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Cultural Topology: The Seven Bridges of Königsburg, 1736

Rob Shields
University of Alberta, Canada

Abstract
In an example of Enlightenment 'engaged research' and public intellectual practice, Euler established the basis of topology and graph theory through his solution to the puzzle of whether a stroll around the seven bridges of 18th-century Königsberg (Kaliningrad) was possible without having to cross any given bridge twice. This 'Manifesto' argues that, born in a form of cultural studies, topology offers 21st-century researchers a model for mapping the dynamics of time as well as space, allowing the rigorous description of events, situations, changing cultural formations and social spatializations. Law and Mol's network spaces, Serre's folded time, Massey's 'power geometries', Lefebvre's 'production of space' and 'rhythmanalysis' can be developed through a cultural topological sensitivity that allows time to be understood as not only progressive but cyclical, relationships and the 'reach' of power can be understood through 'knots', and a topology of experience to model the 'plushness of the Real' via extra- and over-dimensioned time-spaces that capture nuance while drawing on systematic conceptual resources.

Keywords
cultural topology, engaged research, networks, social spatialization, space, time

Topology has existed as a mathematical discipline for little over 80 years. However, as early as the 18th century Leonhard Euler discovered the first topological property: the 'Euler characteristic' establishes the genus of shapes (such as 'circular' or 'linear' or 'cubic'). Regardless of how they are deformed (e.g. by stretching or folding the space they are in), the sum of a particular shape's vertices, edges, and faces remains the same.

This idea was established through a discussion of the Seven Bridges of Königsberg (Euler, 1752 [1741]): Euler solved a problem which had been set by the inhabitants and provided the basis for a more general method

Corresponding author:
Rob Shields, University of Alberta, Edmonton, AB T6G 2H4, Canada
Email: rshields@ualberta.ca
http://www.sagepub.net/tcs/

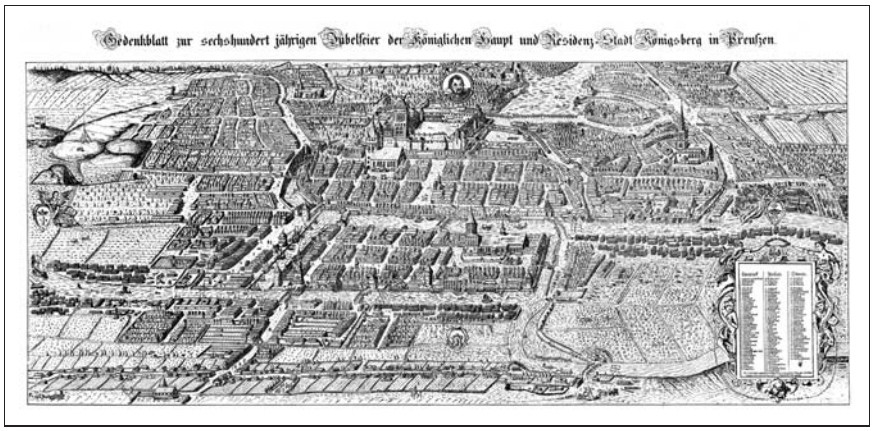

Figure 1. Engraving of Königsburg in 1613.
Source: Wikimedia, Joachim Bering 1813.

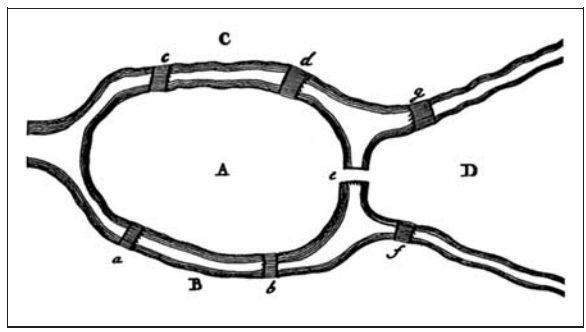

Figure 2. Euler's 1736 diagram of the Bridges of Konigsberg c.1736 (after Mallion, 2008: 26 and Faculty of Science University of Kragujevac, 2007).

of choosing routes efficiently. The old capital of East Prussia was built at a fork in the river Pregel (now named the Pregolya) and a strategic island crossing. Seven bridges connected four areas of the city on the point, each bank and the island (see Figures 1 and 2). Could a person go for a stroll, crossing each bridge once? An acquaintance, the mayor in nearby Danzig (now Gdansk), wrote:

