MODULE 1.3

THE SPATIAL TRADITION

The Centrality of the Spatial Tradition

Of all the geographic traditions, it can be argued that the central one, the one to which the other two are necessarily subordinated, is the spatial. How, for example, can one talk about regions without talking about relative locations, boundaries, the movements that constitute particular regions? The same goes for work in the people-environment tradition: people forge relations with nature in particular places and those places may, or may not be at some remove; likewise nature is constituted spatially, through the movements of airmasses, the migration of biota, and the like. And the people-environment approach was *always* focused on explaining some variation over space, whether it be the variability of population densities in the tropics, as in Gourou's *The Tropical World* or the variations in landuse that were the object of the British Land Use Survey in the 1930s.

Aside from the way it is expressed in the other two traditions, the spatial tradition as an explicit focus for geographic work has a long history. True, the seminal event in the history of twentieth century geography, perhaps more so in human than in physical geography, was the *spatial*-quantitative revolution. This ushered in a self-conscious concern with the way in which human activities -- industry, agriculture, cities -- were organized over space and the spatial regularities that could be observed in that organization: clustering, regularities of spacing, areal specialization. Movements over space -- migration, residential mobility, the diffusion of innovations -- were subjected to the same framework of understanding; their spatial properties were what was to be explained, and space relations -- the relative distances between adopters of an innovation, for example -- were important in that explanation.

But it needs to be stressed that the spatial tradition for its own sake has a much, much longer history in geography. How could it be otherwise given the interest in mapping things and explaining the resultant distributions and the changes in those distributions? Climatologists focused on explaining climatic variation over the surface of the earth. Initially they did so in

terms of the variable distribution of pressure, of wind systems and of solar radiation. After the Second World War, however, attention shifted to the air masses and the way in which their movements and collisions created the weather and hence, through an averaging process, climate.

So too has it been the case in human geography. Sauer emphasized diffusion in understanding the creation of cultural landscapes; Isaiah Bowman worked on settlement frontiers; Platt had formulated the idea of the functional region -- a region of spatial organization -- in contrast to so-called formal regionalizations that emphasized site variables way back in the 'forties; and in 1941 Edward Ullman had published a paper in the American Journal of Sociology with the provocative title A Theory of Urban Location.

Moreover, this sort of interest in relations over space and their apparent regularity can be traced much further back. Here, and to illustrate this, I draw on the writings of the British geographer Halford Mackinder. Mackinder is most famous for his explorations of spatial relations on a global scale in his Heartland theory and the contrasting spatialities of sea power and land power. But it is also clear in other of his writings like his regional study Britain and the British Seas, published in 1907.

The extract presented here lays particular emphasis on the following, arguably spatial, concepts:
1. *Nodality*: Mackinder emphasizes the role of natural waterways and the channeling of land routes by topography in creating nodal points. New nodalities are created as a result of the convergence of railroads on new industrial centers.

2. *Spatial inertia*: 'Should the significance of a town's nodality decrease, because, for instance, of mechanical inventions, or of new customs barriers, it does not necessarily follow that the town will forthwith degenerate. Much capital expenditure has been irrevocably fixed in it, or in connection with its trade, and great efforts may be put forth to improve its artificial nodality. Thus it may persist by *geographical inertia*, analogous to the mechanical inertia or momentum of a moving object. It is a 'going concern' with a goodwill based on the custom of trade, and is worth saving.' (p.330).

3. *The development of functional regions*: Mackinder talks about 'urban communities' and their development around major nodal points. This comes about partly through ejection of people and activities from the nodal center as rents rise so that around it spring up suburbs. Other cities functionally related to the nodal center develop. Mackinder uses the example of seaside resorts catering to the London market (pp.335). In this vein Mackinder also talks about the emergence of 'urban federations where 'the unity tends to express itself by a community of amusements, of fashions, and of reading' (p.338).

4. *The creation of new spatial divisions of labor*: Mackinder draws a contrast between an earlier urban geography in which towns served rural hinterlands and a later one that is being superimposed and in which the towns relate to each other through roles in a country wide spatial division of labor: 'At first a number of small market-towns...were scattered evenly over the more fertile parts of the country. They were local distributive centers at nodal points...now a certain number...are being selected for city-growth, while the rest dwindle with the general loss of rural population and the improvement of communication...But it is characteristic of the rising places that...they obtain their renewed importance no longer as general distributors of the second or third grade, but by specialization of some definite type..It follows that they are not self-sufficing after the manner of the old market-towns, but must supplement one another, or depend on some vast neighboring city' (pp.337-338).

The Spatial-Quantitative Revolution

Nevertheless, the spatial-quantitative revolution was a crucial event and greatly raised the consciousness, of human geographers at least, of the centrality of the spatial tradition.

1. The Intellectual Background: Hartshorne, Schaefer and the Transition to the Quantitative-Spatial Revolution

In understanding the development in the US of quantitative-spatial geography and its rejection of what had gone before it reference is quite commonly made to the Hartshorne-Schaefer debate about exceptionalism. Its significance is probably overdone. Schaefer provided a philosophical grounding for what the quantitative-spatial people were trying to accomplish but they would

probably have gone ahead anyway. Indeed, an interesting empirical question is the degree to which Schaefer's famous paper ('Exceptionalism in Geography') was called upon merely to legitimate to the profession at large a transformation of method and theory that had already been carried out.

