Systems of Innovation and the Learning Region

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Contents

Abstract

In this chapter, an overview is presented of the three-phase evolution thus far of the regional systems of innovation perspective. The connected notion of the "learning region" is situated and subsequently re-situated in this account. The chapter begins by establishing the debate in the regional governance, learning, and policy contexts, especially with reference to the concept of "experimental regionalism." Early reflections upon various critical responses to the 20-year literature on regional innovation represent the first main phase change, indicating the relative conceptual and empirical flexibility of the approach. Innovation in thinking about entrepreneurship is shown to have been at the heart of this first evolving perspective on regional dynamics. The most recent phase change represents the engagement of regional innovation systems, as a core subfield

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of evolutionary economic geography, with key concepts in the complexity sciences. These are coevolution, complexity, and emergence. Each is shown to denote important new ways of thinking about regional innovation and evolution. The continuing relevance of the perspective to regional theoretical and policy application is underscored.

24.1 Introduction

There is now 20 years of solid theoretical and empirical research into regional innovation systems, and the concept is increasingly being applied in the world of policy analysis and practice. Regional innovation systems analysis has evolved through at least three versions (Cooke 1992, 2012; Braczyk et al. 1998; Asheim and Gertler 2005). The first phase change was from a Eurocentric, static, and manufacturing-led approach to a more flexible, dynamic and entrepreneurial approach. The second involved recognition of the importance of entrepreneurship in managing flows between knowledge exploration and exploitation (see below). The most recent phase change has been to fully recognize that regional innovation is an exemplary evolutionary process typical of complex adaptive systems as described by the likes of Kauffman (1993, 2000, 2008). This means a whole new vocabulary has to be comprehended that recognizes such processes as coevolution, self-organization, emergence, path dependence and path interdependence, relatedness, variety, and transversality. This is additional to but complementary with evolutionary economic geography terminology like related variety, search, selection and retention, mutation, speciation, and learning.

In what follows, an attempt is made to outline, critique, and elaborate key aspects of the above-mentioned phase changes in the evolution of a dynamic spatial research paradigm. It does this in a manner that intends to consider regional innovation systems in relation to the rather less-developed idea of "learning regions." Both appear to have cognate origins, but a moment's reflection shows the one to be proactive in its emphasis on innovation while the other looks reactive in its emphasis on learning somewhere else's innovation. An effort is made in the chapter to reintegrate a more nuanced and advanced version of the learning concept. This is influenced by organizational practice based in complexity science. The classic regional innovation systems framework is constructed as follows. First, an open system architecture is proposed, which is the regional innovation system. Second, the system of innovation is composed of two subsystems: an *exploration* subsystem where research knowledge is both endogenously developed and imported and an *exploitation* subsystem where such knowledge is commercialized. Third, in- between is a "membrane" composed of intermediaries that may be "institutional" (mainly public, e.g., venture capital, incubators – expressed as an institutional regional innovation system or IRIS) or "entrepreneurial" (private services firms supplying such innovation support services – expressed as entrepreneurial regional innovation systems or ERIS). "Region" denotes the governance level between national and local. In any region, there is an assemblage of industries

that have distinctive technological trajectories and differential path dependences collectively referred to as the regional "paradigm." Similarly, the region has an enveloping "regime" of hard and soft governance mechanisms influencing innovation as part of regional evolution.

In the section which follows, important aspects of the first phase change for understanding the regional paradigm or nexus of spatial economic processes are discussed. This heralded the emergence of the ERIS concept to balance the prevailing IRIS original. In the next section, some key implications of this for governance and learning at the regional regime or policy and regulatory level of analysis and activity are opened up. This moves the chapter into an assessment of the learning region notion, reasons for its apparent atrophy and a reassessment of its possible future role in a complexity-informed regional innovation systems (RIS) 3.0 model. Following this is a section that explores the foothills of Version 3.0 beginning with a critique of the industrial economists' vertical, specializationist "framing" of economic processes. In this phase change the lateral concept of 'platform' is preferred to the vertical concepts of 'sectors' and 'clusters' for social agency involving innovation. Attached is an elaboration of a more appropriate, geographically informed ontology which is interested in horizontal interactions, knowledge recombination, and understanding innovation as involving "emergence" of novelty from unlike forms. This section, for which certain formulations are worked out for practice, is, like all good regional innovation systems research, theoretically informed and empirically tested with primary research data, but modeling is restricted to the conceptual level. This is because, on the one hand, modeling data are inappropriate in this context, but on the other, and more importantly, the complexity perspective, which actually derives from simulation modeling, has found that in the evolutionary sciences prediction – a prime justification for modeling socioeconomic systems – is impossible. Life itself, it concludes, is not subject to the predictive modeling achievements of physicochemical science precisely because humans are creative, innovative, social agents whose important future achievements cannot be predicted. Thus, evolutionary biological events can be understood *ex post* but not foreseen, except trivially, *ex ante*.

