

Spatio-temporal Approaches to Understanding Human Behavior and Social Organization

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Innovating · Collaborating · Sharing

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spatial@ucsb
perspectives for teaching and research

Objective I:

To explore Geo-Information/communication technologies—implications for:

- Individual space-time behavior
- Space-time social ecology of cities & regions (i.e., behavioral settings)

Why?

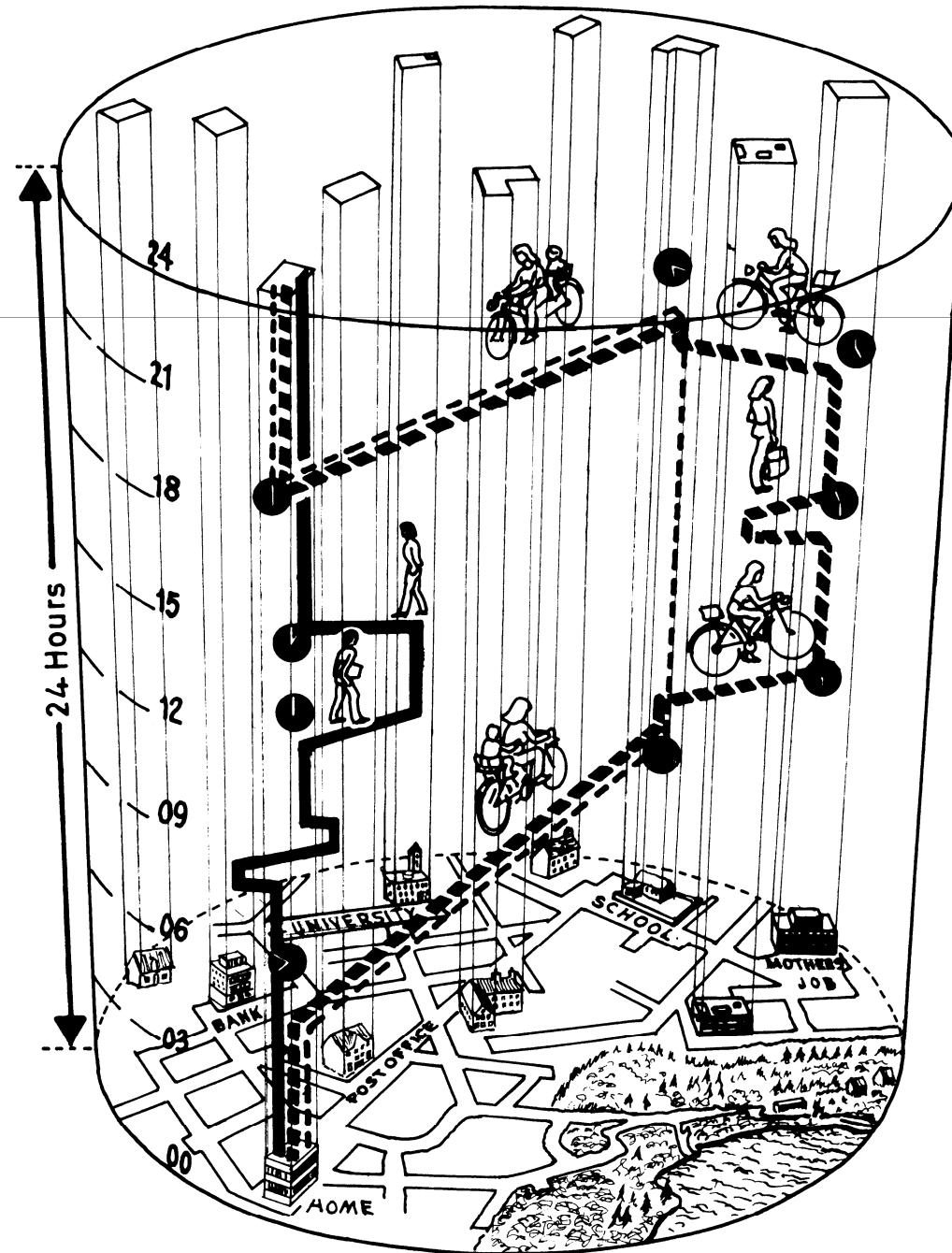
- Geo-ICT influences social consciousness of space, place, & time:
 - Conditioning theoretical perspective & application possibilities
 - Influencing individual decisions & social policies
- Causal reflexivity
 - individuals upon space & place
 - spaces & places (social ecologies) upon individuals

Objective II:

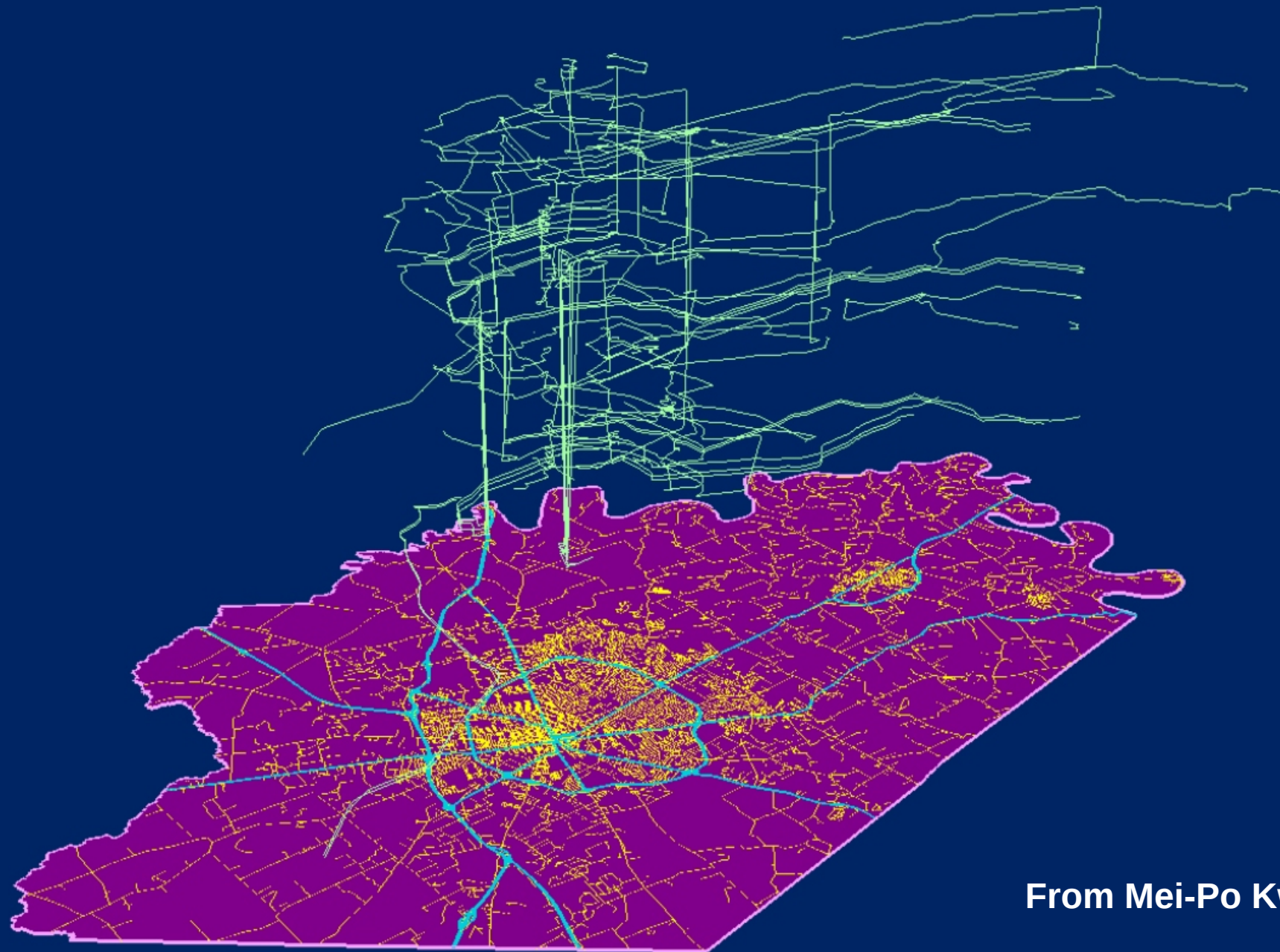
To suggest new information retrieval & display capabilities for :

- Real-time, on-the-fly aggregation
 - Flexible by time and space from individual data
 - Flexible by demography & social attributes from individual data
- Publically accessible, **But:** protective of individual rights to location privacy

Individual Space-time Behavior



Individual
paths in time-
space — after
Hägerstrand



From Mei-Po Kwan

Space-time Perspectives on Individual Activities

- Time-geography —Torsten Hägerstrand
 - Geo-visualization of space-time paths—Mei Po Kwan/Shih-Lung Shaw
- Space-time extensibility—D Janelle/P Adams

Human Space-time Extensibility

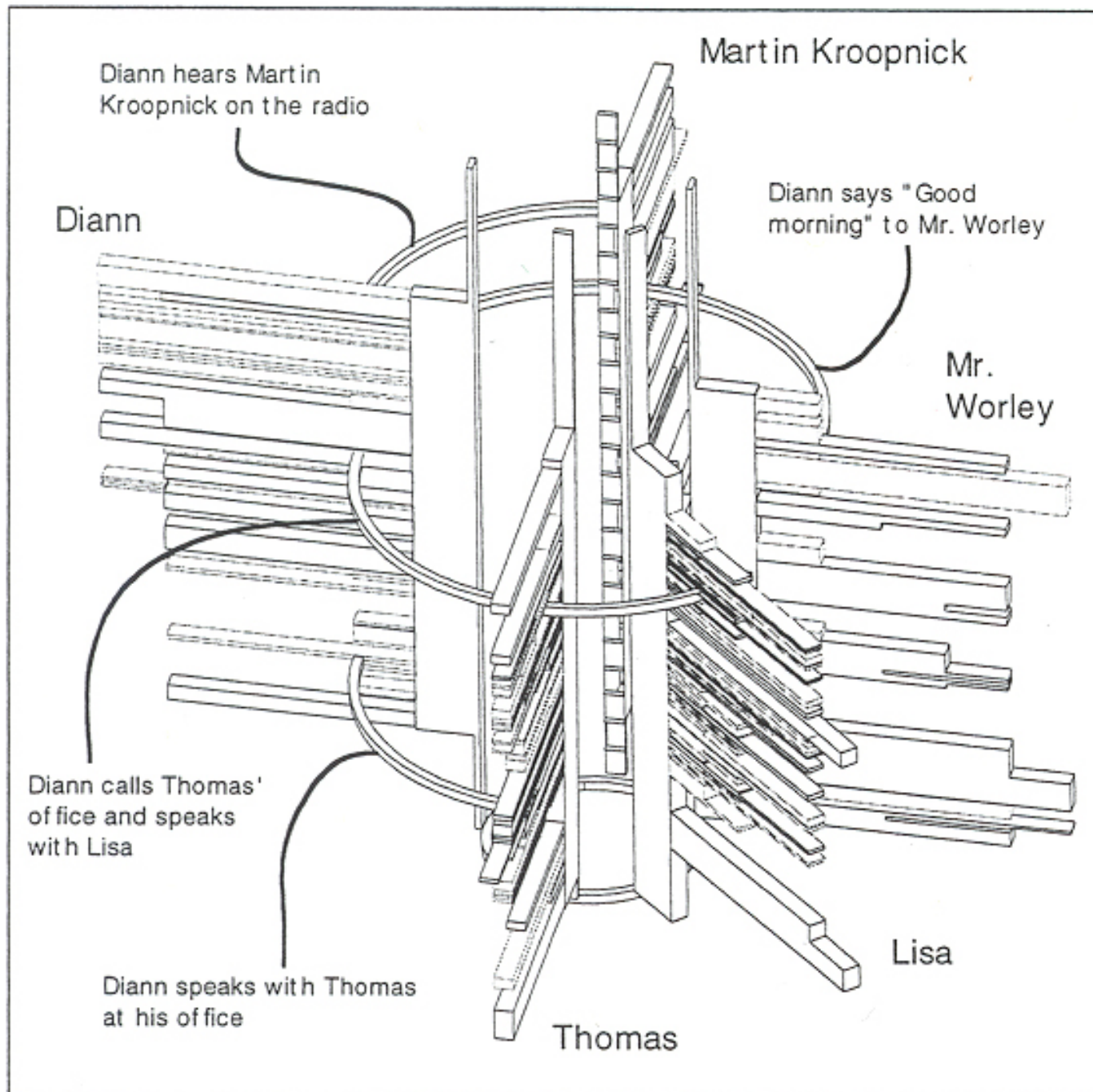
- Interaction beyond one's immediate physical presence
- Projection of authority & presence over space & time
- Parallels Anthony Giddens' 'time-space distancing' (1981, 1984)
 - Stretching social systems across space & time

