systems in nature can be applied to conceptualize similar patterns and complex activities in the economic processes. However, when doing this, it is a dangerous inclination to draw direct conculsions from the external behaviors, because in these organic metaphors, correspondences and disparities co-exisit. When two systems show identical external behavior, this does not necessarily mean that they are ruled by the same internal mechanisms. [14]

Endnotes

1. Ortony, Andrew. Ed. *"Metaphor: A multidimensional problem." Metaphor and Thought.* Cambridge [England] ; New York, NY, USA : Cambridge University Press, 1993.
2. Ibid.
3. Hartmann, Ernest. MD. *Dreams and Nightmares: the origin and meaning of dreams.* Cambridge, MA: Perseus Publishing, 2001.
4. Lakoff, George. *"The Contemporary Theory of Metaphor." Metaphor and Thought.* Cambridge [England] ; New York, NY, USA: Cambridge University Press, 1993.
5. Ibid.
6. Ibid.
7. Ibid.
8. Hartmann, Ernest. MD. *Dreams and Nightmares: the origin and meaning of dreams.* Cambridge, MA: Perseus Publishing, 2001.
9. Ibid.
10. http://www.susqu.edu/facstaff/b/brakke/complexity/hagey/flock.htm
11. Ibid.
12. Ibid.
13. Langton, Christopher. Ed. *"Learning about life." Artificial Life, An overview.* Cambridge, MA; London, England: The MIT Press. 1995.
14. http://www.susqu.edu/facstaff/b/brakke/complexity/hagey/flock.htm

Bibliography

Gallis, Michael and James Russell. *"World City: Why globalization makes cities more important than ever." Architecture Record. March, 2002.*

Hartmann, Ernest. MD. *Dreams and Nightmares: the origin and meaning of dreams.* Cambridge, MA: Perseus Publishing, 2001.

Ortony, Andrew. Ed. *"Metaphor: A multidimensional problem." Meta phor and Thought.* Cambridge [England] ; New York, NY, USA: Cambridge University Press, 1993.

Langton, Christopher. Ed. *"Learning about life." Artificial Life, An overview.* Cambridge, MA; London, England: The MIT Press. 1995.

http://www.susqu.edu/facstaff/b/brakke/complexity/hagey/flock.htm

4 Tool

Fractal versus Euclidean Geometry
Mapping the Unfamiliar

4.1. Fractal v. Euclidean Geometry

> Our official culture is striving to force the new media to do the work of the old. These are difficult times because we are witnessing a clash of cataclysmic proportions between two great technologies. We approach the new with the psychological and sensory responses of the old. This clash naturally occurs in transitional periods. In late medieval art, for instance, we saw the fear of the new print technology expressed in the theme The Dance of Death. Today, similar fears are expressed in the Theater of the Absurd. Both represent a common failure: the attempt to do a job demanded by the new environment with the tools of the old.
>
> - Marshall McLuhan. *The Medium is the Massage.*

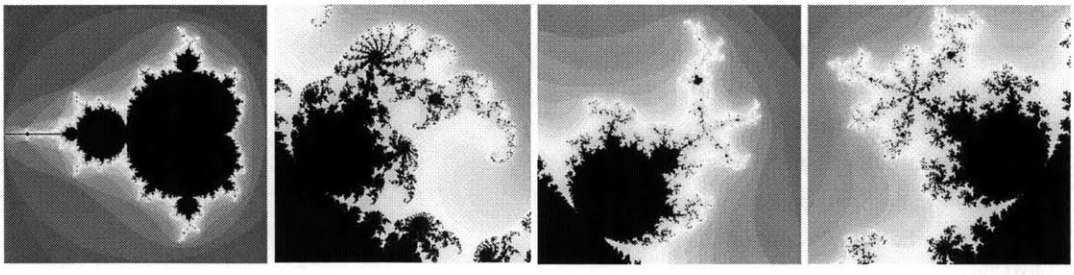
The hope to understand the complexities and to solve the mysteries in each phase of history has often led to the developments of new tools so that complex situations would be manageable through more appropriate underpinnings. Euclid devised his platonic shapes for this reason around 300 B.C. The elemental Euclidean shapes for understanding the complexities of the natural, built, and psychological worlds are still in use today. 1 The earth is a sphere, history and our lives unfold over the course of linear time, the days and seasons are cyclical. The use of Euclidean geometry has empowered humans, with great success, to solve many of life's mysteries. These tools of rationalism have benefited humanity immensely, however, only when applied to questions that were inherent within the tools already. That is, Euclidean geometry can only answer questions that are Euclidean in nature. 2 "Clouds are not spheres, mountains are not cones, and lightning does not travel in a straight line." Mandelbrot is fond of citing these obvious disparities between the tools of rationalism that Euclid has provided and the complexities we have observed in the real world. His bewilderment rose from the insufficiency of the tool with exceptionally pure mathematical shapes and equations but few counterparts in nature. This shortcoming of the entire geometry system was later explored by Mandelbrot and further developed into "the fractal geometry" as a new tool to solve many mysteries in nature.

Mandelbrot describes fractals as having characteristics that are scaling and sometimes self-similar, or self-inverting. 3 The notion of scaling in fractals is the characteristic of self-simulation at all scales of magnification, so that regardless of the shifting relation to the fractal, similar forms or characteristics are always present. (image on facing page.)

Mandelbrot argues for adding fractal geometry to the constructs of human civilization, as one more vehicle for understanding life, nature, and the cosmos. But it is important to stress that the fractal geometry is not a replacement for all the geometry and mathematics that preceded it. It is simply another system by which many of the complexities of reality can be untangled. The theories built on this tool have found numerous applications to solve the mysteries in the fields of modern physics, telecommunication, finance, economics, geography, astronomy and meteorology. The complexity in the geographic distribution of workplaces is one that is interconnceted with and accumulatively shaped by many factors from serveral fields above; interestingly, it also exhibits similar un-linear patterns across different scales. (see section 5.3. & 5.5.)

The fractal geometry reveals the continuous self-similarities at various scales in nature. It helps us understand the complexities in the real world that have existed all along but were unable to be captured or explained using previous tools. The phenomena in recent years as consequences of technological change, urban growth and globalization processes, such as the decentralization of employment, the physical dispersal of workplaces and built mass, (section 5.5), the patterns of the internet connections and the networks of city hubs and satellite centers are almost all among the "jobs" which are"demanded by the new enviorment" and cannot be simply interpreted "with the tools of the old".

Fig. 4.1.
Computer-generated image of a self-similar fractal. Similar patterns are always present in various scale of observations.
Source: http://math.bu.edu/DYSYS/explorer/page1.html



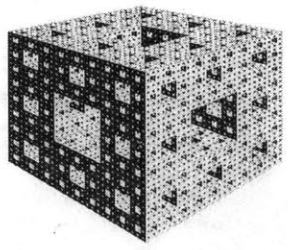
4.2. Mapping the unfamiliar

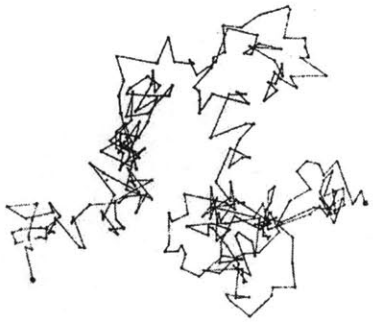
Making sense of this complex reality with traditionalism or conventional tools of rationalism has become increasingly difficult. Jonas Salk in his book *Anatomy for Reality* used the geometry of Mobius Strip as a conceptual tool to describe the complexity. "Converging with itself, it symbolizes the structural kinship, the intimate relationship between subject and object, matter and energy, demonstrating the error of any attempt to bifurcate the observer and participant, universe and man, into two or more systems of reality." 3 In his mind, this mysterious geometric loop without an inside or outside as a single entity manifested the interconnections and the infinite unity in nature. The "unsolved mystery" of Mobius Strip was later discovered as a self-similar geometric fractal. With this new set of intuition and the non-Euclidean mental tool, Salk went on to explore the old questions in other disciplines. 4

To unravel the unfamiliar complexities across different scales, new sets of tools were gradually developed and added to our understanding in order to interpret the phenomena that used to be unexplainable. The Fractal geometry versus the Euclidean shapes, the Brownian motion versus the Newtonian law (fig4.2) are some of the examples that new tools were developed beyond the constraints of old principles and metaphors to help us conceptualize and quantify the complexities.

In the context of dynamic global economy, the dispersed distribution of workplaces and the interconnected relationships among international organizations are some of the complex and unfamiliar realities that have become increasingly difficult to comprehend using traditional tools and vechicles. The unprecedented convergence across macro and micro scales seems to have offered another "mysterious loop".

A mapping process of workplace and organizational change will provide **a visual representation** and **a conceptual interpretation** through the metaphorical meanings in those more familiar contexts, and will provide a more appropriate underpinning in conceptualizing the complex unfamiliar realities in the the globalization process.





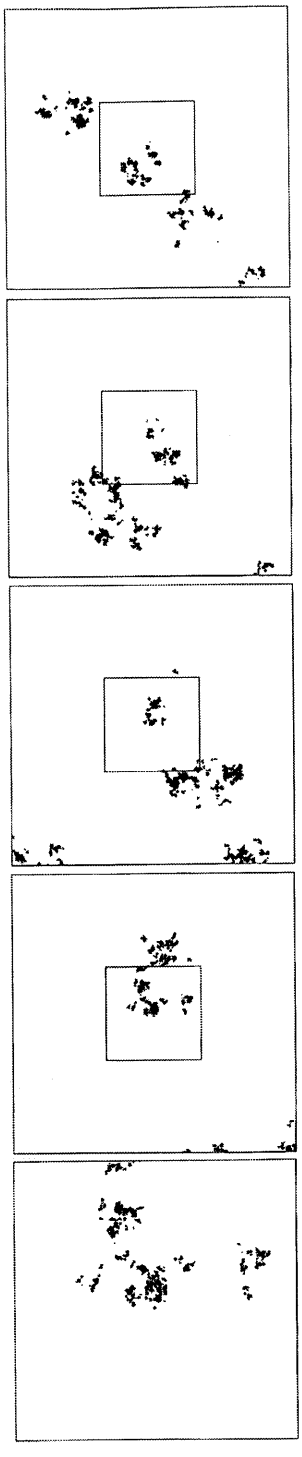


Fig. 4.2. (Facing page)
Computer-generated image of a self-similar fractal cubic. The Brownian Motion of a small particle.
Source: The fractal geometry of nature. Benoit Mandelbrot.

Fig. 4.3. (Right)
Zooming in toward a Levy dust, a self-similar fractal. The edge and overall pattern present similar qualities at different scale. The lower image captures the smaller sqare at the middle of the previous image (one upper level).
Source: The fractal geometry of nature. Benoit Mandelbrot.

Fig. 4.4. (Below)
Computer generated brown coast line, zoomed in. One can soon identify the self-similarities at different scales as well as the applications in geography.
Source: The fractal geometry of nature. Benoit Mandelbrot.

Endnotes

1. Mandelbrot, Benoit B. *The fractal geometry of nature*. San Francisco: W.H. Freeman, 1983.
2. Ibid.
3. Ibid.
4. Salk, Jonas. *Anatomy of Reality.* New York: Columbia University Press, 1983.
5. Ibid.
6. Ibid.

Bibliography

McLuhan, Marshal. *The Medium is the Massage, An Inventory of Effects*. Rev. Ed. San Francisco: Hardwired, 1997.

Mandelbrot, Benoit B. *The fractal geometry of nature*. Rev. ed. San Fran cisco: W.H. Freeman, 1983.

Salk, Jonas. *Anatomy of Reality.* New York: Columbia University Press, 1983.

http://math.bu.edu/DYSYS/explorer/page1.html

http://math.bu.edu/DYSYS/explorer/index.html

5 Mapping

History: Industrialization
Organizational Change
Historical Pattern & Spatial Distribution
Sun Microsystem's "iWork"

5.1. History: Industrialization

The evolution in the geographic distributions of workplaces and the current condition of organizations are joined representations of the trajectory of western industrial development in the past two centuries. British sociologist Tom Burns defined this trajectory in terms of three distinguishable phases.

The **first** phase grew out of the increased use of machines to enhance the productivity in the factory system. The system offered an alternative to subcontracting—a way industrial labor was organized before large-scale factories ever appeared. 1 Emerged in the British textile industry, the factories were initially collections of machines which were operated and maintained by large number of feeders and repair workers. The unprecedented productivity and efficiency achieved by these machines demand enormous amount of labor and capital, thus triggered the corresponding physical agglomerations around towns and cities. The workplaces of the major workforce at this time were largely concentrated in the factories of these towns and cities.

The organizational structure in this machine-centric revolution was relatively flat with huge number of low-level workers and limited size of management. Organizational divisions were clearly defined by job functions, which were lack of communication and sophistication. Workers as the extensions of machines conducted repetitive work with limited skills or creativity. Uniformity and repetitiveness became the dominant expressions of these depersonalized working conditions and relationships. Since most manufacturing firms took advantage of the standardization and the economy of scale, focusing inward on the "exploitation" of existing labor and capital, it was very difficult to see any intertwining relations with other production processes, services or outside organizations as what we observe today. The structures and relationships of various organizations were relatively simple, linear, static and self-focused.

The **second** phase began roughly in the 1850s and 60s and its major characteristics can still be seen today. During this phase, the factory system diffused into clothing and food manufacturing, chemical, iron, and steel processing, all of which depended on complex production processes. 2 According to Burns, this growth and the increased technical complexity of manufacturing operations demanded parallel growth in systems of social organization and bureaucracy, with their large increase in the ranks of managers and administrative staff. 3 More complex, vertically integrated organizational structures emerged

with significant rise of number of sub-level workers and managment. As Weber and Marx pointed out, these changes eventually led to the creation of a new middle class of managers, clerical workers, and professionals employed by large, hierarchical organizations. 4 We have also seen corresponding transition of the workplace with these complex divisions of labor and production processes. Workplaces have celebrated higher flexibility, interaction and autonomy with greatly enhanced individuality and creativity. 5 The industrial structure shifted from standard manufacturing to more specialized productions and services. Many firms began to concentrate on "exploration" and innovation of new territories and services instead of exploiting the existing strategic assets. Consequently, the distribution of workplace undergone a serial of changes, the suburbanization of manufacturing, retail, residential housing, the decentralization of firm sites, (see detail in section 5.3.) the new concentration of management and services in central cities, as well as the increased complexity and speed of connectivity. We will examine these situations later this chapter. (see Fig.5.12.)

The **third** phase, as Burns claimed, is just emerging now. In this phase, production catches up with and overtakes spontaneous domestic demand. 6 In these circumstances, the capitalist organization's dependence on growth leads to enhanced sensitivity to the consumer, to new techniques to stimulate consumption, to the internationalization of firms in search of new markets, and to new technical developments that increasingly occur within industrial firms. 7 Many companies like Sun Microsystem gradually expanded their physical and intellectual assets globally in order to catch up the rising demand and the competitive advantages worldwide. In less than ten years, Sun Microsystem grew out from its base in Silicon Valley into a company with distribution, sales and support, R&D, manufacturing and servicing activities in more than 170 countries. The strongly decentralized field offices and workplaces, both globally and locally, reflect the current trend toward more diversified and decentralized strategies, as well as the convergence of various levels of complexities and orders in the global marketplace.

American organizational theorist Mary Hatch pointed out that the firms' new relationships with the markets demand "greater **flexibility** of organizations which are required to be customer-oriented, active internationally, and technically innovative." Moreover, higher levels of commitment to the economic performance of the firm are demanded of all organizational members, which would lead to more participative styles of organizing. 8 This is another indica-

tion of a transition from the labor-intensive working process in the factory system to knowledge intensive, service-focused working process.

This transition from the second phase to the third phase in Burns analysis has been widely interpreted as a transition from industrialism to post-industrialism. On the following page, a comparison of the key characteristics in the two phases is presented to illustrate the transitions. These transitions well constitute the historical backdrop for the analysis of the change in spatial distribution and organizational structures.

