Embedding Time in Accessibility Analysis

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Accessibility

- Multi-dimensional and multi-disciplinary perspectives on accessibility
- Needs: resources, jobs, health, education, etc
- Facilitators: money, power, information, networks, location, communication, transportation

Accessibility as a Spatial Problem

- Distance / nearness
- Spatial arrangement and mix of phenomena
- Network structures
- Connectedness / adjacency

Accessibility as a Temporal Problem

- Duration
- Scheduling
  - Timing
  - Sequence
- Temporality

Embedding Time in Accessibility Analyses (accessibility as transportation)

- Measuring distance in time
  - Isochrone maps
  - Time-space convergence
- The example of metropolitan spatial development

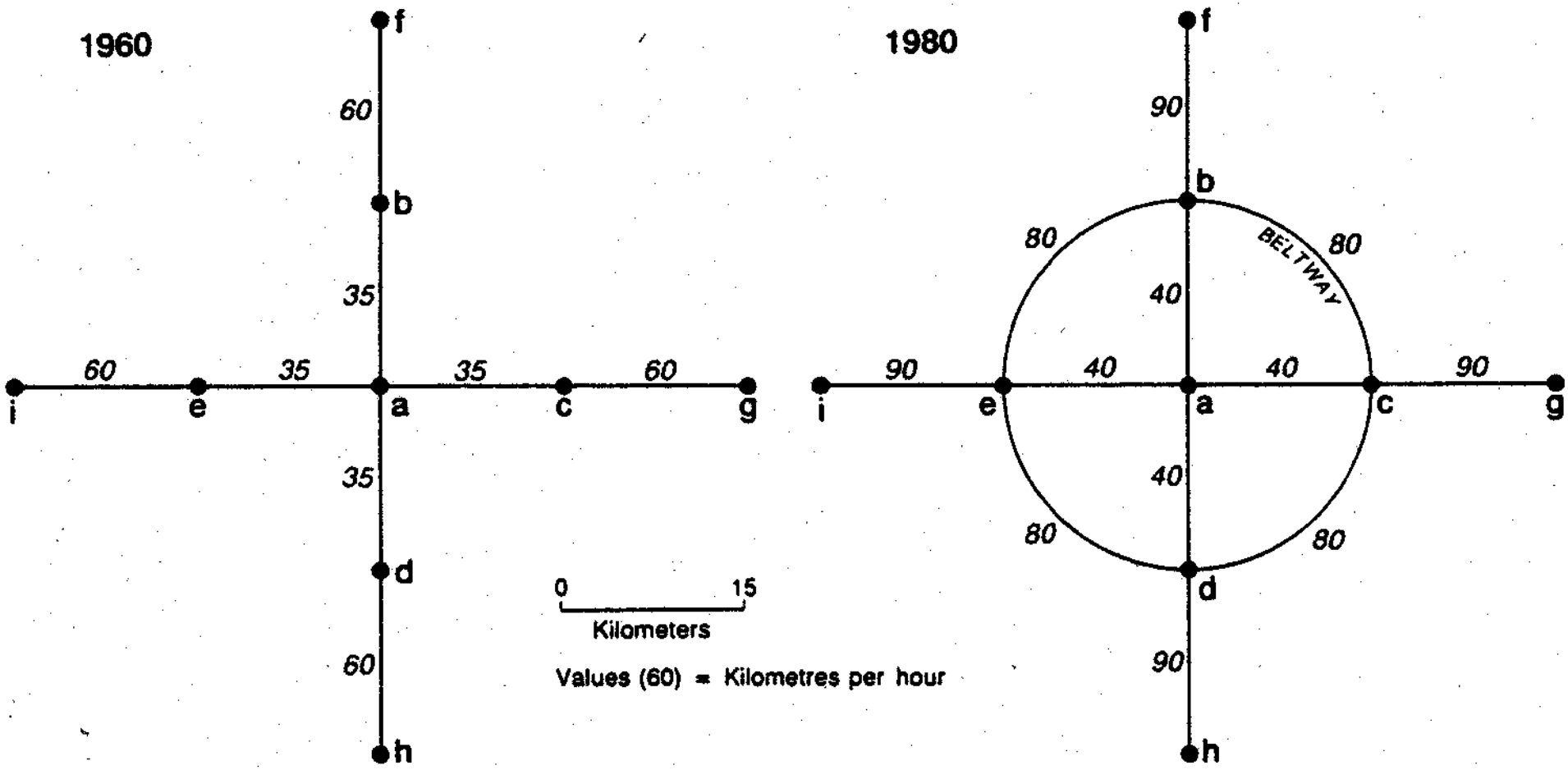
Los Angeles ⟺ Santa Barbara

500 minutes apart in 1901
100 minutes apart in 2001

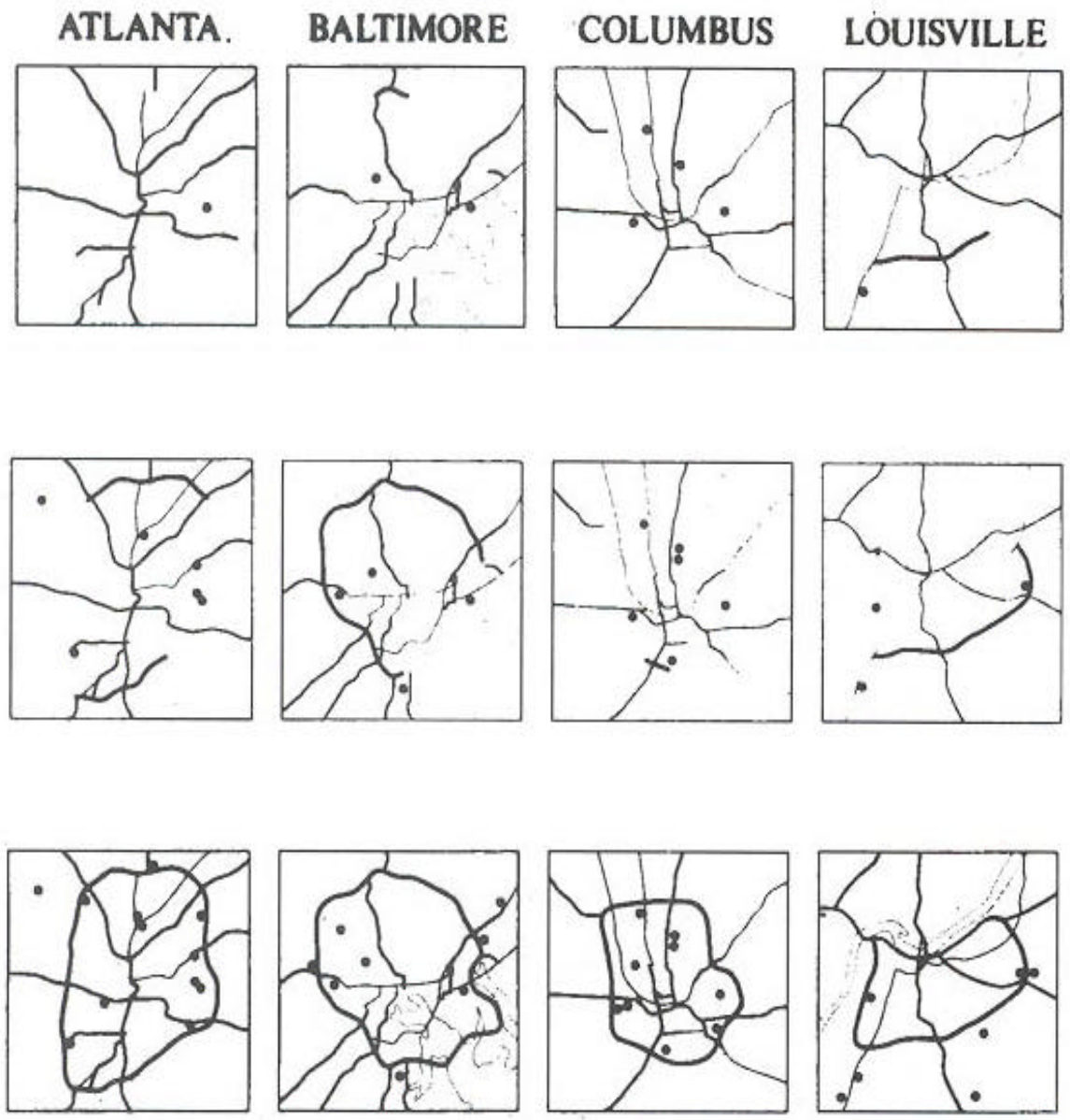
Time-Space Convergence: 400 minutes
Average Rate of Convergence: 4 minutes per year
"velocity"