The starting point for the debate is Hartshorne's massive and often turgid tome The Nature of Geography, published in 1939, in which he set out to identify the essential nature of the discipline by an examination of its history. The outcome of this was thoroughly in accord with prevailing practice. The focus of geography, according to Hartshorne, and following the lead of the German geographer Hettner, was areal differentiation or chorology. Geography, Hartshorne claimed was a science but not a law-seeking science. Rather it interpreted place to place (my emphasis) differences not through analytic strategies but through the synthesis or integration of diverse characteristics. This particular role for geography stemmed from its focus on space in contrast to history with its focus on time and the other sciences which had as their objects of study particular substantive domains like chemicals, the human mind, society, etc. In other words, and in hindsight, Harshorne reduced space to place. Space, or more accurately differentiation over space, was seen in terms of unique combinations of attributes. It was this reduction that provided a point of critical entry for Schaefer.

The response came in 1953 in a paper entitled "Exceptionalism in Geography: A Methodological Examination". Schaefer's essential point was that geography was not exceptional in the sense of a subject matter that did not permit law seeking, and explanations based on laws. All the sciences dealt with the unique. In psychology no mind was exactly like another; in economics no commodity exchanger was exactly like another, etc. But this did not prevent the scientist from abstracting particular attributes and examining them for their association with yet other attributes. In geography these attributes would be spatial so that the focus of geography was spatial patterns and the science of geography was the science concerned with the formulation of laws governing the spatial distribution of certain features on the surface of the earth. Geography, in other words, identified laws of location. To the spatial scientists this must have seemed like manna from heaven.

2. Some Caveats

Several caveats in thinking about the spatial-quantitative revolution:

2.1 The (non-necessary) link between spatial analysis and quantitative methods: a number of spatial analysis people had little or nothing to do with quantitative methods: e.g. Peter Hall, Michael Chisholm, and Edward Ullman. In Britain the early spatial work, as in the journal *Regional Studies*, had primarily to do with policy issues of the growth of large towns, what to do about getting industry into the depressed areas, and much of this work was conceptual, theory-oriented than technical in the narrow sense.

2.2 Physical Geography: In writing a history of change in physical geography, the experience of the different sub-fields was highly heterogeneous; much more so than in the case of human geography and the way it was affected by the SQR.

Geomorphology, or the study of landforms had probably been the least spatial of the sub-disciplines of physical geography. It was also very non-quantitative; at least the climatologists were interested in matters of degree! This was to change in the late 'forties and 'fifties with the impetus coming largely from hydrology and geology. This impetus was with respect to the description and understanding of fluvial landscapes. The unit of observation became the drainage basin. Different elements of the drainage basin could be quantified: obviously its density, but also its relative relief and how much remained to be eroded / weathered away; likewise it was found that there were regular relations between stream order and the number of streams of a given order. Drainage basins and their different elements could be measured, resulting in the term 'morphometry' (http://www.physicalgeography.net/fundamentals/10ab.html) and leading people to talk -- very spatially -- about 'drainage basin *geometry*. Indices from morphometric analyses, like drainage basin densities, could then be correlated with causally plausible conditions, like climate and vegetation. Alongside this interest in landform measurement there emerged an interest in quantifying the processes producing landforms as a means of shedding light on them. Contrary to expectations, for example, it was found that the velocity of a river, and hence its erosive power, all other things being equal, increased with the volume of water. The energy of smaller volumes of flowing water was reduced by greater contact with the stream bed

than was the case with larger volumes - a simple result of the way the ratio of a (half-) circle's circumference to its area diminishes as area increases.[1]

The forces for change in *climatology* were both from within and without geography. An important force for changing the sub-field was the drafting of geographers into the weather forecasting services during the Second World War. This exposed them to the latest thinking in meteorology, and hence to the processes producing climatic variation. One of these geographers, F K Hare, went on during the 'fifties to revolutionize thinking among climatologists in geography departments.[2] Unlike geomorphology, climatology was always an intensely spatial sub-field, dealing with the movements of airmasses, movements in both vertical and horizontal directions, the effect of landmass distribution on atmospheric pressure distributions and hence on the possibility of monsoon phenomena, modification of airmasses as they pass over land or sea and so on. That spatial character has been deepened in a number of directions. One is the upsurge of interest, still apparent, in so called 'teleconnections.' The most well-known of these is the ENSO or El Nino Southern Oscillation (see http://www.ogp.noaa.gov/enso/). You should also be aware of the North Atlantic Oscillation (see http://www.ldeo.columbia.edu/res/pi/NAO/ and http://www.ldeo.columbia.edu/~visbeck/nao/presentation/html/NAO.htm). Teleconnections describe 'seesaw effects.' So, for example, in the North Atlantic Oscillation, which is largely a winter phenomenon, when winters in Northern Canada and over Greenland are unusually cold, the northeastern United States and Western Europe tend to be characterized by relatively warm, wet winters. The Mediterranean, on the other hand, experiences drier winters than normal as the storm belt shifts northwards. When winters over Greenland and Northern Canada are milder, however, there will be a tendency to colder winters over the northeastern United States and Western Europe as the major storm belt is shifted southwards - bringing more moisture to the Mediterranean basin.