Comparison of Characteristics Associated with Industrialism and Post-Industrialism

	Industrial		Post-Industrial
	Environment		
*	nation states regulate, national economy	*	**global** competion
*	mass marketing	*	**de-concentration** of captial with respect to nation state
*	stardardization	*	**fragementation of markets and**
			international decentralization of production
*	the welfare state	*	**rise of consumer choice, demand for customized goods**
		*	**pluralism,** diversity, localism
	Technology		
*	mass production along Taylorist/Fordist lines	*	**flexible manufacturing, automation**
*	routine	*	**use of computer for design, production, and stock control**
*	manufacturing output	*	**just-in-time systems (JIT)**
		*	**emphasis on speed and innovation**
		*	**service/information output**
	Social structure		
*	bureaucratic	*	new organizational forms
			(networks, strategic alliances, virtual organization)
*	hierarchical with vertical communication	*	**flatter** hierachies with **horizental** communication and
			devolved managerial responsibility
*	specialization	*	**outsouring**
		*	**informal mechanisms of influence**
			(participation, culture, communication)
*	vertical and horizental integration	*	**vertial and horizental disintegration**
*	focused on control	*	**loose boundaries** between functions, units, organizations
	Culture		
*	celebrates stability, tradition, custom	*	**celebrates uncertainty, paradox, fashion**
*	organizational values:	*	organizational values:
	growth, efficiency,standardization, control		**quality, custumer service, diversity, innovation**
	Physical structure		
*	concentration in industrial towns and cities	*	**deconcentration** of people
*	local, nationalistic orientation	*	reduction in transporation time links distant spaces
			and encourages **international, global orientation**
*	time is linear	*	**compression of temporal dimension leads to simultaneity**
	Nature of Network		
*	routine	*	**frenetic, complex**
*	deskilled labor	*	**knowledge-based** skills
*	functional specialization of tasks	*	**cross** functional teamwork
		*	**greater emphasis on learning**
		*	**more outsourcing, subcontracting,**
	Fig. 5.2.		**self-employment, teleworking**
	Source:Organizational Theory, Mary Hatch		

5.2. Organizational change

> ABB is a company with no geographic center, no national ax to grind. We are a federation of national companies with a global coordination center. Are we a Swiss Company? Our Headquarters is in Zurich, but only 100 professionals work at headquarters and we will not increase that number. Are we a Swedish company? I'm the CEO, and I was born and educated in Sweden. But our headquarters is not in Sweden and only two of the eight members of our board of directors are Swedes. Perhaps we are an American company. We report our financial results in U.S. dollars and English is ABB's official language. We conduct all high-level meetings in English. My point is that ABB is none of those things—and all of these things. We are not homeless. We are a company with many homes.
>
> *–Percy Barnevik, CEO, Asea Brown Boveri*

The organic metaphor of organization suggests that an organization, like a living organism, is dependent upon its environment for the resources that supports its life. Instead of providing food and shelter, the environment provides raw material, knowledge, labor, capital and other resources that sustain an organization in a way similar to the biological process of an organism. [9] More importantly, the metaphor suggests the strong association with organism in the ideas of organic functioning and adaptation within the ecological system. Both organisms and organizations need to adapt to the external environment for survival and prosperity.

Intense economic activity in the global marketplace is one of the key exogenous forces shaping the external business environment for organizations today. In this situation, organizations need to implement necessary strategies to adapt constantly (like organism) to the rapid changes in the global environment (or ecosystem). As Robert Grant pointed out in *Contemporary Strategy Analysis*, these external changes had occurred through two major mechanisms: the growth of international trade, and the foreign direct investments by corporations. (Graphs in the first chapter indicated these changes. Fig.1.2 & 1.3). The growth of international trade has consistently outstripped the growth of world output, increasing export/sales and import/penetration ratios for almost all countries and all industries. [10] In the case of United States, the share of imports in sales of manufactured goods rose from less than 4 percent in 1960 to 22 percent in 1996. The international commercial exchange of services (transportation, communications, information, financial services etc) grew even faster than manufactured merchandise (at an annual rate of 13 percent of service exports vs. 7 percent merchandise exports in the mid 90s). Foreign direct investment as the other major mechanism shifted notably from products and

resource-based manufacturing to technology and knowledge-intensive manufacturing in the past four decades, amounting to $259 billion in 1995 from industrialized countries. [11] (Fig. 5.3.)

The international trade and the foreign direct investments triggered the process of capital relocation which further generated series of geographic dispersions of production sites and restructurings of organizations on an international level rather than domestic. As a result, local companies that used to be dominant in the domestic and national industries are increasingly open to international commercial exchange and become multinational corporations. Companies like ABB or SUN Microsystem evolved into internationally decentralized entities in a relatively short period of time. ABB has approximately 152,000 employees in more than 100 countries, and SUN Microsystem provides manufacturing, sales and services across production sites and field offices in over 170 countries.

Like organisms whose behaviors are based on the laws of survival in competitive settings, organizations maintain exchanges with the global business environment for their going concerns. The reasons for their increasingly decentralized resources and their global expansions are twofold: one is to exploit market opportunities worldwide; the other is to take advantage of local conditions to exploit production opportunities on the most efficient sites wherever possible. One of the major consequences in this globalization process of business is the creation of a complex network of international transactions comprising merchandise trade, flows of capital, flows of service and flows of people.

These exogenous conditions constitute the fundamental logic for global expansions. Additionally, the emerging technologies and transportation tools are maximizing the possibilities for geographic dispersal. Within those macro level forces, what are the micro level implications for the new organizational structures and forms? Can we visualize these transformations?

The comparisons of industrial and post-industrial conditions have inferred certain changes in the organizational structure: flexible, decentralized configurations, horizontal and cross-level integrations, new forms of central functions and fewer well-defined hierarchies and boundaries. The following hypotheses might highlight some of the most important changes and trends based on the organic metaphors:

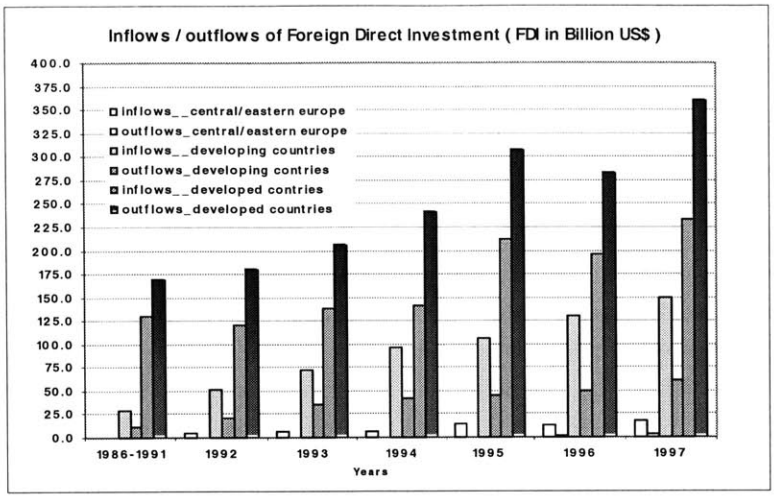


Fig. 5.3.
Comparison of real numbers of inflows and outflows of Foreign Direct Investment (FDI in billions US$) across developed countries, developing countries and central/eastern europe.
Source: Yan li, based on World Bank data from *Cities in a global economy*, Saskia Sassen.

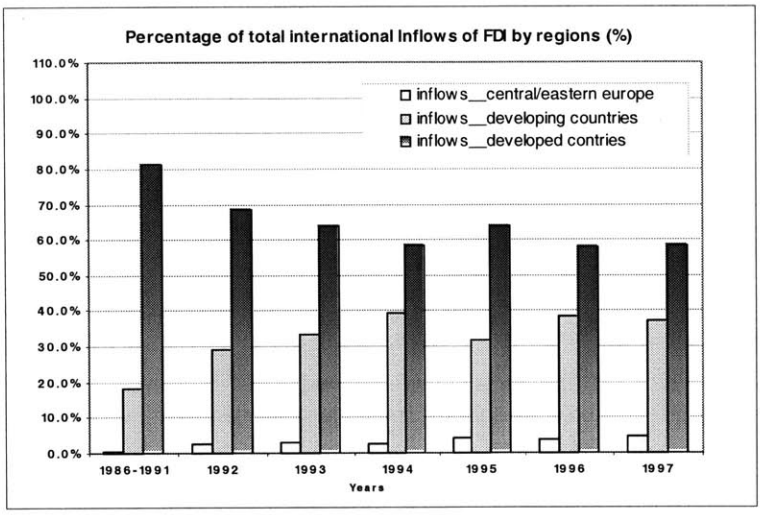


Fig. 5.4.
Comparison of percentage of inflows to total inflows of Foreign Direct Investment (FDI in billions US$) across developed countries, developing countries and central/eastern europe.
Source: Yan li, based on World Bank data from *Cities in a global economy*, Saskia Sassen.

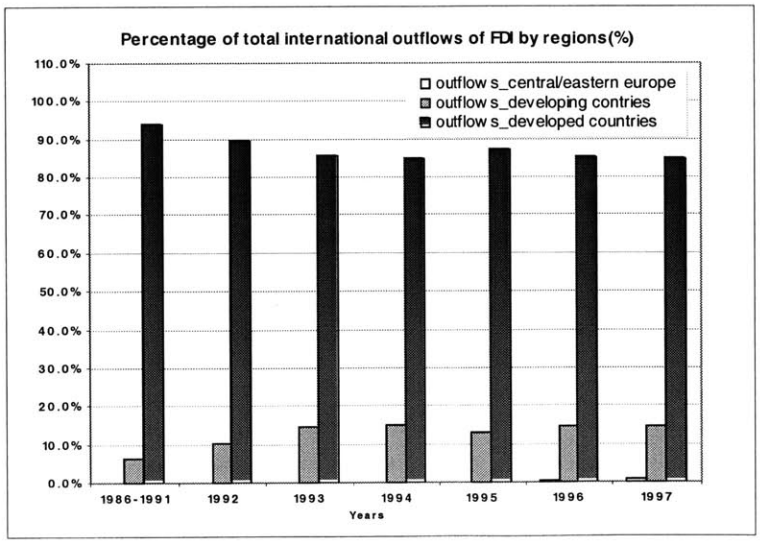


Fig. 5.5. (Below)
Comparison of percentage in outflows to total outflows of Foreign Direct Investment (FDI in billions US$) across developed countries, developing countries and central/eastern europe.
Source: Yan li, based on World Bank data from *Cities in a global economy*, Saskia Sassen.

1. *New forms of central function:*

The geographic dispersal of economic activities and the simultaneous integrations of such dispersed activities are the key components feeding the growth and importance of central corporate functions. 12 As firms increasingly reallocate their strategic assets and operations across different countries, the central functions of these geographically dispersed firms become more complex and strategic. New forms of centralities may encompass managing, coordinating, servicing and financing a firm's entire network of operations across many regions. Multinational companies like GE, Proctor and Gamble have complex central functions while maintaining a relatively flat and decentralized structure.

2. *Complex structure and outsourcing:*

As the central functions become more complex, the headquarters of global firms begin to outsource these functions to more specialized service firms. Functions such as accounting, legal, telecommunications, public relations are gradually flowing into the firms that have those strong specialties. The organizational structures of these global firms are no longer self-contained but open and interconnected with these sub-contracted specialized service firms which perform some of the functions that used to be completely operated under the roofs of the headquarters. The phenomena of decentralization in geographic locations, in central functions and in organizational structures are the reactive strategies of global firms toward the complex situations in the external environment. In contrast, at the beginning (the first phase) of industrialization, centralization and agglomeration of resources were the reactive strategies then toward external complexities. Those parallel and opposing situations in the history of industrial growth presented many self-similar or self-inverting processes across time.

3. *Flexible, decentralized configurations:*

The increasingly complex externalities and the accelerating global competitions have driven many headquarters to outsource rather than to perform certain functions in-house. The more a headquarter buys and sub-contracts certain important services to highly specialized firms, the less it needs to depend on the agglomeration economy and the freer it can choose its firm locations across geographic regions. In the case of ABB, only 100 professionals in its Zurich headquarter are conducting central commands which manage its business in over 100 countries. This by no means these people in Zurich are machine-like individuals who can process constantly every single piece of infor-

mation for its global field offices. On the contrary, it is a demonstration of its flexible downsized headquarter which outsourced and redistributed its functions and services to other companies or its own subsidiaries. The flexible, decentralized configuration enables its field offices and sub-centers to have the agility and adaptability to react to local changing conditions very quickly.

4. *An intertwining network:*

The complexity was revealed when we start to observe the interactions of organizations in the system. (Metaphors apply to similar situations of flocking vs. individual behaviors, while the flocking seldom considers other individual units as competitors as in the market situations, but rather as "strategic alliances".) Those specialized service firms engaged in the outsourced functions might themselves be multinational entities which also outsource some parts of their functions to other companies. This entails a complex global network of affiliates and strategic alliances or other forms of partnerships across different levels and industries. The speed, complexity and uncertainty involved in these markets with either the headquarters for which they are producing the services or the firms from which they are buying the services constitute a very sophisticated dynamic loop. Consequently, an intertwining network emerged with vast amount of cross-border transactions, serendipitous encounters, unforeseen exchanges of knowledge and information as well as unplanned mixes of talents and expertise from numerous global organizations. The traditional inward-looking, tree-like structure of an isolated organization (Fig. 5.6. and 5.7) does not serve as an accurate, complete representation of the current complexities in the global environment; alternatively, a rescaling view of this intense and dense network (a social fractal?) across macro and micro perspectives is quite essential to construct the new conceptual model.

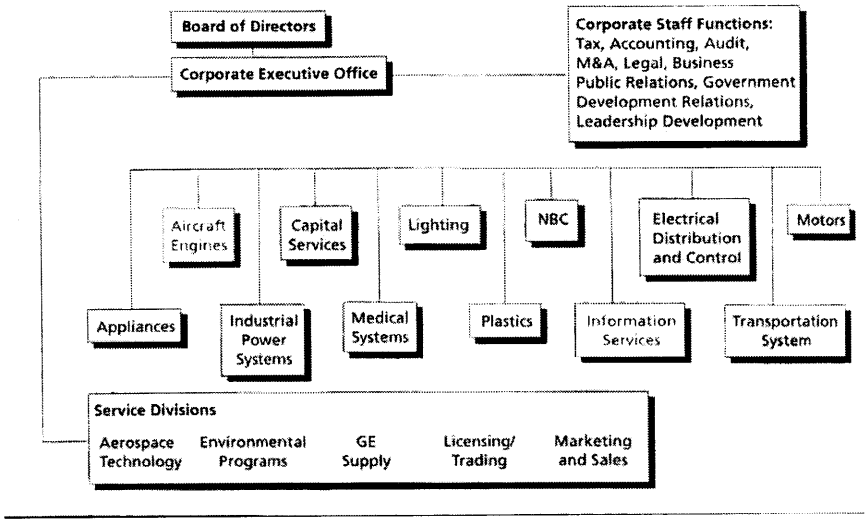


Fig. 5.6. General Eclectric Organizational Structure, 1995
Source: Comtemporary Strategy Analysis, Robert Grant.

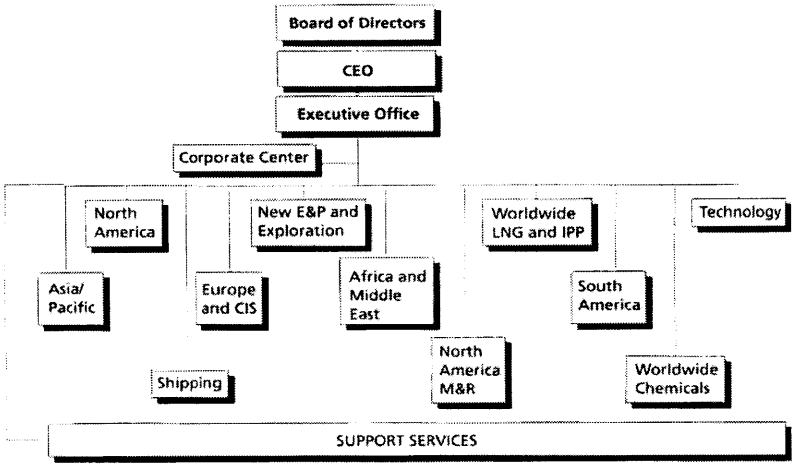


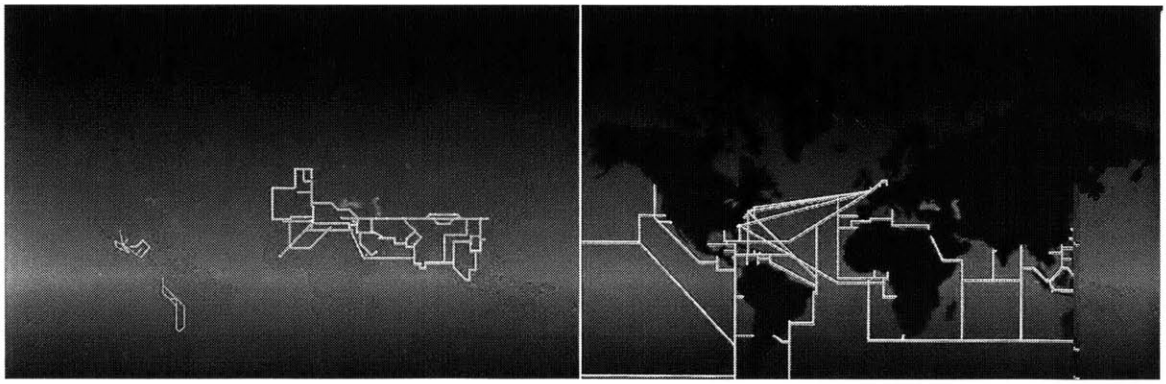
Fig. 5.7. Mobile Corporation Organizational Structure, 1997
Source: Comtemporary Strategy Analysis, Robert Grant.

5.3. Historical pattern and spatial distribution

The attempt to conceptualize the complexities inherent in the global economies via visual means brought to the departure of this thesis. The complexities involved are much due to the fact that these activities are taking place in a dynamic, organic system. The organic metaphors of organization, revealed not only the similarities between organism and organization in terms of functioning and exchanging with the environment, but most importantly, the metaphors revealed the adaptability as the key component for long-term survival and prosperity that connects organism and organization in a coherent mapping.

Much of the effort in visualizing adaptation and organic behavior has taken place in the field of artificial life and media sciences. Seldom have we seen successful examples to replicate the economic behaviors of organizations in the digital visualization process because of its level of complexity. As mentioned above, how does one headquarter outsource its services to other firms and how do these firms reconnect to other entities in different industries or regions, and how all of these interactions affect an organization, an industry, or their distributions? In the following studies, I tend to use the examples as recommendations in the exploration of these situations instead of providing a solid, complete solution. The purpose of these experiments is to go back to the historical pattern and spatial distribution of workplace, employment, organizations or communities as a metaphorical understanding of the complexities.

To recapture the geography of places involved in globalization allows us to recapture people, workers, communities, and more specifically, the changing workplaces and the interactions among organizations which have embedded all along in the network of complexity.