Adams on Human Space-time Extensibility

- **Paul Adams (2000)**
 - People as branching structures
 - Linking micro and macro scales — the role of IT
 - Using CAD with data from personal interviews & detailed records of communication activities

Extensibility Diagram

linking Diann's
communications
with other
survey
participants



Paul Adams (2000)

Some New Realities for Individual Behavior

- Techno-enabled **multi-tasking** & **hyper-mobility**
- **Virtual tools** (e.g., wireless Internet) link **mobile objects** (pedestrians, vehicle operators, public transit riders) to broader social systems and networks
- **VGI** volunteered geographic information (M Goodchild) as a new virtual form of human extensibility

Hypotheses about Changing Human Activity Patterns

Helen Couclelis

- Growing **space-time disconnect** between activities & places and between activities & times
- Increasing **fragmentation** of activities & events
- Decreasing reliability of behavioral models for capturing the complexities of human interactions

Discontinuities in Space-time Paths

- Individuals as *agents* can:
 - do more than one thing at a time
 - occupy more than one place at a time (virtually)
 - occupy more than one time at a place (virtually)
 - interact with others independently of their presence
- Individuals as *mobile objects* can be:
 - traced continuously in space & time
 - intercepted in-route
 - redirected along new space-time trajectories
 - archived into long-term surveillance databases
- Individuals as members of *networks* can:
 - be independent of place or dependent on place
 - coalesce into ad hoc groups to meet temporary objectives
 - be stable even though locations of members change

Communication Options and Constraints on Interactions			
		Spatial Coincidence Required?	
		Yes Transportation Dependent	No Transportation Not Needed
Temporal Coincidence Required?	Yes Synchronous	Face-to-Face meeting Requires coordination Allows intense, rich, & personal communication Very High Costs	Telephone (wire, wireless, net), teleconference (audio / audio-visual), Text messaging, radio (CB/HAM,VHF). May need complex coordination Reduces Costs
	No Asynchronous	Refrigerator notes Hospital charts, mail Eliminates coordination Reduces Costs	Answering machines, voice mail, e-mail, telegrams, telex, fax, computer conferencing, podcasting, printed publications Eliminates coordination Very Low Costs

Adapted from Janelle (1986, 1995, 2004), Mitchell (1999), Harvey (2000), van Geenhuizen (2002)

Space-time Perspectives on Behavioral Settings

- Time Landscapes – Barbara Adam
 - Time Ecology – Martin Held/Gus Koehler
 - Chronomaps – Sandra Bonfiglioli
- Space-time Social Ecology of Cities
 - D Parkes & N Thrift / M Goodchild & D Janelle

Paths to Space-time Urban Ecological Analysis / Modeling

1800s Population Census

Early 1900s Time & activity diaries / Social ecology

1940s – 1950s Daytime population / Social area analysis . .

1960s – 1970s Census factorial ecology

1960s Time geography

1970s Space-time diaries / Space-time ecology

1980s GIS / Spatial demographics

1990s GPS / GIS / Time geography

2000s Space-time diaries / GPS / GIS

Time geography / Space-time ecologies

Web 2.0 / Voluntary geographic information (VGI)