One of the prospects held out by the SQR was of some convergence around a spatializing, quantifying agenda. This is clear in Bunge's *Theoretical Geography* and there were some useful

[1] A book which did much to popularize and celebrate the 'new geomorphology' was George Dury's *The Face of the Earth* (1959).
[2] His *The Restless Atmosphere* was required reading for budding young geographers in the mid to late 'fifties.

contributions in which various analogues between human and physical systems were explored. That phase of work which came of age in the 'sixties, rapidly met with diminishing returns, however.

Nevertheless, it seems fair to say that both physical geography and human geography did become much more aligned with their respective disciplinary peers - the physical sciences for physical geography and the social sciences for human geography - than had been apparent previously. It has been argued that this was due to the shock to its self-esteem suffered by academic geography, particularly in the US, with the closure in the immediate post-war period, of geography departments at Harvard and Yale.

3. Characterizing the Quantitative-Spatial Revolution

3.1 Quantification

Obviously a defining characteristic of the quantitative-spatial revolution is the adoption and spread of so-called quantitative methods. Early on this involved simply the application of conventional descriptive statistics to geographical data. This is very clear in the early work of the so-called Iowa School where it was formalized in terms of an iterative procedure. This involved the use of multiple regression to test hypotheses; and then the examination of residuals from regression in order to identify other 'variables' that might be important in explaining a particular geographic distribution. These new variables might be included in a reformulation of the regression model in order to achieve a higher level of 'explanation'. People strongly associated with this approach were Harold McCarthy and Edwin Thomas.

This quickly gave way, however, to a second phase in which there was a more focused search of other literatures for techniques and methods which might have been devised more specifically for the sorts of data and problems geographers were interested in. This was especially clear in the case of the people at the University of Washington including William Garrison and his graduate students (Dacey, Berry, Marble, Tobler, Nyestuen in particular). Some examples include:

a) the borrowing of methods from quantitative plant ecology for the analysis of point patterns as in quadrat count analyses and nearest neighbor techniques;

b) the borrowing of methods from operations research for the identification of normative geographic patterns with which the actual could be compared. Garrison was especially interested in this and this is apparent in the sequence of three review papers he wrote for the AAAG. An example is the use of linear programming solutions (allocation of resources under constraints of demand and supply) to the so-called transportation problem (how to allocate the supplies available at a set of locations to the demands present at another set of locations).

c) the borrowing of methods from mathematics in the form of graph theory for the description of networks. Again Garrison was to the fore here to be joined later by Marble.

d) the borrowing from psychology of the technique of factor analysis and its use to help solve the problem of regional delineation by Berry: in particular how to reduce the variation of large numbers of variables to that of a smaller number as a step in the creation of multi-variable regions and the achievement of the old goal of regional synthesis.

Possibly a third phase that can be identified in the earlier work is the modification of aspatial statistics and techniques for spatial problems. An early paper by Tobler (strangely Tobler gets no references in the Johnston book or in Unwin) tried to adapt techniques for the description of time series (e.g. moving means) to what he called spatial series. A couple of the measures he came up with were the spatial moving mean for smoothing out geographic variation (this could be applied at a variety of geographic scales and so afforded an entree into the problem of scale); and a spatially moving variance -- to provide a measure of variation in variability! Another instance of the adaptation of aspatial methods to geography is the work of Chorley and Haggett on trend surface analysis (or was it the geologist Krumbein?). The idea here is to summarize trends in geographic distributions through fitting a multiple regression model: specifically regressing some geographically varying characteristic like population density on geographical coordinates (eastings and southings). This could provide estimates of the fit of linear trends or by the addition of powered terms, non-linear trends.

On the other hand, and in these early years, there was little attention to the problems of describing specifically geographic data sets through quantitative methods. Interestingly, and for example, the problems of analyzing areal data which emerged with the early work at Iowa and Wisconsin were taken up in relatively exhaustive fashion first by sociologists (Duncan Duncan and Cuzzort, Statistical Geography). It was only later, in the early 70s, for example, that the quite crucial problem of spatial autocorrelation was taken up and also that there were real attempts to come to terms with problems of spatial aggregation as in the work of Openshaw.