Problems of Travel Time as a Metric of Space:

- Variability in convergence and divergence among places
- Time-space inversions
- Asymmetric relationships between places
- Simultaneity of different convergence / divergence levels – by social class / transport mode

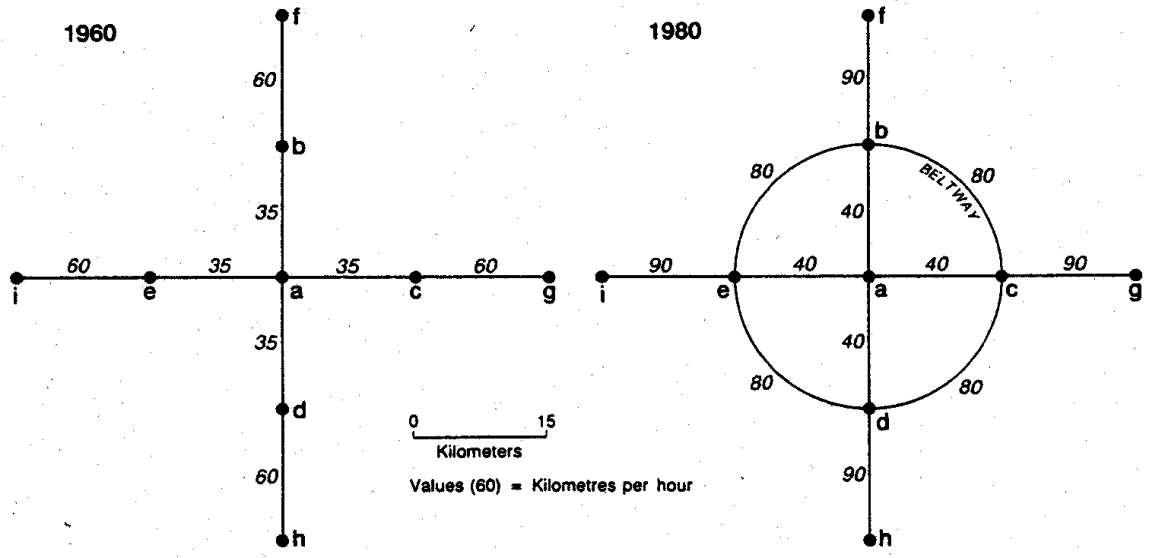


Janelle 1995


ATLANTA.
BALTIMORE
COLUMBUS
LOUISVILLE
Pre 1957
1961-1965
1976-1980

Convergence Rates for Metropolitan Settings

Topologically Equivalent Locations	**Average Travel Time (minutes)** each place to all 8 other places		**Convergence Rates 1960-1980** Average minutes per year, each place to all 8 other places using shortest time paths
	1960	**1980**	
City Center **- a**	33.2	27.5	**0.29**
b,c,d,e - Beltway	49.3	25.5	**1.19**
f,g,h,i - Ends	62.4	34.3	**1.4**