24.2 Regional Governance and Learning

Since the 1990s, a growth area in spatial analysis and practice has focused on regional innovation analysis and policy. To a remarkable extent, new problems and avenues for exploration emerge regularly regarding regional innovation processes and institutions, for example, intermediaries (Tödtling and Trippl 2011a, b; Nauwelaers 2011); variety, a key underpinning in respect of "relatedness"; and "conventions" – the soft institutions that inform culture and that are marked features of the new regional innovation challenge (Sunley 2011). These pose interesting tasks for modes of governance of regional innovation and demands for new kinds of learning, both more proactive than the "institutional borrowing" that characterized the supply-side era when markets became perceived as the solvents of

developmental dilemmas. Main results of the uncritical belief in the stability of markets in many countries have involved social polarization, financial market collapse, continued regional deindustrialization, if not industrial "desertification," and dependence on now-eroding regional public sector employment to mitigate the resulting imbalances. Faced with the budgetary reckoning of this neoliberal experiment, regional governance, where it exists or survives, must perforce itself to become innovative.

Coordinated market economies (Austria, Germany, Nordic countries) have recognized this for some time, sustaining innovation support institutionally. The task was harder in liberal market economies, where injunctions that state intervention was the problem rather than the solution penetrated most deeply into the governance fabric. Heidenreich and Koschatzky (2011) reviewed the literature on regional governance of innovation, pointing to some fallacies and open questions about the manner of its conception and execution. These authors inhabit Germany's coordinated market regime and are accordingly comfortable with federal norms that devolve some innovation and other knowledge responsibilities (e.g., universities) to the meso-level. They identify key efficiencies from knowledge recombination coordinated in regional institutions from the outset, primarily lower transaction costs, learning advantages from spatial proximity, and direct provision of "collective competition goods." "Governance" moves beyond a region's "soft institutions" such as conventions by addressing its "harder" government plus civic or associational governance regime. These can involve the nature of financial support for innovation (this can range from grants to loans); university coordination (e.g., regional mergers or centers of excellence); sectoral, cluster, or platform stimulus (see Harmaakorpi et al. 2011); training and skills formation; foreign direct investment; and regional promotion abroad, a nontrivial package of innovation instruments.

24.3 Regional Governance and Policy Learning

These authors, like many others, see building social capital as a target of regional governance. Variety in the interactions between paradigm and regime exerts a strong influence on the distinctiveness of regional governance idiosyncrasies, which extend to regional innovation system configurations. Although for complex systems to function effectively, there must be considerable system articulation, especially those involving multilevel regional-national-supranational strata; Heidenreich and Koschatzky (2011) also refer to studies that see considerable friction among such levels. This is caused by networks negotiating and bargaining about innovation according to distinctively layered democratic politics. Thus, although not hierarchically organized in a top-down manner, the supranational may still withhold resources from the national or regional levels if proposals to access policy funds infringe the "rules of the game" being targeted. Occasionally a region can reject national innovation policy inclination, clarify that it has reserved

powers, or move ahead with its own projects where the state has abdicated or allowed to fall into disarray, conceivably for ideological reasons, a national strategic responsibility. "Real service" provision to SMEs by Italian regional administrations was a case of the last named, which was subsequently forced into privatization by a hostile right-wing national government. "Regional experimentalism" after Sabel (2004) characterizes aspects of such friction resolution. In general, friction of the kind noted is a minority pastime.

Regional agglomeration and associated regional advantage arising from spatially proximate innovation, productivity, and growth also partly explain the success of ideas and practices promoting regional innovation governance. So does recognition by evolutionary social scientists and practitioners (for whom neoclassical theorems can seem otherworldly) of the difficult-to-measure value of social networking and "untraded interdependencies." These constitute Storper's (2009) regional "dark matter" measurable only by its gravitational influence. Enough is understood of these to at least see their effects in rapid regional mobilization that can swiftly translate identity into innovative action, showing a region has "got its act together." Is this an immutable regional comparative advantage for some, or can it be "learned" for wider regional practice? The generic design for this is portrayed in Heidenreich and Koschatzky (2011) as dilemmas surrounding regional economic structure, regional networks, regional institutions, and regional policies. The "big shift" for new regional innovation policy is to attend to the content and multidimensional interrelationships of regional networks and institutions, in particular, rather than mapping structure directly onto policies and vice versa. Regional intelligence and policy learning thus suggest a more proactive, "catalytic," or "orchestrating" role being required of regional innovation governance in future.

One crucial characteristic of the species evolution of regional innovation systems theory and empirics is that it has responded to the relatively few solid critical observations in an adaptable manner. Thus, as Tödtling and Trippl (2012) remind us, what we may call regional innovation systems version 1.0 (e.g., Braczyk et al. 1998) can, in hindsight, be seen to be somewhat Eurocentric in its emphasis upon public regional innovation intermediation and static in its portrayal of regional innovation system circuitry. These were products of the emergence of a new subfield (in both *regional* and *innovation* analyses) that began with European comparative regional research utilizing European-derived conceptual categories and generating tailored primary research data of a comparative kind. An important step forward was to recognize that other regional setups, though actually globally relatively few, were less "institutional" and more "entrepreneurial" in the provision of intermediary services (i.e., markets for innovation services were more developed, e.g., as in California or Massachusetts, Cooke 2007). To some extent, as also recognized by Tödtling and Trippl (2012), a dynamic element was introduced by returning for more longitudinal analysis 10 years later to re-research content for the primary regional innovation systems source book (Cooke et al. 2004). So this phase change we may refer to accordingly as RIS Version 2.0.