The slow adoption of quantitative methods in human geography in the late 50s and early 60s provoked vigorous debate and contestation within human geography. On the one hand quantitative methods were touted as the medium for making geography 'scientific': the lack of ambiguity, the precision inherent in quantification made it an ideal vehicle for re-creating geography in the image of a law-seeking science embarked on building knowledge of a cumulative kind. These were things that the geographer's traditional tool -- map analysis and comparison -- could not do as was demonstrated in early exercise carried out at the University of Iowa. But there was an avalanche of ripostes and skepticism from more traditional voices in the discipline. It was suggested, for example:

a) that the findings of the 'new geography' often amounted to little more than statements of the obvious: that of course (e.g.) land values would be correlated with increasing distance from the CBD or that migration would drop off with distance from its point of origin.
b) that methods were being put ahead of theory and findings of real substance; that there was too much research on method for method's sake.
c) and that the real point of research was to explain not to generalize; a generalization in the form of a correlation or regression coefficient, for example, was only specifying what had to be explained and so the new geography was a very partial answer to achieving the real aim of any science, including human geography (Lukermann's interventions in the early 60s are interesting in this regard).

Much of this debate was markedly inter-generational in character: a case of young gladiators against an old guard resisting change.

3.2 Models

A second major theme in the early work was that of the model. Reference to models was widespread. Indeed an early and very influential compendium vigorously announced the fact in its title (*Models in Geography* edited by Chorley and Haggett 1967).

Models were defined as simplified and/or idealized representations of the real world and could come in many different forms. There were, for example, statistical and mathematical models in which reality was represented by various symbols and which could be compared with the real world and also manipulated to resolve 'what if' questions. Monte Carlo simulation models were one early form of statistical model deployed to great effect by the Swedish geographer Hagerstrand. Other forms included scale models as in maps or analog models in which a model for one substantive domain was applied to some other. Thus Lovgren the Swedish geographer applied interregional input-output analysis, originally developed for understanding commodity flows to migration. The gravity model was applied to an increasingly wider range of substantive domains including the geographic origins of news stories in newspapers to the location of lost prehistoric cities in the work of Tobler. Models were to be compared with the real world, they could be manipulated in order to afford insight into the real world, they could be subject to correction in an iterative fashion.

The interest in models led to some partial rapprochement with physical geography. This was mainly through the use of analog models and their transfer from the physical to the social domain (travel in the reverse direction was not so apparent though there were attempts to -- e.g. -- apply quadrat count analysis to the distribution of sink holes in limestone terrain). A major expression of this was a book by Chorley and Haggett with the title Networks in Geography in which (e.g.) they showed how some of the models used in describing drainage networks could be usefully applied to the description of transportation and commodity flow networks. A prominent American exploiter of this type of convergence was Michael Woldenberg. But, and as Johnston observes, once one moved beyond pattern to explanation the seeming unity between physical and social worlds appeared more illusory.

Nevertheless, it remains useful to ask why the concept of model became such a crucial part of the lexicon of the new geography in the 60s and has indeed remained with us. In part it was an attempt to assert the scientificity of the new approaches: this was part of the language in the prestigious natural sciences and also in the most prestigious of the social sciences, economics. But there is another answer and that has to do with the problem of theory. Quantification provided a method in a very narrow sense. It provided, in particular, a means of testing hypotheses as in regression or tests of statistical inference. But where were the hypotheses to come from? And how were the results to be incorporated into a growing body of theory? The crucial medium here was the model. This was because through its idealizations it provided a set of expectations about the so-called real world which could be evaluated and adjusted in cumulative fashion. So as geographers moved on from an early fascination with methods for their own sake to actually applying them so the concept of model satisfied an essential need.

3.3 Questions of Substance

On the other hand, what about the substance of those models? To what were their terms to refer? It is here that the spatial part of the term quantitative-spatial revolution assumes clear significance. In this regard a connection is made with the earlier paper of Schaefer and his call for the elaboration of laws of location.

Some early evidence (1963) of the emergent dominance of the spatial language is provided by a paper by one of Garrison's students, John Nyestuen. Nyestuen tried to formalize the spatial point of view in terms of its fundamental concepts. These he argued were threefold -- distance, direction and connection -- and that other spatial concepts like neighborhood and accessibility were derivative of these. Another but more descriptive statement was that of Haggett in his profoundly influential book Locational Analysis in Human Geography. In the introductory chapter to that book Haggett identified the basic constituents of spatial organization -- the foci, in other words, of the new geography. These included:

a) point patterns as in settlement patterns and distributions of cities, and retailing patterns;
b) networks as in highway, airline networks, and also social networks;
c) flows like those of migrants, commuters, tourists, commodities, shoppers;

d) hierarchies such as those of cities with respect to one another or, one might add in the light of recent work, of corporate headquarters with respect to branch plants;

e) surfaces as in population density or land value surfaces or any other pattern of areal differentiation;

On the other hand this says little about how we are to understand these regularities in spatial organization. I think it is useful here to differentiate between two streams which are still with us: spatial analysis and locational analysis. Though some might object to the precise labels I have assigned I think that the existence of two streams is thoroughly defensible.

Spatial analysis has much more to do with morphological laws than with the reasons those particular regularities exist and is more an elaboration on descriptions of geographic pattern than a delving into substance that might shed light on causation. Of primary significance in spatial analysis has been the gravity model. This has generated an immense amount of literature. It continues to do so and so testifies to the continuing importance of spatial analysis. It clearly applies to a wide variety of flows and contact patterns (migration, commodity flows, commuting, marriage patterns, the places to which newspaper stories refer, where the students at a particular university come from, tourism). It therefore provides a benchmark for the examination of seeming exceptions (e.g. Hagerstrand on migration). More recently attention has turned to the empirically varying character of the coefficients in gravity models. On the other hand a good deal of the interest in the gravity model comes from its utility in city and regional planning.