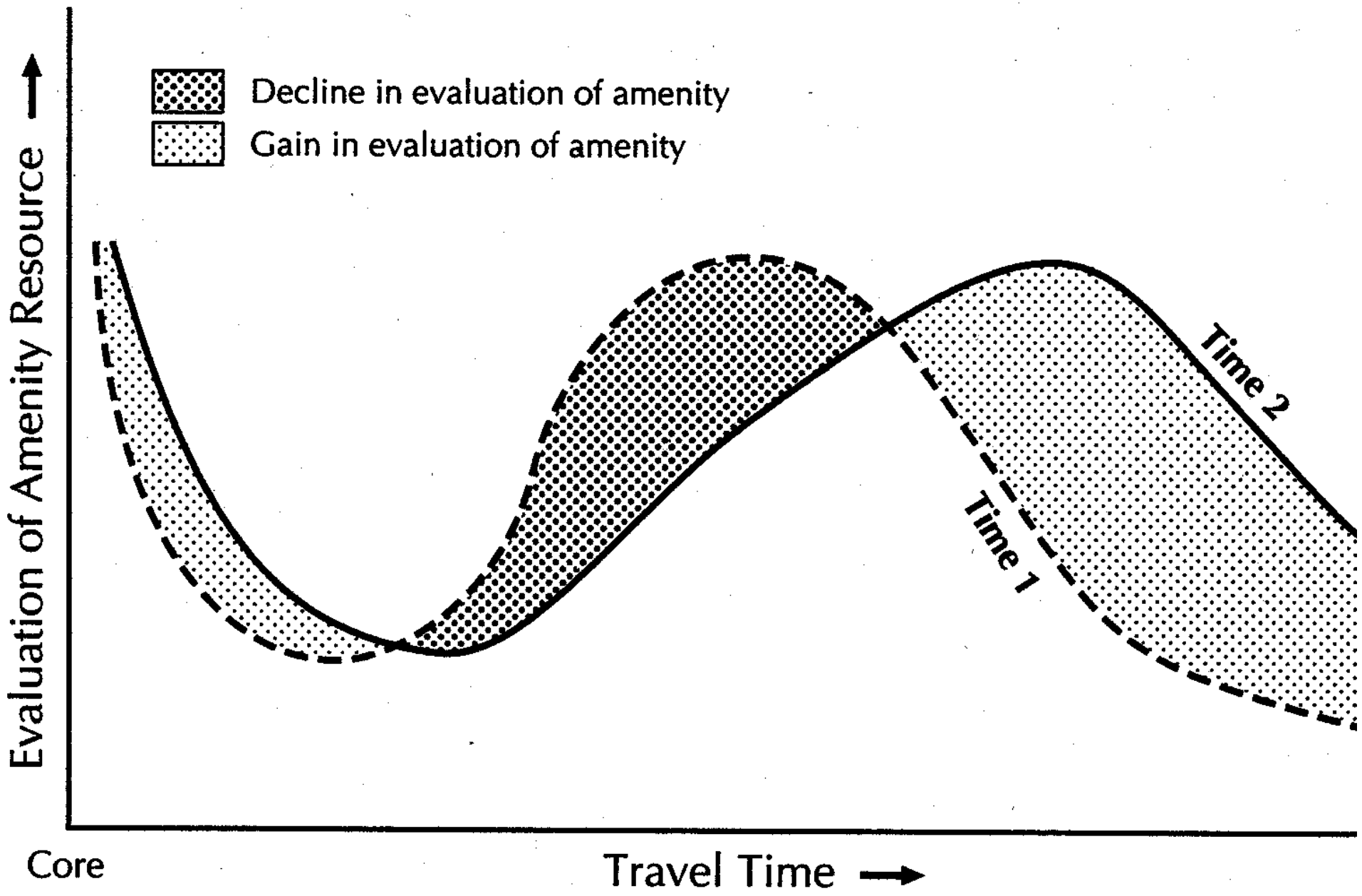


Janelle 1995

Travel Speeds and Accessible Land Resources from Urban Center

Average Travel Speed (Km/hr)	Average Daily Commuter Trip (1-way minutes)	Potential Distance from City Center (km)	Land Resource (Sq Km)
60	30	30	2827
70	30	35	3848
80	30	40	5027
80	50	67	14103

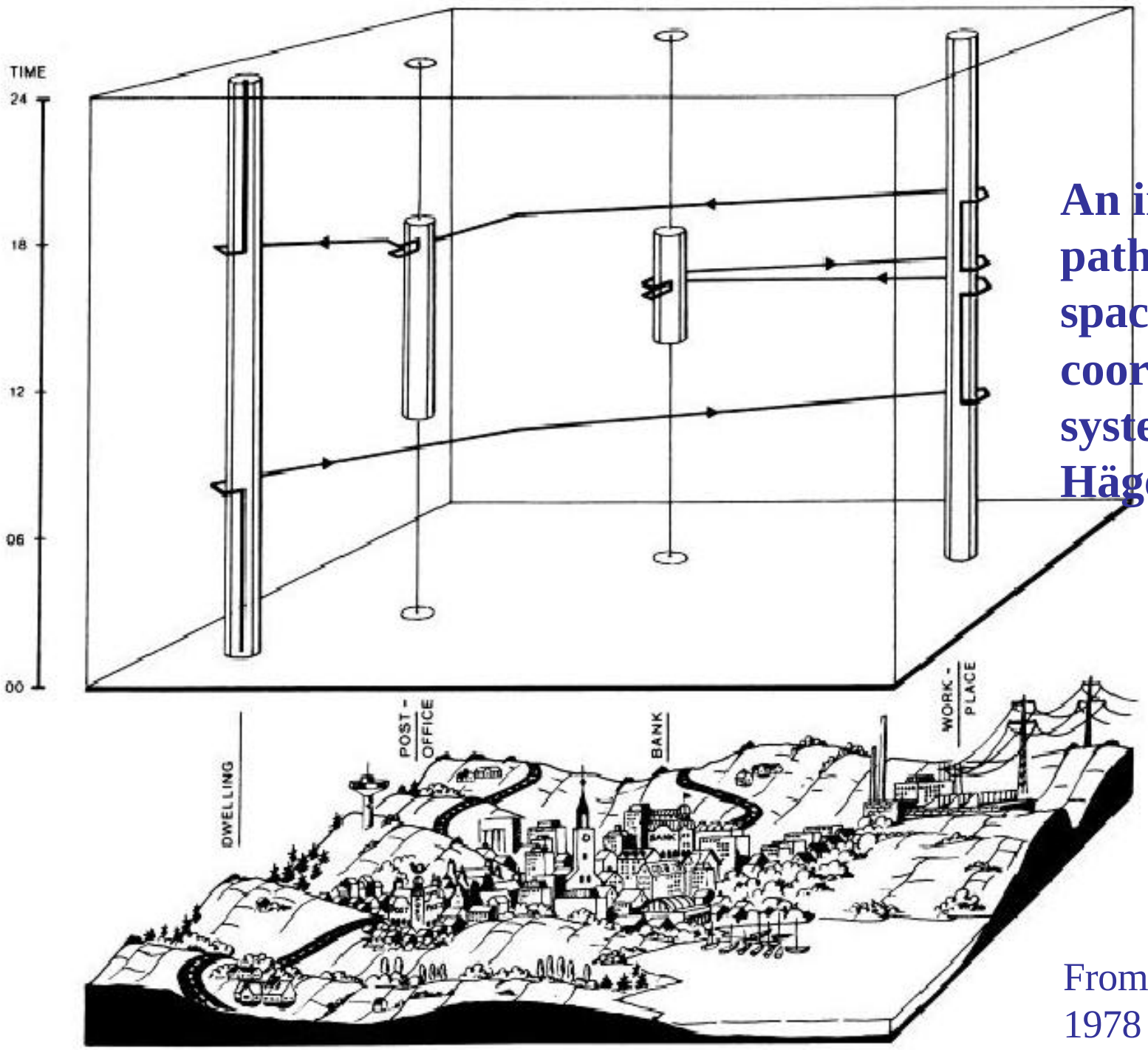
Janelle 1999



Janelle 1995

Accessibility as Individual Autonomy over space and time

- The time-geography perspective – Hägerstrand
- Geo-visualization of space-time paths - Kwan
- Space-time extensibility – Janelle/Adams
- Time Landscapes (Barbara Adam)
- Time Ecology (Martin Held/Gus Koehler)



An individual's path in time-space coordinate system -- after Hägerstrand

From B. Lenntorp 1978

Human Space-time Extensibility

‘Human Extensibility in a Shrinking World’ Janelle (1973)