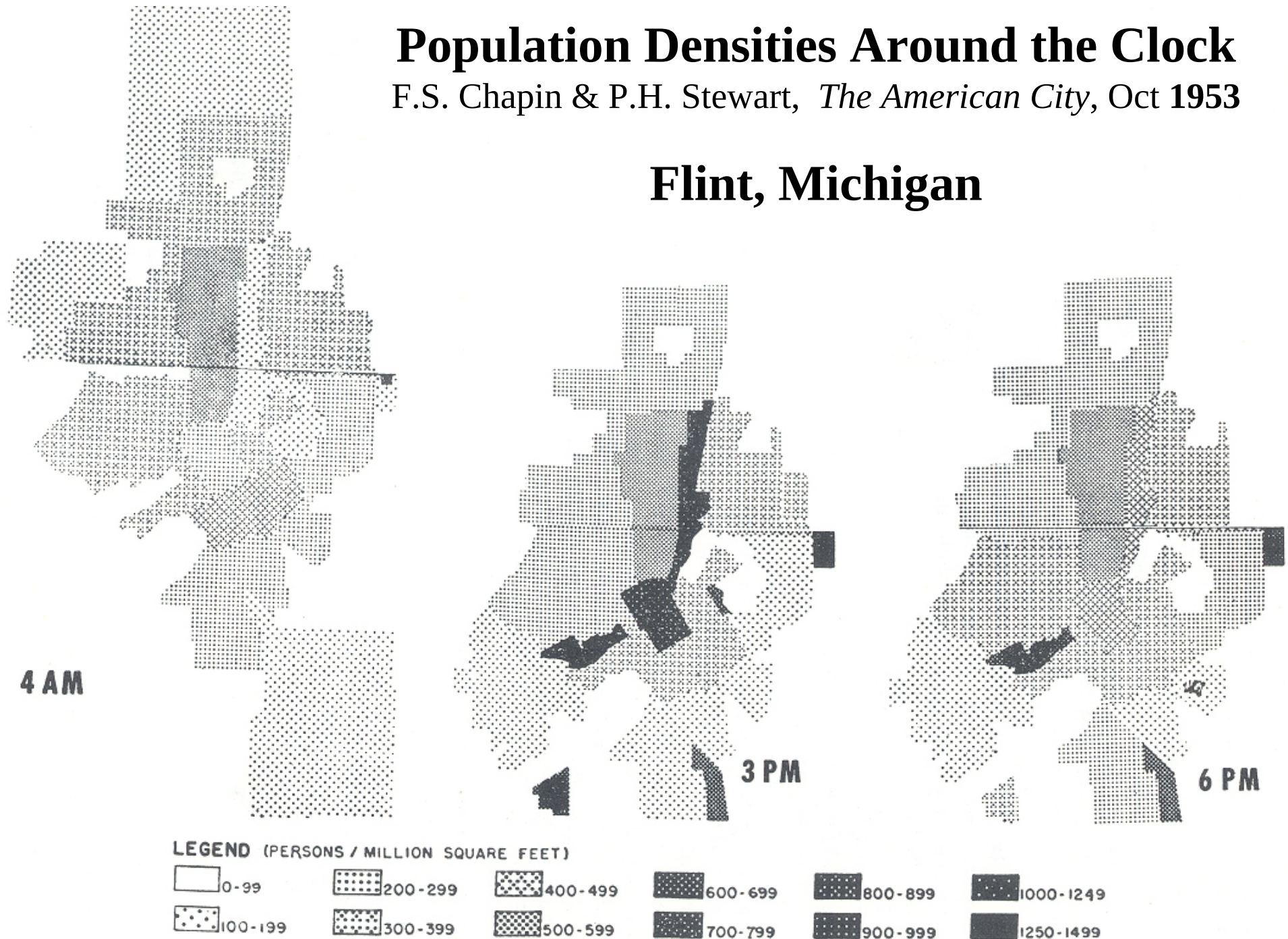
Early Interest in Space-time Ecology of Cities

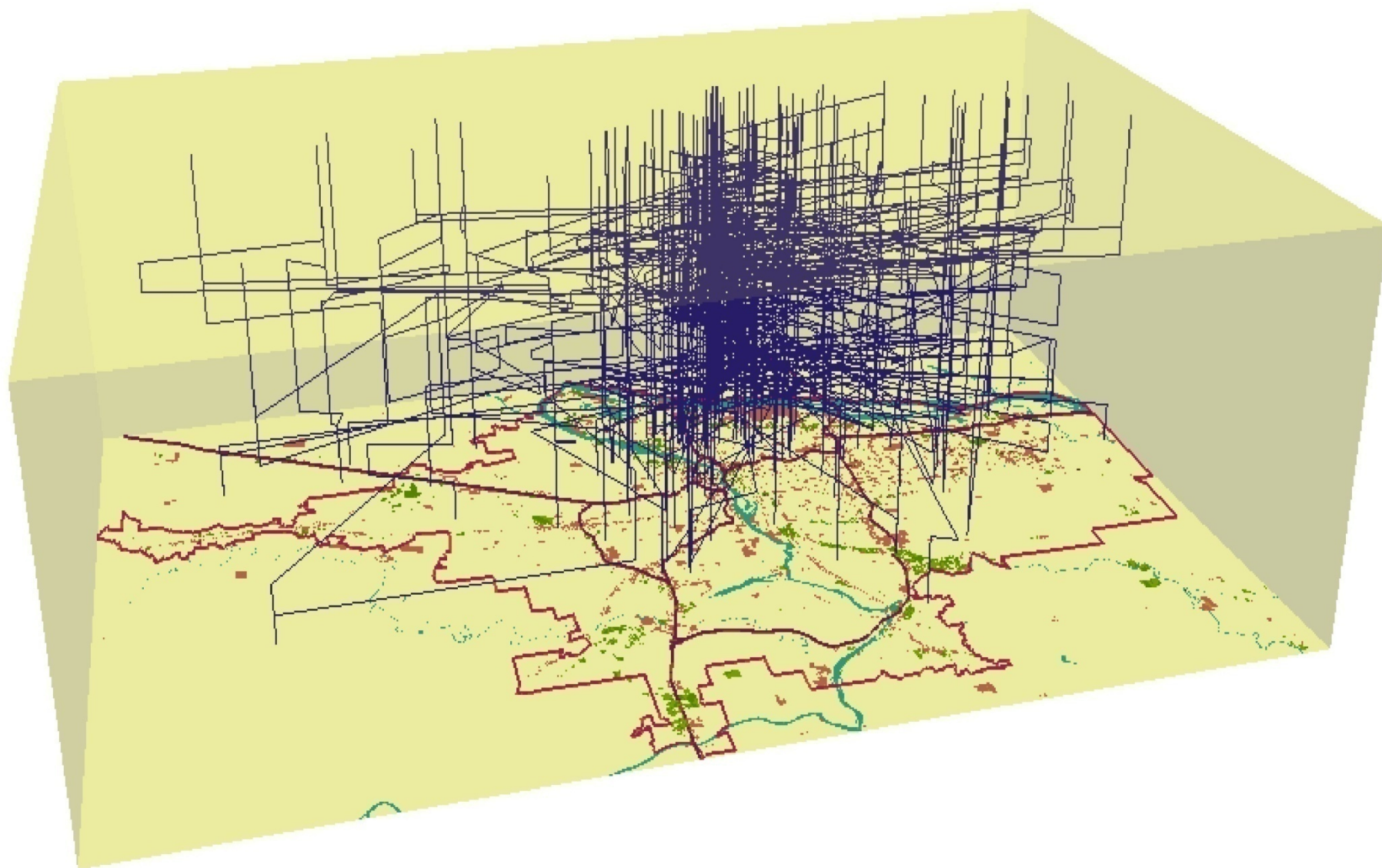
- Conceptual:
 - Chicago School of Urban Ecology 1920s–1940s
 - G Engel-Frisch, Temporal Aspects of Human Ecology 1948
 - Amos Harley, Human Ecology 1950
- Empirical / Enumeration:
 - F Stuart Chapin, Population Densities Around the Clock 1953
 - Donald Foley, Urban Daytime Populations 1954
 - RC Schmitt, Estimating Daytime Populations 1956
- Conceptual / Computational / Static:
 - E Shevky & W Bell, Social Area Analysis 1955
 - R Murdie & others, Factorial Ecology late 1960s/early 1970s
- Conceptual / Computational / Dynamic:
 - D Parkes & N Thrift, Factorial-ecology in space & time 1975
 - MF Goodchild & DG Janelle, Time-geography of cities, 1982-97