24.4 The Learning Region

One perspective that promised regional policy learning was "the learning region," a concept developed by Florida (1995), adapted by Asheim (1996) and Morgan (1997) and recently reviewed by James Simmie (2011). Somewhat disappointingly the promise of this notion has not materialized, partly because as Simmie shows it got bifurcated into a normative idea, resting on the injunction that learning was a desirable end for regions to aspire to, on the one hand, and more empirically that it was a modest action line in regional innovation *strategy*, on the other. Accordingly, it has never developed analytically even though, as much of the regional innovation systems literature makes clear, there is evidently an acutely perceived need for better qualities of "learning" by firms and other innovation actors and for "regional policy learning" to tackle issues such as "cognitive dissonance" among corporate functionaries and entrepreneurs, "convention analysis" of regional production culture, policy mixing to stimulate "path creation," and the hybrid skills to facilitate relatedness and transversality among policy functionaries. It will be shown below how in the evolution to RIS Version 3.0, learning techniques and instruments have been refined to facilitate it in both RIS and learning contexts.

Correctly, in its origins, in the work of Richard Florida in 1995, "learning region" is a response to the rise of the knowledge economy as is even more the case in a rapid follow-up article by Björn Asheim which grounds the notion in Lundvall and Johnson's advocacy of building a "learning economy" to face the exigencies of the same phenomenon. Michael Storper did not write about "learning regions" as such but devoted research time to comparing "technological learning" in clusters with different convention sets or modes of untraded interdependence, which were probably the most fruitful theory and practice lines to follow. Finally, probably the most-cited variant of the "learning region" idea was Kevin Morgan's paper of 1997. Here, Simmie shows the key to regional regeneration and improved social welfare lay in strengthening a region's social capital and institutional capacity to support learning.

Critique of the concept has ranged from ascribing it the status of "fuzzy," an "impressionistic neologism," "unlikely," "over-localized," and challenged by "learning asymmetries" (see, e.g., Martin 2001). This is reminiscent of the many critiques aimed at the cognate concept of "organizational learning" in the large corporation. Here, problems concerning how to sample, from where, or from whom to learn, whether what might be learned was applicable, and indeed whether it was yesterday's knowledge, meaning the learner would be engaged in a permanent failure to "catch up" were all raised. This all seems rather unfair to what – if the concept had been better specified, perhaps in terms of learning the region's paradigm and regime uniqueness and how it might be "nudged" toward path interdependence – we now see to be a fundamental cognitive need in accomplishing regional innovation and growth. This seems to be the thinking in recent attempts to revisit the concept by Rutten and Boekema (2007). However, the kind of conceptual and policy instruments needed to achieve such endogenous regional change remain to be clearly specified. We shall see below how some progress in this regard has

been made from the viewpoint of complexity theory (Mitleton-Kelly 2006; 2011). One task of this chapter is to evaluate such progress from the viewpoint of RIS Version 3.0.

24.5 Regional Platforms, Methods, and New Innovation Policies

This task was begun in the early 2000s, culminating in Harmaakorpi et al. (2011) with their "platform" concept of regional innovation and renewal. The roots of this model are found in recognition of basic Schumpeterian insights into the nature of innovation as a product of cross-fertilization (recombination) of knowledge and ideas. This is something which the cluster idea, as the apotheosis of proximate specialization, obscured for academics and policy-makers alike for two decades or more. Accordingly, there has been a lack of policy measures to foster practice-based, networked innovation processes that combine diverse knowledge bases. It could be added that until recently, and in the process of being articulated into a synthesis here, there has been relatively little intellectual leadership of an alternative perspective either. One reason for this is Lundvall's line that policy learning is for policy-makers not academics, which on a moment's reflection is a little timid. For while it is always difficult to think out and design policy abstractly in the "ivory tower," a thoroughgoing critique of the economist's traditional vertical "framing" of spatial processes opens up significant opportunity for innovative policy guidance. Harmaakorpi and associates are by no means alone either in having the privilege of occupying both "worlds": academia and innovation policy-making simultaneously. This enabled them to conduct "regional experiments" à la Charles Sabel. Out of this experience, a newly minted criticism they discovered of the "proximity" perspective is that it fails to explain how learning from knowledge spillovers actually happens and that the effect of these may be negative. They find the distance implied in the notion of variety more appealing because it avoids negatives like involuntary spillovers, opportunism, and lock-in. Accordingly, their aim is to create an efficient *balance* between the contradictory purposes of enhancing proximity and distance. The cluster model is seen to be suboptimal in this respect and accordingly inferior to a platform model of regional innovation policy.

