Center for Spatially Integrated Social Science

Torsten Hägerstrand: Time Geography.

By John Corbett

Background

As late as the 1960s, there were no accepted models linking the spatial and temporal capacities and restraints on individual behavior. Torsten Hägerstrand, professor in the Department of Social and Economic Geography at Sweden's Lund University, had studied human migration in the 1960s. In August 1969, he presented a paper to the European Congress of the Regional Science Association in Copenhagen, Denmark. Although the paper was ostensibly an argument for regional scientists to address the individual human element in their aggregate models, at the heart of it was the need to examine the spatial and temporal coordinates of human activity. The spatial-temporal model that he unveiled was destined to change the course of history in the social sciences.

Innovation

Historically, social scientists studying the effects of space on human behavior tended to treat time as an external factor, something that is relevant to understanding a given phenomenon, but not essential. Activity choices were seen being made in the context of distance alone, such as with the gravity model, and often these decisions were seen in an aggregate sense, with individual decisions viewed as minor variations of those of larger zonal-based groups.

Torsten Hägerstrand's paper, *What about People in Regional Science?* published in 1970, challenged such long-held beliefs. Having spent many years researching human migration patterns, he was convinced that the study of human beings as groups and aggregate populations masked the true nature of human patterns of movement. "It was primitive economics to assume that banks should worry about the identity of coins," he noted. "Is it advanced or primitive social science to disregard the identity of people over time in the same fashion?" While he felt that social scientists should "leave it to the historian[s] to concern [themselves] with biographies of sample individuals," he believed that an understanding of disaggregate spatial behavior was paramount.

Along with using the individual human as the unit of study, Hägerstrand also emphasized the importance of time in human activity. "Time has a critical importance when it comes to fitting people and things together for functioning in socio-economic systems," he noted. Hence, a given location may be near an individual, but if a person cannot allocate enough time to travel to it, spatial proximity alone will not be enough to allow the person to visit it.

Hägerstrand came up with the concept of a space-time path to illustrate how a person navigates his or her way through the spatial-temporal environment. The physical area around a given individual is reduced to a two-dimensional plane, on which his or her location and destination are represented as zero-dimensional points. Time is represented by the vertical axis, creating a three-dimensional "aquarium" representing a specific portion of space-time. The path of a stationary individual will appear as a vertical line between the starting and ending times, and a specific location (or "station") will trace a vertical "tube" in the same manner. If an individual moves between two stations over a period of time at a constant speed, it will draw a sloped line in the three-dimensional space-time between the two tubes. The faster an individual travels, the sooner he or she will reach the destination, and the more sloped the line will be.

Hägerstrand used the space-time path to demonstrate how human spatial activity is often governed by limitations, and not by independent decisions by spatially or temporally autonomous individuals. He identified three categories of limitations, or "constraints": capability, coupling, and authority. Capability constraints refer to the limitations on human movement due to physical or biological factors. Thus, for example, a person cannot be in two places at one time. A person also cannot travel instantaneously from one location to another, which means that a certain trade off must be made between space and time. Those with access to cars and bullet trains have a spatial-temporal advantage over those who are limited to their feet or bicycles for transportation. A coupling constraint refers to the need to be in one particular place for a given length of time, often in interaction with other people. This coincidence of space-time paths is described (in an electrician's jargon) as "bundled" paths in a station's tube. In other words, your space-time path must temporarily link up with those of certain other people to accomplish a particular task. This could mean anything from visiting the supermarket to going to work for the day. Lastly, an authority constraint is an area (or "domain") that is controlled by certain people or institutions that set limits on its access to particular individuals or groups. For example, a person's space-time path is normally not permitted to enter a sensitive military base or private club.