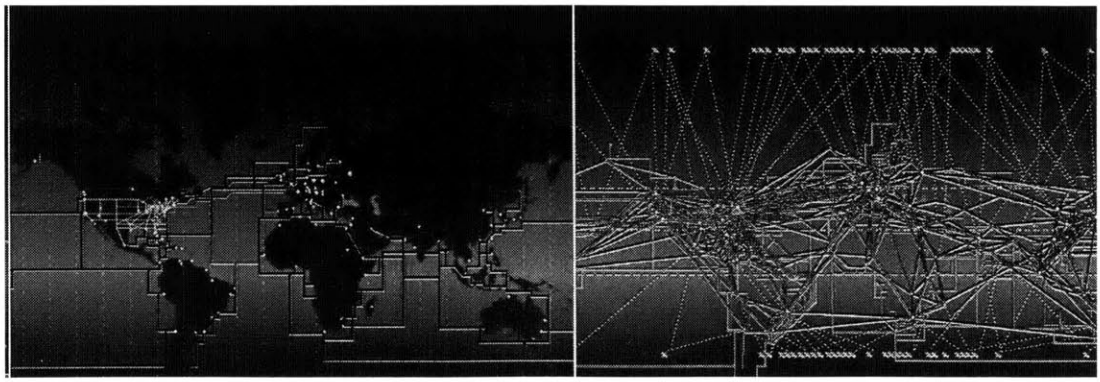
1. From Silk Road to interconnected Global City
2. Comparison of global regions (6)
3. Development of Boston metropolitan area
4. National Geographic: Map machine : Employment / Population
5. Development in the northeastern corridor
6. Internet mapping
7. Organization "is not a tree"

5.3.1. From Silk Road to interconnected global city

People in the history of civilization have succeeded in reaching out to distant places, discovering mysteries in faraway locations and building up new territories and new vehicles to reconnect these remote sites. Cities, as the culminations of this process, have succeeded in linking themselves together throughout the ages. The visual representation below replays this record of linkage – an intensification of connectivity from the Silk Raod, the Age of Sail, the Age of steam, to our age of oil, autos, air, satellites and telecommunications. We have continuously devised new tools to solve "the old problem in the new environment" – reconnecting to the remote places, which has brought us into an age of interconnected global city.

Interestingly, the fundamental logics in this development pattern: growth, mobility and connectivity, are replications of the logic of many kinds of organisms striving for survival and prosperity as groups in the natural environment. The interconnected oneness of global city today might be another self representation of the logic in the interconnected oneness of human, other creatures and the environment.

Fig. 5.8. Connectivity in the Age of Silk Road, the Age of Sail, the Age of Steam and our current age of autos, air, sattellites and telecommunications. *Source:* Architectural Recond. March, 2002.



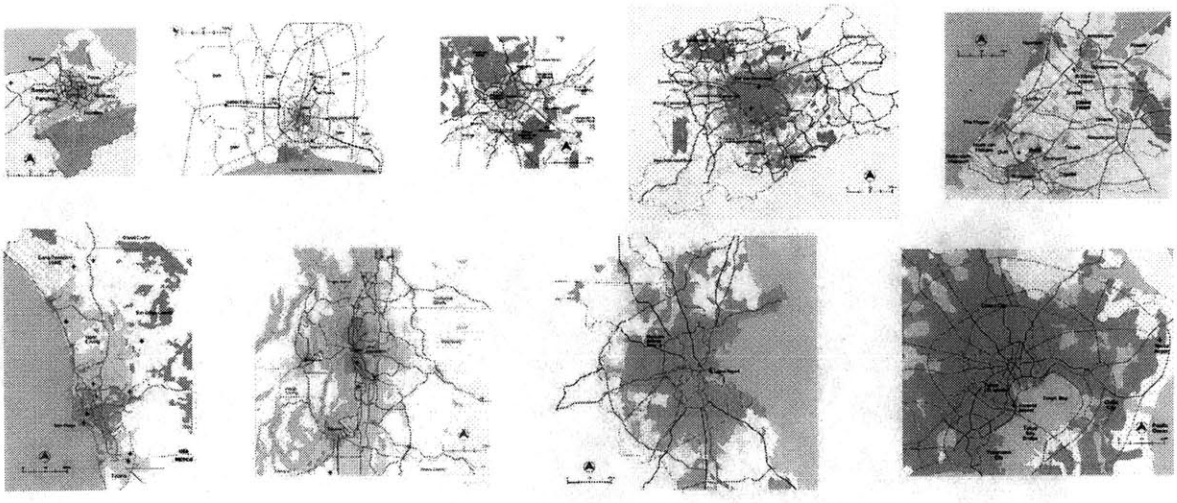
5.3.2. Comparison of global city regions

A recent study of "global city regions" conducted by Gary Hack and other renowned planners is presented here (*Global City Regions: Their Emerging Forms*). I included nine of them, the city regions of Bangkok, Taipei, Madrid, Sao Paulo, Randstad, San Diego, Seattle, Boston, and Tokyo. (See Fig.5.9.). They are in the same scale.

The definition of spatial extent in this study is closely linked to economic activities rather than jurisdictional definition of the settlement. Clearly, similar pattern of spatial dispersal along with the growth and strong centrality of the region can be found in each of the nine cases. Globalization has enabled capital to flow more freely into new locations around central cities and has become one of the key factors leading to the current urban and regional forms.

In these examples, central city governments have relatively limited capacity in controlling the condition driven by economic activities that go beyond city lines. The new anchors of regional developments –airports, new universities and associated science parks, recreational theme parks, wholesale marketing areas, and even new office and financial centers – are quite often located on the urbanizing fridge. 13 The regions are gradually growing into giant sprawling conurbations. More detailed examples of Boston region and northeastern economic corridor in the United States will be analyzed in the next two sections 5.3.3. & 5.3.4. The distributions of employment and workplace will surely

Fig. 5.9.
Comparison of urban forms of current global city regions. Upper row: Taipei, Bangkok, Madrid, Sao Paulo, Randstad
Source: Global city regions, their emerging forms. Lower row: San Diego, Seatle, Boston, and Tokyo.



have strong overlaps and exhibit similar patterns of human occupations driven by economic activities and inhabitation.

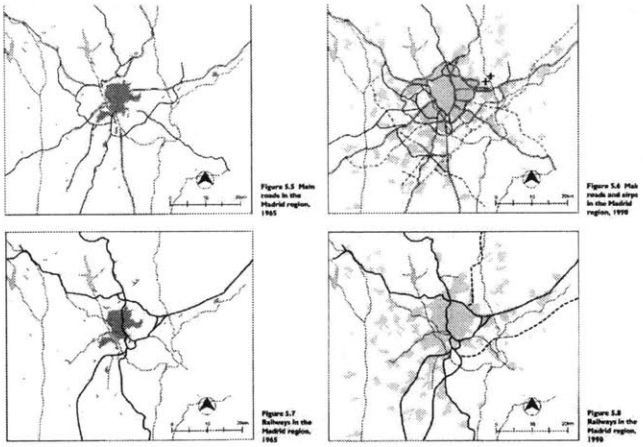


Fig. 5.10.
The conditions of main roads and railways in Madrid, 1965 and 1990.
Upper: comparison of main roads. '65-'90.
Lower: comparion of railways. '65-'90.
Source: Global city regions, their emerging forms.

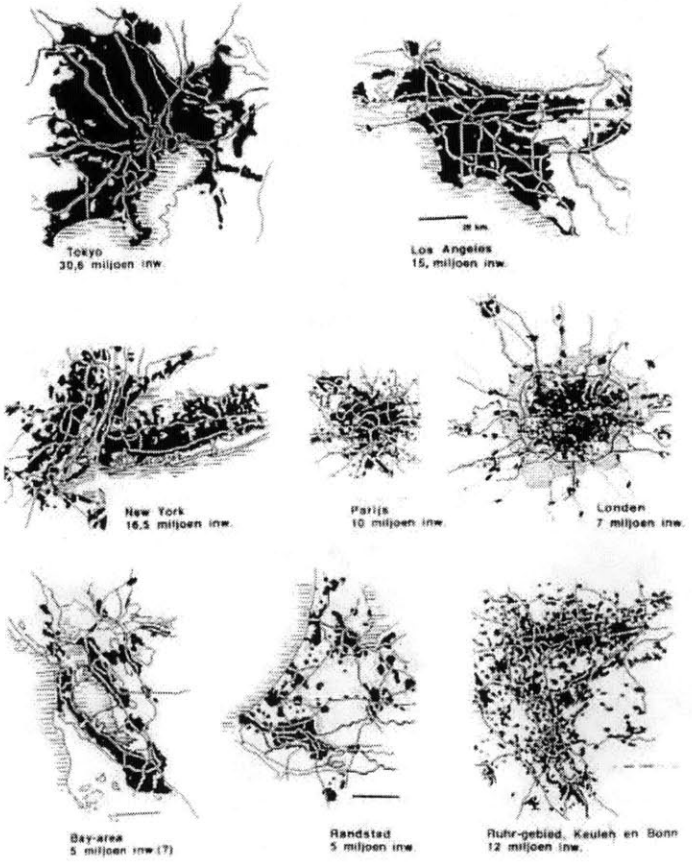
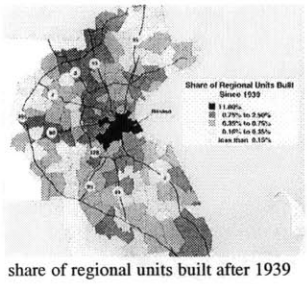


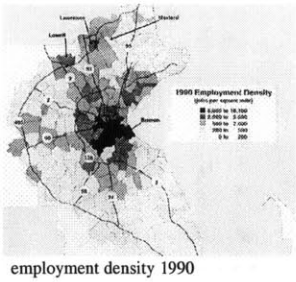
Fig. 5.11.
Comparison of emerging urban forms in other global city regions.
Tokyo, Los Angeles,
New York, Paris, London,
Bay area, Randstad, Bornn.
Source: Global city regions, their emerging forms.

5.3.3. Development of Boston Metropolitan Area

Historically, the spatial concentrations of commercial, industrial, or retail tended to be in a single central location. The traditional explanations of the central market and transportation dependence of production as well as the agglomeration economy have successfully interpreted the phenomenon. However, in the past several decades, we observed this strong trend toward decentralization of the above functions that used to concentrate in central cities. Part of the reason behind this phenomenon was because of the large demand of land by many different kinds of productions, especially manufacturing, has pushed those productions to fringe locations where land is cheaper. The advancement of transportation and technology have further enabled easy access to highway systems and other kinds of infrastructure, thus, reducing the dependence of physical proximities to central locations, to clients, customers and other market players.

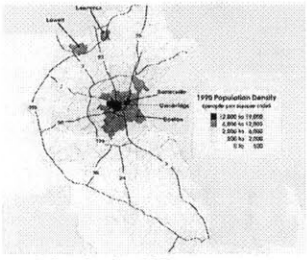


share of regional units built after 1939

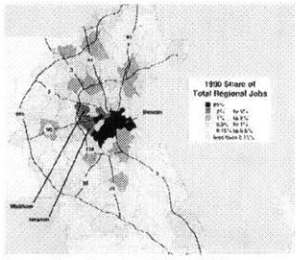


employment density 1990

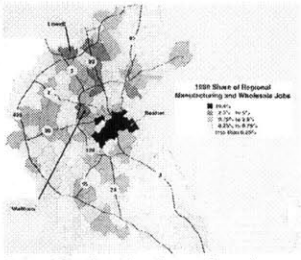
Fig. 5.12.



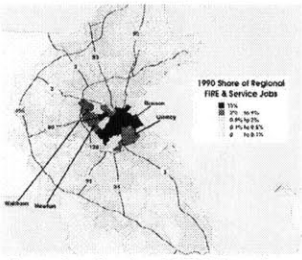
population density 1990



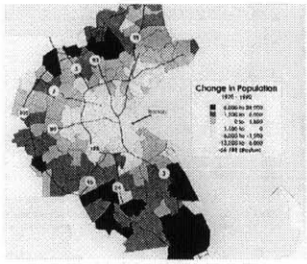
share of total regional jobs 1990



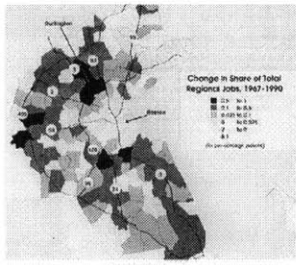
share of total regional manufacturing and wholesale jobs 1990



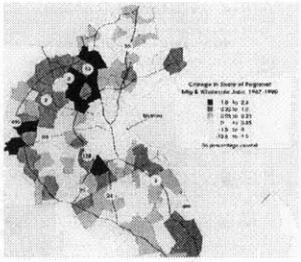
share of total regional FIRE & services jobs 1990



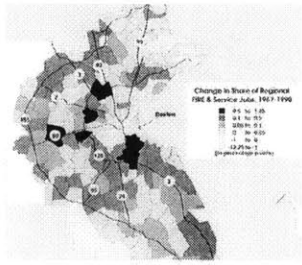
change in population density 1967-1990



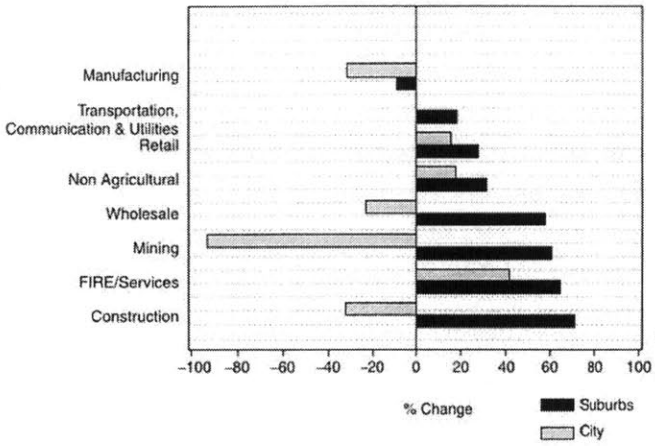
change in share of total regional jobs 1967-1990



change in share of total regional manufacturing & wholesale jobs 1967-1990



change in share of total regional FIRE & services jobs 1967-1990



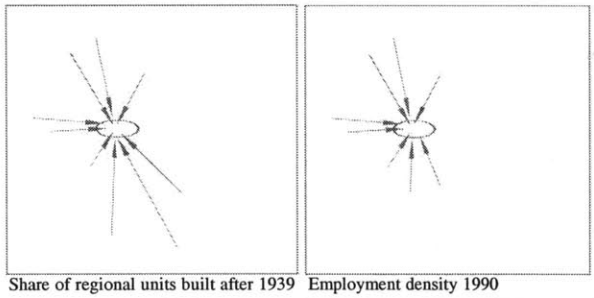
Boston area employment change, by industry sector, 1980–90.

Fig. 5.13.

Fig. 5.12. (Facing page)
Comparison of physical patterns and spatial distributions in Boston Metropolitan Region. Upper two rows are based on information in 1990. The lower row is based on the changes from 1967 to 1990. Clear indications of decentralizations are shown in population, overall employment, share of regional jobs in different sectors.
Source: Urban Economics and Real estate Market, Wheaton and DiPasquale.

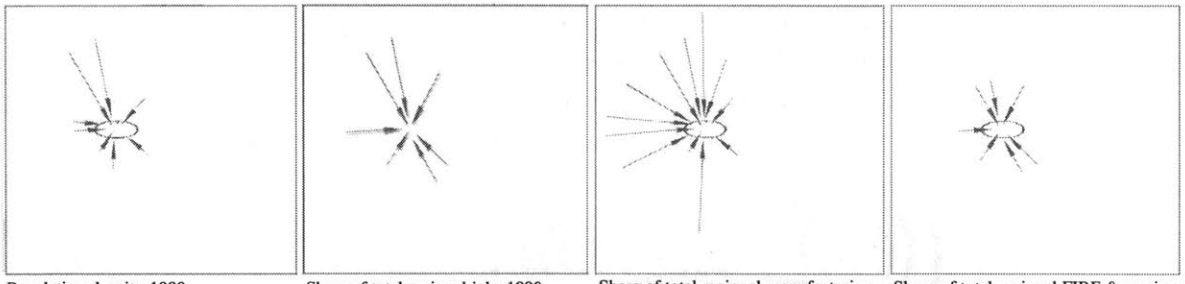
Fig. 5.13. (Left, this page)
Diagram showing Boston Area employment change by industry sector.
1980-1990.
Source: Torto and Wheaton (1994).

Fig. 5.14. (Below)
Visualization of the phenomena of centrality and decentralization exhibited in the diagrams on the left. Arrows are pointing higer numbers or densities.
Source: Yan Li

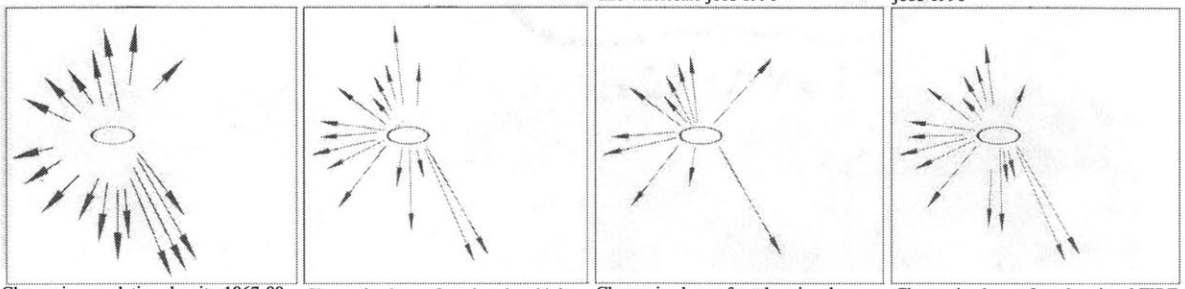


Share of regional units built after 1939 | Employment density 1990

Fig. 5.14.