The "platform model of regional innovation policy" displays the following key characteristics: Its network morphology is one based on *loose coupling* of weak ties engaging with "structural holes." Structural holes are the spaces (sometimes "white spaces") between industries or specialized clusters. As we shall see later, loose coupling is an essential property of innovation-inducing adaptive systems from a complexity theory perspective (Mitleton-Kelly 2011). These are areas where network interactions may produce innovations if the holes can be bridged with innovation discourse, action, and content; social capital is thus of the institutional "bridging" kind; knowledge production is transversal; knowledge conversion is by means of cross-fertilization; regional absorptive capacity is future-oriented; experience-based learning is favored over science-based learning; external economies

are those of "urbanization" rather than "localization" in kind; and innovation systems are regional and national. On this basis, structured experiences of challenges and change of conventions, competences, and capabilities are induced by articulation of discourses among firms and stakeholders combining related knowledge from inside and beyond the region. The aim of this rendering of RIS 3.0 is to create a regional platform based on relatedness and supported by platform policies that optimize it to optimize innovation.

Facilitation of the required articulation of discourses that may valorize or change conventions and build up firm and intermediary competences and capabilities is intended to instigate a structure of learning institutions and processes in the region. The key spatial process aims here are as follows: to clarify the nature and forms of regional-related variety; to facilitate the *recombination* of knowledge; to identify the "structural holes" or "white spaces" where innovation opportunity may lie; and to evolve regional platforms that combine knowledges, clusters, and sectors for purposes of innovation. Complementing these in a new regional innovation systems perspective are four policy concepts. First, "enlightenment" may be diffused through the deployment of dramaturgy, literally acting out scripts of representative "convention sets" under challenge; second, assistance comes from having a mode of "orchestrating" dramaturgy and other learning facilities, such as "ideas incubators," "living laboratories," and "improvisation sessions." Orchestration here implies promotion of such assets and conducting their articulation into a coherent narrative. Third, innovation system integration comes from achieving "transversality" or the cross-pollination of intercluster or sector-cluster innovation potentials within and beyond the region, and finally, of key importance is evolving methodologies, such as technology or creativity matrices to concretize commercializable innovation actions and outcomes. The exemplar of this is engineering-rich Bavaria, but it is also practiced in the design-driven innovation context of Lombardy and its creative and innovative design-intensive domestic furnishing, lighting, and kitchenware clusters as described by Verganti (2006). Here, the innovation paradigm is changed relatively frequently and radically in the "episodic" sense by articulation of discourse that changes conventions through changing the meanings prioritized in the prevailing "sociocultural regime." This demands inputs both from expert "circles" inside and well beyond the region and within and well beyond the specific cluster. It requires strong articulation of regional firms and stakeholder institutions, and it is "orchestrated" in ways that "propose" innovations to markets. It can thus be vulnerable to overestimation of the market appeal of new lines, but such "practical reasoning" is also built into the articulation of discourse process.

Accordingly, a new paradigm for regional innovation and growth has been evolved in ways that meet the criticisms of the weaknesses and *lacunae* of inherited models, rooted as these initially were in Eurocentric regions, statically described and under the influence of manufacturing supply chain thinking of the 1990s. This is by no means the only way forward, but it resonates completely with the main threads of the discourse from its Schumpeterian origins to the modern day. Accordingly, the new agenda for regional innovation policy is different from the old.

As others have noted, endogenous innovation policy with the regional agency in a more catalytic role is now expected to replace the backstop functions of old. These had evolved in responding to market failures and welfare enhancement imperatives in the neoliberal, supply-side era. This is conceived as the appropriate posture in the context of a global knowledge economy regime assailed by seemingly intractable crises of economy and ecology. The region where innovation platform methodology was pioneered was a declining economy within Finland; the region where pulp and paper relatedness evolved to cross-media clustering is a relatively poor, peripheral region in Sweden; London and other metropoles may not be as innovative as presumed because they bask in conventions of entitlement, expectation, and privilege. Accordingly, the traditionally conceived "innovation paradox" in which least absorptive capacity is found in regions needing most innovation is clearly somewhat shaky and in need of measured reflection. This draws attention to the problematic nature of "smart specialization" as a "learning" response. Rather than implementing inappropriate initiatives from a supranational hierarchy, regional systems grow best by "emergence" of innovation from the recombination of their own paradigm and regime assets.

24.6 Regional Innovation Systems Version 3.0: Learning Dilemmas

One of the strong criticisms of the advocacy for "learning regions" a decade or more ago is that they were implicitly or explicitly modeled on an exemplar, usually Silicon Valley. The reason why this "framing" of the problem always produces disappointing results is aptly summed up below:

> . . .The [organisational re-design] process was systemic and could not be reduced to individual parts or components or specific individuals on their own. That is part of the reason why "best practice" cannot be copied. The process is systemic, emergent and context dependent. It cannot be reduced to "building blocks" which can simply be re-assembled in a different context and give rise to an identical outcome. . .. (Mitleton-Kelly 2011, 49)

This criticism is expressed from a complexity science perspective, which is wholly compatible with the kind of regional innovation system analysis and practice described in the preceding section. In order to explore the new take on regional innovation systems further, the following sections will explore the analytical and policy relevance of the approach by focusing on three of its master concepts: coevolution, complexity, and emergence. The revitalized role of "learning" in regional development is considered in the section on complex policy learning.