Other sorts of regularity in spatial analysis that have generated substantial literatures include: the rank size rule (with more recent interest again focusing on empirically variable coefficients), nodality in flows as in airline links, (**point pattern analysis a la Dacey -- the cheese cloth and the pattern of rain drops) and the region (see the large literature on how to derive regions of both the formal and functional kind). A useful example in the literature is the book edited by Berry and Marble and with the title Spatial Analysis.

Locational analysis has more to do with explanation of a substantive (as opposed to geometrical) sort, and unlike spatial analysis, it applied to human geography alone (cirques don't get 'located'!). This was clearly dominant in the work of Garrison and to a lesser extent Berry (as compared with some others in the Washington school like Dacey and Bunge who were more clearly geometrical in their approach). In its interest in location theory it was also closer to the regional scientists as in the work of, say, Muth and Alonso on urban population density and land value patterns. Interestingly the founder of regional science -- Walter Isard -- was an economist by training and regional science initially evolved out of his attempts to incorporate spatial components (usually conceived simply as transportation costs) into economic models. Not all locational analysis drew upon location theory for its substance theories but the ideas of Losch, Christaller and Von Thunen (as applied to land use patterns with cities) were prominent. This alignment of locational analysis with location theory and hence with neo-classical economics continues to the present day. A good instance of early work in location theory-inspired locational analysis is the book edited by Taaffe, Smith and King (Readings in Economic Geography).

3.4 Another thing that we should note about the spatial quantitative revolution was its close association with applied work. This, of course, continues as a result of the close enmeshing with GIS and its many and varied applications in both business and the public sector. In the early days, though, urban and regional planning was an important stimulus. Some of this worked through the Regional Science Association (RSA). Regional science was the brainchild of an urban and regional economist called Walter Isard who proved himself an able missionary. As Barnes points out in his entry in the *Blackwell Dictionary of Human Geography*, regional science is very difficult to define but it shared considerable overlaps with the work of geographers under the heading of the spatial-quantitative revolution. Human geographers were enthusiastic attendees of the annual meetings of the RSA in the 1950s and 60s, but so too were planners and urban economists (notable names include those of William Alonso, Richard Muth, John Kain, John Friedmann and Melvin Webber). Perusal of the Papers and Proceedings of the Regional Science Association from those days indicates just how significant the input of planners and urban economists was.

3.5 Fifth and finally, the impact of the SQR on human geography was very, very uneven. The most significant impacts were in economic, transportation and urban geography. It was in these fields that the idea of location theory was most applicable. Some sense of this applicability is apparent in a reader edited by King, Smith and Taaffe entitled *Readings in Economic Geography* and which appeared in 1968 (and a very good book it is too). Virtually all the notable names of the SQR were associated with one of these areas. Berry was an economic and urban geographer, Dick Morrill's work was largely in urban geography, Garrison, Marble and Taaffe made their names in transportation geography.

However, the fields of cultural, historical and political geography were much less affected. In fact it was cultural and historical geography that provided the core of resistance to the SQR. Their complaints were ad hoc and lacked a strong theoretical basis but that would change in the 1970s with the advent of humanistic geography. Political geography was slightly different in that the area of voting studies – hitherto known as electoral geography – readily lent itself to quantification. This was a minor growth area in human geography in the 60s and 70s with Kevin Cox, Ron Johnston and Peter Taylor notable in that movement. What is also interesting is the way in which this attempt at rapprochement with the SQR led to a conscious attempt to spatialize the field; something that was to lead to increased interaction with political scientists because now it seemed that geographers had something distinctive to say about voting. Even so, this was an exception. For the most part political geography remained apart and the reason was not difficult to see: the SQR had very little time for the question of power; something that we will pick up on again later.

4. Internal Critique and Development

Work in the spirit of the SQR changed over time as it encountered difficulties in application, but the underlying principles of measurement, the discovery of pattern and facts speaking for themselves have remained intact. Adjustments have been made but spatial-quantitative work remains recognizable as a distinct approach.

4.1 An early issue was that of what was known as spatial separatism. The focus was the assumption that a spatial domain could be identified independently of any substance. This assumption is very clear in Bunge's view that the appropriate language for the new geography was geometry. The most argued-out critique of this view came from Sack. Thus, and to exemplify his logic, to argue that a city expands in area because the distance of its boundary from its center increases does not constitute an explanation, even though it expresses a geometrical law. Likewise 'distance' tells us nothing that is substantively useful unless we know something about the time it takes to traverse such a distance, how costly it is, etc. So the 'friction of distance' is a misnomer: it is substances that impose the friction. In other words, if geographers wanted to explain substantive patterns like the spacing of cities, the location of industries, or flows of commodities then questions of space and spatial relations could not be separated from the substance -- people, material artifacts like highways -- to which they referred.