> You would render to me and our friend Kühn [a local mathematics professor] a most valuable service, putting us greatly in your debt, most learned Sir, if you would send us the solution, which you know well, to the problem of the seven Königsberg bridges, together with a proof. It would prove to be an outstanding example of the calculus of position [*Calculi Situs*], worthy of your great genius. I have

> added a sketch of the said bridges . . . (letter from Ehler, 9 March 1736)

This is a topological problem in that connectivity is at issue, not the size of any one bridge or its distance from another bridge. Euler 'understood that the problem did not depend on the precise map of the city . . . it was not a problem of geometry. . . . Euler establishes the new nature of the problem by using the term "geometry of position", an expression introduced for the first time by Leibnitz' (Kantor, 2005) as *geometriam situs*, or *analysis situs*, 'another kind of analysis, geometric or linear, which deals directly with position, as algebra deals with magnitudes' (Leibniz and Clarke, 2000; Letter to Huygens, 1679). Euler presents his argument in 21 numbered paragraphs, beginning by saying:

> 1. Hence, when a problem was recently mentioned which seemed geometrical but was so constructed that it did not require the measurement of distances, nor did calculation help at all, I had no doubt that it was concerned with the geometry of position – especially as its solution involved only position, and no calculation was of any use. I have therefore decided to give here the method which I have found for solving this problem, as an example of the geometry of position.
>
> 2. The problem, which I am told is widely known, is as follows: in Königsberg . . . (Euler, 1752 [1741]: 128).

And so begins one of the foundational papers of modern mathematics, in a problem of *urban cultural space and leisure* – an historical example of engaged scholarship and research – and the importance of public curiosity to innovation. This is to assert a methodological claim on cultural studies and a theoretical claim on topology. Against the usual stereotypes of Enlightenment methods and scholarly practice, we see an engagement that is thoroughly 21st century in its responsiveness. It ties topology to culture and to the complexity of everyday experience rather than the formalism of social laws in a manner that prefigures the stress on relationality in later cultural studies research, for at issue is the way the town is put together in two and three dimensions and how the bridges connect its island (see Figure 2). It is not the exact shape of an object that is of interest but the way objects are put together – how parts relate to wholes or how a shape divides a plane by containing an inside separated from an outside.

Euler showed that it was impossible to find a route through the town that would cross each of its seven bridges across Pregel exactly once. 'If there are more than two areas to which an odd number of bridges lead,

then such a journey is impossible' (Euler, 1752 [1741]: 139, para. 20). Euler develops a technique of assigning each area a capital letter A–D and each bridge a lowercase letter a–f and then asking about the path necessary to connect the areas, crossing each bridge only once. How many times does the letter for a given bridge appear when one connects the areas? 'A path signified by n letters corresponds to crossing n-1 bridges, so a solution to the Königsberg problem requires an eight-letter path' (Hopkins and Wilson, 2004: 204). One can perform a similar calculation for any given arrangement of areas or objects joined by bridges or links. This sums up the number of bridges required in any path that doesn't have to re-cross a bridge (Euler, 1752[1741]: paras 8–12).

The strategically-located town and most of its bridges were destroyed by aerial bombing and heavy fighting in 1945. After the Second World War, the town was used as a key military base and was closed to foreigners for 50 years. The area bordering eastern Poland along the Baltic Sea, now separated from the Russian Federation by the independent republics of Lithuania and Belarus, is both an exclave of Russia and an enclave within the European Union countries of Poland and Lithuania. Of the few buildings that survived, the Cathedral with the grave of the philosopher Emmanuel Kant is still standing. To mark the tercentenary of Euler's solution, a number of mathematicians re-surveyed the original location, now Kaliningrad, and concluded that 'Eulerian Walks' are still possible but not a perfect 'Eulerian circuit' as the bürgers dreamt of. Despite the war-time destruction, a new Kaiserbrücke footbridge was rebuilt in 2005 and a motorway now spans Kneiphof Island but allows pedestrian access to the island. Bailey adds:

> War, ironically, has led to the solution of the problem of the Seven Bridges. The case of Koenigsberg/Kaliningrad shows how politics affects spatialization: what was once an abstract mathematical problem concerning space is completely altered due to politics. The city teaches an important lesson about how space is not simply a static, apolitical, mathematical entity, but rather a dynamic entity that is constantly changing due to natural, economic, social and political forces. . . . To this day Kaliningrad remains a Russian 'island' and is now situated within the EU, sandwiched between Poland and Lithuania . . .
>
> Kaliningrad Oblast is a living palimpsest, which complicates spatial questions concerning nationality, identity and homeland. Vesiland and Chamberlin describe Kaliningrad as haunted: 'The Russians and others who came here after World War II for a new life

> moved into the shell of a nation, into other people's homes and farms, to use other people's furniture and pots and pans' (1997). The Russians living in Kaliningrad occupy a space with a German past, from which they are disconnected; a space which is at the same time disconnected from their motherland. (Bailey, 2010: online)

Writing on the mathematical history, Mallion makes the speculative statement: 'if the 1542 Honigbrücke [bridge *e* in Figure 2] had never been built, Euler would never have been asked to look at this problem at all.... And if Euler had not intervened, topology and graph theory might have developed along different lines' (Mallion, 2008: 34–5). Bailey's point is that Königsberg/Kaliningrad continues to provoke questions of relations between areas and cultural spaces as a type of what Blackwell calls *cultural topology* (Blackwell, 2004; Shields, forthcoming).

Non-Euclidean Topological Spaces, Surfaces and Mobilities

Early proto-topologists such as Euler accepted the existence of an absolute space as a real medium needed for the determination of absolute rest and motion and for a law of inertia. But what if M.C. Escher were to paint an imagined Königsberg in which one could find a Eulerian walk, crossing each bridge only once? This would require a weird painterly space in which the ground and bridges warped back on themselves to allow a strolling *flâneur* to never cross their own path.

Non-Euclidean 'topological spaces', a term introduced by Felix Hausdorff in 1922, are behind the visual tricks of Escher's paintings. However, they are studied as geometric wholes. Changing the parameters of spaces reshapes them by continuous stretching and bending much as a potter could change their mind mid-creation to reshape an object. Topology focuses on spatial properties of these object-spaces that do not change under such 'homeomorphic' continuous deformations. For example, any object with one hole is 'homeomorphic' with any others with one hole. Similarly the angles of a triangle on a flat plane add up to 180 degrees, but laid onto a sphere one can still discern a triangle with three points. But because of the curvature introduced into its sides, the sum of the angles of a triangle will be greater, altering one of Euclid's *Laws*. So topology includes not only strict shape invariance but also fuzzier, yet mathematically rigorous, 'shape consistency' under deformation.

This can usefully be compared to other things that change yet are held to remain the same, such as a family or community or group – virtualities, that is, intangible-but-real-entities that remain despite turnover in membership. Other examples include objects that age (e.g. a corroding automobile) yet are still referred to as the same object. The virtual builds beyond a social constructionism to a post-structural empiricism that

acknowledges the realism of entities such as a group or a mathematical set independent of the elements (e.g. the set of prime numbers versus the numbers that make it up – see Shields, 2006b).

Topology can shed new insight into familiar social science objects of research by mapping out how such objects change and how they relate, in this process, to other changing objects in multiple, relational spaces. Topology sets aside the privilege granted to Euclidean space in lay understandings of the social to problematize even the spatio-temporal ironies and anomalies we do recognize in everyday life. That is, topology allows us to systematically adopt a critical stance to how notions such as a 'shrinking' or more closely tied world is represented and understood. For example, how is it that the rapid changes introduced in only half a century by technologies of mobile computing, communications and travel are construed as unremarkable entwinings of distant places into a new spatialization of the world as distinct but normatively de-differentiated?

Topology provides methodological and conceptually precise frameworks for conceiving not only of relationships or the structure of activities or tasks such as crossing bridges. Topology also allows one to rigorously approach situations where the order of things is deformed by any given force. That is, it provides the mental hand-holds for working with situations where relationships are changed, distanciated, collapsed or distorted, reshaping the 'diagram' one might draw of the situation. Typically, diagrams are projections of multi-dimensional processes onto the two-dimensional topology of the page. Complexity is strategically visualized in a reduction of overall relations and transformations. In general, topology spatializes variables as the respective dimensions or parameters of 'manifolds' (what popular complexity theory has called 'phase spaces'). Within manifolds, 'neighbourhoods' of relative predictability may be related to neighbourhoods with different qualities. Independent variables are referred to as 'dimensions' that operate on the manifold as a whole rather than on objects or specific points within it. For example, theories of relativity popularized the notion of everyday life as a three-dimensional spatial manifold, operated on by a further, fourth dimension: time.