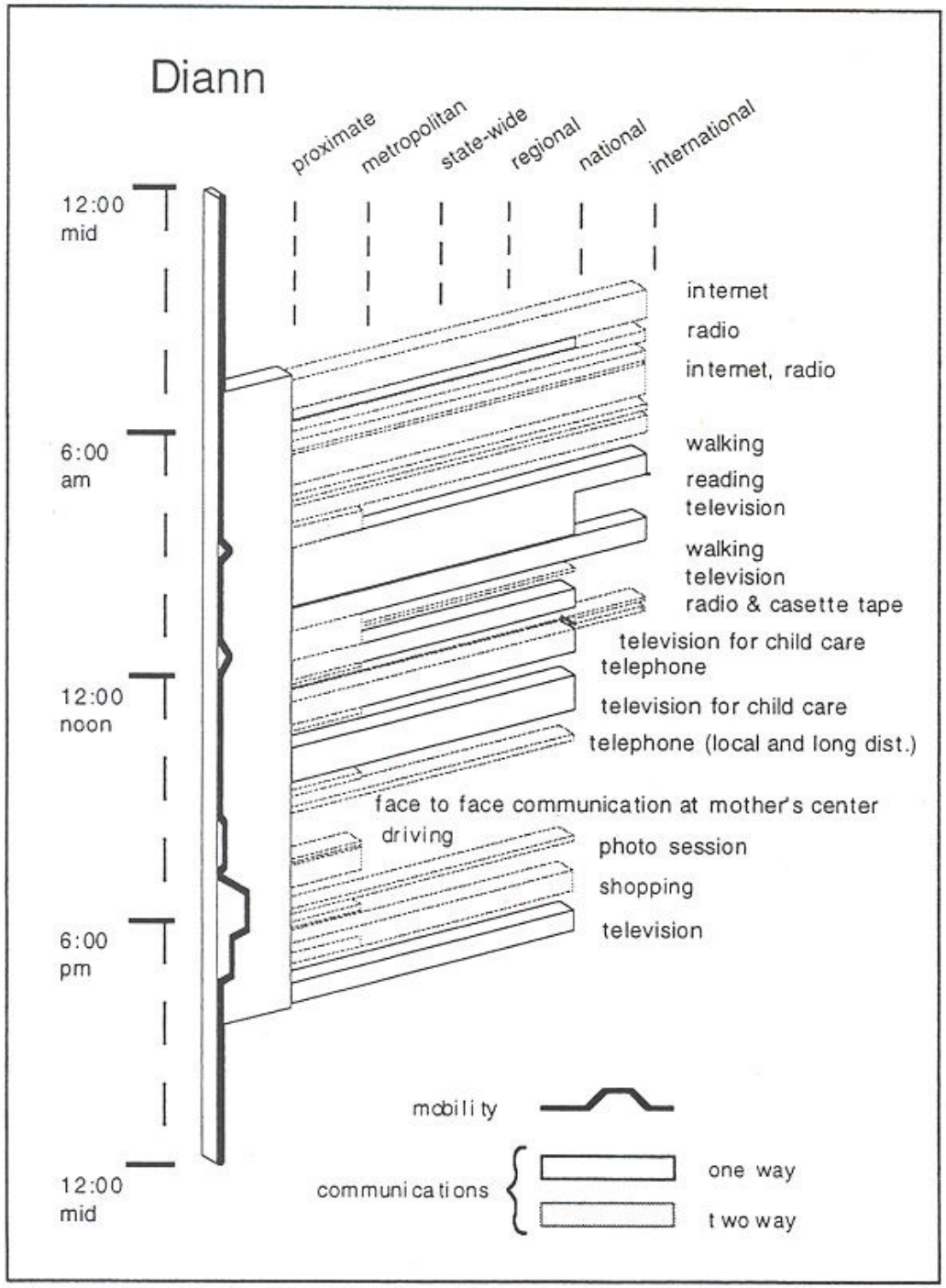
– Interaction beyond one’s immediate physical presence

– Projection of authority and of one’s presence over space and time

- Parallels with Anthony Giddens’ ‘time-space distanciation’ (1981, 1984)
  - Stretching social systems across space and time

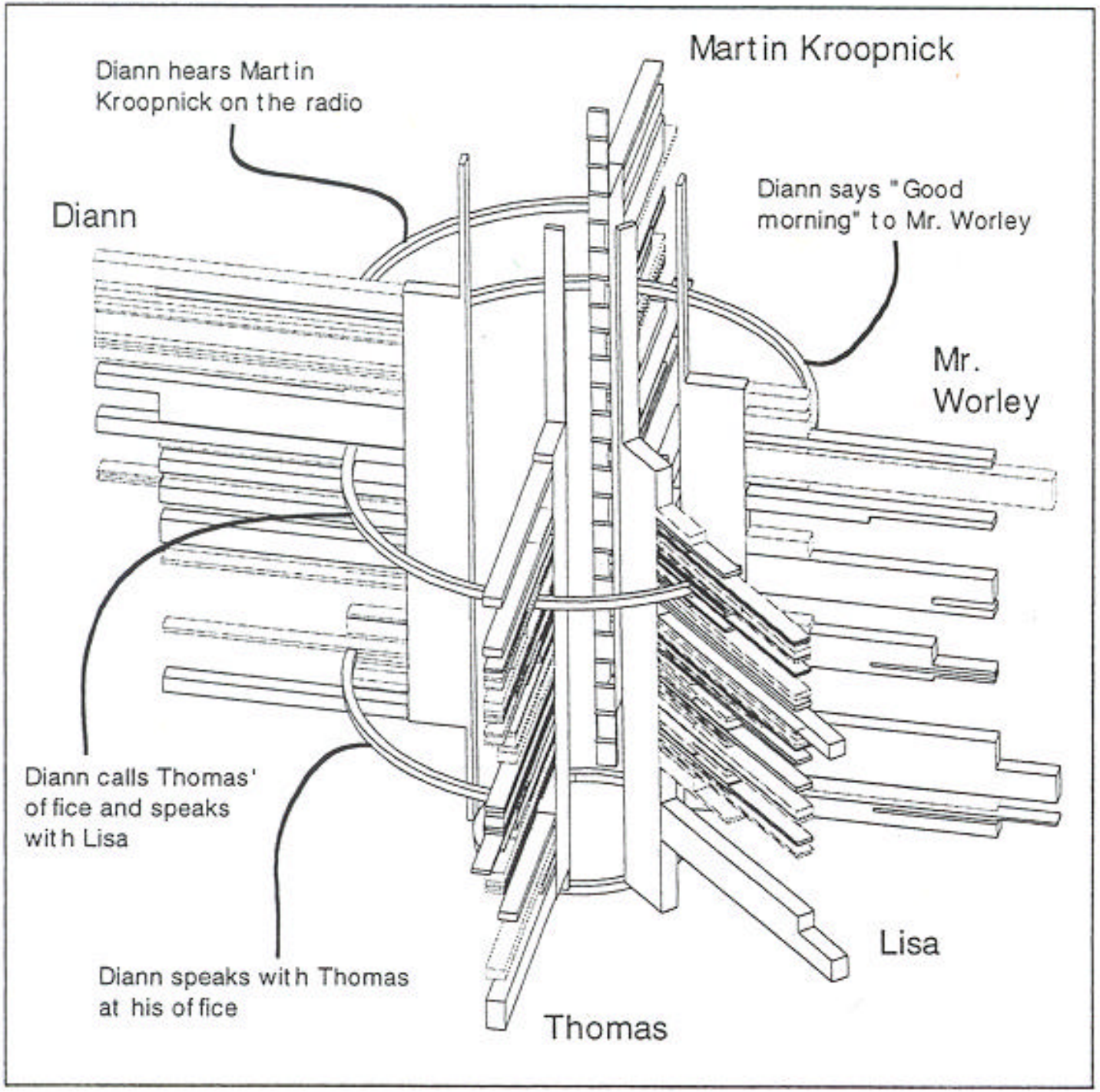
Recent Research Human Space-time Extensibility

