WILLIAM BUNGE'S *THEORETICAL GEOGRAPHY*

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Introduction

Theoretical Geography first appeared in 1962 (Bunge, 1962), and later in an expanded second edition in 1966 (Bunge, 1966). To Cox (2001) it is "perhaps the seminal text of the spatial-quantitative revolution. Certainly in terms of laying out the philosophical presuppositions of that movement it had no peer." (p71) But Cox goes further:

> "It was also the spatial-quantitative revolution that gave impetus to conceptual precision in the field … it was the prospect of measurement, of operationalization in some piece of empirical research, that helped us discover the value of a careful specification of our concepts and an examination of their consistency … So, if we want to see where we have come from, what our intellectual debts are, there are few better places to start than *Theoretical Geography*." (p.71)

The motivation for the book, laid out in the Introduction, is that geography is a science; that every science is defined by its domain of knowledge, which for geography is the Earth as the home of humanity; that every science has both a factual or empirical side and a theoretical side; and that "there are many books on geographic facts and none on theory" (Bunge, 1966, p.x). Moreover, "the author is a theoretical geographer" (p.x) – theory is what he does. Theory "must meet certain standards including clarity, simplicity, generality, and accuracy" (p.2), and only through theory can we discover "these patterns,

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these morphological laws … so that (our) planet, Earth, fills (our) consciousness with its symmetry and ordered beauty” (p.xvi).

The content

The medieval Christian idea of a geometrically perfect world centered on Jerusalem (Harley and Woodward, 1987) had been abandoned in the Renaissance, and replaced with view that the Earth’s surface was infinitely complex. So although science had made great strides in explaining other aspects of the cosmos, at the same time by apparently rejecting religious teaching it had led to a confusing view of human behavior, and of our immediate surroundings. In Bunge’s view, it was only through geographic theory that we could return our concepts of the world to an emotionally satisfying and reassuring simplicity.

To Bunge, there were simple laws to be discovered about the Earth’s surface, and particularly about the patterns of phenomena found there. They would be found for both human and physical phenomena, and because the study of one could inform the other it made sense for departments of geography to house both physical geographers and human geographers. The key to understanding patterns was geometry, which allowed the precise description of pattern and, through its theorems, allowed the researcher to reason about pattern and thence to theory.

The book[2] opens with a chapter on the methodology of geography, and makes the author’s position clear. Two examples are used to focus attention on what will be the recurring geometric theme of the book. Regional geography, long dominated by descriptive work that emphasized the unique properties of places, could be put firmly within a scientific paradigm if one focused on devising objective and replicable methods for defining regions, and concentrated on statistical evidence instead of subjective impression. As a second example, the shifting river courses of the lower Mississippi bore a striking geometric resemblance to the historic development of north-south highways in the Seattle area, and similar explanations could be found if the geomorphological process of building natural levees were compared with the social process of commercial development along arterial roads.

The second chapter, titled “Metacartography”, takes another icon of traditional geography, the map, and goes to great lengths to argue its essential mathematical nature, and the degree to which such core cartographic concepts as projection, overlay, and generalization can be expressed in the mathematical frameworks of geometry and set theory. A chapter on shape discusses potential measures of this somewhat elusive property, while subsequent chapters cover sampling, topology, and geodesics. A full chapter on central place theory reflects the early 1960s focus on this as an icon of the push to theorizing in geography. The book hints at many of the major developments of quantitative geography and geographic information science of the coming decades, though of course it is impossible to find anticipation of today’s emphasis on computation and computer networks

But there is far more to the book than is suggested by this quick summary, and as one might infer from the commentary from Cox quoted above. The book needs to be understood within the context of debates that raged in geography at about that time, and in the context of the much wider intellectual movement of which it is in many ways the

[2] All references are to the second edition published in 1966

opening statement. It also needs to be understood within the ageless desire of geographers to rank among the respected disciplines of the academy.

Debates within geography

To Bunge, the most important intellectual debate in geography in the late 1950s and early 1960s was that between the *nomothetic* and *idiographic* perspectives on science. Although their actual positions were much more nuanced, we often identify the perspectives with the names of Schaefer (1953) and Hartshorne (1959) respectively. Bunge had been strongly influenced by Schaefer, having been drawn to his work by William Garrison while a student at the University of Washington, and it is no accident that the first citation in the book is to his paper.