Dimensions can also be understood as degrees of freedom: the point has zero, the one-dimensional knot one; two-dimensional surfaces can be stretched on two axes. Similarly, if a manifold has a boundary, it is one dimension lower: string tied in a knot has two boundaries at either end that are points (zero dimensional – unless its ends join [a circle], in which case it would have no boundaries); the boundary of a two-dimensional surface is a line (one-dimensional), that is, an edge, and so on. Such topological axioms of connectivity, relationality and dimensionality already operate in spatial data sets and the algorithms of Geographical Information Systems. However, they deserve more political-economic

and sociological critique as they tend to operate normatively with institutional and governmental effects.

Taking a more social example, anthropologists have long posited a spatial aspect to rites of passage where a liminal zone of initiation is counterposed as a threshold zone in which the rules of the usual social environment do not apply but are suspended; young initiates are removed from the tribe to be initiated and instructed, then 'reborn' back into the social world of the tribe as adults. The differential relationship between centres and peripheries is a second geographical commonplace, so much so that one could speak of a liminal spatialization of the periphery (e.g. historical seaside Brighton compared to London; Shields, 1993).

Massey has called these social spatializations (Shields, 2006a) 'power geometries' (Massey, 1999). Power geometries are located, not stretched, and refer to capabilities as potentials. But Massey is more obviously topological when she considers the remolding of the Earth by tectonic forces and the rapid transformation of the relationships between distant places entailed by globalization as a virtual 'shrinking' of the world achieved through closer ties and communications (cf. Shields, 2003, 2006b). Other examples could include Giddens' time-space distanciation as the stretching out of social relations, or Harvey's time-space compression as a metaphor for theorizing globalization, or Virilio's emphasis on acceleration and the speed of travel and communications as having the effect of 'shrinking' our world (Virilio, 1986). How is it that these transformations in not only our understanding of but our practices in space seem so commonplace? The implications of these theories have not been systematically understood, thereby cutting short critique. Virilio, for example, goes on to assert: 'The reduction of distances has become a strategic reality bearing incalculable economic and political consequences, since it corresponds to the negation of space' (1986: 133). However, it is not a matter of negation of space but a change to conventional understandings and practices of space, a topological shift which involves both time and space: a new cultural topology. These are questions of not just a single era's experience but of cultural topology in general which asks further – how is that such global connectivity is mapped onto a local neighbourhood in which Euclidean and Cartesian rules of engagement and embodiment apply? More than a changing spatialization, this appears as a multilayered topology with different spatializations applied at different scales. A topological sensibility generates these sorts of novel and non-totalizing hypotheses which shed light on the dynamism of experience and perception, norms and practice. What are the topologies of capitalism, and could this not be a better framework for comparative insight than the nervous shifting from foot to foot that has marked two decades of critique, grasping at organizing rubrics such

as postfordism, hypercapitalism, late capitalism and neoliberal globalization?

Even critical approaches to time and space would benefit from topology's accommodation of multiple dimensions of both at once. This constitutes a dramatic change from organizing metaphors of surface and depth. Furthermore, it offers a basis on which one might reassess the binarisms of the tradition from Hegel through Heidegger and on to Lefebvre, Virilio and more recent writers that accepts the language of the 'negation' of space – that is, that time as instant or point is the antithesis of space (and only a certain, European notion of space as *spatium*) as unbounded field. This 'black-boxes' both time and space as opposed singularities. While elegant, it is only one diagrammatic reduction when there are many possible time-space relationships between spatialities and temporalities.

For example, the common experience of duration stretching out like eddies in the flow of time can be mapped as extra-temporal dimensions. These have been compared to the many loops of thread that make a 'terrycloth' towel. Lower dimensional temporalities may be insignificant under most conditions but become the site of emergent psycho-political change (see Randall, 2001). A prototype for this approach might also be found in the anthropology and psychology of time (respectively e.g. Lomnitz, 2001, and Csikszentmihalyi, 1990; see also Kubicek, 2008, on the history of the scalar concept of 'deep time' in geology). What difference does this make to critical practice? It allows new practices of 'thick description' (Ryle, 1968; Geertz, 1973). It reminds us to relate, trace and contest the relationships between these multiple dimensions and to wonder at the priority given to the time-space relations between all these dimensions that make up the 'plushness' of the real (see Shields, forthcoming).