- **Paul Adams** 'A reconsideration of personal boundaries in space-time' (1995); 'CAD-based accessibility model' (2000)
  - People as branching structures
  - The extensibility diagram
  - Linking micro and macro scales – the role of IT
  - Using CAD with data collected though personal interviews and detailed records of communication activities



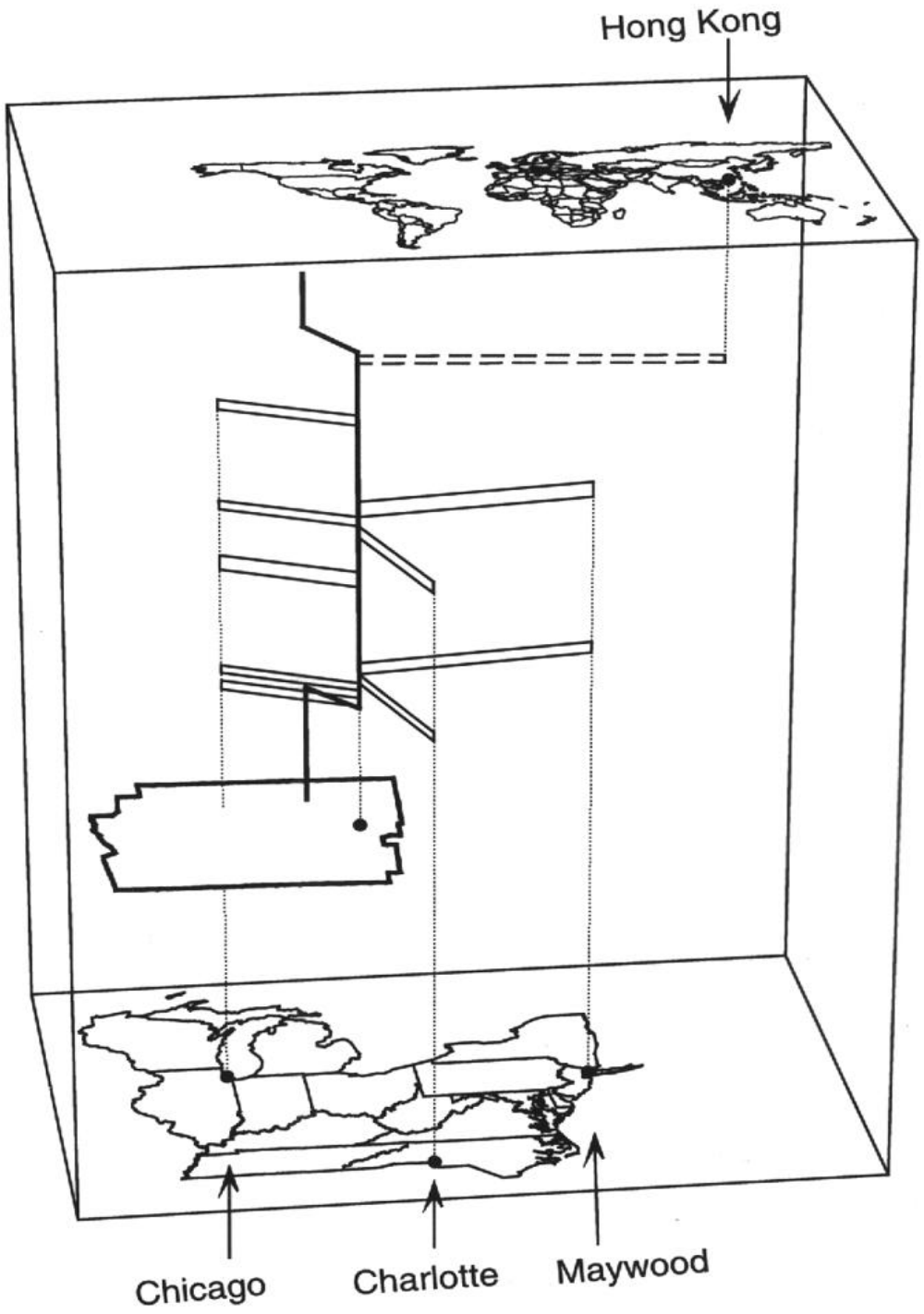
Diann's extensibility for a typical Thursday, autumn 1997

Paul Adams (2000)



Extensibility diagram linking Diann's communications with survey participants

Paul Adams (2000)



Multi-scale Extensibility diagram
3D GIS using data from Web browser logs and personal interviews

Mei-Po Kwan 2000

Embedding Time and Human Activity in Metropolitan Analysis

- **DOMA (Dimensions of Metropolitan Activity)** Halifax Canada

  Space-time budget surveys and analyses (Andrew Harvey 1971-72).

  – Approx 2100 one-day diaries spread over the week
  – 99 activity types (Multinational Time Budget Study, Szalai 1972)
  – space-time coded to resolution 1-min in time and 100 m in space

- **Time Geography of a Canadian City Project** (Janelle & Goodchild)

  Reconstructing "census-like" data for any time of day

  – Factorial ecology based on activity data instead of census data (who is where when? What are they doing and with whom?)
    - PARAFAC 3-mode solution (activities, space, and time)
  – What is the link between individual behavior and urban ecological structure?