Population density 1990 | Share of total regional jobs 1990 | Share of total regional manufacturing and wholesale jobs 1990 | Share of total regional FIRE & services jobs 1990

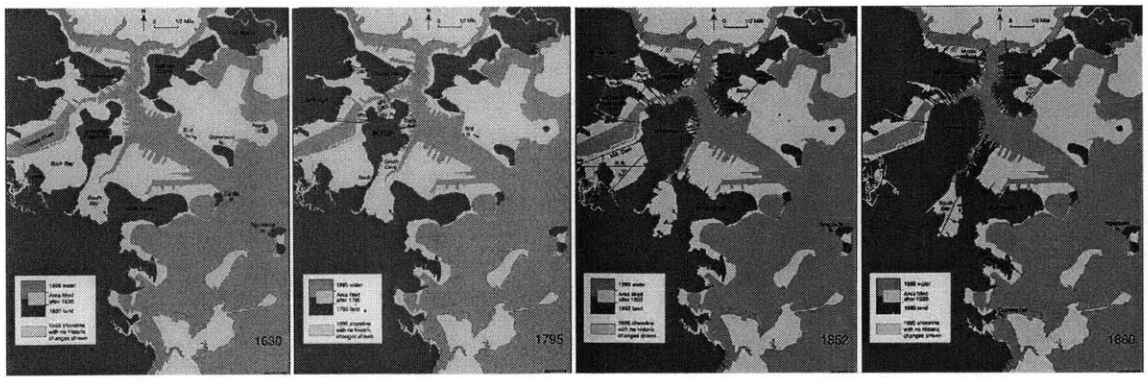


Change in population density 1967-90 | Change in share of total regional jobs 1967-1990 | Change in share of total regional manufacturing & wholesale jobs 1967-1990 | Change in share of total regional FIRE & services jobs 1967-1990

All these facts have constituted the reason for a very important change--the decentralization of labor. Workplaces as the physical and virtual providers of the working environment closely follow the dispersed patterns of firms and employment; thus, dissolve into the multi-centered city regions.

In the case of Boston, (images in previous pages) the population and employment density, the share of total regional jobs in 1990 were still high in the central city area. While the share of regional units (built after 1939) and the employment density exhibited prominent growth in suburban areas. When compared to the situation in 1960, the trend was clearly indicated in the two graphs at the lower left corner. The change in population density has manifested the suburbanization of residential units, at the same time, a strong aggregation effect at the nodes or intersections of the highway system. (Fig. 5.15) In this diagram, I used circles to represent the important strategic nodes in the Boston Metropolitan region. These nodes have become the new centers of its surrounding areas. This demonstrates that the forces used to shape the central cities are now influencing the formation of these nodes to further connect other similar nodes to develop into a multi-centered metropolitan region.

The phenomenon of decentralization has differences across industry sectors. Fig. 5.12 shows a statistic of suburbanization of various industries between 80s and 90s. Manufacturing, wholesale, mining and construction sectors have decreased dramatically of their appearances in central city areas, and moving considerably into suburbs. The decrease of manufacturing in suburbs of Boston might be the consequence of shifts in industrial structures, a transition from labor, product intensive industry to technology and knowledge based industries. This is well proved by the changes in other sectors, especially FIRE



services and non-agricultural industries with prominent increase in both central city and suburban areas. In the two graphs at the lower right corner among the distribution maps, the change in total regional jobs in both manufacturing and FIRE & services have decentralized into suburbs. There was a simultaneous concentration in central city as well as in the strategic nodes that scattered around highway intersections across the region.

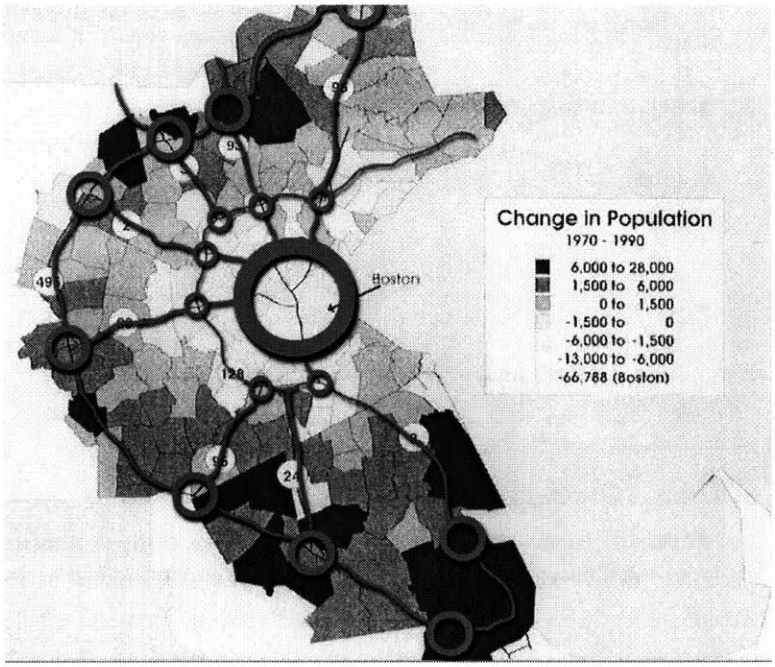
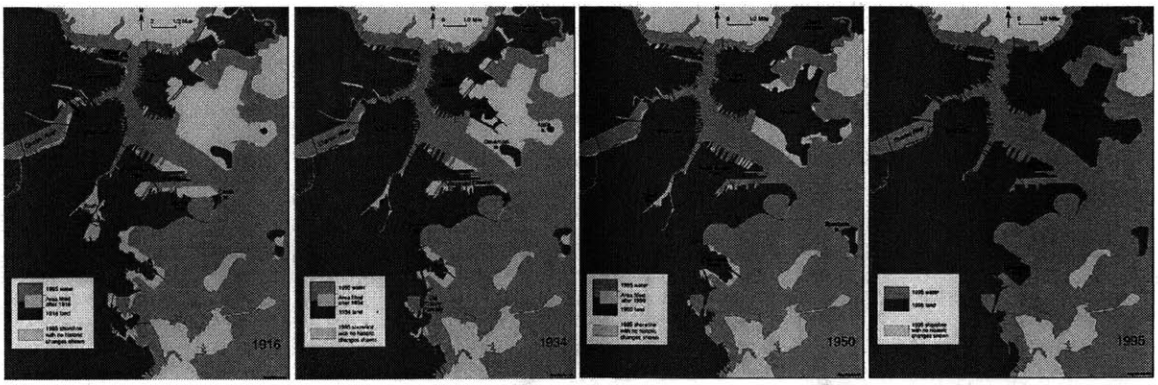


Fig. 5.15. (Right)
Diagrams indicate that the important strategic nodes at the intersections of highway system have formed new subcenters in the surburban area in the Boston Metropolitan region. These strategic nodes generate a network of uprising satellite centers with high concentrations of population and employment (similar forces that used to shape the central cities.)
Source: Yan Li.
Based on map of 'change in population' in *Urban Economics and Real Estate Market,* Wheaton and DiPasquale.

Fig. 5.16. (Below)
The change of shoreline and occupation of land from 1630 to 1995, a stroy of growth and expansion.
Source: Mapping Boston.



5.3.4. National Geographic: Mapmachine

National Geographic's Mapmachine (www.nationalgeographic.com/mapmachine) is an interactive visualization tool of maps based on a vast GIS database on a series of themes, such as political, cultural, economic, physical and natural environment. If a user wants to examine a specific country or a region—say the United States, Midwest, for example—they can zoom in or type in a state and then click to see earthquake information, tornado patterns, transportation density, political boundaries, ecological regions, land-use zones and other geographic information. 14 Users can have access to the database through a small window representing the focus of observation on a specific location of the global map.

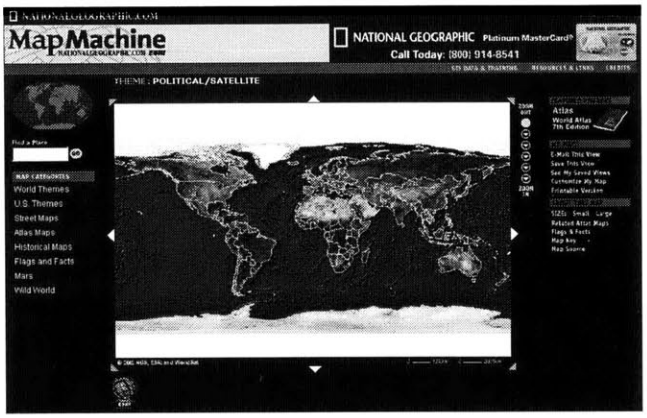
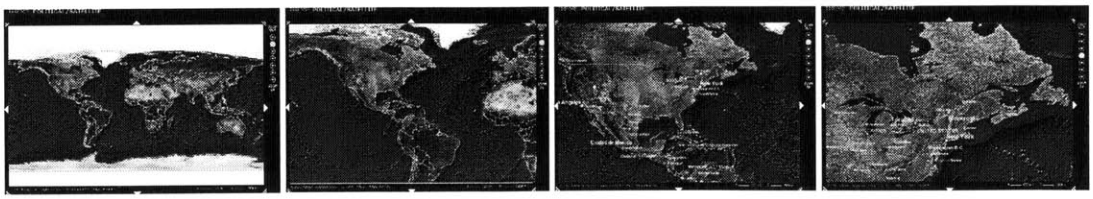


Fig. 5.17. (Above) National Geographic's Mapmachine website. *Source*: www.nationalgeographic.com/mapmachine

The interaction between the user and the content within the window, as well as the interaction between the user and the context beyond the window raise the interesting question of visualizing large amount of information on a small area. As you keep on zooming in and out of global and local scales, you constantly shift your perspectives and reposition yourself in a conceptual dimension that is beyond what the window can define at a specific moment, though this dimension is usually captured by the arrow key on the right of the interface, representing your position in that lost dimension. (An interesting experiment of dynamic mapping can be found in Axel Killian's thesis project in map navigation of loose typology).

Fig. 5.18. (Below) Mapmachine's visulization. Zoom-in views of the world, satellite images with political divisions. Source: National Geographic.



Another point raised by observing this large database of maps is how the global and local level of information is consumed by the user. The quantitative detail is usually well understood at the very local level, but extremely difficult to consume when large amount of similar details are presented together on a global level. The human brain's visual function resolves this problem by understanding it in a more impressionistic way instead of a rigorous way of absorbing all details at one time. In Bertin's *Semiology of Graphics*, (Fig. 5.19 below) the cartography of social information of France is provided in two ways. The rigorous way on the left juxtaposed the detail number of each subdivision, while on the right, the impressionistic way of representing numbers through changing densities in a pattern of dots with corresponding diameters. The impressionistic way conveying characteristics of the overall settings of the data is immediately readable through its overall qualitative quality. Of course, the impressionistic way gave less accurate information when you zoom into the local level. It makes more sense to use the dots in a global scale based on the coherent relationships and similar forms of the dots. And this method tells a more discernable story when the connections and comparisons among the local level information are explicit.

Fig. 5.19. (2 images on left) Comparison of two kinds of visulization in mapping social information in France. Left: rigorous way with detailed local information by numbers. Right: Impressionistic way with qualitative characteristics of the region by changing densities of the dots, or dipicting their major differences. Source: Bertin's Semiology of Graphics.

Fig. 5.20. (Image far right) Color patches representing population density in Virginia and North Carolina. The density is expressed by the levels of shades in which darker areas are densely populated. Source: Mapmachine. National Geographic.

In the case of Mapmachine, the detail level of information is interpreted through the color and level of shades—another pictorial metaphor when we start to conceptualize density and intensity (fig. 5.20.). Population densities and income levels are well described in such an impressionistic way so that we lose the accuracy in the local scale in exchange for the ability to consume the pattern in the global scale.

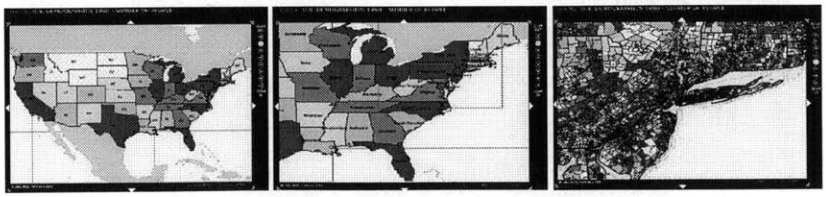
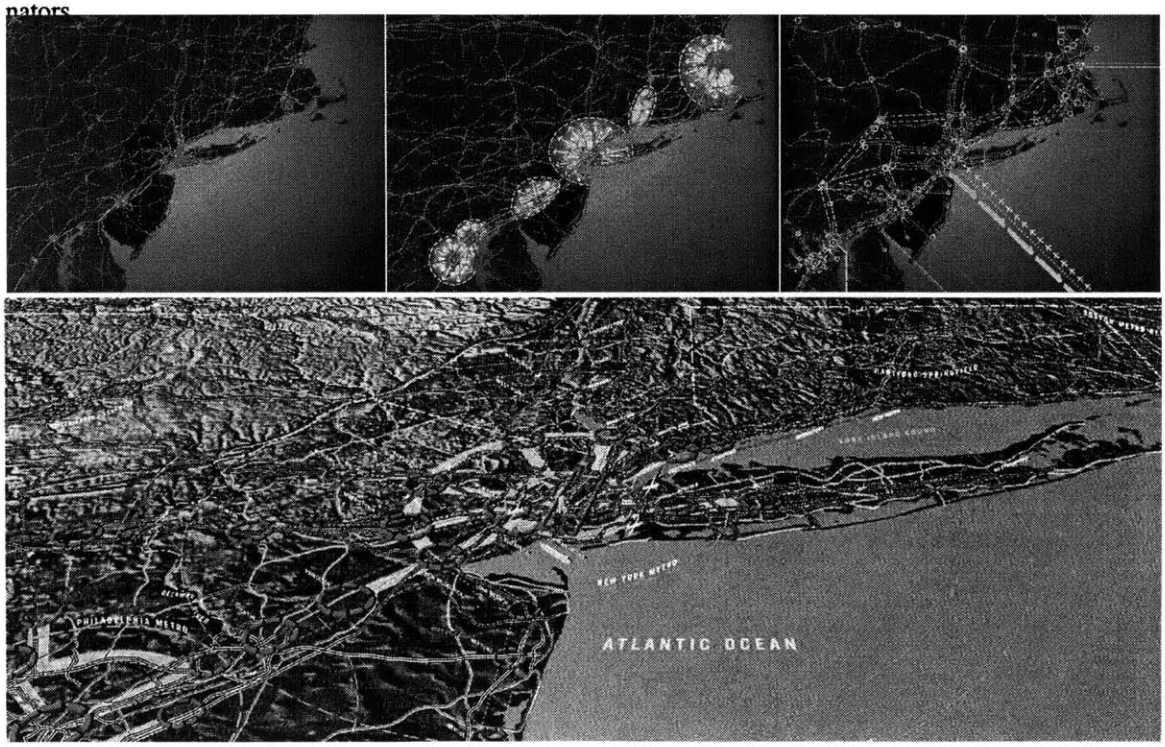


Fig. 5.21. (Below) Population density of North America, and northeastern states. Constant zomming in with different scales. Source: Mapmachine, National Geographic, US population 1990.

5.3.5. Northeastern Corridor

The economic activities and the cross-city, cross-state flows of information, capital, goods and people have led to enormous growth in the northeastern region of the United States. From Washington DC, Philadelphia, New York city, Hartford to Boston metro, the expansion of the territories of these city regions has created numerous sub-centers and satellite cities and towns around these metro areas. These sub-centers have similar growth patterns that used to be dominant in the central cities, generating new central effects in their surrounding regions. The decentralized or dispersed sub-centers have further linked each other to form a giant interconnected conurbation based on the lattice of existing transportation systems and infrastructures.