A *topology of experience* may be strategically sketched as a diagram of what happened or what happens, but the contingencies of the embodied flow of experience, and its knotting of the past as 'experiences' and the present as experiencing, suggest more multidimensional models of happening than a two-dimensional diagram would conventionally capture. As Vannini (2011) illustrates, travel and other mobilities are more complex than a mere line between departure and destination. That is to say that mobilities not only indicate the contours and dimensions of a topology, but are traced on or in topological surfaces that delimit the degrees of freedom of any movement: 'In truth, to change the world, one must change space' was Lefebvre's 'strategic hypothesis' (1974: 220, my trans.).

The itinerary that threads back and forth across Königsburg's bridges and island also has the quality of knots or of a cat's cradle game. Familiar knots are embeddings of a one-dimensional space or manifold, such as a loop of string, into more dimensions, such as a

three-dimensional physical space. We know that the string can be unknotted and re-tied into a different type of knot, making some knots equivalent to others. A geometrical solution would be confined to one dimension – pulling the string out of the knot bit by bit. A topological solution would consider how to untie the knot as a manifold set in extra dimensions. By extension one might consider the knots of everyday life in even more dimensions: adding historical time is already a topological move, but considered in the varying tempo of time and virtual temporalities such as, for example, Braudel's *longue durée* or Benjamin's flash of *Jetz-zeit*, now-time, or Lefebvre's 'moment' that displaces the steady march of clock time. These variations to the rhythms of everyday life are only a few established examples that use 'over-dimensioned' representations of experience to sound and probe relations.

Knots have been the basis for cross-cultural conceptions of complexity, from Piranesi's labyrinths, to fishing nets to children's games. Because topology offers the insight that it is possible to analyze systematically relationships and configurations themselves, it shows us that knots are more than metaphors: knots describe topologically not only complex networks but the twisted path a document might take through a bureaucracy, or that a decision-making process might follow. Topology maps across boundaries and interfaces where 'translations' that may recode, warp or recast objects, such as a document or terminology that is understood in different ways on either side of this border, a topological fold, held in place by power, that reorients the internal sense of a message. One might thus trace the experience of boundary-objects that have these qualities (Bowker and Star, 1999) as well as discursive sleights of hand in which meanings are realigned according the interpretation of different groups and their interests. For example, Stark, Vedres and Bruszt show how discursive meaning can be shifted to allow divergent local and transnational interests to engage in shared projects and narratives amongst groups in civil society (Stark et al., 2006).

From Spatial to Topological Turn

These itineraries or mobilities are a fundamental aspect of the topological shift which moves away from relatively static or intersecting spatializations to the dynamism and tensions amongst objects set in conflicting spatial orders or spatializations that recast those objects and their qualities and powers or reach (in very different ways). Topology thus accounts for both the proper and improper, the legitimate and the out-of-place. Building on the so-called 'spatial turn', a 'topological turn' in cultural studies is foreshadowed by proto-topologies such as Arjun Appadurai's description of globalization as a series of 'scapes' of sectoral flows such as information, bodies or capital (Appadurai, 1996). Theorists such as Deleuze, Mackenzie, Delanda and Massumi have also mobilized

topological insights, for example the role of 'attractors' as 'catastrophe' points in the 'bifurcation' or sudden phase change of complex systems (Delanda, 2002; Deleuze, 1986; Mackenzie, 2005; Massumi, 2002). On the social science side, the tendency has been to exploit only the metaphorical richness of topology. A cultural topology promises to allow generalization across cases by drawing on the rigorous language and classification system already developed in mathematics. On the natural science side, no non-algebraic primers are available (but see Barr, 1989; Blackwell, 2004) and the tendency is to discuss the mathematical intrigue of the science (Delanda, 2002; Mackenzie, 2005).

For example, the geographers John Allen and Allan Cochrane describe topological models of power as an alternative set of metaphors to those that structure the thinking of power as either vertical hierarchies or horizontal networks. Rather than these 'extensive' relations, topology suggests 'intensive' relations whereby the state makes itself felt within policy and decision processes as 'reach': 'proximity and reach play across one another in a variety of intensive ways to bridge the gap erected by the physical barriers of distance' (Allen and Cochrane, 2010: 1075). But the topological is in fact not directly addressed: their model is topological in that they describe ways that the central state in the UK is implicated institutionally in regions and thus peripheries are brought close to the centre – space shrinks and warps dynamically as an institutional creation that is re-conjured and re-actualized by different interests and constituencies in a process of permanent struggle.