Location Quotients – Concentration of Unmarried Respondents by time of day

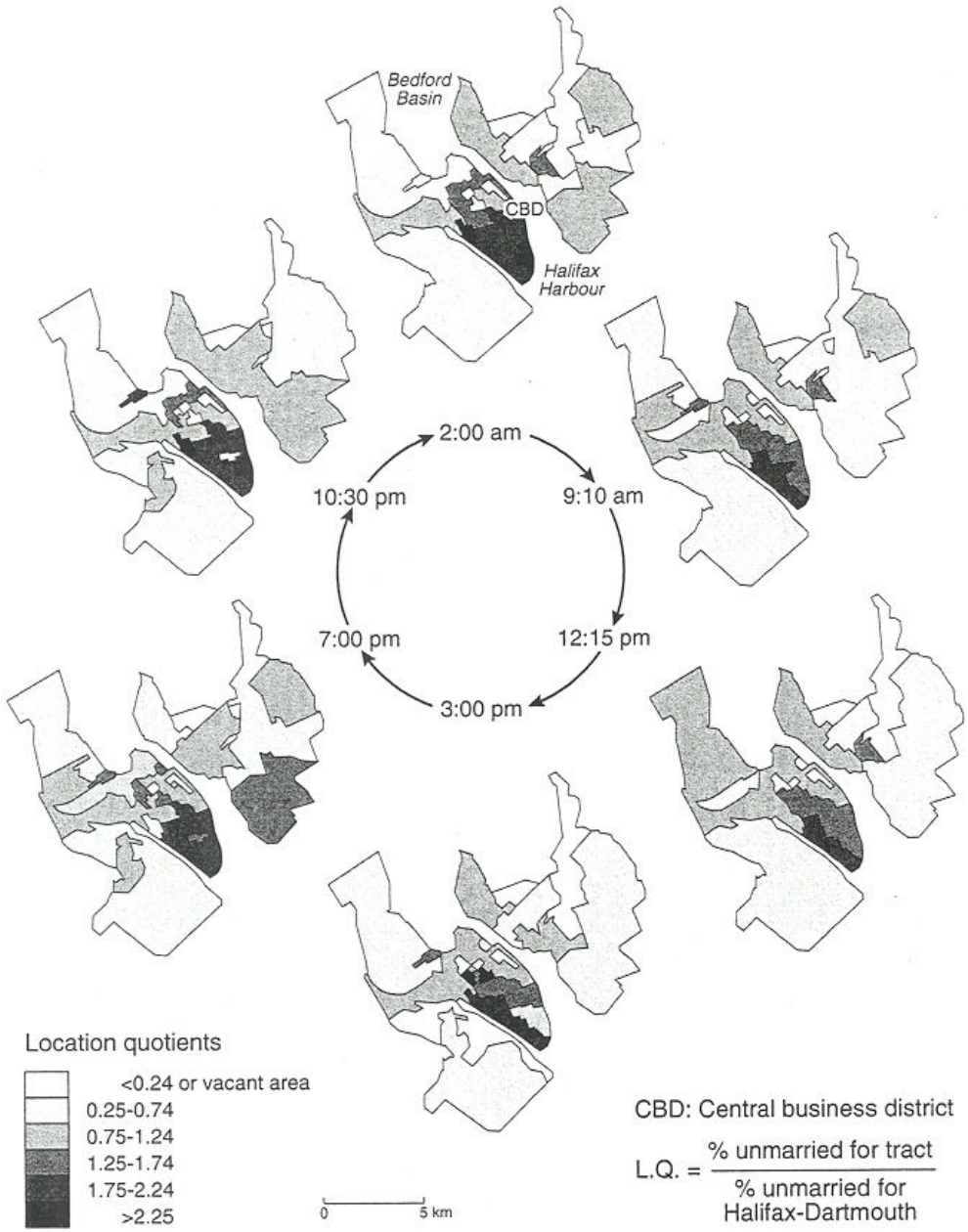


Figure 5.2
Diurnal variations in spatial concentration of unmarried respondents in Halifax-Dartmouth. Reproduced with permission from Janelle and Goodchild (1983: 412).

Diurnal Variations in the Spatial Correspondence of Subpopulations.

(Based on 32 Pseudo Census Tracts for Halifax-Dartmouth, Canada.)