In a study of New Jersey by Michael Gallis & Associates, the distribution activities that once took place within a few blocks or a few miles of the vast Elizabeth containership docks now occur as far away as Harrisburg, Pennsylvania –160 miles west. 15 The growth patterns bringing upon land-use conflicts and enormous increase in local and state traffic were important consequences of changes in port activities and retail-distributions beyond the limits of city and state governments. This constitutes the correspondence with dynamic pack behaviors in the adaptation metaphor from nature --emergence -- the complex system behaviors beyond local units and without central coordinators



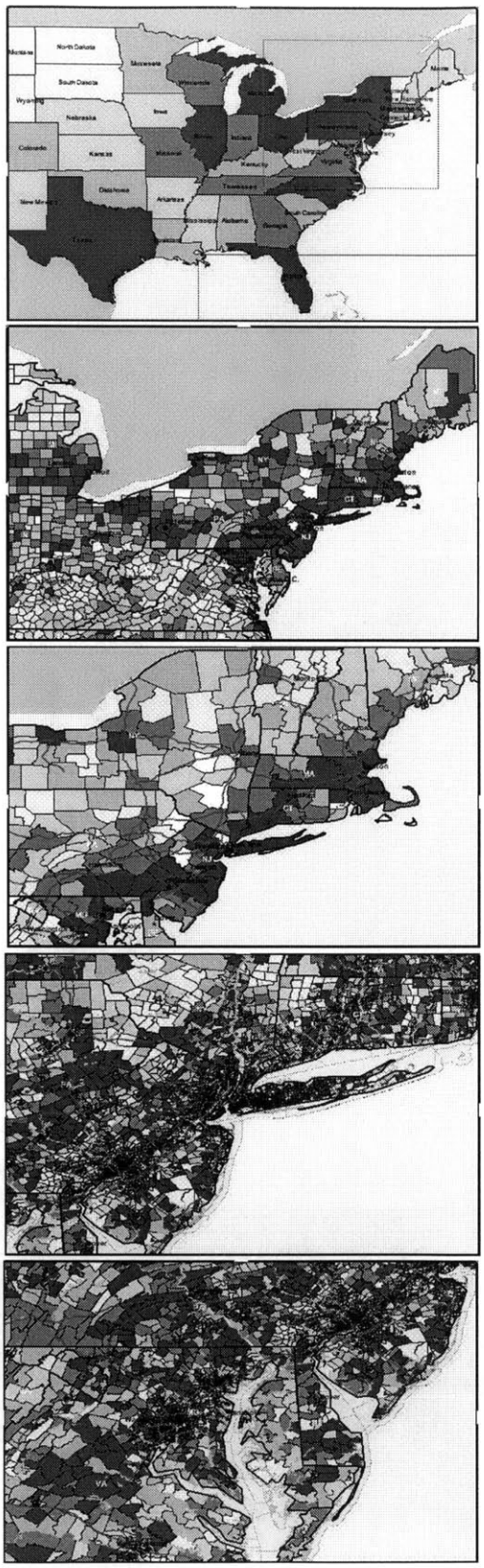


Fig. 5.22. (Images on facing page). Diagrams analyzing the growth of the northeastern cities. The existing transportation systems, especially the highway system, have transformed the cities in the northeastern region in the US into a complex networked conurbation.
Source: Architectural Record. March, 2002.

Fig. 5.23. (Images on this page). GIS data on population densities in the northeastern region in different scales. Strong urban concentrations appear in major cities and their surrounding regions.
Source: National Geographic, Mapmachine, US population, 1990.

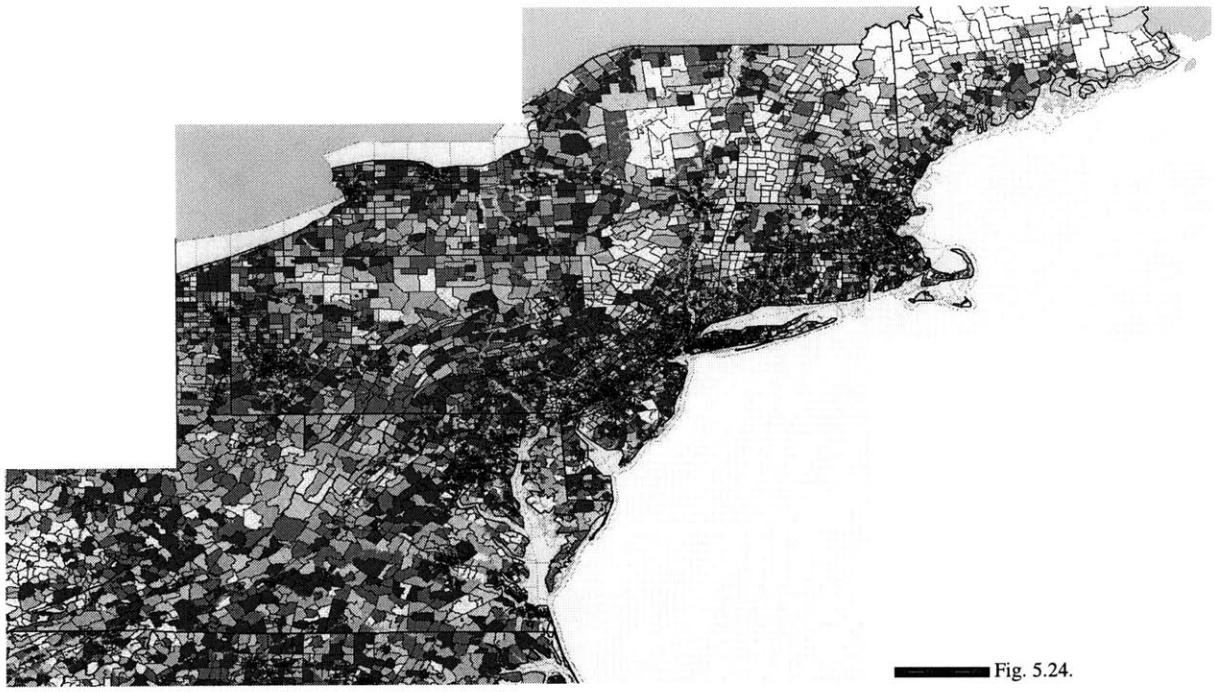


Fig. 5.24.

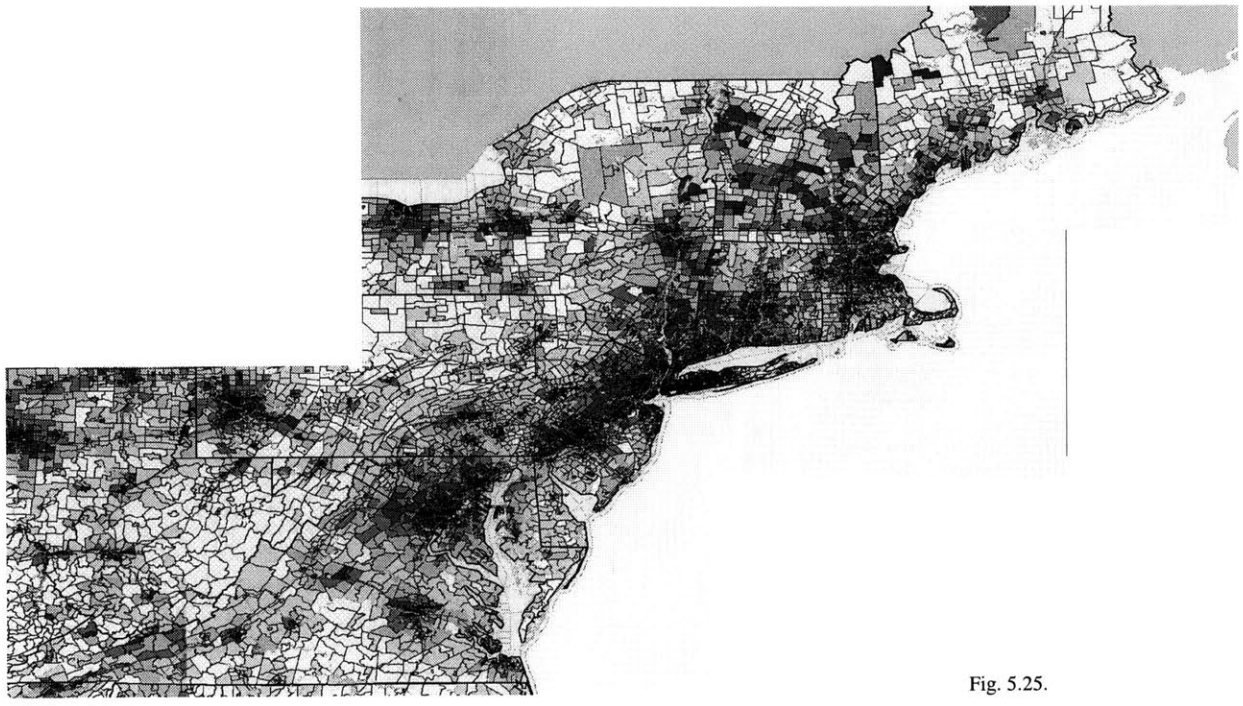


Fig. 5.25.

Fig. 5.24. & Fig. 5.25. (Facing page).
Upper:
GIS data on population densities in the northeastern region. Strong urban concentrations (darker areas) appear in major cities and their surrounding regions.
Lower:
GIS data on income per capita in the same region.
Source: National Geographic, Mapmachine, US themes in population , employment and income, 1990.

Fig. 5.26. (Image on this page).
GIS data of percentage of regional pepople working in the FIRE and services sector in the northeastern corridor. Strong centralities are obvious.
Source: National Geographic, Mapmachine, US employment, 1990.

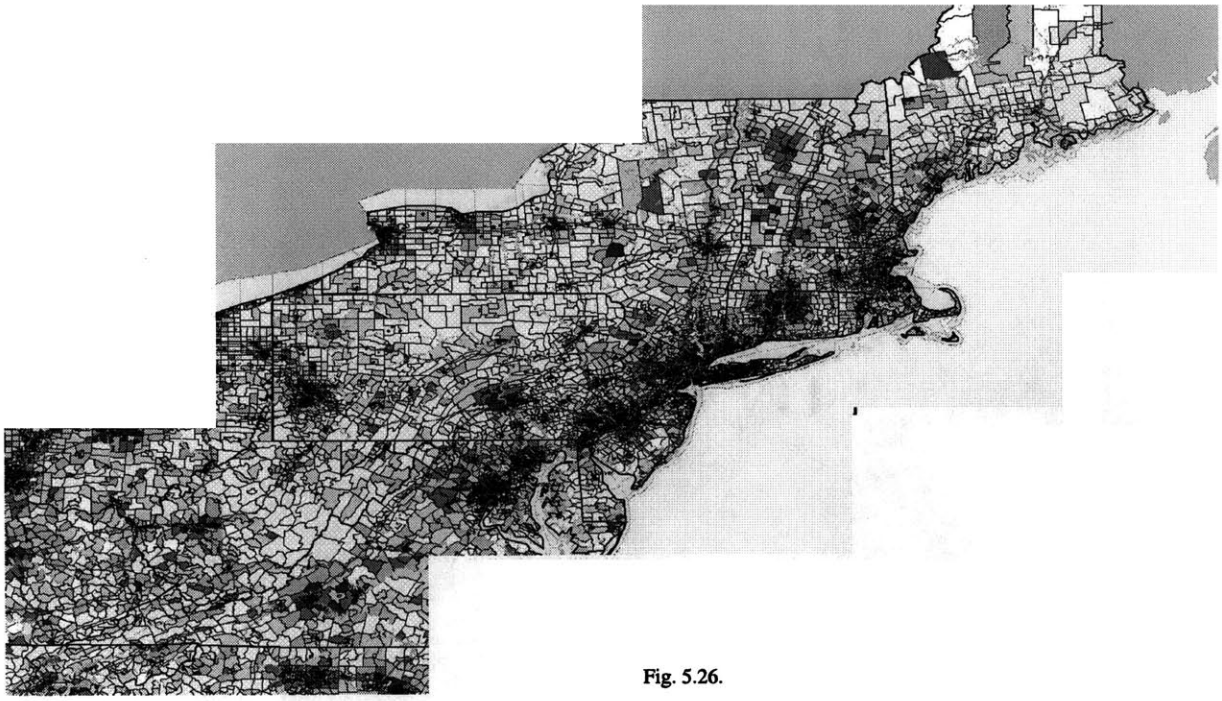


Fig. 5.26.

5.3.6. Mapping Internet

The previous mappings have mainly focused on tangible changes around us, i.e., the built mass, population density or employment pattern to reflect possible factors that have reshaped the distribution of workplace. The following texts intend to analyze some of the less tangible factors, the internet, virtual connection, organizational structure and the dynamic relationship among human interactions.

The images on this page and the facing page are maps from Telegeography. They are representations of the increased internet connectivity across geographic locations. The intensified encounters on a global scale through the use of internet have further propelled the convergence of the diversities from different cultures and regions. For global organizations, this transition has various important implications. How do companies re-allocate their resources and implement strategies to fully exploit its advantage? How do companies reconnect its branches and field offices, reconnect its clients and customers, restrucure its internal architecture, so on and so forth?

A mapping study of the structure of the internet seems to be quite necessary and critical for us to understand the connectivity patterns that go beyond the conventional physical infrastructure, as well as to understand the internal mechanisms governing the growth and consumption of dynamic information input.

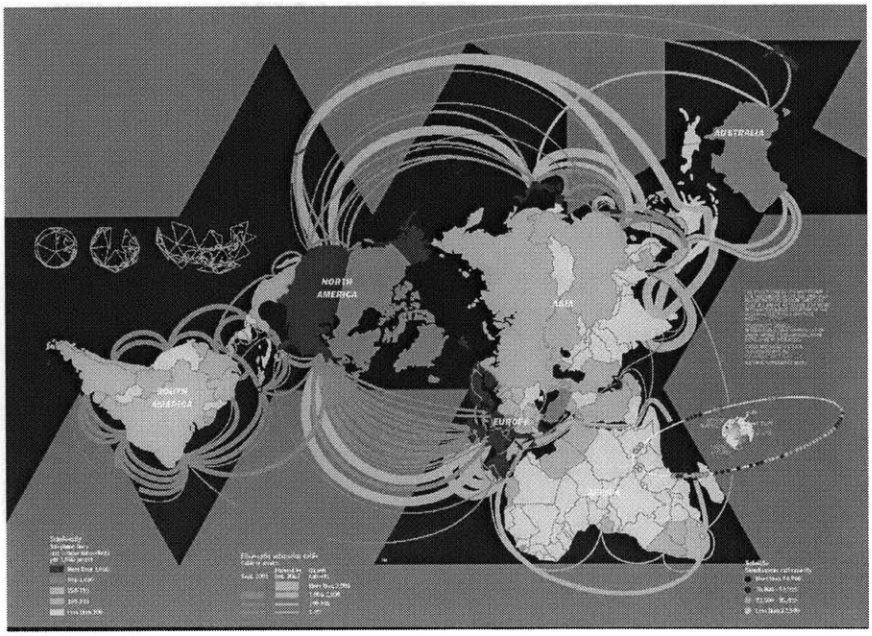


Fig. 5.27.

Burch and Cheswick at Bell lab developed a strategy to map the major central routers (gateways to thousands of other machines. Fig. 5.35.) They designed the messages that could "die" as they reached the destination points and sent

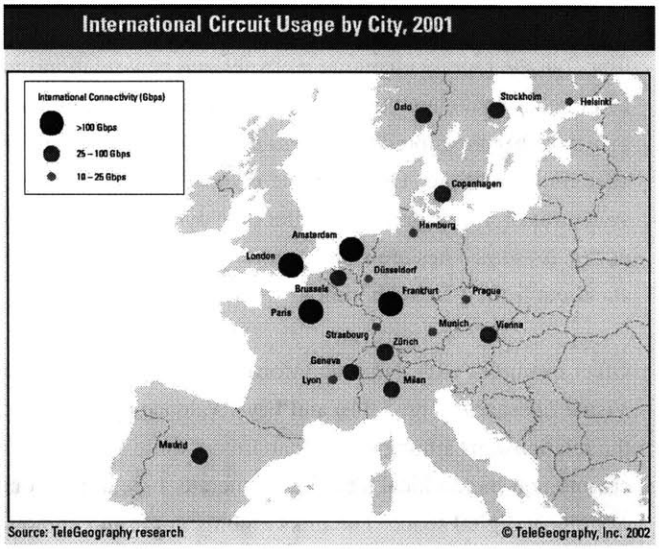


Fig. 5.28.

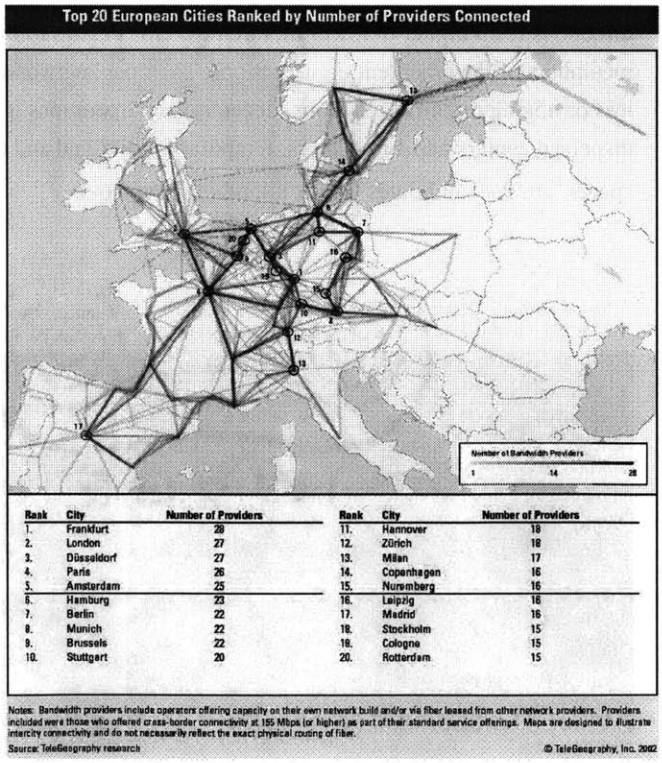


Fig. 5.29.

Fig. 5.27. (Facing page). Teledensity. Telephone lines and fiber-optic cables on Fuller's Dymaxion map.
Source: telegeography, 2002.

Fig. 5.28. (Upper right). International circuit usage by cities in Europe, 2001.
Source: telegeography, 2002.

Fig. 5.29. (Lower right). Top 20 European cities ranked by number of bandwith providers connected.
Source: telegeography, 2002.

back death notices to the tracers. The map shows the interconnectivity, while Tamara Munzner and her colleagues at Standford University continued the quest and found the cities in which these central routers are physically located then created an interactive map showing the geography.