An important consequence of this analytical indissolubility of space and matter is that all social sciences are concerned with spatial relations. Geography, therefore, cannot claim an independent status on the basis of the spatial variable. Note, incidentally, how the belief that it could parallels Hartshorne's earlier argument about the exceptionalist nature of geography. Geography was exceptional because owing to its interest in specific places it could not be a generalizing science. In the revised spatial version geography's enduring interest in distribution again asserts itself but this time as space. And while the focus on space allowed geography to become a generalizing science according to the advocates of the spatial-quantitative revolution, it also gave geography an independent role from the other, more substance oriented social sciences. So instead of being 'exceptional', geography becomes 'separate'.

The incorporation of substance theories from the social sciences did something to blunt Sack's criticism, though not entirely. It also raised new issues of a critical nature. This had to do largely with the nature of the substance theories used. These initial thrusts continue to the present day, though along with an accumulating body of criticism.

The initial incorporation of substance theories was from neo-classical economics. There was already a developing body of ideas, location theory, which sought to apply neo-classical theories to an understanding of (e.g.) land rent and population density surfaces in cities, and the location patterns of industries. Much of this work found an early outlet in the conferences and publications of the Regional Science Association that tended to emerge parallel with the development of spatial analysis in geography.

The second source was psychology. The use of neo-classical economics in understanding geographies spawned criticisms of its assumptions, including those of rational behavior under conditions of perfect information. This led to an interest in (e.g.) learning theory, the effects of imperfect information on decision making, the replacement of assumptions of rational with satisficing behavior. This was the so-called behavioral revolution in geography that was at its height in the late 'sixties to early 'seventies.

4.2 Behavioral geography, however, was also a response to the fact that the models didn't always fit the data. As Hagerstrand noted in his work on migration there were deviations from the distance decay rule: migration from some points of origin would be wildly underestimated by the gravity model. There was also a creeping suspicion that the space in which locators operated might not be the same as the supposedly objective one to which the experts – the geographers – had access. This led to two significant and related, even overlapping, ideas: that of perceived space; and that of the variable information that people had about different locations.

The first of these ideas led to the notion of the mental map. This was initially normative in content and Peter Gould was the initiator of this line of research. What he was interested in were people's preferences for places as places in which to live. No matter where respondents were currently located their preferences tended to be quite uniform. So in the US states like California and Florida emerged as more desirable than ones like, say, New Jersey. But there was also a local component in which people expressed strong preferences for their current location. This idea of place preferences could be extended by reference to what the data indicated as to people's choices. A notable argument here was that of Rushton on what he called space preferences. This

was an attempt to spatial the preference schedules of neo-classical economists by examining not actual consumption behavior but actual travel behavior. In this way, for example, Rushton was able to challenge the assumption Christaller had made in central place theory: that people patronized the nearest town (or central place) offering the good or service they wanted. The problem with this approach, however, was its circularity: deriving schedules from actual behavior in order to predict that same behavior.

To this idea of preferred places or locations was later added a more cognitive approach to mental maps. If asked, for example, what sort of map of major urban centers in Ohio would people provide? You could give them a map of Ohio and ask them to insert the locations of the nine or ten largest urban centers. The maps could then be analyzed for inaccuracies or biases. So the sort of conclusion coming out of this research was that people tended to underestimate distances to places further away and overestimate them to places that were actually closer. A variant on this sort of research had more to do with people's understandings of regional classifications. Everybody has an idea of the South, the Midwest, etc., but what exactly are those understandings?

One important feature of this mental maps work was how it became an area of research in its own right and connections with location theory became quite loose, even though the deviation of results from models had been one of the stimuli to the exploration of mental maps. In contrast, a second area of emphasis tended to have closer ties to researching actual locational outcomes. This looked at variations in the (objective) information people had about places: not just relative locations but the characteristics of different places. The work of Hagerstrand on migration was exemplary.

His focus was initially on what he called 'deviations from the distance decay rule.' In other words, while migration from particular places of origin might vary in its intensity according to distance from the destination there were also 'deviations': places sending far more migrants than might have been expected given distance from the destination. What he was able to show was that this was a result of a biased information field. People in the discrepant location just knew

more about jobs and housing in a particular destination regardless of distance. This might have been due to a chance migration – a military billeting, perhaps, followed by marriage – that had then set in motion a flow of information back to the place of origin about job opportunities and the offer of help with housing.

The work of Golledge was also important here. What he was interested in was the process of learning and how the individual's mental map would become denser and, from the learner's standpoint, more accurate over time. One of his early interests was the marketing decisions of hog farmers. Just what was the process through which they decided that one market – more accessible? better prices? – was superior to another?