The nomothetic position holds that results in science are of value only when they are general, applying equally at all locations in space and time. For example, Mendeleev's Periodic Table would be far less significant if the elements behaved differently during leap years, and Newton's Laws of Motion would be far less significant if they applied only in the State of Minnesota. In other words, empirical science proceeds by abstracting and generalizing away from the space-time context in which all observations are made; and scientific results are applied by re-inserting them into context.

To Bunge science was inherently nomothetic, and geography was a science. Its success would be measured strictly by the number of general principles that it discovered, within its defined domain of knowledge. These would be principles governing the patterns that emerge on the Earth's surface as a result of social and physical processes, ranging from the dendritic patterns of stream channels to the regular spacing of settlements. The purpose of geography was to discover these principles, and the chapters of his book laid the foundation, by outlining a methodology and providing examples.

Geographers are clearly going to find this nomothetic position difficult, since the description of variation over the surface of the planet is so much part of the intellectual tradition of the discipline, and much would be lost if description were justified only if it led to general principles. So while physicists might marginalize *mere* description, geographers must necessarily treat it with more respect. The idiographic position holds that description has inherent value, particularly if it is conducted according to scientific principles – for example, using generally agreed terms, and methods that are described in sufficient detail to be replicable by others. But Bunge and others rejected this position, arguing that an idiographic geography would always be a marginal science.

To Bunge, then, it was important that geography establish its credentials as a science. The first edition appeared in 1962 (Bunge, 1962), at the very outset of what later became known as the *quantitative revolution* in geography (Berry, 1993). Bunge was one of a group of graduate students who had been inspired at the University of Washington in the late 1950s by William Garrison, Edward Ullman, and Donald Hudson. The group included Duane Marble, Brian Berry, Michael Dacey, Richard Morrill, John Nystuen, Arthur Getis, and Waldo Tobler. As these fresh PhDs fanned out to positions in influential universities in the U.S., their approach rapidly caught the imagination of others, including Leslie King, Leslie Curry, Maurice Yeates, Peter Haggett and Richard Chorley in the U.K., and many more. Further books appeared, including Haggett's *Locational Analysis in Human Geography* in 1966 (Haggett, 1966), Chorley's and Haggett's *Models in Geography* in 1967 (Chorley and Haggett, 1967), and King's

Statistical Analysis in Geography in 1969 (King, 1969). New journals were established, positions created in almost all departments, and by the end of the decade it could truly be said that geography had been transformed.

But it would be oversimplifying to suggest that this transformation merely altered the balance between nomothetic and idiographic visions of science. As Cox argued in the passage quoted earlier, Bunge also contributed to a transformation of geographic practice that included all aspects of the scientific enterprise. It came at a critical point, when computers were becoming available as engines of analysis and modeling. His book makes a passionate case for mathematics, as the *lingua franca* of science, with its well-defined and widely accepted terms and its formal reasoning, and for particular applications of geometry to the analysis of geographic pattern. It argues the merits of quantification, and of the formal reasoning of statistical inference, and as we have seen it is at pains to elaborate the relationship between maps, the traditional research tool of the geographer, and mathematics, the pervasive tool of science.

Reading the book again after 40 years, one is struck with the sense of excitement of the early quantifiers, and by a rhetorical style that clearly emulates the sciences and is rarely encountered in geography today. In the introduction to the second edition, published in 1966 (Bunge, 1966) the author writes:

> "the discovery of a great number of patterns of location during the fall of 1962 was helpful. We now know why political units have their overall shape, why rivers are dendritic, and why alluvial fans and Burgess's rings are such close spatial cousins. Also, the problem of the construction of the isometric surface is much better understood." (p.xiv)

Nevertheless the author cannot resist continuing:

> "To see region construction, one of the last preserves of the non or anti-mathematical geographers, crumble away before the ever growing appetite of the computing machines is a little unnerving even for a hard case quantifier." (p.xiv)

The revolution is well on the way to victory.