Even though the map successfully showed the tree structure of connectivity and the overall fractal geometry of internet routes, it had several shortcomings. One of them was that it only represented the situation in certain point of time, but the rapidly changing websites and new relationships among the sub-level nodes challenge the accuracy of the map. To improve this, other strategies have been explored to process dynamic information input to reflect these changing conditions. One example is *Ben Fry's Anemone* to track the changing structures of a website which reflect the dynamic traffic patterns across all nodes. As some sites are visited more often, they start to grow thicker and stand out from its neighborhood.

Other examples with dynamic information input, such as Plumbdesign's Visual Thesaurus (fig. 5.34.) and Fry's Valence (Fig. 5.31 – 5.33) are showing the relationships among nodes that are not quite like trees. The less-hierarchical and non-hierarchical situations generate three dimensional juxtapositions of units in digital space. The links among words and phrases are indications of sequences, frequencies, meanings, correspondences rather than the flows of directions from higher to lower hierarchies. This creates foundations for metaphors of the emergent organizations. The open, networked relationships, less or non hierarchical positions, decentralized operations, geographically dispersed centers and sub-centers, temporary individual and team work spaces, are the candidates for such kind of metaphors.

Fig. 5.30.
Valence, reading "Innocents of Abroad", a book of Mark Twain. *Source*: Ben Fry. http://acg.media.mit.edu/people/

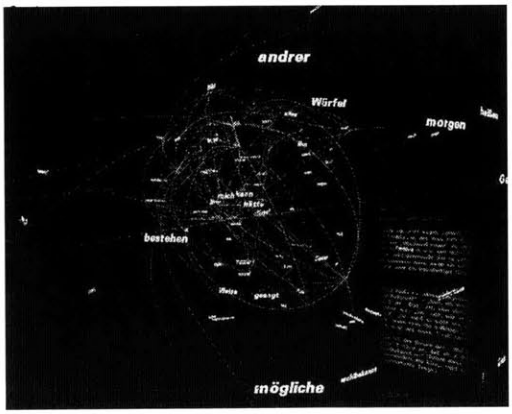
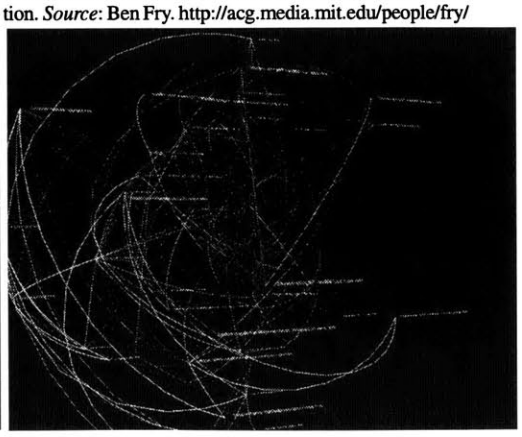


Fig. 5.31.
Valence, visualization of interconnected organic information. *Source*: Ben Fry. http://acg.media.mit.edu/people/fry/



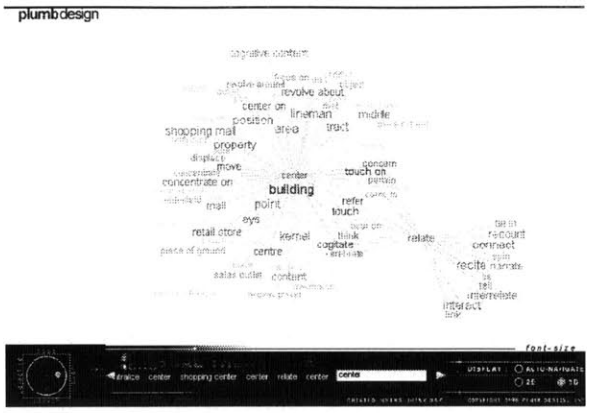


Fig. 5.34.
Plumbdesign's thinkmap, Visual Thesaurus.
Source: Plumbdesgin.

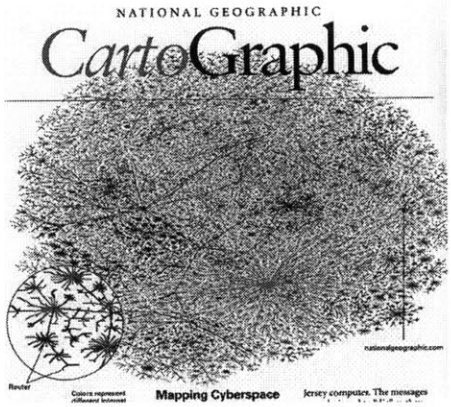


Fig. 5.35.
Mapping internet. Burch and Cheswick' map at Bell Lab.
Source: National Geographic, 2000.

Fig. 5.32.
Valence, visualization of dynamic input from organic information. *Source*: Ben Fry. Same as left.

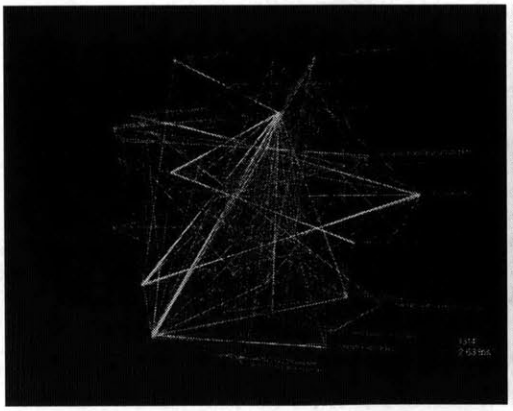
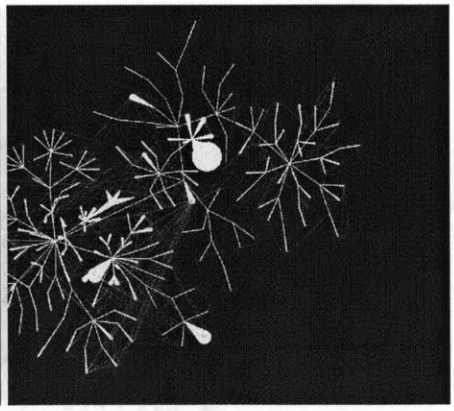


Fig. 5.33.
Anemone, a visual representation capturing the dynamic structure of website. *Source*: Ben Fry.



5.3.7. Organizational Structure

The traditional views of organizational structure usually refer to the tree-like diagrams with different job functions or geographic locations , along with a much centered position of the firm itself in the larger external environment. (Fig. 5.36 & Fig. 5.39) Though not every firm fits in these categories, most managers tend to think in these ways. These diagrams and structures may well interpret the hierarchical relationships in certain extent, but when comes to the complex changing global networks of relationships, they are usually less effective or even useless, especially in situations of complex connections among the sub-levels and outsourced functions with those of the other organizations. An alternative approach based on the existing tree structure would be one that is derived from the metaphors above, which uses a dynamic perspective and an overview of the external environment to locate the firm. A more balanced view in the international networks is presented in Fig. 5.37 and Fig. 5.38 where the organization is not at the central location, rather, competitors, suppliers and customers are floating around toward the center. 16

Another diagram is developed (Fig. 5.40) to represent the complex networked relationships in the international business environment, in which organizations are embedded in relational networks and themselves are in even larger scale networks. The sub-level and outsourced functions of one organization A might become the high-level and specialized section of another organization B, while other functions in that organization might act back on A or other organizations in the relational networks. This is especially useful in conceptualizing the emerging less or non-hierarchical organizations, temporary and decentralized functions.

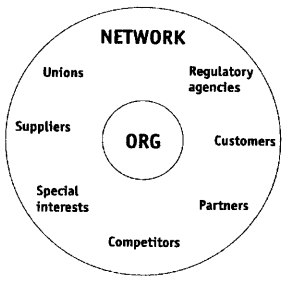


Fig. 5.36.
Organization as a central position in its networks and external environment. though not all organiztions will work this way, many managers conceptualize it using this diagram.
Source: Organizational theory, Mary Hatch.

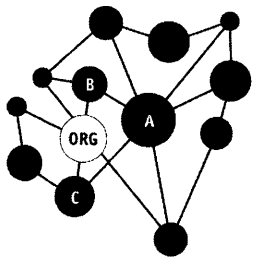


Fig. 5.37.
A more balanced view of an organization in its external evironment. Here A, a competitor of org is located at the center, while B and C are suppliers and customers of both organizations.
Source: Organizational theory, Mary Hatch.

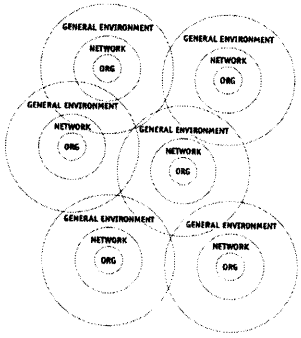


Fig. 5.38.
An international perspective of network evironment where organizations are not central, but embeded in relational networks which themselves embeded in larger relational networks. (a fractal)
Source: Organizational theory, Mary Hatch.

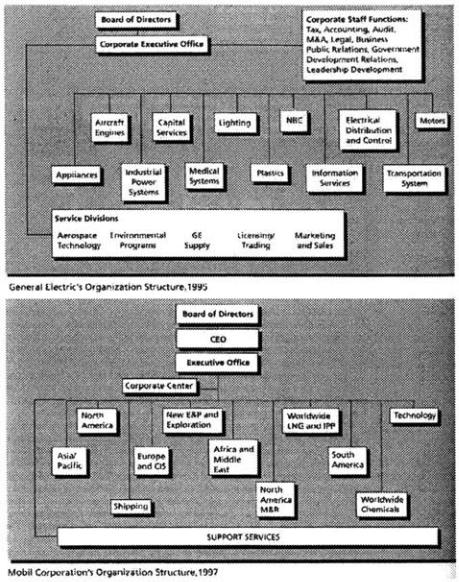


Fig. 5.39.
Tree-like diagram representing organziation sturctures of General Electric in 1995 and Mobil Corporation in 1997. The central command was divided according to either job functions or geographic locations.
Source: Comtemporary Strategy Analysis, Robert Grant.

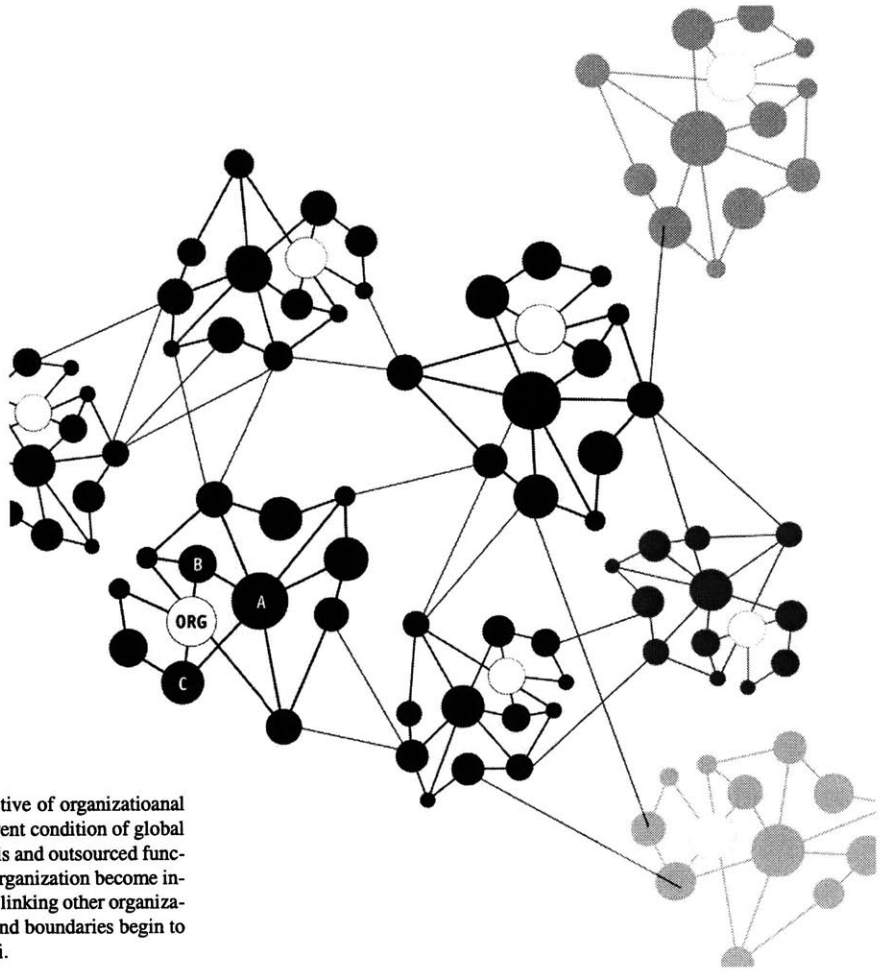
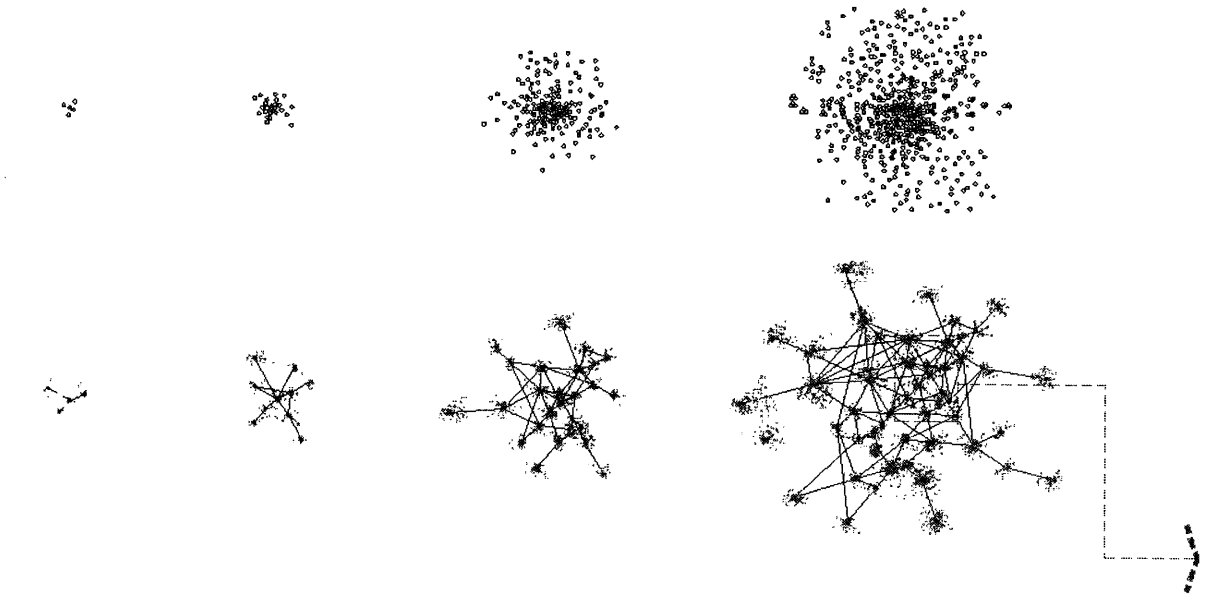


Fig. 5.40.
A balanced perspective of organizatioanal structure in the current condition of global economy. Sub-levels and outsourced functions of a specific organization become interconnected nodes linking other organizations. Hierarchies and boundaries begin to blur. *Source*: Yan Li.

5.3.8. Diagrams

A Global Fractal:

Fig. 5.41.
A Global Fractal: representations of growth, aggregation, connectivity and decentralized conditions. Similar qualities in forms are always present with different scales of magnificaitons.
Source: Yan Li.