24.7 Coevolution

A good example of a coevolutionary analysis is Murmann (2003) who compares the evolution and institutional interactions involved in the separate fates of the British,

German, and American chemical industries. He finds that the coevolution of science and industry in Germany was a crucial coevolutionary series of events in that industry's success. However, in recent years, coevolutionary thinking came to the fore in the eco-innovation field. Here the intellectual effort was devoted to trying to understand and facilitate the transition of global society from its traditionally carbonized energy systems toward a non-carbonized, renewable energy future. Of special spatial interest has been why rising global concern with climate change issues produces national and regional policy responses that vary from the concerned and enthusiastic to the apparently unconcerned and apathetic. The idea of coevolution, and its absence is germane to such variable outcomes, a conclusion of Unruh (2000) who described a politico-economic institutional regime that has produced worldwide "carbon lock-in" as much for institutional as economic reasons. The US sub-prime financial crisis demonstrates negative coevolution (or systemic positive feedback) perfectly. Accordingly, the political subsystem, the consumer subsystem, the construction subsystem, the financial subsystem, and the energy subsystem were all coevolving in a particular, "dominant design" modality. Elsewhere, things were different, and a region like North Jutland and its country, Denmark, had simultaneously begun to express their "emergence" away from "carbon lock-in" through eco-innovation, initiated in the regional paradigm, whereby agro-engineering capabilities (milk cookers and turbofans) "emerged" into wind turbines, giving the innovating region the status of a "transition region." This meant it could innovate away from "carbon lock-in" by recombining a well-developed regional eco-innovation paradigm. Being home to former agro-engineering firm, *Vestas*, the world's leading wind turbine producer, *Grundfos*, a leading photovoltaics (solar energy) exporter, *Velux* (insulated windows), its owner *Arcon* (a leader in biogas energy production), and numerous green engineering SMEs allowed dynamic knowledge capabilities to be recombined in sustainable combined heat and power (CHP) design and construction. This capability was embedded in a pervasive "green" sociocultural and consumption regime supportive of local renewable energy networks (Cooke 2010). One complementary way to understand this process is according to a coevolutionary transition model (Geels 2006).

Coevolutionary transition theory, even with its multilevel perspective (MLP) is intellectually interesting on the one hand but frustrating on the other. The intellectually interesting level concerned is the process whereby globally significant innovation rose to prominence if not yet dominance at the level of the socio-technical system (STS). Theory suggests such innovation is destined eventually to become the dominant design (as hydro, solar, or wind power are for renewable energy today) and ultimately take over from carbon. Evolutionary economic geography theory also opened up this coevolutionary vein of research as evidenced by Martin and Sunley (2010a) who had critiqued classic path dependence theory as static and equilibrium orientated, opening up the prospect of a more dynamic perspective on regional development based on path *inter*dependence. However, their approach lacked a convincing mechanism for bringing such novel states about. Similarly, the frustrating aspect of the earlier STS approach to transition was that it lacked a causal mechanism, change being seen as unproblematically arising from

market transactions or something akin to "enlightenment." Reflecting upon this for path interdependence, it seemed primarily because, like much evolutionary economic geography, the nevertheless interesting and creative insight lacked a convincing theory of *innovation* as distinct from a vague notion of "technological change" as being somehow involved.

The key thing about a complexity analysis (which the coevolutionary transition model is not) is captured in the following observation by Eve Mitleton-Kelly that is relevant also to the broader project of evolving a richer theory of regional innovation and development:

> . . .The distinguishing characteristic of complex co-evolving systems is their ability to create new order. In human systems this may take the form of new ways of working or relating, new ideas for products, procedures, artefacts, or even the creation of a different culture or a new organizational form. . .. (Mitleton-Kelly 2006)

The way forward here is helped by "reframing" the theoretical problem as a transition from thinking of path dependence to one of conceptualizing path interdependence. This is integrated to another core concept in evolutionary economic geography (EEG), namely, "related variety" (Boschma and Frenken 2003; Frenken et al. 2007). These authors showed empirically that regions with industries in neighboring sectors (North Jutland's eco-industries would be an excellent illustration) benefitted from a double "proximity effect." The first of these is a *relational* advantage, which facilitates exploitation of "knowledge spillovers" because of the high lateral absorptive capacity potential of firms toward each other's external economies of information. The second effect is in terms of the *geographical* proximity that facilitates by time-space compression the aforementioned *relational* advantage. This enriches information such that its elements of difference and surprise ("news") may be communicated and factored into innovation calculations early, even before their full meaning has had time to be realized commercially.