Population Densities Around the Clock

F.S. Chapin & P.H. Stewart, *The American City*, Oct 1953

Flint, Michigan





From Mei-Po Kwan

Time Geography of a Canadian City Project

(Janelle & Goodchild)

- Space-time activity survey of Halifax (A. Harvey)
 - Approx 2100 one-day diaries spread over the week
 - 99 activity types
 - Resolution 1-min in time and 100 m in space
- Creating “census-like” data by time of day
 - Based on activities (Who is where when? What are they doing? with whom?)
- 3-mode factor analysis (activities, space, time)

Location Quotients – Concentration of Unmarried Respondents by Time of Day

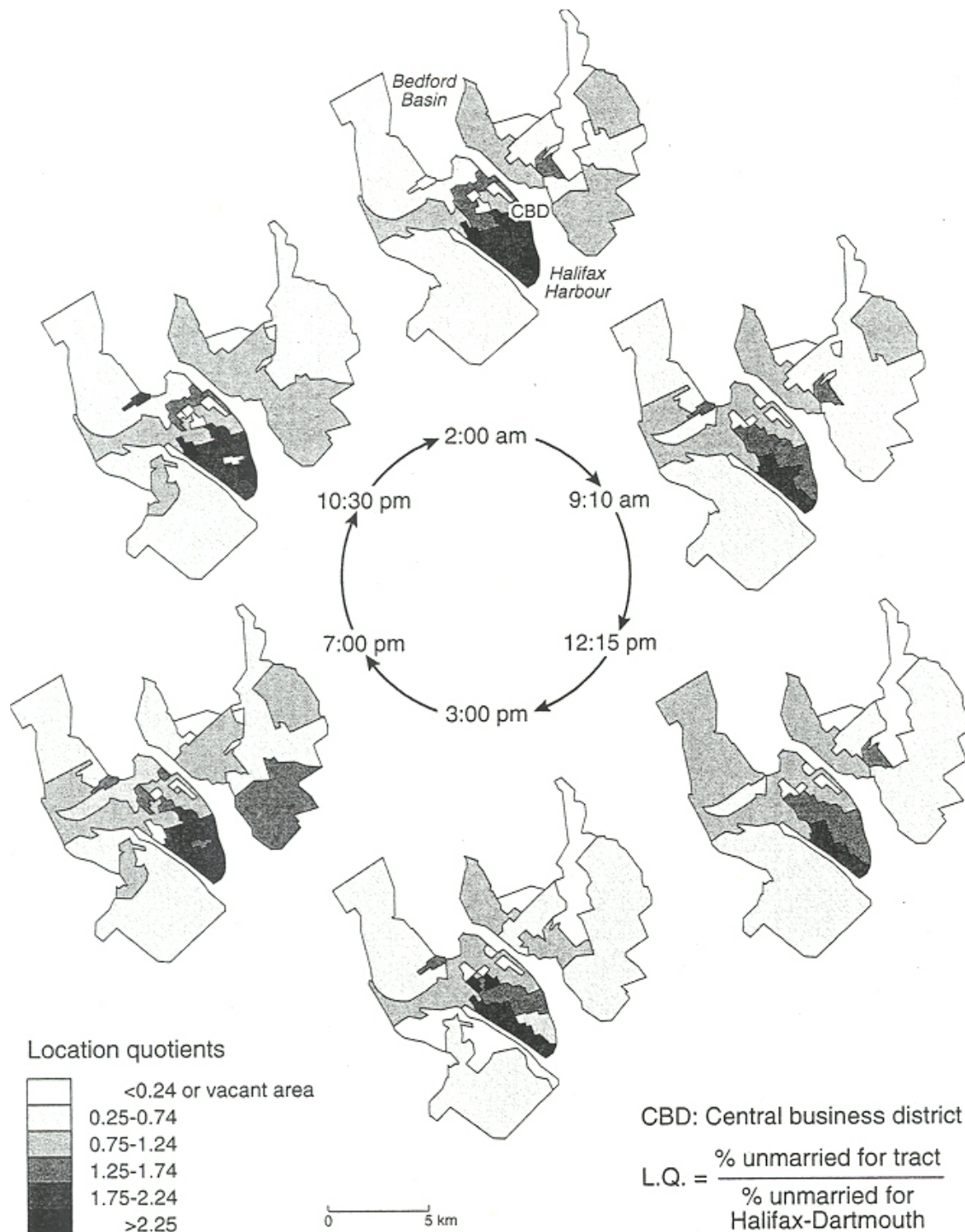
Space-time measures for subpopulations:

- densities
- segregation indices

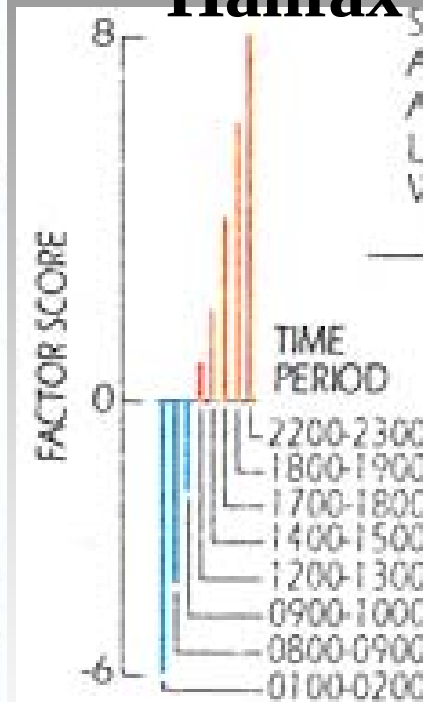
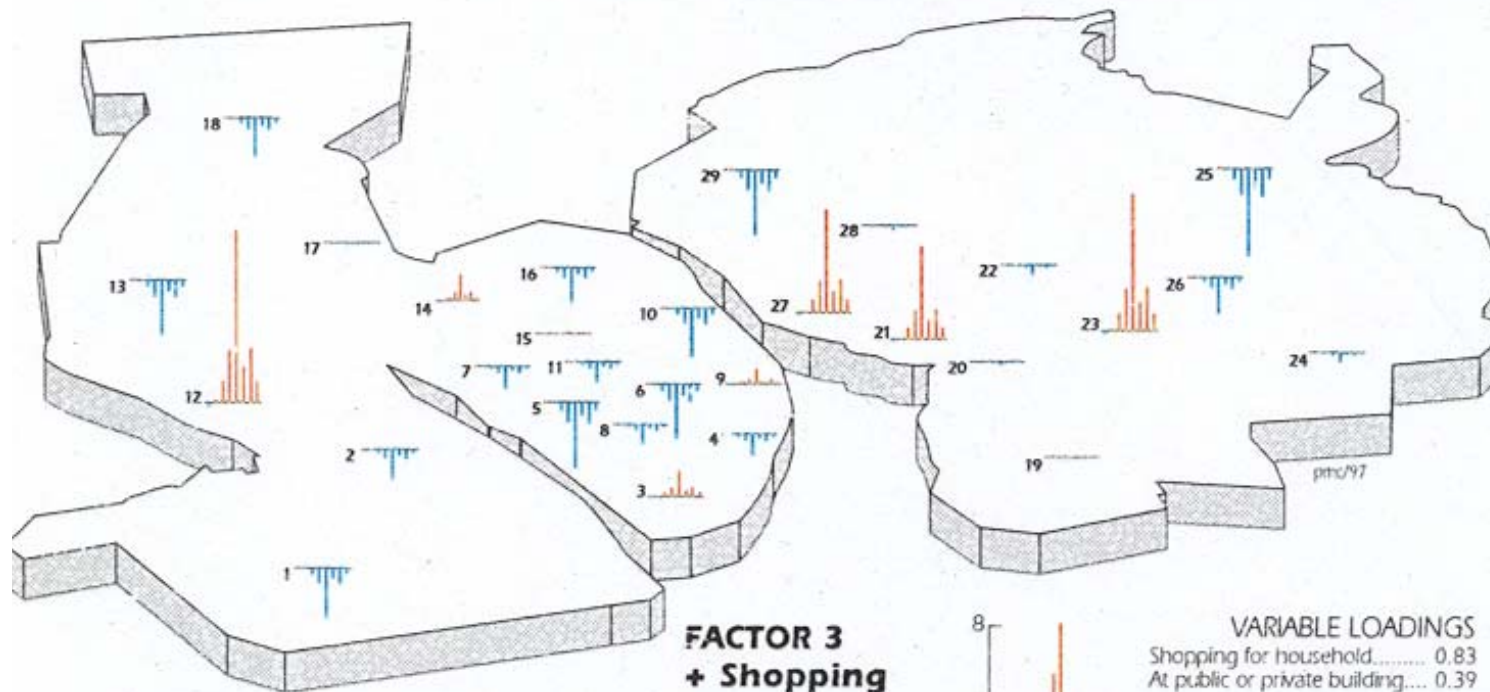
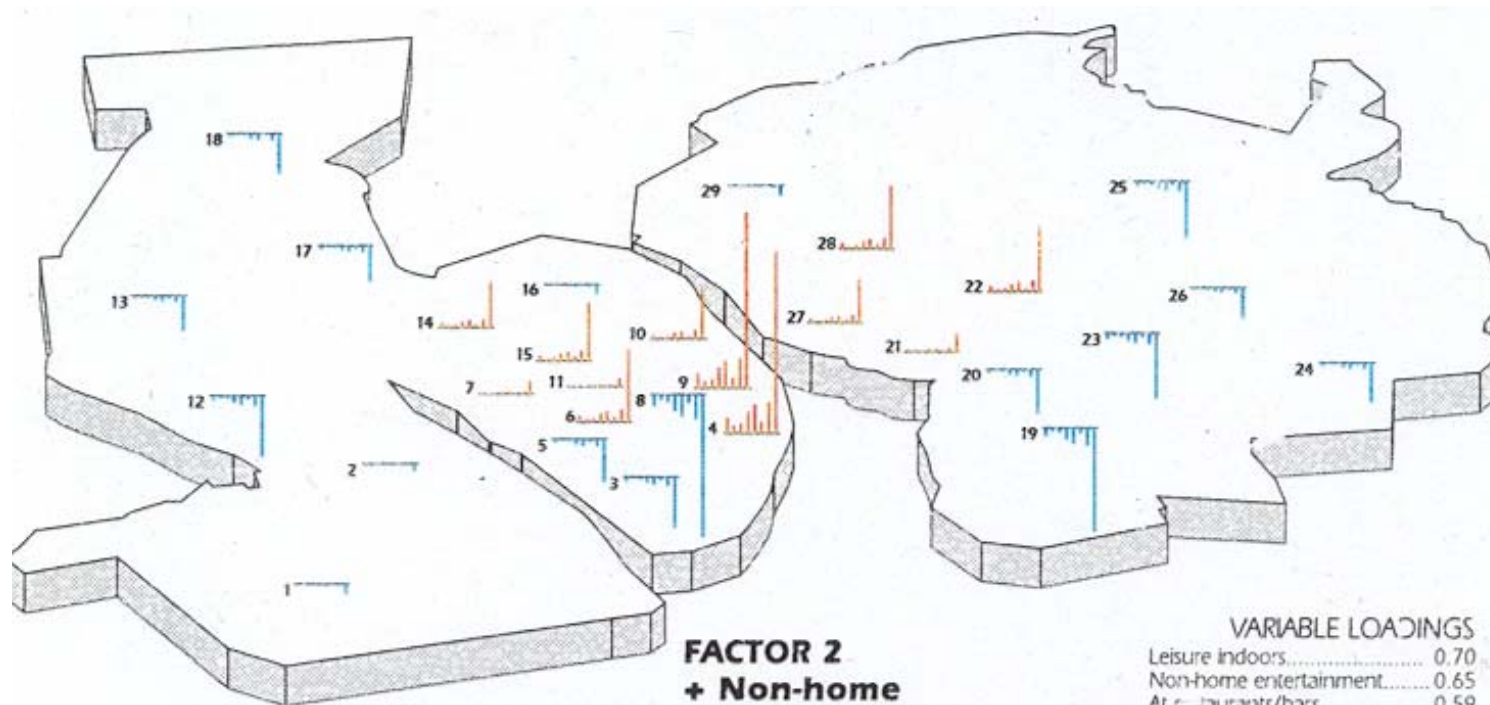
From space-time paths:

- activity times & spaces, durations, sequences, fragmentation
- average trip speeds
- activity dispersal, range

Janelle & Goodchild, 1983



Space-time Ecology of Human Activity Halifax



*Janelle,
Klinkenberg &
Goodchild, 1997*

What is the link between individual behavior & urban ecological structure?

Objective II

To suggest new information retrieval & display capabilities

Real-time, on-the-fly aggregation

Individual data

Flexible by time & space

Flexible by demography & social attributes

Publically accessible, **But:** protective of individual rights to location privacy

The Case for Synoptic Mapping

Synoptic Analysis

(Climatology, meteorology, oceanography)

- **Analyzing processes** of short & long duration over space
- **Fixed & mobile distributed information sensors** for continuous real-time coverage
- **Integrated data archives** for aggregation at any spatial scale or temporal period
- **Modeling** & visualization tools to **describe & analyze** changes in patterns & to **render results on demand**
(e.g., weather map; hourly, daily, seasonal forecasts)

Dynamic Mapping of Urban Social Synoptic Patterns

Imagine

- Having/using massive amounts of dense tracking data from stationary & mobile sensors for **dynamic conversion into mapped synoptic real-time patterns, index measures, & forecasts**
- drawing on data **archives to analyze trends** over any unit of time for different aggregations of space & for different aggregations of people
- **Modeling changing patterns** over space based on refined temporally-sensitive data streams about locations & activities of the population

Possible Dynamic Maps of Urban Social Synoptic Patterns

- Diurnal, weekly, & seasonal shifts in population densities by subpopulations
- Temporal variations in social group integration & spatial concentration by regions/small areas
- Risk exposures to geographically distributed hazards
- Surface representations of average travel speed, congestion, & other indexes of traffic by neighborhood or road segment