> What is politically at stake in favouring topology over topography, spatial intension over spatial extension, is that such an approach is able to show how the state's hierarchical powers have not so much been rescaled or redistributed as reassembled in terms of spatial reach. Equally, a topological understanding of the politics involved also reveals what lies behind the opening up of authority in the more complex institutional arrangements unfolding. (Allen and Cochrane, 2010: 1073)

There are more questions and possibilities to this topology: How does the spatial interleave with the time of the state – of election cycles, parliamentary sittings, budget years, bureaucratic work-plans, policy events and news media deadlines – and the time of crises, of people's needs and events?

Giaccaria and Minca build on Agamben's discussion of Schmidt's contrast between the topological and topographical (inside/outside, far/near and so on) in describing Nazi concentration camps such as Auschwitz as not 'outside' of the Nazi social system but imbricated within it as an internal 'threshold, or a zone of indifference, where inside and outside . . . blur with each other' (Agamben, 2005: 23–4 cited

in Giaccaria and Minca, 2011: 4). It is not a simple space of confinement but of indeterminacy that breaks the linkage between location and identity (Agamben, 1998: 19–20). Solzhenitsyn describes the Soviet Gulag system in similarly evocative terms as an 'archipelago' within the doorsteps of everyday life (Solzhenitsyn, 1977), suggestive of a topological rationality deployed in the service of power that analysts continue to struggle with, for example the case of the CIA's extraterritorial network of holding cells, 'black sites' and flights, and program of 'extraordinary rendition' after 9/11. This 'topological' informs but escapes the topography that spatializes a set of policies as an actual environment. An overlapping communication or tension is thus set up that potentially destabilizes the self-consistency of ordered space.

It is worth recalling a well-known attempt to draw on topology builds on Bachelard's phenomenological consideration of experience and experiment. Law and Mol consider the deformation of networks, developing the example of the colonial Portuguese sailing ship, an unreliable vessel that required constant repair and is thus itself a manifold of changing parts, mobile within a further manifold of the space of the oceans. Thus the analysis stages the confrontation between shape invariance of a stable network of components of the vessel – its hull, rudder, sails and so on – and its mobility and displacement in the water. Their work moves on to fluidly changing and intermittent, flickering topologies and the inter-topological effects between them, but more can be made of topology itself as an organizing trope for unpacking the concept of immutable mobile. It is worth rereading the insight that topology lends to the analysis of this case and of the methodological workings of actor network theories. For Law and Mol:

> In fact to talk about 'immutable mobility' is to play a double game . . . the immutable mobile achieves its character by virtue of participation in two spaces: it participates in both network and Euclidean space. And such is Latour's trick. To talk of an 'immutable mobile' is to elide the two. The immutability belongs to network space: to a first approximation the vessel doesn't move within this. If it did, it would stop being a vessel. But it is that immutability in network space which affords both the immutability and the mobility in Euclidean space. To put it more strongly, it is the interference between the spatial systems that affords the vessel its special properties. We are in the presence of two topological systems, two ways of performing shape invariance. And the two are being linked together . . .
>
> . . . In this looser locution it is *relationality* that becomes important, the possibility of thinking in terms of (broadened) forms of

> connection – rather than the network metaphor which links an appreciation of relationality to a specific image of connectivity.... More complicated visions of spatiality are required.... The challenge, then, is to inquire into the possibility of other, non-Euclidean, non-network, spatialities. (Law and Mol, 2000)

By suggesting analysis move to the level of interacting spaces or manifolds, they argue that success may depend on this interaction (in this case, stability and fixity of the vessel-network allows mobility in the ocean space). This may include disturbances of the stability of objects, such as Law and Mol find in another case: the Zimbabwe bush pump. This village hand pump can be a mash-up of jury-rigged elements such that the form changes to achieve constancy in the function of the water pump, and because of this fluidity its usage spreads. Law and Mol note that graduate change and modification allow entities in a 'topology of fluidity', adaptation and resilience allows continuity in their functions. The punchline must be added: as the manifold or network-space of the object warps, the relationships of the object remain constant within the manifold. But seen from 'outside' its workings, improvisation and repair, from the vantage point of everyday Euclidean space as it were, the entire object-network morphs together with its manifold. It is the topology that is fluidly changing, not the object.