In conclusion, though we should underline the way in which in behavior geography most of the underlying assumptions of the SQR remained intact. Most significantly there was the idea of some discrepancy between a 'subjective' understanding of space – the mental map or the awareness of jobs and housing at different places – and an 'objective' understanding calculable in terms of actual intervening distances, travel times, transport costs or whatever. There are two things here that we should note. The first is the way in which, in this way, the idea that the world is out there available to the senses in an unmediated form persists; this is a central idea of the SQR and relates to its positivist foundations which we will explore later. Second, and intriguingly, it is professional geographers who are the discoverers and guardians of this objective knowledge. They are the ones who create the 'real' maps, for example. In other words the idea of expertise lurks in the undergrowth of the mental map literature; something technical, divorced from values, available to 'science.' Again, this is another methodological hallmark of the SQR and directly related to positivism.

4.3 The problem of determinism: One of the criticisms of the SQR was that it was deterministic. In that regard it might be regarded as a new determinism to replace the environmental one. But instead of the environment determining human activities in different places it was the pressures of the market transposed onto space: the idea of convergence on minimal cost locations, as in Weberian location theory, or on points of maximum accessibility, as in central place theory, or

simply the allocation of different agricultural activities according to the rent that the landlord could extract; a rent that would depend on location.

This was a little unfair. It was recognized early on that there would be deviations from the predictions of location theory and that these deviations might have perfectly reasonable explanations: not in terms of behavioral geography but in terms of other causal conditions having to do with real distributions in the world. So, and for example: One might reasonably expect deviations from the locations of towns predicted by central place theory as a result of deviations from the isotropic plain – a plain across which people could move at equal cost per mile in all directions. Rather the real world was not isotropic but it was one in which accessibility would also be affected by the locations of bridges across rivers or by gaps in ranges of hills or by the defensive qualities of sites that made them particularly suitable for the location of castles (and the market that would go with that castle and its personnel).

One way round this problem was to treat locations as chance events: events that might have occurred, with a given probability of P, but might not have (with a probability of 1-P). This conception led in turn to the idea of stochastic models as lending insight into locational outcomes. One particularly powerful application of this idea was through what is known as Monte Carlo simulation. The goal here was to simulate a geography as it changed over time on the basis of certain rules about the probability of different events occurring. The simulated geographies would then be compared with what actually happened to check to see if the rules governing the simulation might actually be the ones operating in the real world.[3]

The most noted exponent of this approach was the Swedish geographer, Torsten Hagerstrand. His work was particularly important in shedding light on chain migration and on the clustered way in which innovations diffuse over space. Dick Morrill adapted these techniques and did further important work on such processes as the peripheral expansion of cities (why doesn't expansion proceed in all directions at the same rate? Why does new development leapfrog

[3] A crucial qualification here is the word 'might': one could never be sure that the rules were the ones describing what actually happened in the production of empirically observable geographic outcomes.

beyond the existing boundary of the built-up area?). There is still considerable scope for applying this method. How, for example, to explain the unevenness of gentrification? There are often several different neighborhoods around a central business district that might become gentrified, but typically it will be a very spotty process, occurring more much more extensively in a minority of areas that might seem to have similar things to recommend them for it.

So with reference to the latter, one might make the reasonable assumption (one of the 'rules') that initial decisions to rehab properties are independent of one another: investment in one potential candidate for gentrification is just as likely as in another. When you make this assumption, however, and allocate points at random to equally sized subdivisions of an area (cells), what you end up with is a distribution with some local clustering – purely by chance! So one might also include a rule that allows the probability of different areas receiving a point changing over time, depending on the number of points a cell already has; in other words, decisions are assumed to be no longer independent of one another, but to depend on the pre-existing distribution of gentrifying activity. And so on.

An alternative approach to the problem of determinism has been to recognize the significance of geographic context. Physicists and chemists can control the variables and conditions under which the variables are interacting experimentally and so can establish laws of a deterministic character: given such and such, then Y will necessarily follow. This is not something that is possible in the social sciences, including geography (both physical and human). So models like Christaller's central place theory or the gravity model have to be fitted to empirically data if they are to be tested. But when that is done one quickly realizes (e.g.) that the slopes and intercepts of the relevant regression lines vary from one test to another and that what is affecting them are features of the geographic context in which the models are being tested. Population density, for example, makes a difference to how close central places distributing a particular set of retail goods and services will be to each other, as Berry made clear quite early on. Likewise the so-called 'distance exponent' in the gravity model varies according to such contextual features as,

again, the distribution of potential destinations (the further apart they are, the lower the distance exponent), or how peripheral a point of origin is with respect to the set of destinations.[4]

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From the early seventies on, however, spatial analysis was on the defensive and the early promise that it would come to dominate human geography never materialized. Major points at issue included: i) its spatially determinist character; ii) the positivistic character of its epistemologies which tended to marginalize questions of social values and which gave spatial analysis a highly empiricist tone. This latter meant a derogation of unobservables and a naivete as to the role of conceptualization in research. Many of these criticisms are drawn together and discussed at length in the accompanying reading by myself (krc).

The Spatial Tradition Since Spatial Analysis

1. The spatial tradition in human geography has developed enormously since spatial analysis and quite apart from it. Particular substantive themes that have received an emphasis they never had under spatial analysis include:

1.1 An interest in concepts of territoriality and territorial activity: spatial analysis was strong on interaction through contact at a distance -- moving to a point to enhance access to others or to get away from them, for instance. Territorial activity, on the other hand, is an attempt to enhance/reduce access to others not by movements with respect to them but by trying to influence the content of areas: keeping them out or attracting them in. This interest in selective exclusionary and inclusionary behavior has made the spatial tradition more political and sensitive to questions of relative power.