This idea about the nature of information in innovation makes a significant contribution to RIS Version 3.0. It explains how coevolution of path-dependent processes can combine in order to branch into new path creation through facilitating path interdependence. The small but crucial addition that has to be made, from a spatial perspective, is that even though the relevant message may come from a great distance *geographically* or *relationally*, it has to be exploited in a particular space or place – the location of the innovation *design*. Such a location may take the form of a "transition region" as discussed above. Many innovations display this characteristic of combining or recombining information from widely different sources in a place that is nevertheless nonrandomly "selected" and explicable in terms of path dependence and path intersection of STSs. One of the key contributions the perspective makes is to expand the meaning of "related variety" beyond the narrow confines of neighboring industries such as electrics and electronics, automotive and aerospace engineering, or banking and insurance. This means speaking of "relatedness" more generally, encompassing both routine and possibly surreal knowledge combinations for specific innovation. Information, even devoid of semantically precise meaning, is capable of making a *difference*. This means that

the unexpected interest or surprise that even *information* may provoke may help solve a problem related to the tendency to disorder (entropy) faced by the social agent seeking knowledge to innovate. The strong element of *surprise* involved here means that innovation prediction is impossible except in relatively trivial ways. Accordingly, "related variety" effects may be hypothesized ex ante, but they may only satisfactorily be understood ex post. This is called "revealed related variety" and captures the strong element of unexpectedness and unpredictability that seems to be associated with most innovation. This occurs with increasing frequency due to the expansion of "cocreated" variety in economic evolution, which means novelty becomes both more widespread and easier (Kauffman 2008, 151–154).

24.8 Complexity

There are clear resonances between the coevolutionary perspective that also incorporates key concepts like path dependence, related variety, and relatedness from EEG and the key findings of the complexity sciences (see, for an early economic geography approach to complexity, Martin and Sunley 2010b). One key difference between that treatment of the spatiality of complexity science and the present one is that this one relies significantly on complexity theory with an evolutionary biology inflection while, the other is informed by more of a physicochemical systems model. This is important because, as noted, Kauffman (2008) shows that evolutionary biological processes like selection, speciation, and mutation are unpredictable. By contrast, planetary and subatomic movements are largely predictable, albeit surprisingly often vitiated by data difficulties and even cavalier attitudes by scientists toward data where they do not fit the mathematics.

A second area of agreement between coevolutionary and complexity theory concerns the element of *difference* referred to above as being of such importance. This applies even in the analysis of the manner in which "mere" information, let alone meaningful *knowledge*, contributes to cognitive combinations and recombinations. The complexity science explanation of path interdependence is conceived of as occupying an imaginary topological landscape characterized by "strange attractors." This is because complex adaptive systems are conceived to have an "ontogenetic" topology or "fitness landscape." This fitness landscape can be rugged or sleek and variations in between. The sleeker the landscape, the more stable the system because there are few sources of perturbance and little opportunity for communication between system entities. This epitomizes the "wilderness" region with few sources of economic energy with which to interact. The more rugged the landscape, with metaphorical valleys and their tributaries acting as communication lines between centers of energy or potentially interacting entities, the more potentially unstable is the system. This is in the sense that it is prone to disequilibriating "collisions" of economic activities or their sub-elements that give rise to novelty. Some such interactions are considered to occur between "normal" attractors (or "routine"-related variety from an EEG viewpoint), but others involve "strange attractors" that are unexpected or surreal combinations that nevertheless

find ways to combine or recombine into innovative pathways. In Kauffman (1995), such centers of energy in complex adaptive systems are called "clusters," and while these are different from the usage in economic geography, the latter are nevertheless a good illustration of the former. When such interactions are abundant, the system is said to be operating at "the edge of chaos." This does not mean it is an utterly disorderly space but rather a condition in which the kind of system change, novelty, or innovation called for by Mitleton-Kelly (above) can occur. Finally, the complexity perspective also helps open the black box of innovation because of two core concepts introduced by Kauffman (2008), namely, "preadaptation" and "the adjacent possible." These are options from within the complex adaptive system's "normal" or "strange" attractor subsystem elements or "clusters" that are seeking novelty from the interactions that "the edge of chaos" has provided. In Kauffman (1995), he talks about these, naturally enough, although in complexity science it is, to be sure, a rare enough occurrence, in terms of communication between persons. Thus, interactions may initially take on the informal status of "gossip" between even lower-order employees of two incumbents (firms) in different entities (clusters or industries). Connectivity of this kind may reach middle managers in the strange attractor companies who might be *surprised* at the information passed on to them for semantic interpretation with senior executives interested in solving an innovation problem.