A space-time path represents the path taken by an individual, but any one path is only one of many that can actually be taken by a person in a given amount of time. A space-time "prism" is the set of all points that can be reached by an individual given a maximum possible speed from a starting point in space-time and an ending point in space-time. For example, if a man has to leave home at 11:00 a.m. and return home by 1:00 p.m., and he can travel at a maximum of 50 miles per hour, a point 50 miles away would be unreachable by 11:30 a.m. (hence outside of his prism). He could arrive at that point at noon, but would have no time to stay, since he was exactly on the outermost extent of the prism, and would have to immediately turn back. However, if he traveled at 100 miles per hour, the prism's boundaries would widen, and the point would easily be reachable by 11:30 a.m. Instead of having to immediately turn back, he could stay at that station for a full hour before leaving, amounting to a significant savings of time. In essence, the physical life-paths that we can take are controlled by the constraints in each of our space-time prisms, known more precisely as "potential path spaces," or PPSs.

Hägerstrand's concept of space-time was powerful because it was simple. Although its inspiration was derived from the study of human migration patterns, it quickly took hold across the social science spectrum during the 1970s. Space-time geography revolutionized the study of transportation accessibility largely because of its ability to represent individual behavior in a reasonably accurate manner. In 1976 Bo Lenntorp, one of Hägerstrand's associates at Lund University, studied how increased bus services in the city of Karlstad could increase the number of areas within the city that would be accessible to a person given a particular individual "activity program." Three years later, Lawrence Burns further elaborated on the accessibility aspect of the space-time model by demonstrating the impact of altering factors such as differing modes of travel, increased transportation options, even the hour of the work commute. For example, Burns showed how space-time prisms are in effect narrower during rush hour, and how flextime schedules could enable commuters to maximize their prisms by traveling at optimal times of the day. He also foresaw the advent of modern communications technologies having significant impacts on time savings.

Throughout the 1980s and 1990s Hägerstrand's model continued to influence fields ranging from city planning to social equity. In 1991 Harvey Miller from the University of Utah demonstrated how space-time prisms could be applied to modern transportation GIS systems. Miller pointed out that the two-dimensional footprint of the PPS, known as the "potential path area", or PPA, was conceptually similar to potential paths taken along a network system of arcs and nodes to determine accessible areas for a given location. Several years later, Mei-Po Kwan of Ohio State University demonstrated that space-time models could show disparities in gender accessibility—even from the same household—that were invisible in traditional spatial gravity models.

More than thirty years after it was first introduced, Hägerstrand's space-time model continues to provide new ways of understanding human activity in space, and promises novel solutions for solving difficult issues of transportation and access in modern society.

Publications

Innovation diffusion as a spatial process. Translated by A. Pred. Chicago: University of Chicago Press, 1967.

On the definition of migration. Lund: Lunds Universitets Kulturgeografiska Institution, *Rapporter och Notiser*, 9, 1973.

The impact of transport on the quality of life. Lund: Lunds Universitets Kulturgeografiska Institution, *Rapporter och Notiser*, 13, 1974.

The domain of human geography. *Directions in geography*, ed. R. J. Chorley, 67–87. London: Methuen, 1973.

Space, time and human conditions. *Dynamic allocation of urban space*, ed. A. Karlqvist et. al. Lexington: Saxon House Lexington Book, 1975.

Related Works

Pred, A. The choreography of existence: Comments on Hagerstrand's time-geography and its usefulness. *Economic Geography* 53: 207–221, 1977.

Pred, A., ed. *Space and time in geography: Essays dedicated to Torsten Hagestrand*. Lund: Gleerup, 1981.

Kellerman, A. *Time, space and society: Geographical-societal perspectives*. Boston: Kluwer Academic Publishers, 1989.

Miller, Harvey J. Modelling accessibility using space-time prism concepts within geographical information systems. *International Journal of Geographical Information Systems* 5(3): 287–302, 1991.

Kwan, Mei-Po. Space-time and integral measures of individual accessibility: A comparative analysis using a point-based network. *Geographical Analysis*, 30(3): 191–216, 1998.