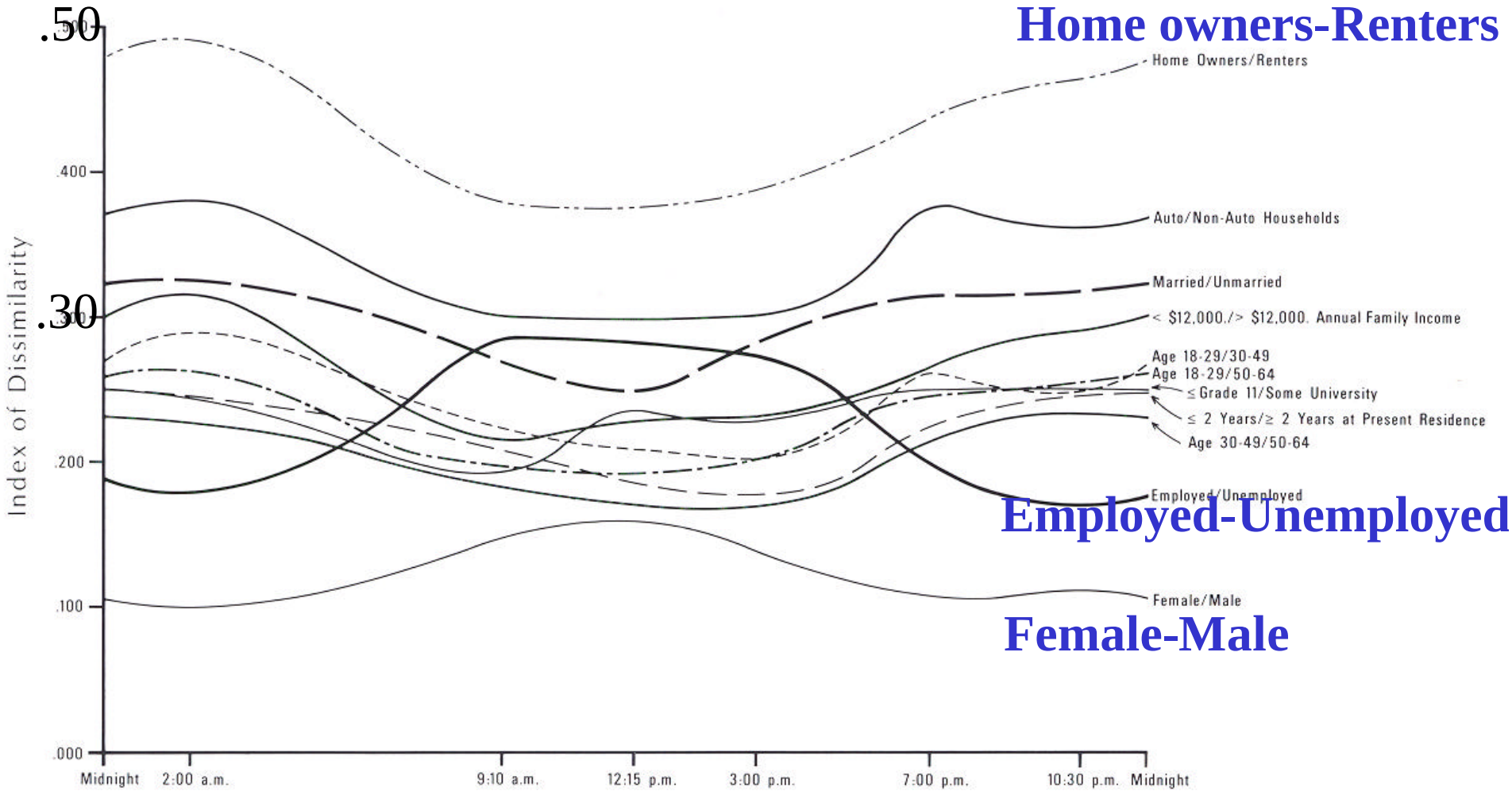


Figure 7

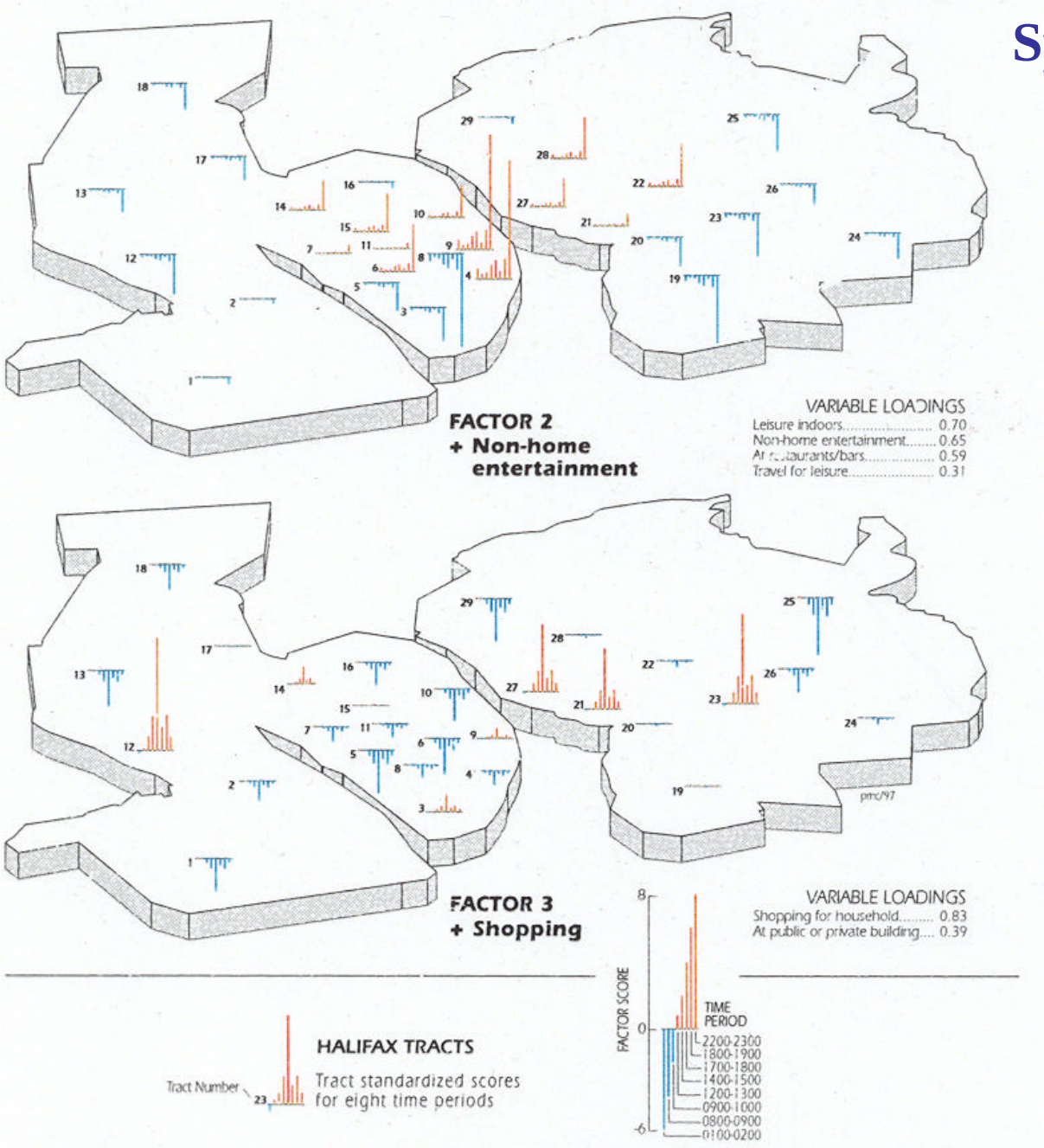
Home owners-Renters

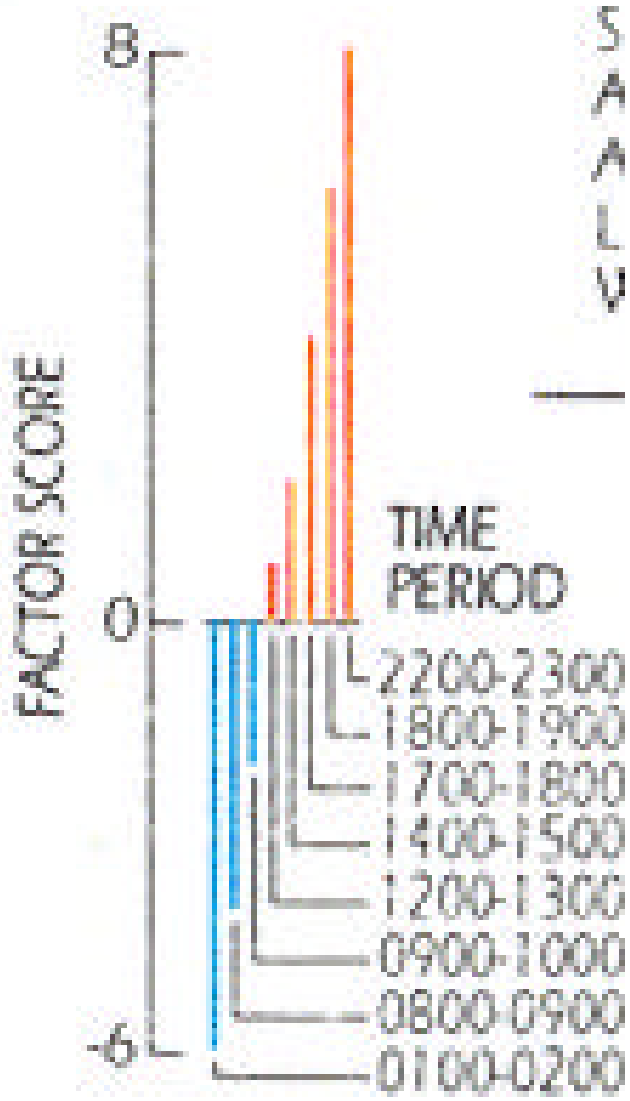
Employed-Unemployed

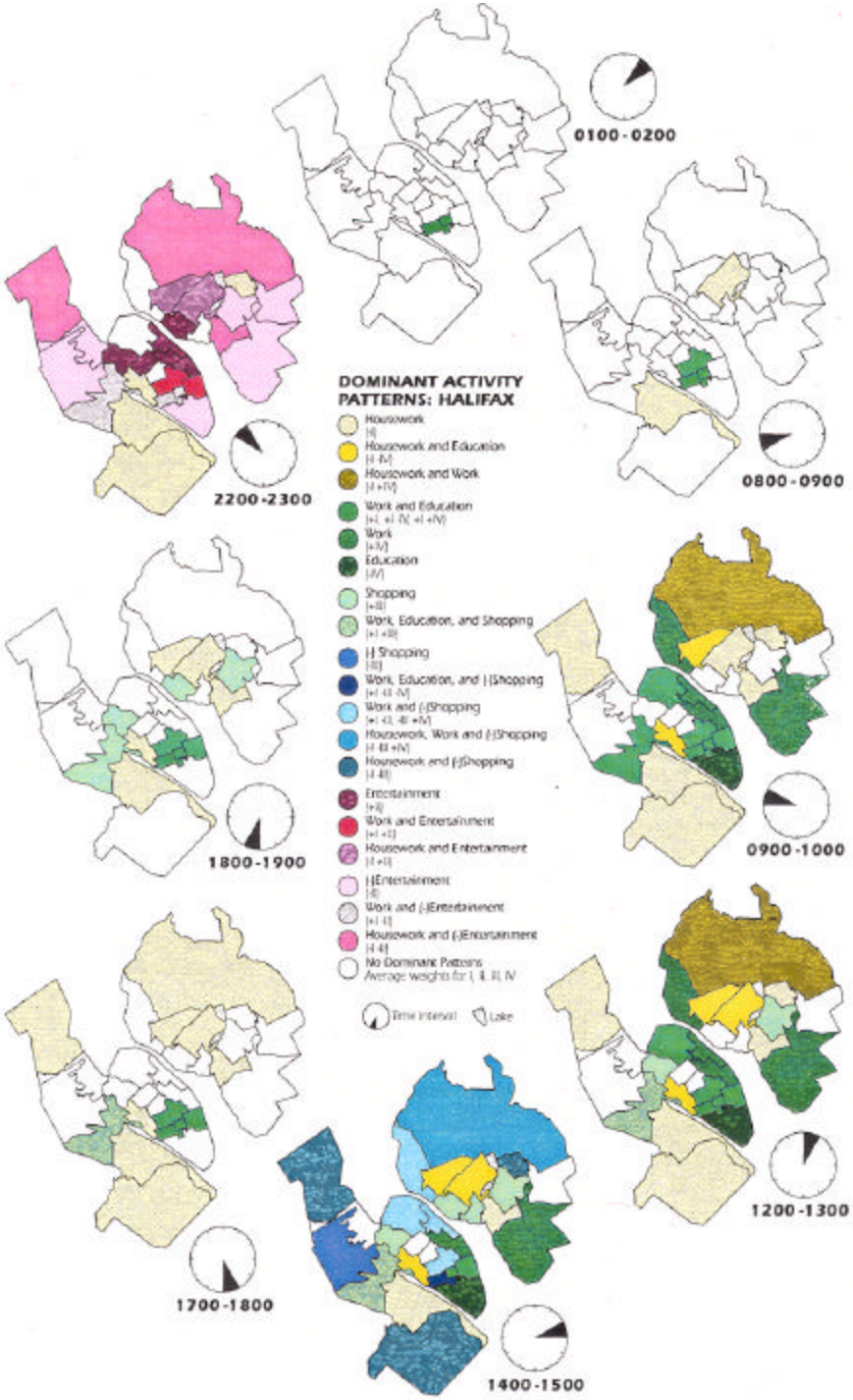
Female-Male

Index of Spatial Dissimilarity between subpopulations by time of day

Space-time Ecology of Human Activity in Halifax







Dominant Activity Patterns By Time of Day

Metropolitan ‘Time Policy’

- Chronomap systems for mobility (Sandra Bonfiglioli – Milan)
- Urban time-oriented policies
- Time Offices in Europe (Dresden / Paris)
- Uncharted terrain in spatio-temporal behavior (Guido Martinotti /Milan) of city “users” – residents / commuters / users / inter-metropolitan transients

Accessibility and information / communication technologies

Space Adjusting Technologies

transportation systems

communication systems

wireless communication

intelligent transportation systems

Location-based Services

Information Enhancement via

robotic systems

expert systems

smart cards

digital storage media

display technologies

voice recognition

image recognition systems

control systems

mobile wireless computing

. . . and more

Table 9.1. Spatial and temporal constraints on communication systems

		Spatial coincidence of communicating parties required	
		Yes	**No**
Temporal coincidence of communicating parties required	**Yes**	Face-to-face meeting **A**	Picture phone **B** Phone – (wire/cell/satellite) Teleconference (audio or audio-visual) Radio - CB/HAM/VHF Net phone Instant messaging Cuseeme
	No	Refrigerator notes **C** Hospital charts	Answering and recording machines **D** Mail/E-mail Telegrams, telex, fax Printed publications Computer conferencing

Source: Adapted from Janelle 1995

Trackability

- Consensual
  - Space-time activity diaries
  - Travel surveys
- Indirect surveillance
  - Zip code matching of Credit card expenditure patterns (M.J. Weiss, *The Clustering of America*; O.H. Gandy Jr. *The Panoptic Sort*)
- Direct real-time surveillance
  - Cameras, mobile phone, GPS, telemetry

Location Based Services

- An LBS ". . . is an information service that exploits the ability of technology to know where it is, and to modify the information it presents accordingly" (MF Goodchild). [E.g., wireless GPS in real-time navigation]