One direction such deliberations might take involves "preadaptation" whereby an innovative practice, product, or service implemented or marketed by a firm in one distinctive industry might already have within it sufficient information to allow it to be reworked in the other distinctive industry or cluster. This is both a not uncommon way in which usually incremental innovation actually occurs, and a strategy of how some "ahead of the curve" intermediary, innovation support agencies define their function in the regional innovation system. A good deal of such effort can involve "creative" activities like "sensemaking" of the kind Weick (1995) writes about, to "storytelling," and even "critical theater" after Schreyogg and Hopfl (2004). This may seem strange to audiences unfamiliar with corporate change management practices or those of regional innovation agencies in countries that habitually make use of living laboratory learning and training settings. The second direction the innovative mind has the opportunity to follow is described as "the adjacent possible" where a step or steps into the unknown seeks to bridge the gaps where innovation potential might lie. This may lead to radical innovation where many sub-innovations may spin off an initial breakthrough, or it may be disruptive where some change in product status is induced in the appropriate market (online financial services, budget airlines, etc.), or it may be incremental but nevertheless an improvement to current practice. Evidence of both kinds of strategic innovation advice and practice are presented in the final brief section of this chapter that precedes the conclusions.

24.9 Emergence

This is a cognate concept to coevolution and complexity that provides theoretical interest but also gains additional practical meaning from its engagement with

regional innovation systems and practices. It has also usefully been reviewed by Martin and Sunley (2012) albeit from a fairly conventional top-down perspective. In "emergence" theory, the higher level tends to have been seen as the one responsible for qualitative change in elements that already exist in independent form at the lower levels of magnitude. But from an evolutionary biology perspective, the lower levels are usually determinant. Rarer is evidence of top-down causality. The examples of sugar or water existing at a superior level to that of the molecules that comprise them are often utilized as an illustration of emergence in the physicochemical world. The key point, however, is that "emergence" is caused by transversality rather than simple additivity. Transversality unites horizontally the properties latent in "relatedness" of natural or strange attractors. Thus, exploiting *difference* is actually at the heart of both "innovation" and "emergence": Indeed they may, from a regional innovation systems perspective, be interchangeable.

In the economic geography literature, the question of "emergence" has been directed at, for example, the issue of cluster emergence (Fornahl et al. 2010). Hence, we might want to explain a cluster's existence in terms of its agglomerative scale, which is a quantitative matter, but in terms of "emergence" the phenomenon under inspection is not scale dependent but relational. If colocated firms in the same field are working together on a regular basis, they can be a cluster. Accordingly, it is then a question of finding out why they find collaboration, colocation, and cocreation agreeable business strategies rather than how they simply came to agglomerate in space. The latter is an interesting question about *agglomeration* (which typically lacks collaboration and cocreation), but not especially about clustering. In other words, the cluster is "emergent" from the shared interests of the elements in higher-order economic activity; they could not achieve acting alone just as sugar is formed from but more than its constituent, lower-order molecules. Accordingly, it is as clear that the cluster elements colocate in space as the necessary sugar molecules do. The key point for regional innovation systems here is that when not interacting to create sugar, carbon atoms are available to bond with hydrogen atoms to make water or innumerable other chemical compounds used in everyday life. In other words, their "existence space" is the basis upon which their innovative recombination operates. Equally, some such atoms (or firms) may like to colocate, but not cocreate.

24.10 Policy Emergence and Learning

The exposition of RIS phase changes given above invites questions regarding the validity of its key propositions about coevolution, complexity, and emergence. A research project was, accordingly, implemented in Sweden, where complexity theory-derived measures were being deployed in two out of three regions studied. Thus, the research material alluded to in this section on policy was elicited from face-to-face interviews conducted with three regional development agency heads and some 12 cluster intermediaries in three Swedish regions during early 2011 (Cooke and Eriksson 2011). Briefly, the following case comparisons show instances both of "emergent" policies interlinking different activities at local level into

a grander synthesis at regional and even national levels. They also reveal, in one case, policy "learning" that leads to a complexity variant of "bifurcation" toward "clusters" of energy in a region that show more economic potential than the formerly path-dependent trajectory. Hence, the "emergence" perspective, informed by coevolution and complexity, begs some questions we hope to answer. At which system level does initial causality lie when, for example, the phenomenon under inspection is policy agency to seek mitigation from a planetary condition such as that of climate change? To what extent is top-down system hierarchy initiating or being influenced by lower levels? As will be seen "emergence" of a nonlinear kind was practiced in two Swedish regions (Västra Götaland and Skåne) under inspection and, more interestingly, learned by path interdependence in a third (Östergötland, centered on Norrköping and Linköping). In brief, one of the two regional agents, Västra Götaland, had by 2001 the outline of a regional eco-innovation strategy, preceding any EU member state, including its own, as well as the EU itself in this so much so that in 2001, it came to be known as the "Gothenburg Model of the Lisbon Strategy" (the EU's competitiveness strategy). Over approximately a decade, a double feedback loop brought the EU's advocacy of climate change strategizing back down to regional level in the *Europe 2020* (EU 2010) strategy document. However, long before then in the originating region, regional cluster initiatives inflected toward sustainability had "emerged" as practical actions. Moreover, such regional initiatives were "emergent" elsewhere in the same member state, and the member state itself was becoming more active. Thus such "edge of chaos" regional system adaptability was moving beyond the molecular level due to the exercise of *transversality* as regions and firms sought innovation by stimulating information flow and knowledge appreciation among unlike kinds of cluster. Nevertheless, eventually the EU resource-incentive narrative of "Grand Challenges" emanating from the highest system level gave a further degree of coherence to national and regional strategy discourse, expressing a third feedback loop (or "phase change") in strategy emergence. A fourth will probably be added when *regional* policy emergence influences the formation of *national* strategy with its own resource-incentive discourse.