Counter-revolution

While *Theoretical Geography* may indeed have been the "shot heard round the world", and while it provided a general outline of how to make the pitchforks, guns, and guillotines that would be needed before the revolutionaries could prevail, much of its content does not stand up well to detailed analysis. While it argues strongly for mathematics, there is precious little actual mathematics in the book, and it fell to others such as Alan Wilson (1970) to provide the rigorous theorizing. It is easy to see parallels between the behavior of floating magnets in a dish of water and the behavior of vendors positioning themselves on a featureless plain (p.283). But on more careful analysis it is obvious that the laws of magnetic force do not have precise analogs in the laws of entrepreneurial behavior. Bunge was (and still is) the passionate visionary, but it took others with a deeper knowledge of mathematics and a patient commitment to rigor to begin to build the peer-reviewed literature of quantitative geography. Moreover it was not long before the counter-revolution began.

One of the first salvos was fired by Sack (1972; and see the continuing discussion: Sack, 1973; Bunge, 1979). Certainly one could find consistent patterns across the Earth's surface – the geometric form of the river meander, Horton's laws of stream number

(Horton, 1945), the regular spacing of settlements in Southern Germany – but geometric pattern in and of itself could not be regarded as *explanation*, and could not therefore provide the sense of satisfaction that comes from knowing how a pattern is caused. Spatial properties such as latitude, distance, or direction could never be said to truly explain anything. Sack saw Bunge as the primary exponent of a confusion between geometric pattern and explanation, and attacked his notion that it was an interest in space and spatial properties that defined the discipline.

This issue remains an important one today. The spatial tradition is still a key part of the discipline, though only one of many in an increasingly pluralistic field (Pattison, 1964). At the same time few would claim today, as Bunge seems to have done in 1962 (Bunge, 1962), that geography somehow has or should have a monopoly on all things spatial. Sack points out that it is not distance itself that explains human behavior, but the costs or other impediments that result from spatial separation, such as transport cost or the time taken to travel. But if these are approximated by mathematical functions of distance this argument seems to be hair-splitting – to all intents and purposes it is distance that explains why people have more friends nearby than far away, even in the Internet age, and why fresh milk is more likely to come from nearby cows.

Moreover the floating magnet example points to another fundamental problem, the fact that many different processes can lead to similar geometric forms. Thus it can be difficult to deduce general statements about process from the patterns found on the Earth's surface, particularly if one cannot observe how those patterns change through time.

The spatial clustering of cases of a disease provides a compelling example. In the traditional re-telling of the story, the map made by Dr John Snow of the cholera outbreak in London in 1854 showed a clear clustering around the pump that he had suspected of providing cholera-carrying water, and thus of causing the outbreak (see, for example, Longley *et al.*, 2005). But a cluster in space can always arise through two very different processes. In a *first-order* process the likelihood of an event is a function of location, and events are more likely in some locations than others, in this case near the pump. In a *second-order* process events affect each other, and the presence of one event makes others more likely in the immediate vicinity; an example in epidemiology would be contagion, in which a disease is passed directly from one individual to another. Under the hypothesis of a contagious process, which at the time was how cholera was generally believed to have been transmitted, an initial carrier of the disease who happened to live near the pump could have caused the same spatial pattern. Only by observing the pattern's development through time could one acquire evidence to resolve between the two hypotheses.

The lasting impact

It was problems and issues such as these that led geographers in the 1970s to question the value of Bunge's heavy reliance on the spatial approach, and to look elsewhere for more productive sources of explanation. Many others remained firmly committed, however, and continued to refine the methods and models that Bunge had pioneered. Computing provided an additional impetus, as it became possible to bring much more powerful tools to bear on geographic data. By the 1980s geographic information systems (GIS) had become a focus for much of this work, and many of Bunge's ideas had been implemented and successfully applied. The rather simplistic ideas of central place theory had evolved into location-allocation, his discussion of optimal routing and geodesics had blossomed into corridor location, and his primitive ideas of spatial similarity had spawned metrics of spatial autocorrelation and the fields of spatial statistics and geostatistics.