Challenges to Dynamic Urban Social Ecology

- Managing & protecting the data
- Demonstrating worthwhile applications, e.g.:
 - Permitting transportation synchronization to changing needs
 - Promoting social capital at neighborhood levels
 - Evaluating time policies on work schedules / services
 - Enhancing responsive emergency services
 - Building space economies from principles of equity, social cohesion, quality of life, & sustainability
- Adding **theoretical understanding of process rules / testing hypotheses** in a dynamic world
- Designing data capture & display systems that **honor the individual's right** to shield identity & protect **location privacy**
- **Avoiding intrusive & unsafe demands** on respondents
 - See 2007 NRC report *Putting People on the Map: Protecting confidentiality with linked social-spatial data.*

A Space-time Testbed

- Begin with archive of individual-level data to represent occupants of a hypothetical/real city or region
- Log the hypothetical/real whereabouts, activities & attributes of individuals over their lifetimes, including current real-time information capture
- Create **Testbed** for Education & Development to:
 - Design & compare approaches to data assembly & aggregation
 - Evaluate trade-offs between location privacy & the scientific benefits of access to individual-level activity archives
 - Develop synoptic index measures & visualizations
 - Assess methods to protect individual confidentiality & guard against malevolent uses
 - Test scientific hypotheses
 - Compare socio-economic or land-use plans & policies at different levels of spatial organization & durations

Conclusions

- Tools are at hand for integrating space-time concepts with the realities of documented dynamic behavior
- A testbed may help in developing new ways to portray the dynamics of ever-emergent social geographies
- Understanding of dynamic social ecologies can yield refined theory & modeling for applied uses
- Entering new territory that will test the ethical bounds of space-time analyses in the social sciences
- Capturing the sense of our dynamic world will set the paradigm that defines the future for more responsive decision making & for better understanding of human social organization

Thank you



References:

- Adam, B. (1998). *Timescapes of Modernity : Environment and Invisible Hazards* (London: Routledge).
- Adam, B. (1995). *Timewatch: The Social Analysis of Time* (Cambridge: Polity Press)
- Adams, PC (2000). Application of a CAD-based Accessibility Model. In DG Janelle and D Hodge, eds. *Information, Place, and Cyberspace: Issues in Accessibility* (Berlin: Springer-Verlag), 217-239.
- Bonglioli S. [1997] Cronotopos, Il tempo e la citta fra natura e storia. Atlante diprogetti sui tempi della citta, *Urbanistica Quaderni*, INU, Roma (Italy).
- Chapin, FS & P.H. Stewart (1953). Population Densities Around the Clock, *The American City*, Oct.
- Engel-Frisch G, (1948), "Some neglected temporal , aspects of human ecology" *Social Forces* 22 43 -47
- Foley D L, 1954, "Urban daytime population: a field for demographic-ecological analysis" *Social Forces* 32 323-330
- Gandy, O.H. (1993). *The Panoptic Sort: A Political Economy of Personal Information*. (Boulder, CO: Westview Press).
- Giddens A. (1984). *The Constitution of Society: Outline of the Theory of Structuration*. Berkeley, CA: University of California Press.
- Goodchild, MF and DG Janelle (1984). The City Around the e Clock: Space-Time Patterns of Urban Ecological Structure *Environment and Planning, A* 16: 807–820.
- Hägerstrand, T (1970). What about People in Regional Science? *Papers of the Regional Science Association* 24:7-21.
- Hawley A, (1950). *Human Ecology: A Theory of Community Structure* (New York: Ronald Press
- Held, M. and K. Geißler, (eds). (1993). *Ökologie der eit. Vom Finden der rechten Zeitmaße* (Stuttgart: Universitas).
- Janelle, DG, MF Goodchild, and B Klinkenberg (1998).The Temporal Ordering of Urban Space and Daily Activity Patterns for Population Role Groups. In: R. G. Golledge and M. Egenhofer (Eds) GIS and Disaggregate Behavioral Travel Modeling, Special Issue, *Geographical Systems: The International Journal of Geographical Information, Analysis, Theory and Decision*, 5 (1–2): 117–137.
- Janelle, DG (1973). Measuring Human Extensibility in a Shrinking World. *The Journal of Geography* 72(5):8-15
- Janelle, DG, and A. Gillespie (2004). Space-time Constructs for Linking Information and Communication Technologies with Issues in Sustainable Transportation, *Transport Reviews* 24, no. 6: 665–677.
- Janelle, DG, and MF Goodchild (1983). Transportation Indicators of Space-Time Autonomy, *Urban Geography* 4 (Oct–Dec): 317–37.
- Janelle, DG, and MF Goodchild (1983). Diurnal Patterns of Social Group Distributions in a Canadian City, *Economic Geography* 59 (Oct): 403–25.
- Kwan, M-P (2000). Human Extensibility and Individual Hybrid-accessibility in Space-time: A Multi-scale Representation Using GIS. In DG Janelle and D Hodge, eds. *Information, Place, and Cyberspace: Issues in Accessibility* (Berlin: Springer-Verlag), 241-256.
- Kwan, M-P (2004). Geovisualization of Human Activity Patterns Using 3D GIS: A Time-geographic Approach. In MF Goodchild and DG Janelle, eds. *Spatially Integrated Social Science* (New York: Oxford University Press), 48-66
- Mitchell, WJ (1995). *City of Bits: Space, Place, and the Infobahn*. (Cambridge, MA: The MIT Press).
- Schmitt R C, 1956, "Estimating daytime populations" *Journal of the American Institute of Planners* 2283-85
- Szalai A (Ed.), 1972 *The Use of Time, Proceedings of the World Time-Budget Study (The Hague: Mouton)*
- Taylor P J, Parkes D N, 1975, "A Kantian view of the City: a factorial ecology experiment in space and time" *Environment and Planning A*, 7: 671-688.
- Weiss, M. J. (1989). *The Clustering of America* (Harpercollins).