Skåne region is committed to giving greater identity and focus to its established and nascent industries by promoting its cluster policy which targets about eight fields. However, regime management builds upon transversal thinking and practice. These recognize the evident advantages of filling regional "white spaces" by stimulating the discovery of "revealed relatedness" and promoting transversal or interface projects and initiatives among clusters. As it stands, the clusters are mostly new and rather weak, except for life sciences, food, and film, but Skåne's position on the Swedish periphery yet a Scandinavian core, due to its proximity to Copenhagen, means geographic proximity is important, something recognized in the status of the international Medicon Valley life science cluster between Skåne and the Danish capital. In this way, this region operates an "adjacent possible" innovation model inspired by two similar "Grand Challenges" as Västra Götaland in sustainable cities and healthcare but inflected according to regional expertise. Thus, recycling and eco-design are more pronounced elements meeting the national and EU aspirations for a concerted approach to tackling big issues.

Briefly instructive too is the way in which Östsam, Östergötland's regional development agency, and particularly its optoelectronics research institute Acreo, branched away from a 30-year struggle to fit innovative printed electronics technology to a regional and national path dependence upon the packaging products of the pulp and paper industry. A low-intervention, "market-shaping" model here informed the strategy of stimulating the "emergence" of an indigenous supply chain to market the innovation. This failed because it was an overspecialized solution in search of a problem (consignment tracking in the logistics industry) that was already solved by more traditional and cheaper barcode methods. This led to thoroughgoing reversal (phase change) of policy methodology represented in a search for already "emerged" regional industry and clusters customers. These included renewable energy, biotechnology, and healthcare, where potentially appropriate applications of liquid polymer technology might evolve. As Juarrero (2000) observes,

> . . .The precise path that the phase change takes can be explained only after the fact. Such explanation must take the form of a genealogical narrative that reconstructs the bifurcation. . . Phase changes embody essentially incompressible information. . . That is why fiction and drama. . . [are] better than deductions or formulas for explaining. . . transformations of this sort. (Juarrero 2000, 55)

Apart from our preference for factual over fictional narrative, as a justification for the kind of innovative change management approach explored in this chapter, this is difficult to improve upon. Accordingly, this review presents a rethought and empirically supported base for paying greater attention to the horizontal capacity and bottom-up capabilities of systems to stimulate innovation as an emergent property of interorganizational interaction. Recall this is a rebalancing act that underlines two-way and vertical as well as horizontal feedbacks or phase changes in multilevel process and policy systems.

24.11 Conclusions

Hypothetically, printed electronics began to be rethought once it was realized that its most successful innovative application had emerged in the touch screen controls of smartphones pioneered by *Samsung* of South Korea and early adopters like Taiwan's *HTC*. This looks to be a clear instance of multi-sectoral innovation "blindsiding," arising from technological path dependence since former Nordic leader companies in mobile telephony like *Sony Ericsson* and *Nokia* were locked-in to inferior proprietary and customized telephony system "frames." This can almost perfectly be framed by Mitleton-Kelly's (2011) comparative conclusions on the fate of two hospitals she researched, one that adopted a complexity learning format and one that adopted another approach:

> . . .There was, however, no active learning from these [business process engineering] successes and the focus was very much on attaining financial balance. There was also little active feedback, and few opportunities for staff to get together to review performance and reflect in an open, relaxed and informal atmosphere. Reviewing was done formally in terms

> of performance management. By restraining self-organisation and exploration and by not actively reflecting on the outcomes the learning environment was constrained. . .. (Mitleton-Kelly 2011, p. 49)

Hence, we see a revitalized role for learning in RIS Version 3.0. It is that it should be the means whereby innovative organizational change can be motivated against a rather simple, linear model of change based, essentially on cost accounting with little employee engagement, feedback, or learning. Intellectually speaking, this is explicable in complexity science as the failing, cost accounting hospital having, as a system reached the "edge of chaos":

> . . .In complexity theory terms, changes in the ecosystem had pushed the hospital far-from-equilibrium in the sense that they could no longer operate under their existing regime using established norms and procedures. They reached a critical point and had to either do things differently or go downhill. . .. (Mitleton-Kelly 2011, p. 51)

Of considerable influence is that we were able to show from selected examples recently studied that this way of thinking has, partly by a "design" approach broached in more detail in Cooke (2012) how regional innovation systems can be assisted toward optimal outcomes and evolutionary trajectories by utilizing insights from the theoretical material under discussion in this chapter.

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