Today, Bunge's ideas of a geography grounded in geometry are alive and well, but not for quite the reasons he suggested. As many have argued (see, for example, Laudan, 1996), science is not only about the rather emotional topic of explanation, but also about prediction, design, and other useful human activities. Goodchild and Janelle (2004) list six arguments for a spatial approach in the social sciences (and note that all six apply to both space and time):

- Integration. A spatial approach allows information to be placed in context, and allows information from different sources to be correlated. These are often presented as the most compelling functions of GIS.
- Cross-sectional analysis. As Bunge argued, spatial patterns can often provide insight into process, particularly if patterns are observed through time.
- Spatial theory. A spatial theory can be defined as one that includes such spatial properties as location, distance, or direction in its structure. Central place theory, theories of spatial diffusion, and theories of spatial ecology all have this property.
- Place-based analysis. These are recently developed methods of analysis that recognize the fundamental variability of the Earth's surface, and produce maps of results rather than single summary statistics. The geographically weighted

regression devised by Fotheringham, Brunsdon, and Charlton (2004) is a good example.

- Prediction, design, and policy formulation. As noted earlier, the application of general results requires that they be placed back into a space-time context. To predict the effects of a change in oil prices on the economy of California, for example, it is necessary to take general results on how economies respond to oil prices and to apply them in the specific space-time context of California.
- Information storage and retrieval. Space and time provide a powerful way of organizing knowledge, and of retrieving information from today's vast stores of digital data (see, for example, the Alexandria Digital Library, www.alexandria.ucsb.edu, and the overview of *geoportals* by Maguire and Longley, 2005).

The later Bunge

And what of the author himself? William Bunge is a very imposing person, two meters in height and powerfully built, and with enormous energy. Like many others, he was strongly engaged by the political turmoil of the 1960s, and frustrated by the slow, reflective pace of academic life and what he perceived as its lack of direct influence and action. He felt a strong urge to demonstrate the practical importance of the ideas he espoused in *Theoretical Geography*. As a faculty member at Wayne State University, he spent several years implementing his ideas in the ghettos of Detroit (Bunge, 1971), while continuing to participate in the meetings of the Michigan Inter-University Community of Mathematical Geographers (MICMOG), which were held close to the point of minimum aggregate travel of the University of Michigan, Michigan State University, and Wayne State University (in a high school in Brighton, MI). The Detroit Expedition became a seminal exercise in working with disadvantaged communities, applying many of the ideas of the early quantifiers towards the improvement of the human condition. Detailed maps of human deprivation were created based on observation, and the group worked aggressively towards the adoption of better school districting plans that implemented many of the ideas of location theory.

Bunge took a strong stance against the Vietnam War, and became increasingly disillusioned with both U.S. society and U.S. academe. His positions led to increasing friction both on and off campus, and in the early 1970s he left the U.S. for Canada, where he took short-term positions at the University of Western Ontario and York University. The graduate seminar he gave at the University of Western Ontario was well received by many of the students, but his openly expressed disgust with the political positions of some of his colleagues made it impossible to renew his contract. He drove taxis for a time in Toronto, and eventually settled in small-town Quebec. In 1988 Bunge's *Nuclear War Atlas* appeared (Bunge, 1988), a powerful application of spatial techniques to draw attention to the impossible consequences of the use of thermonuclear devices.

The evolution and politicization of his thinking is clearly evident in his 1979 retrospective on *Theoretical Geography* that was published in the *Annals of the Association of American Geographers* to mark the AAG's 75th Anniversary (Bunge, 1979). The passion is there, more strongly than ever, as is his commitment to scientific method, empirical observation, and sound theory, but it is directed at different targets.

As Macmillan argued in another 2001 commentary (Macmillan, 2001), despite all the critiques of quantification, theory as Bunge conceived it, and positivism that have appeared in the past three decades, Bunge's *Theoretical Geography* remains as "a major landmark in the history of geographic thought" (p.74). It appeared "on the cusp between the old world and the new" (p.74), between the old analog world of crude, imprecise tools and the modern world of abundant data and powerful techniques of analysis, visualization, and simulation. Reading the book one gets a sense of what an effort it must have been to prepare the maps, tables, and summary statistics using the pens, slide-rules, hand calculators, and log tables of 1962, and how much more one could have achieved today. Yet virtually all of the major areas of today's spatial perspective are there, in a book largely written while Bunge was a graduate student. There can be few periods in the history of any discipline when a group of people created quite the intellectual ferment that must have existed in geography at the University of Washington in the late 1950s and early 1960s. *Theoretical Geography* captured that ferment in a way that is still meaningful today.

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