Time-Space Convergence and Changing Accessibility Patterns for Cities and Regions

Donald G. Janelle
Center for Spatially Integrated Social Science
University of California, Santa Barbara

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Question: How do Human Settlement Systems Evolve?

Inspiration:
• Walter Christaller’s Central Place Theory
• James Blaut—“Structures of the real world are simply slow processes of long duration” 1961
  – A time-space view of reality
• P.W. Bridgman’s *A Sophisticates Primer of Relativity* 1963 Locations, Velocities, Directions

Premises:
• Things are where they are having moved there
• Human geography is, in significant part, a product of the effort required to overcome distance
  » time-distance
  » cost-distance
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
Average Time-Space Convergence

Land
60 min/yr (1658-1966)

Land - Air
29 min/yr (1776-1966)

Railroad
3.4 min/yr (1850-1966)
TIME-SPACE CONVERGENCE
NEW YORK TO BOSTON
1800 - 1965

Avg TSC
26 min/yr
Presentation Agenda

• Experiments in Measuring TSC
• TSC and Settlement System Response
• Stagecoach Networks – Early 1800s
• Highway Development – Mid 1900s
• Speed Limits on Interstate Highways
• Transport Culture and the Economy of Speed
Measuring Time-space Convergence

Hypothetical Situation:
• Line World
• Uniform Travel Speeds
• Uniform Increases in Travel Speeds
Travel-time from A at 25 mph in 1960 (minutes)

24   48   72   96   120

Travel-time from A at 50 mph in 1980

12   24   36   48   60

CONVERGENCE RATES
1960–1980 (minutes per year)

.6    1.2   1.8   2.4   3.0

TIME-SPACE CONVERGENCE
Time-Space Convergence
Settlement-System Development

• Demand for Accessibility
• Locational Utility
• Innovation Search and Adoption
• Spatial Adaptation Strategies
Increase in Locational Utility
A PROCESS OF
SPATIAL REORGANIZATION

DEMAND FOR ACCESSIBILITY

TECHNOLOGICAL DEVELOPMENT

SEARCH

LOCATIONAL UTILITY

TRANSPORT INNOVATION

INCREASING INTERACTION

SPATIAL ADAPTATIONS TO CHANGES IN TIME-SPACE ORGANIZATION (CENTRALIZATION AND SPECIALIZATION)

TIME-SPACE CONVERGENCE
An Expanded Model of the Process of Spatial Reorganization

Spatial Adaptation:
1) Decentralization
2) Decentralized Centralization (Shopping Centers and Industrial Parks)
3) Skyscrapers

Demand for Space:
- (Either land peripheral from the CBD, or vertical space)

Time-Space Divergence

Traffic Congestion and Route Deterioration

Increased Interaction

Spatial Adaptation: Centralization and Specialization

Demand for Accessibility

Development of Technology

Transport Innovation

Time-Space Convergence

Search
Time-Space Convergence
Metropolitan Expansion

• Morphologies of Cities
• Topologically Equivalent Locations
• TSC and Susceptible Land Supply
• Behavioral Responses to TSC – the Quest for Amenity
Values (60) = Kilometres per hour
## Convergence Rates for Metropolitan Settings

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

![Diagram showing locations and distances](image)
<table>
<thead>
<tr>
<th>Average Travel Speed (Km/hr)</th>
<th>Average Daily Commuter Trip (1-way minutes)</th>
<th>Potential Distance from City Center (km)</th>
<th>Land Resource (Sq Km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>30</td>
<td>30</td>
<td>2827</td>
</tr>
<tr>
<td>70</td>
<td>30</td>
<td>35</td>
<td>3848</td>
</tr>
<tr>
<td>80</td>
<td>30</td>
<td>40</td>
<td>5027</td>
</tr>
<tr>
<td>80</td>
<td>50</td>
<td>67</td>
<td>14103</td>
</tr>
</tbody>
</table>
Decline in evaluation of amenity
Gain in evaluation of amenity
Adapted from
Guert Hupkes
1982

Utility derived without travel by substituting telecommunications

Shorter working hours — possible increase in geographic range of the utility curves
Temporal Discontinuity of Networks

• Stagecoach Networks and Travel in Early 19th Century Maine
• Frontier Situation
• Rapid Change
• Time Distance Matrices and Multi-Dimensional Scaling
Stage Coach
Network - Maine

(A) 1826

(B) 1829
Stage Coach Networks Maine 1826


D.G. Janelle
Stage Coach Networks Maine 1829
Multi-Dimensional Scaling of Trip-Time Matrices for Travel in Early 19th Century Maine

Contour values = % of all places a town has access to without overnight stays

The bases for these diagrams were derived from the multidimensional scaling configurations of Fig. 5. They summarize the time-distance structures of the stage-coach networks.
Road Investments in Michigan

• TSC as Surrogate of Network Investment
• Relative Advantage for Linkage Investment
• Declines in Travel Time per Unit Mile
Average TSC
9.5 min/yr
CHANGES IN STATUS OF MAJOR HIGHWAYS IN SOUTHERN MICHIGAN
1919 – 1965

- UNIMPROVED
- GRAVEL
- BRICK
- PAVED, 2 LANES
- DIVIDED, > 2 LANES
- LIMITED ACCESS, > 2 LANES
- NO DATA (1919)
Minutes Saved Per Route Mile (Convergence Measure of Route Improvement)

1900-1925

1940-1965

(C)
Speed Limits on America’s Interstates

Historical Benchmarks

• 1901 – CT – 12 mph Open Roads / 8 mph Cities
• 1942 – Office of Defense Transportation – 35 mph
• 1973 – 74 OPEC Oil Embargo
• 1974 – 55 mph
• 1987 – 65 mph on Rural Interstates
• 1995 – Restoring State Control over Speed Limits
Speed Limits

1949

1973

1998

Miles per Hour

40  45  50  55  60  65  70  75  R & P  Zone
Average Travel Time (Hours)
Each State to All Other 47 States

Interstate Highways @ 55 MPH

AVERAGE HOURS

- 31.5 to 39.4 (5)
- 24.1 to 31.5 (7)
- 22 to 24.1 (7)
- 20.1 to 22 (7)
- 19.1 to 20.1 (8)
- 17.6 to 19.1 (6)
- 16.1 to 17.6 (8)
Changes in Average Highway Travel Times by City for Trips among 22 American Cities 1986 to 1998
Average Time-Space Convergence among 22 American Cities
1986 to 1998
Transport Culture and the Economy of Speed

Distance as Contested Social Construct
- The politics of speed-limit legislation and enforcement
- Technological warfare -- fuzz busters

Safety and Environmental Concerns
- “time pollution” (the complete social costing of travel speed, John Whitelegg)

Cost of Doing Business
- Transport Culture – an attribute of modernism that reinforces prevailing value systems for maintenance of an Economic System Dependent on Speed for capital accumulation
- Toffler’s Axiom: “Survival of the Fastest” – quick response, just-in-time
Conclusions

• There is need to understand how things move through time-space
• Representation of space in non-Euclidean and fluid frameworks can yield useful insights about social processes
• Understanding settlement system development benefits from both experimental and empirical assessment of time-space convergence processes
• Recognition and analysis of the political and economic motivations that underlie time-space convergence processes offer research challenges that are related to issues of equity, prosperity, and environmental quality
References