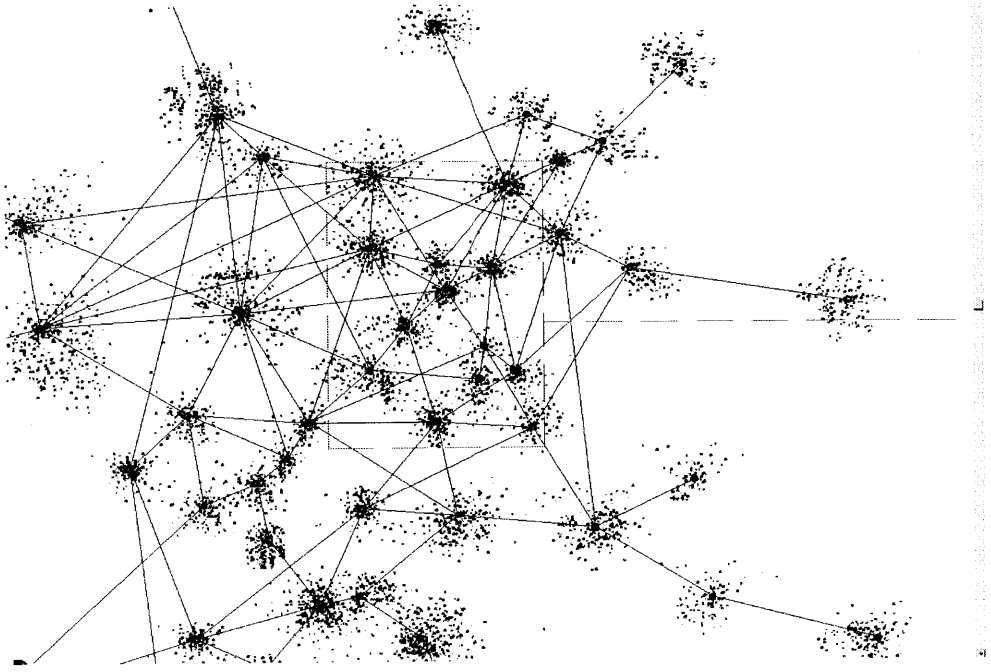
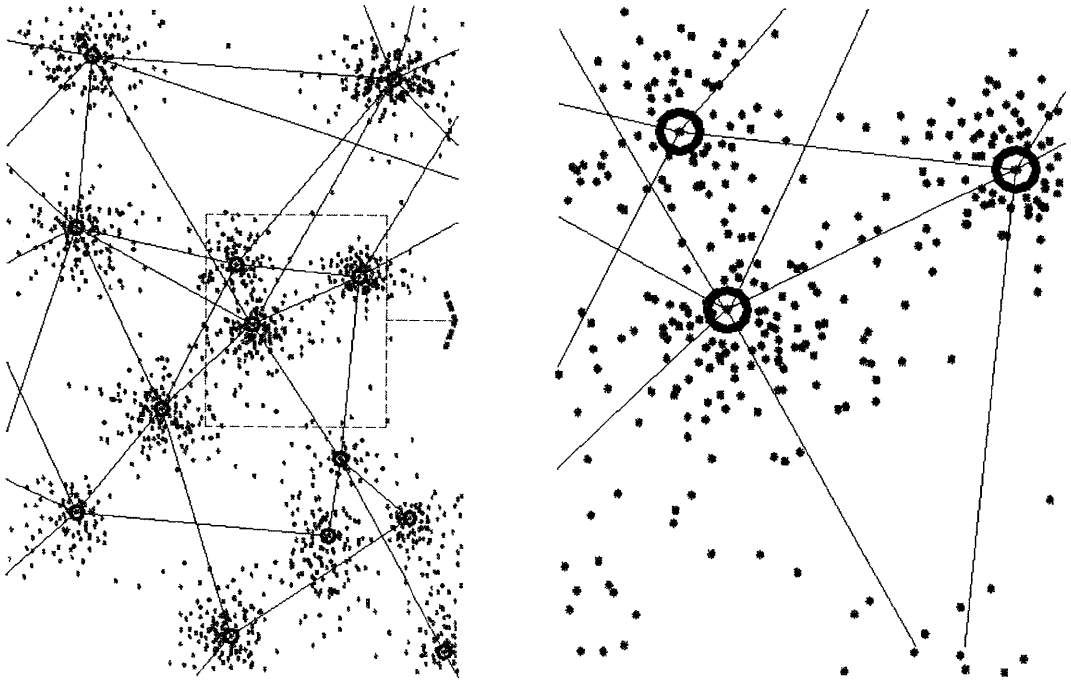


Fig. 5.42.
A Global Fractal: representations of growth, aggregation, connectivity and decentralized conditions. Zoomed in view of detail, similar forms still present.
Source: Yan Li.



5.4. Sun Microsystem's "iwork"

Sun Microsystems, Inc. (SUNW) is a leading worldwide provider of products, services and support solutions for building and maintaining network computing environments. Sun sells scalable computer and storage systems, high-speed microprocessors, and a complete line of high performance software for operating network computing equipment. The company also provides a full range of services, including support, education, and professional services. Sun's products and services command a significant share of the rapidly growing network computing market, which includes the Internet and corporate intranets. Products are used for many demanding commercial and technical applications in various industries including telecommunications, manufacturing, financial services, education, retail, government, energy and healthcare.

The company has focused its organization on the following product and service lines-of-business:

Computer Systems and Storage designs, develops and brings to market a broad range of desktop systems, servers, storage and network switches, incorporating the UltraSPARC microprocessors and the Solaris Operating Environment. This organization also designs and develops high performance UltraSPARC and MAJC microprocessors, computer board platforms, processor modules, chip sets and logic products for Sun systems products and OEM customers.

Enterprise Services provides a full range of global services and support for heterogeneous network computing environments, including system/network management, systems integration, and support, education, and professional services.

Software Systems designs, develops and brings to market Sun's Solaris Operating Environment, the Java platform and the company's core technologies for consumer and embedded markets including implementations which utilize the Java technology, Jini connection technology, XML technology, software development tools and Sun's StarOffice application software.

Network Service Provider designs, develops and brings to market carrier-grade software, systems and storage that are designed to meet the needs of traditional telecommunications customers as well as the increasing demands of service providers. Sun's Network Service Provider business focuses on the needs of network-based telecommunications companies, cable operators, and the network equipment suppliers who develop products and technologies for the broader service provider industry.

Source: compustat.

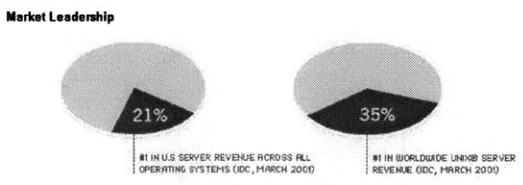
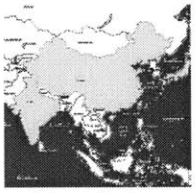


Fig. 5.43.
Sun Microsystem's market leadership in domestic and international market.
Source: www.sun.com

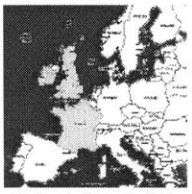
Corporate Headquarters
Sun Microsystems Inc.
901 San Antonio Road
Palo Alto, CA 94303
USA

Telephone:
1-(650)-960-1300

Research / Development Facilities:

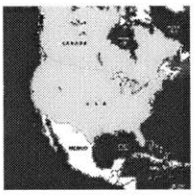


China, India, Japan

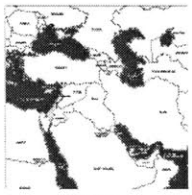


Ireland, France, U.K.

Fig. 5.44. (Left)
Sun Microsystem's headquarter and R&D facilities.
Source: www.sun.com.



Canada, U.S.



Israel

Fig. 5.45. (Below)
Sun Microsystem's worlwide operations in more than 170 countries, including distribution, sales and support, research & development, manufacturing.
Source: www.sun.com.

Albania	Algeria	Angola	Antigua	Argentina
Armenia	Australia	Austria	Azerbaijan	Bahamas
Bahrain	Bangladesh	Barbados	Belarus	Belgium
Belize	Benin	Bermuda	Bhutan	Bolivia
Benin	Bermuda	Bhuten	Bolivia	Bosnia
Botswana	Brazil	Brunei	Bulgaria	Burkina-Faso
Burma	Burundi	C. African Republic	Cambodia	Cameroon
Canada	Canary Islands	Chad	Chile	Colombia
Comoros Islands	Congo	Costa Rica	Croatia	Cyprus
Czech Republic	Danmark	Djibouti	Dominica	Dominican Republic
Dubai	Ecuador	Egypt	El Salvador	Equatorial Guinea
Estonia	Ethiopia	Falkland Island	Finland	France
French Antilles	French Polynesia	Gabon	Gambia	Georgia
Germany	Ghana	Greece	Grenada	Guadaloupe
Guatemala	Guyana	Haiti	Honduras	Hong Kong
Hungary	Iceland	India	Indonesia	Ireland
Israel	Italy	Ivory Coast	Jamaica	Japan
Jordan	Kazakhstan	Kenya	Kuwait	Kyrgyzstan
La Reunion	Laos	Latvia	Lebanon	Lesotho
Lesser Antilles	Liberia	Lithuania	Luxembourg	Macao
Macedonia	Madagascar	Malaysia	Maldives	Mali
Malta	Martinique	Mauritania	Mauritius	Mexico
Moldavia	Monaco	Mongolia	Morocco	Mozambique
Namibia	Nepal	Netherland Antilles	Netherlands	New Caledonia
New Zealand	Nicaragua	Niger	Nigeria	Norway
Oman	Pakistan	Panama	Paraguay	Peru
Philippines	Poland	Portugal	PRC	Puerto Rico
Qatar	Romania	Russian Federation	Saudi Arabia	Scotland
Senegal	Singapore	Slovakia	Slovenia	South Africa
South Korea	Spain	Sri Lanka	St. Christopher	St. Kitts-Nevis
St. Lucia	St. Vincent-Gren.	Suriname	Swaziland	Sweden
Switzerland	Syria	Tahiti	Taiwan	Tajikistan
Thailand	Togo	Trinidad	Tunisia	Turkey
Turkmenistan	Turks/Caicos Island	Ukraine	United Arab Emirates	United Kingdom
Uruguay	USA	Uzbekistan	Venezuela	Vietnam
Virgin Islands	Western Sahara			

Sun Microsystem's "*i*Work" as workplace strategy

Facts:

< Silicon Valley based global provider of network-based hardware and software.

< Reorganized in the last two years into a global organization by product and market segments,rather than by geography.

< As the leading provider of the network techonology, its workplace and work processes have followed the decentralized nature of technology.

Objective:

< Right information services to **Anyone, Anytime, on Any device**

Strategy:

< "iWork" + "flexible office" (technology driven)

< Anyone, anytime, on any device.

< From field sales and services employees.

< Free address model: Shared or just-in-time basis of office space

.....Unassigned work settings on a reservation or just-in-time basis.

.....Team work

.....Proximity

< Worldwide field offices: Current: 24 US, 9 international. In process: 37 worldwide.

< Physical facilities -mobility / team building / technology

< **Decentralized workplaces : Hub : Satellite locations : Home offices**

Business Needs:

< To attract and retain a globally and locally dispersed workforce

< To support mobile work. Access from any Sun office in the world.

< To contain costs. savings to date exceed $200 million per year

Tech:

< connect the WR organization with employee population. self-service platform.

< "webify" all workplace related processes, space/ asset planning

< connect WR with its ESPs. transaction management

Importance:

< three workplace functions:

HR, IS, and corporate real estate collaborate in the workplace management process.

< Leadership support

< Place orientation - service orientation

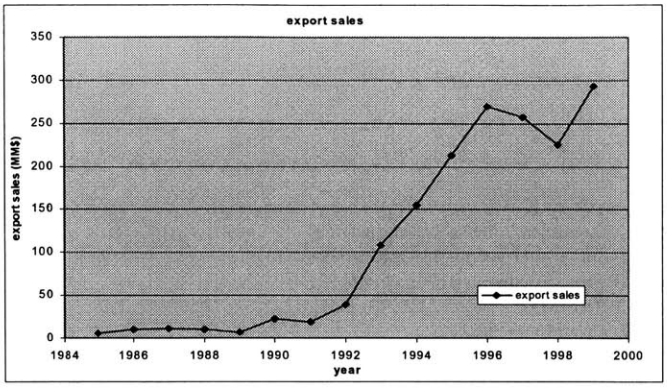


Fig. 5.46.
Sun Microsystem's export sales (MM$) from 1985 to 1999.
Source: Yan Li.
Data from compustat.com.

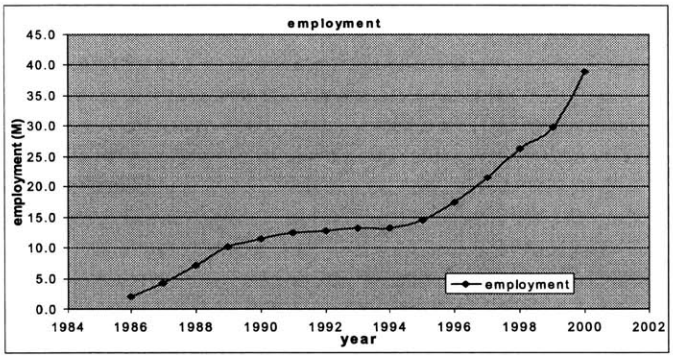


Fig. 5.47.
Sun Microsystem's employment (in millions) from 1985 to 1999.
Source: Yan Li.
Data from compustat.com.

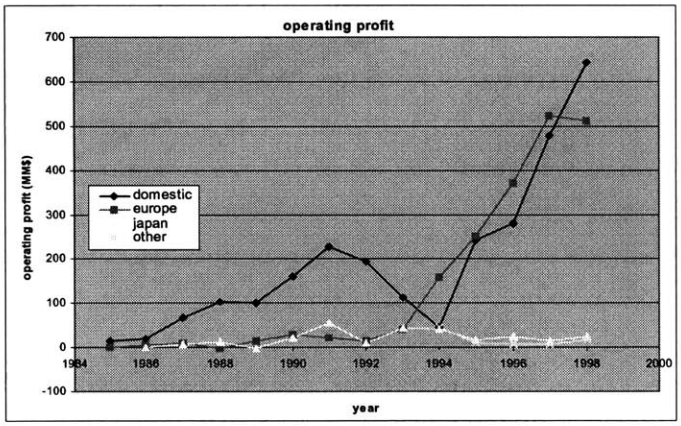


Fig. 5.48.
Sun Microsystem's operating profit across four geographic regions, domestic, europe, japan and others (MM$) from 1985 to 1999.
Source: Yan Li.
Data from compustat.com.

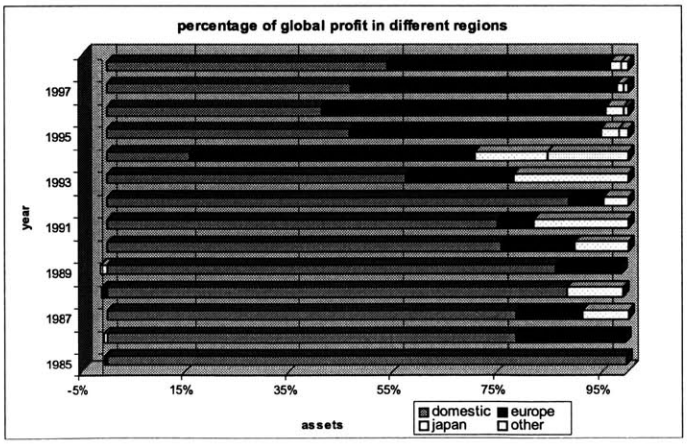
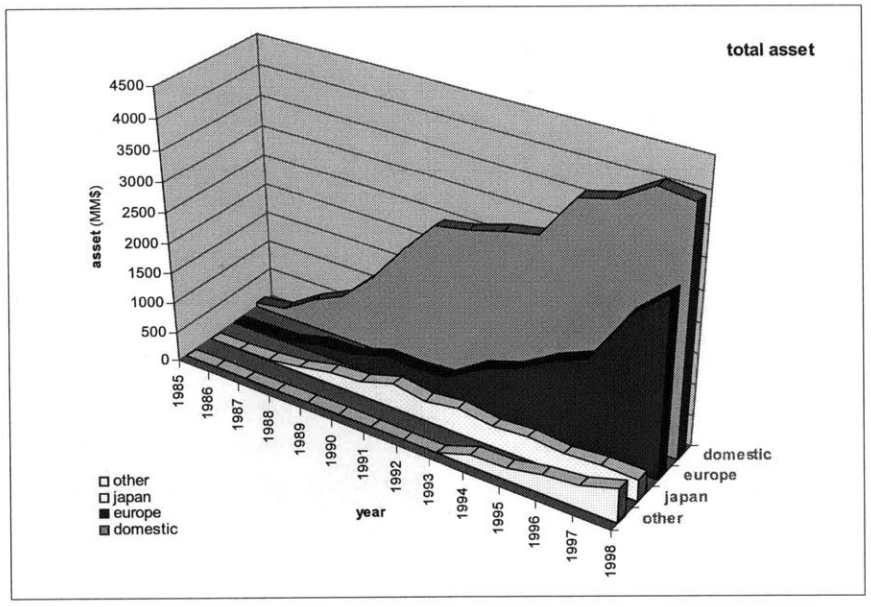


Fig. 5.49.
Sun Microsystem's percentage of global operating profit according to four geographic regions, domestic, europe, japan and others from 1985 to 1999.
Source: Yan Li.
Data from compustat.com.

Fig. 5.50.
Sun Microsystem's total assets and net sales according to four geographic regions, domestic, europe, japan and others from 1985 to 1999. (MM$)
Source: Yan Li.
Data from compustat.com.