The Topological Turn and Cultural Studies

Bachelard himself comments in other works on knots as a potential model of consciousness (Bachelard and Flocon, 1950). These and the previous cases of nested manifolds illustrate a knotting of spaces that itself requires a *topological sensitivity*. This would extend beyond the geometries of single objects and even the performative dramas centred around them. Rather than actual objects, the less tangible but still real threads of relations and the ways in which these can be interwoven with other, more or less systematic sets of relations to produce complex patterns of behaviour and function as outcomes are the focus. This might be imagined as the weaving of warp and weft, two ordered sets of thread or yarn, to produce patterns on a loom.

These precedents suggest the potential of a topologically-informed cultural studies, but in fragmentary fashion. While describing what topology is, the purpose here is neither to systematically critique nor to establish an agenda for what a cultural topology can do. Topology offers cultural studies a new 'dimensionality' and level of precision regarding spatial and temporal relations. As Massumi shows, the political is as much in the dimension of anticipation – that is, in the structuring of futures in the form of anticipated outcomes, normalized desire and the governance of choice – not in a topologically Euclidean present.

The strangeness of everyday life is precisely its disequilibrium as a knotting of topologies that entwine local with global, present with past and future, rather than its banality, presentism or constrained domestic space.

Rather than solely relating to situations of ongoing or marked change or deformation, knotting, multiply-imbricated spatial and temporal orders, a cultural topology exposes the complexity of the everyday, the settled. In setting the static or routine if not in motion, then in an orbit that becomes a wobble of becoming, a cultural topology is as much about mobility as about the emergence of what is taken for granted as the actually real.

The topological turn suggests a reconsideration of themes of relationality not well addressed in English-language social science writing since before the Second World War (cf. Sorokin, 1937–41). As the comments above suggest, cultural topology holds promise for cultural studies and the analysis of power. Cultural topology advances studies of social spatialization by including dynamic changes over time in space itself rather than only the relative relations of objects and entities in a static space. As entities move or relations change it is the space, field or manifold which is understood to also undergo topological changes: folds, stretching, shrinkage and warping. This approach to cultural studies also has methodological and pragmatic implications for research itself. It folds up academic social science into a new relation between the disciplines of space, time and the social and brings this into a new relationship with communities and with public curiosity – a precedent set by the historical case of Euler's topological response to the burger's puzzle of Königsberg's bridges. The implications of cultural topology for knowledge projects and institutions such as the university should not be underestimated.

This brief overview finds in the early beginnings of topology as *analysis situs* of the bridges of Königsberg a model for the relationship between theory and public curiosity. A rigorous analysis of connectivity and relation contributes to major themes in the social sciences. The analysis of change and transformation, the knotting of inter-topological effects and the specification of degrees of freedom of movement, that is, of the relations that can be effected actually or virtually in a time-space, implies a topological approach. If unacknowledged, it leads analysts to miss the broader time-space conjunctures that are at play in everyday life, in cultural formations and regimes of governmentality. This is advanced both economically for neoliberal capitalism and culturally as in social spatializations. Not 'connecting up' time-space insights is compounded by assumptions such that space is simply negated rather than warped by new, suddenly impinging dimensions, perhaps catastrophically.

Although political geographers in particular have advanced topological models of power and sovereignty to ask what is at stake

politically, spatial naivété in the social sciences has allowed the persistent assumption of a Euclidean and absolute space-time despite the inclusion of virtualities operating with their own separate topological qualities as objects of analysis. Topology offers not only a rigorous language but is already incorporated, untheorized, in the mathematical algorithms of spatial statistical computing. Moving beyond spatial critique, this challenges us to rethink organizing metaphors of both time and space and to bring critical attention to bear on the intersecting topologies that contribute to the complex knotting of everyday life and the plushness of the real. A topological sensibility deserves to be put on the agendas of social science theory and method.

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Rob Shields holds the Henry Marshall Tory Endowed Research Chair at University of Alberta, City Region Studies Centre. His work spans architecture and cultural theory. Publications include *Spatial Questions*: *Social Spatialization and Cultural Topologies* (Sage, 2013), *Ecologies of Affect* (coedited with T. Davidson and O. Park, 2011) and *Jean-François Lyotard: New Encounters* (coedited with H. Bickis, 2012).