- The Global Positioning System and cellular technologies enable new devices that know where they are, and are capable of modifying the information they collect and present based on that knowledge.
- The U.S. *Wireless Communication and Public Safety Act* (1999) permits operators of cellular networks to release geographic locations of users in emergency situations. [Tracking devices are now required in cell phones sold in the U.S.]
- New electronic services are being developed / offered to find locations, compute routes, identify nearby businesses and other facilities, notify of proximal events, report and find a stolen vehicle, Mayday alert, etc.

Location Service Concepts

- The Device
  - Cell phone
  - Palm top
  - Lap-top
  - Kiosk
  - Car-based computer
  - Cell antenna
  - Mobile device
  - Display
- Actors
- The Location
  - Point and Reference
  - Segmented Line
  - Address
  - Route
  - Descriptive Directions
  - Gazetteer
  - Direction
  - Polygon
- Payload Items
- The Service
  - Routing
  - Avoiding Traffic
  - Tourism
  - Regional Attractions
  - Event Handling
  - Maps and Backdrops
  - Guidance
  - Preference
- Service Providers

From T. John Kim, 2002

Issues Regarding LBS

- Use of LBS to support primary data capture in space and time -- by whom, for what purpose, and why?
- What new industries will emerge from LBS, and where? [E.g., new tools for visualization and analysis]
- What new forms of social / economic behavior are enabled? [Will surveillance uses undermine some current activity patterns or allow others?]
- What will be the implications of such behavior on regional development and on the social capital of places?
- Privacy, ethical, and security issues?

See www.csiss.org/events/meetings/location-based/

Challenges in Research and in Policy

- Facilitating constructive uses of new information and communication technologies to enhance accessibility
- Protecting/respecting individual autonomy over personal information and behavior
- Protecting/respecting a minimum basic economic and cultural autonomy for places, regions, and nations