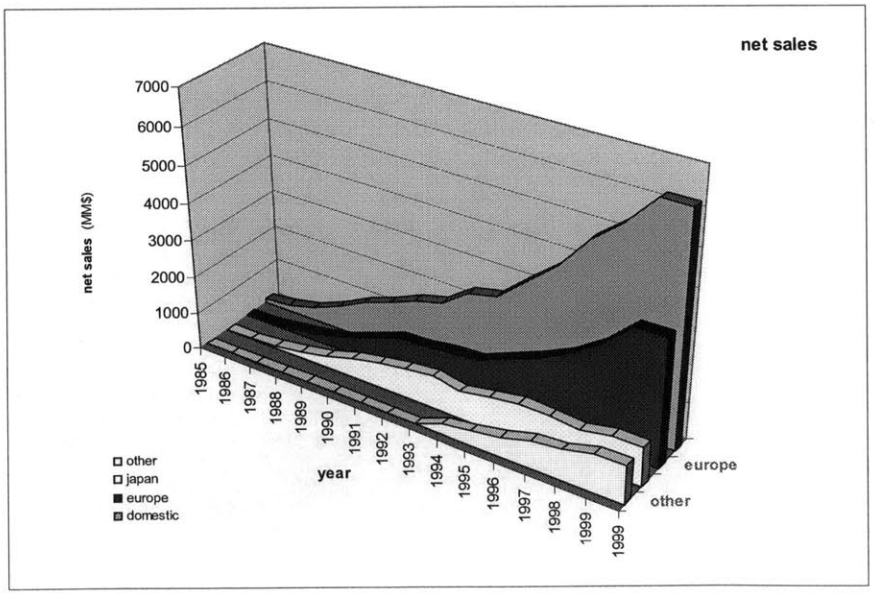
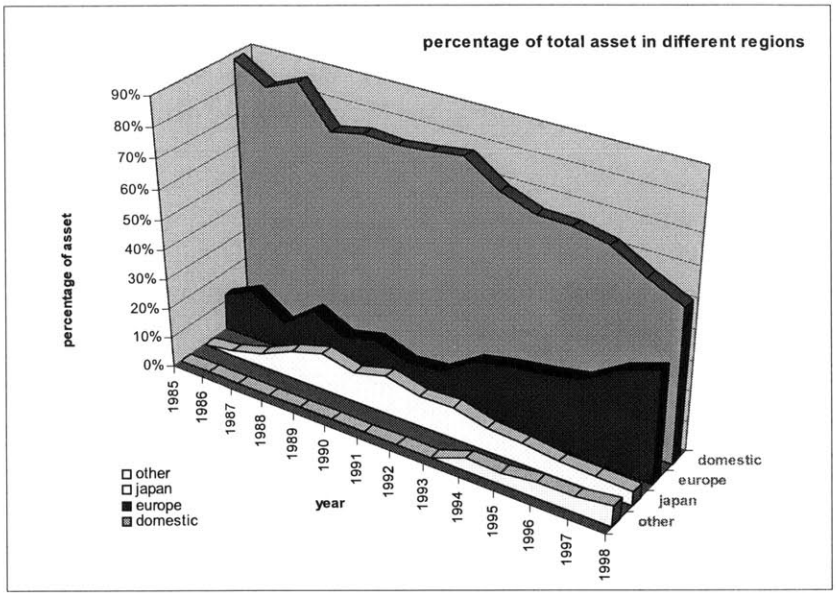
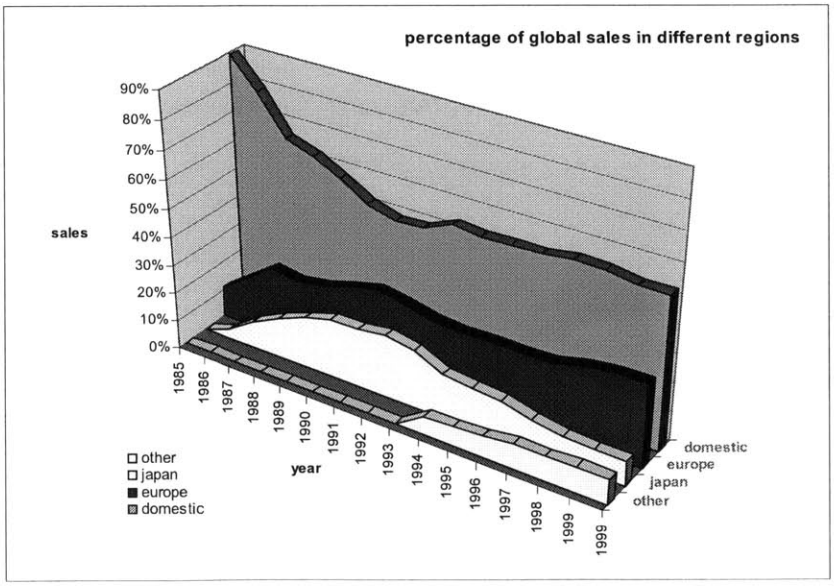


Fig. 5.51.
Sun Microsystem's percentages of total assets and net sales according to four geographic regions, domestic, europe, japan and others from 1985 to 1999. (MM$)
Source: Yan Li.
Data from compustat.com.





Endnotes

1. Hatch, Mary. *Organization Theory: Modern Symbolic and Postmodern Perspectives.* New York: Oxford University Press Inc., 1997.
2. Ibid.
3. Ibid.
4. Ibid.
5. Duffy, Francis. *The New Office.* London: Conran Octopus Ltd, 1992
6. Hatch, Mary. *Organization Theory: Modern Symbolic and Postmodern Perspectives.* New York: Oxford University Press Inc., 1997.
7. Ibid.
8. Ibid.
9. Ibid.
10. Grant, Robert M. *Contemporary Strategy Analysis*, Oxford: Blackwell Publishers Inc, 2000 (First published in 1991).
11. Ibid.
12. Sassen, Saskia. *Cities in a world economy.* Thousand Oaks, Calif.: Pine Forge Press, 2000.
13. Simon, Roger and Gary Hack. ed. *Global city regions: their emerging forms.* London ; New York : Spon, 2000.
14. http://www.nationalgeographic.com/mapmachine
15. Gallis, Michael and James Russell. *"World City: Why globalization makes cities more important than ever."* Architecture Record. March, 2002.
16. Hatch, Mary. *Organization Theory: Modern Symbolic and Postmodern Perspectives.* New York: Oxford University Press Inc., 1997.

Bibliography

Bertin, Jacques. *Semiology of graphics: diagrams, networks, maps.* Madison, Wis. : University of Wisconsin Press, 1983.

Burns, Tom, *The sociology of industry*. London: Toutledge, Kegan and Paul, 1962.

Gallis, Michael and James Russell. *"World City: Why globalization makes cities more important than ever."* Architecture Record. March, 2002.

Grant, Robert M. *Contemporary Strategy Analysis*, Oxford: Blackwell Publishers Inc, 2000 (First published in 1991).

Hatch, Mary. *Organization Theory: Modern Symbolic and Postmodern Perspectives.* New York: Oxford University Press Inc., 1997.

McLuhan, Marshal. *The Medium is the Massage, An Inventory of Effects.* Rev. Ed. San Francisco: Hardwired, 1997.

Sassen, Saskia. *Cities in a world economy*. Thousand Oaks, Calif.: Pine Forge Press, 2000.

Simon, Roger and Gary Hack. ed. *Global city regions: their emerging forms.* London ; New York : Spon, 2000.

http://www.nationalgeographic.com/mapmachine

http://www.telegeography.com

http://www.compustat.com

http://wrds.wharton.upenn.edu/

http://www.sun.com

6. Conclusion

This section summarizes the methods, findings and shortcomings of this thesis work. It attempts to analyze the appropriate areas and contexts to employ the mapping tools, the limitations of such tools, the implications for the types and distributions of future workplaces, along with several directions and sorts of data needed for future research.

6.1. Findings

Explanatory Metaphors -- The thesis explores the use of explanatory metaphors to conceptualize the complexity in the emerging global economic activities. It is based on the visual, and more importantly, the conceptual correspondences with the forms and patterns we observed in the natural and built environments. The organic metaphors of organization and many other metaphors from nature are all compelling mapping processes enabling us to familiarize the unfamiliar realities as well as to re-interpret the already familiar situations.

Impressionistic interpretation - The fractal concept is introduced as an impressionistic interpretation of the convergence across different scales and time in the globalization process. Shifting points of view through the global and local window reveal certain similarity at all levels.

Qualitative representation - The diagrammatic and other visual expressions are effective qualitative representations of the overall system. The impressionistic way of interpreting characteristics of the overall settings is revealing through its qualitative quality. It depicts local level information in such a way that the complexity at global level is comprehensible and less vexing.

6.2. Shortcomings

Conceptual disparities and ambiguities of metaphor - Correspondences across different conceptual domains are the key factors in the mapping process of metaphor. Complex stories can be told through such correspondences that we can interpret the unfamiliar or familiar realities in a new way. However, this might be misleading, because conceptual disparities and ambiguities exist across those different conceptual domains. Whether the visual metaphors from natural and built environments can reveal the underlying logic still remains questionable. The same external behaviors sometimes are emerged from quite different internal mechanisms.

Quantitative vs. qualitative approach - The explanatory metaphors seem to be potentially less useful once the conceptual correspondences are established and detailed local level information and underlying mechanisms need to be addressed specifically. More quantitative rather than qualitative studies (section 5.3.4) of these situations seem to be more compelling and necessary. But an integration of these two approaches will benefit both the global and local level studies of organizations and strategies.

6.3. Applications

Economics - The complexity in the global economic activities, the similarities of laws across Macro/Micro scales and the convergence of diversity can be conceptualized through the use of these tools.

Organization analysis - The tools of metaphor and fractal can be helpful for organizations to re-position themselves in the global condition, to understand and devise global strategies through re-interpreting local dynamics. The tools can also aid organizations to simulate the human interactions and communication pattern before certain decisions are made.

Distribution analysis - The distribution of strategic resources, especially physical assets across geographic locations can be re-assessed using these tools. Existing allocations might not be necessary or sufficient in certain locations. The diagrams and metaphors from other disciplines may help in decision making. Whether or not to invest on physical assets in specific locations, though cannot be determined, can often be inferred from the dynamic perspectives of re-scaling the existing strategic resources.

6.4. Limitations

The tools of metaphor and fractal are more in the conceptual level appropriate for interpreting phenomena rather than in detail level for analyzing data and predicting happenings. Their lack of quantitative quality will make them less appealing or useful to attack specific situations. But interesting solutions might emerge from incorporating these tools with other quantitative tools in analyzing real data and specific conditions.

6.5. Implications on future workplaces

The study of global phenomena and the use of metaphor and fractal as conceptual tools have at least the following implications on the future workplaces:

Decentralization - The future workplaces will continue to adapt to the external environment with strong decentralization effects and intense forms of centrality (section 1.2, section 5.3.1., 5.3.2., 5.3.3.) With decreased size but increased complexity in central functions, more outsourcing, and more dispersed spatial units across larger geographical locations. (More metaphors can be drawn from the organic distributed systems.)

Integration of physical and virtual workplaces - The future workplace will continue to integrate physical and virtual competitiveness as new technologies constantly change the speed of connectivity and the perception of distance. Collaborative work through both means will enhance the opportunities of encounters on a global basis, taking further of the metaphor of a global village.

Less hierarchy, more flexibility - The technology, the existing physical dispersal and the new structures of organization will celebrate a workplace environment with less hierarchy and more flexibility. The metaphors from nature imply the form of a system with high mobility, adaptability and self-organizing capacity to the rapid changes in the external environment.

Workplace follows people and knowledge - The future physical and virtual workplaces will closely tied to the distribution of people, especially the distribution of knowledge workers. They might be in the central business districts, as well as in faraway locations and at homes. The high mobility of these people will take various forms of mobile workplaces along with them.

6.6. Future research

Directions - In addition to the current correspondences within the areas developed in the thesis, future research might find it potentially interesting to use metaphors and self-similarities in inter-disciplinary studies. A wide range of subjects can be drawn together and re-mapped to find correspondences and disparities, in which deeper understandings or new interpretations of these fields can be established. Possible candidates would be found in economics, organization analysis, adaptive systems, human behaviors and geography...

Data - The sorts of data to establish the mapping tools are critical to the eventual senses of the maps, thus determining the appropriate sources of data to use might be quite challenging in the mapping process. Whether the data are representing physical locations of employment, physical inhabitation of the workforce, or representing the frequency and volume of workflow, types of communication and connectivity might have totally different consequences on the spatial distributions of the subjects. The condition of centralization or decentralization, might be explicit or implicit, or might not matter at all. Tracking the physical workplace will not tell the complete story of the pattern of employment in an industry which virtual communication is mostly used. Mapping the physical asset allocation might not give a real picture of the organization structure or relationships among diverse functions. Moreover, in many cases, the data might be missing or extremely difficult to collect to constitute a useful map to a level that metaphors and conceptual correspondences can be meaningfully created.

References

Academy Edition, *A guide to Archigram 1961-74*. London: Academy Group; Berlin: Ernst & Sohn; New York: St. Martin's Press, 1994.

Albrecht, Donald and Chrysanthe Broikos, ed. *On the Job: Design and the American Office*. New York: Princeton Architectural Press, 2000.

Allen, Thomas. *Architecture and Communication, Among Product Development Engineers*. Working Paper, WP Number 165-97, 1997.

Argyris, Chris. *On organizational learning*. Oxford, UK; Malden, Mass.: Blackwell Business, 1999.

Becker, F. and Fritz Steele. *Workplace by design: mapping the high-performance workscape*. San Francisco: Jossey-Bass Publishers, 1995.

Becker, Franklin. *The Successful Office: how to create a workspace that's right for you*. New York: Addison-Wesley Publishing Company, 1982.

Bertin, Jacques. *Semiology of graphics: diagrams, networks, maps*. Madison, Wis. : University of Wisconsin Press, 1983.

Black, Thomas, K. Roark, L. Schwartz. *The Changing Office Workplace*. Washington DC: Urban Land Institute, 1986.

Brand, Stewart. *How buildings learn: what happens after they're built*. New York, NY: Viking, 1994.

Burns, Tom. *The sociology of Industry*. London: Toutledge, Kegan and Paul, 1962.

Davidow, William H. *The virtual corporation: structuring and revitalizing the corporation for the 21st century*. New York: Edward Burlingame books/Harper Business, 1992.

Duffy, Francis, J. Klein, J. Graf. *The office book: ideas and designs for contemporary work space*. New York: Facts on File, 1982.

Duffy, Francis. *The Changing Workplace*. London: Phaidon, 1992.

Duffy, F., A. Laing. and V. Crisp. *The Responsible Workplace: the Redesign of Work and Offices*. London: DEGW, 1993.

Duffy, Francis, ... [et al.]. ed. Design for change : the architecture of DEGW. Basel ; Boston : Birkhäuser ; Haslemere : Watermark, 1998.

Duffy, Francis. *The New Office*. London: Conran Octopus Ltd, 1992.

Eley, J., and A. Marmont. *Understanding Offices*. London: Penguin Books, 1995.

Garreau, Joel. *Edge city: life on the new frontier.* New York: Anchor Books, 1992.

Grant, Robert M. *Contemporary Strategy Analysis*, Oxford: Blackwell Publishers Inc, 2000 (First published in 1991).

Handy, Charles B. *The age of unreason.* Boston, Mass.: Harvard Business School Press, 1989.

Horgen, T., M. Joroff, W. Poter, and D. Schon. *Excellence by Design: Transforming Workplace and Work Practice.* New York: John Wiley & Sons, Inc., 1999.

Hannan, Michael T. *Organizational ecology.* Cambridge, Mass.: Harvard University Press, 1989

Hatch, Mary. *Organization Theory: Modern Symbolic and Postmodern Perspectives.* New York: Oxford University Press Inc., 1997.

Hirschheim, R. A. Office automation : a social and organizational perspective. Chichester [Sussex]; New York: Wiley, 1985.

Jones, Gareth, *Organizational Theory: Text and Cases.* New York: Addison-Wesley Publishing Company. ????

Koolhass, Rem, et al. *Mutation.* Barcelona : Actar, 2001.

Koolhass, Rem. *Delirious New York.* New York, NY: The Monacelli Press, Inc., 1994

Klein, Judy Graf. *The office book.* London: Quarto Marketing Ltd. 1982.

Langton, Christopher, ed. *Artificial Life, An Overview.* Cambridge, MA: The MIT Press, 1995.

Mack, Lorrie. *Calm Working Space.* New York: HarperCollins, 2000.

Mandelbrot, Benoit B. *The fractal geometry of nature.* San Francisco: W.H. Freeman, 1983.

Marberry, Sara. *Color In the Office: Design Trends from 1950-1990 and beyond.* New York: Van Nostrand Reinhold, 1994.

March, James. *Exploration and Exploitation in Organizational Learning.* Organization Science, 1991.

McLuhan, Marshal. *The Medium is the Massage, An Inventory of Effects.* San Francisco: Hardwired, 1967.

Ortony, Andrew. Ed. *Metaphor and Thought.* Cambridge [England]; New York, NY, USA: Cambridge University Press, 1993.

Pélegrin-Genel, Elisabeth. *The office*. Paris ; New York : Flammarion, 1996.

Peters, Thomas. *Thriving on chaos: handbook for a management revolution*. New York: Knopf: Distributed by Random House, 1987.

Propst, Robert. *The office: a facility based on change*. Ann arbor, Mich.: Herman Miller Research Corp. 1968.

Progetto ufficio = office project. Milano: Electa, 1983.

Saphier, Michael. *Planning the new office*. New York: McGraw-Hill, 1978.

Salk, Jonas. *Anatomy of Reality*. New York: Columbia University Press, 1983.

Salmon, Geoffrey. *The working office*. London : Design Council, 1979.

Sandra, Edwards. *Office systems : designs for the contemporary workspace*. New York: PBC International, 1986.

Sassen, Saskia. *Cities in a world economy*. Thousand Oaks, Calif.: Pine Forge Press, 2000.

Sassen, Saskia. *The global city: New York, London, Tokyo*. Princeton, N.J. : Princeton University Press, 1991.

Sassen, Saskia. *Globalization and its discontents: [essays on the new mobility of people and money]*. New York : New Press, 1998.

Senge, Peter M. *The fifth discipline: the art and practice of the learning organization*. New York: Doubleday/Currecy, 1990.

Simon, Roger and Gary Hack. ed. *Global city regions: their emerging forms*. London ; New York : Spon, 2000.

Smith, Harold T. *The office revolution: strategies for managing tomorrow's workforce*. Willow Grove, PA.: Administrative Management Society Foundation, 1983.

Stickland, Francis. *The dynamics of change: insights into organisational transition from the natural world*. London ; New York : Routledge, 1998.

Wilson, David C. *A strategy of change : concepts and controversies in the management of change*. London ; New York : Routledge, 1992.

Zuboff, Shoshana. *In the age of the smart machine: the future of work power*. New York: Basic Books, 1998.

http://math.bu.edu/DYSYS/explorer/page1.html

http://www.susqu.edu/facstaff/b/brakke/complexity/hagey/flock.htm

http://www.nationalgeographic.com/mapmachine

http://www.telegeography.com

http://www.compustat.com

http://wrds.wharton.upenn.edu/

http://www.sun.com

7479-3