1.2 An interest in micro-spaces: the spatial organization of offices, of workplaces and schools. Again this is due in part to a heightened political sensitivity. The way micro-spaces are organized, as in prisons, schools, factories, is partly a function of the need for surveillance.

[4] So, for example: If you fit a gravity model to migration from Washington or Florida to all of the other continental states of the US, the value of the distance exponent will be considerably lower than if you fit it with data on migration from, say, Missouri or Kentucky; i.e. from more centrally located states.

1.3 An efflorescence of interest in so-called industrial areas. This recalls earlier work on the industrial agglomeration but goes well beyond it to examine, for instance, the socio-spatial conditions for technical innovation.

1.4 The question of scale: During the 1990s, scale became a big focus in human geography. It was by no means absent during the SQR. The tendency then, though, was to see a geographic distribution as something that could be decomposed into what were called 'scale components.' The assumption was that different processes worked at different geographic scales and so produced geographic variation at different scales. Thus if you examined the distribution of industrial employment across counties of the US, one of the things that would stand out would be a contrast between urban and rural counties. But if you examined it across the states of the US, what would be clear there would be a clustering of industrial employment in the Midwest and the Northeast (the old so-called Manufacturing Belt0 and the West coast. You could also take the data for counties, grouped by states, and partition it into a percent of total variation at the level of counties and a percent of total variation attributable to variation between states (i.e., once the inter-county variation had been extracted).

One of the interesting things here is the way in which scales are treated independently of one another: the variation for each scale simply adds up to account for the total variation. Today, however, the emphasis is on relations between scales. Having said that, though, the framing of the question of scale is now quite different. Two things to note in particular: i) In SQR work there was no question of power or politics. That is now central to work on scale. As a result it is more accurately described as 'the politics of scale.' ii) Scales are no longer assumed as in 'county-level' or 'state-level.' Instead of being given, scales are now seen as being constructed. A scalar concept like 'Silicon Valley' or 'Southern California' is constructed over time and its adoption can, in principle, be tracked over the years. The political character of scales can enter in at a number of different points. First, the construction of scale is often highly political, as in the division of the US into two broad regions the Coldbelt and the Sunbelt: this was done to mobilize the forces in the de-industrializing states of the Midwest and Northeast which faced a similar challenge from locational shifts to the Sunbelt. This is typically an inter-scalar process as, for

example, the process of constructing a regional identity proceeds 'bottom-up' from the individual states. Second, there are inter-scalar relations. The states relate through their Congress-persons and Senators to the country as a whole through the federal government. States enter into coalition with one another, for example, in order to secure favors from the federal government; not least some shift in the direction of subsidies away from Sunbelt states towards those of the Coldbelt.

1.5 From mental maps to spatial imaginaries: The mental maps that were drawn and studied during the SQR are one type of spatial imaginary in the sense that they are indeed imagined and they are about space relations. But they are emphatically only one type of spatial imaginary. The imaginary is a necessary part of the social process and therefore of the socio-spatial process. We imagine things before we act; we imagine a path to a place to get there; and when looking around for a new house we bring to bear some idea of the geographic organization of the city (for example, we certainly assume that there will be variations in the quality of schools from one area to another and that the population will be socially segregated). Any sort of conceptualization of space and space relations is a spatial imaginary ranging from the constructs of the lay person to the ideas of the academic (as in Koeppen's imaginary continent showing the space relations of different climates one to another).

Today, as in so much of contemporary human geography, though, it is the spatial imaginary as a power relation, something that can be deployed politically, that dominates. In the thesis of Orientalism, for example, Europe was conceptualized by Europeans in terms of contrasts with those lands over which they held imperial sway or were politically dominant in other ways (e.g. China). The colonial 'other' was defined in terms which would justify continuing colonial rule: they were defined as barbaric, sunk in superstition and traditional practice and so needing the guidance of the – by definition – civilized Europeans if they were to become modern and Christian: traits which were taken for granted as desirable. So here the spatial imaginary is construed in terms of an identity, but one which can be put to use in justifying a political relationship.

2. A major theoretical motif in the spatial tradition post-spatial analysis has been a recognition of the necessary relation between social individuals and spatial pattern. People are *social* individuals: we need others in order to realize our needs, exercise our powers. But that means making contact with other people, keeping yet others away. As a result spatial arrangement becomes a necessary condition for our (socio-spatial) activity. And as we engage in our spatial activities so we reproduce and transform those spatial arrangements: footpaths not used get overgrown and fall into disuse; highways that *are* used, get congested, widened, draw in more traffic, etc. Spatial pattern has come to be seen, therefore, as something that is socially constructed. When we talk about scale or region these are social constructs (e.g. the emergent scale that we know as 'Central Ohio' – something that did not exist when I first came to Columbus thirty years ago).