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Abstract

This paper gives an overview of the concept of path dependence and explores its relevancy for sustainability-related research. The importance of path dependency for evolutionary economics is discussed, along with some important criticisms of the concept. The framework of path dependency is then applied to a case study of a regional rail transport plan with implications for sustainable transportation systems.

Traditional economic theory emphasizes a set of assumed initial conditions, a series of decisions guided by rationality and perfect information which deliver a market to a state of predictable equilibrium where efficiency reigns. The orthodox idea of equilibrium holds that any and all pathways lead to a state of stability; in effect a market equilibrium outcome is predetermined and inescapable.

Yet this approach leaves much unconsidered. It does not account for much of the dynamic behavior of markets and economies. It cannot explain why markets fail to efficiently allocate resources or select suboptimal technologies for widespread use. Or why policy interventions so often fail to shape market outcomes in predictable ways. For practitioners or researchers interested in applied questions such as how to foster innovation, how R&D investments can deliver greater economic returns, how to promote the diffusion of technological improvements, or how regions can align policies and programs to launch and sustain development, traditional analyses offer 'thin' explanations. These voids suggest a need for alternative frameworks that better fit what is observed in actual economies, rather than theoretical ones (Simmie, 2012).

This paper examines an alternative conceptual framework that addresses some of these gaps: Path dependence. The paper provides an overview of the concept of path dependence and an exploration of its relevancy for sustainability-related research. In structure, the first section is an introduction to path dependence and its relationship to evolutionary economics, followed by some important criticisms. The next section outlines how a path dependence approach has been used in studies of change in the transport sector. The final section offers a brief case study of a sustainable transport project from the path dependence perspective.

Path dependence and evolutionary economics

The limitations and abstractions of mainstream economics have prompted the development of alternative theoretical frameworks. Among these is evolutionary economics. Evolutionary economics draws from the biological, rather than mechanical sciences, more specifically Darwin's work in mutation, variation, and adaptation as well as more recent research in evolutionary biology (Dopfer, 2005). Evolutionary economics is focused on the dynamics of change and emergent features rather than 'steady states' or static equilibriums. This leads to greater interest in processes rather than outcome conditions.

Using Darwin as a point of departure, Dopfer (2005) describes economic change as a dynamic process which involves movement between states of order and disorder. As in biology, disorder or variety, offers the potential for new forms and states. Through interactions with the environment (context), variety is reduced to those potentials that best coordinate with their environment. This 'best fit' solution is then adopted by and diffused across populations (economic actors), thus becoming a new form of life or behavior (economic rule). From this perspective, the generation and uptake of economic behavior patterns and structures are not assumed or exogenous, as in mainstream

economics, but are a central topic of analysis. Among the goals in advancing the theory is the development of a theoretical framework for economics that is equivalent to genetics in biology. Because economics is the study of social interaction and human decision making, evolutionary economics asserts that human cognitive processes should be incorporated into economic science. Such a framework will enable the deciphering of the foundations and processes of progression in human culture to better understand how we structure a social system: the economy (Dopfer 2013).

The concept of path dependence has been proposed as a framework for understanding dynamic processes in evolutionary economics. The 'path' is a metaphor for a sustained trajectory that results from a series of interrelated and cumulative events—in short, history matters. 'Dependence' conveys the idea that the path itself is contingent upon and conditioned by its own existing trajectory. Path dependent processes thus involve increasing returns; 'each move down the path strengthens probability for additional steps along the same path' (Lagerholm and Malmberg, 2009, p 88). Further, paths can branch off on new trajectories when an event occurs at a critical point. Change is, therefore, contingent and probabilistic rather than deterministic, with alternative outcomes entirely possible. At the same time, just as for biological adaptations, the set of potential next steps in a given path is limited to those possible from the current position on that same path. Of course this resiliency is no guarantee of continual positive change; problems and inertia can be persistent as well.

In the economics context, path dependence focuses on the idea that economic patterns and trajectories develop from their own history, are importantly conditioned by early and often random events, and involve self-reinforcing mechanisms which intensify direction and momentum. It has become a popular metaphor for explaining unexpected market outcomes, irregularities in market processes, and apparent exceptions to some of the 'laws' of economics. Path dependence refers to how variety emerges in an economy; how certain technologies, innovations, or patterns are selected and initially adopted; and then how they are diffused and perpetuated in the economic system. Thus from a path dependence perspective, meaningful descriptions of an economic outcome should include a telling of the characteristics and history of the product and market involved, the institutional context, and points along the way where direction or momentum changed, along with the behavior of and interrelationships between market actors. Path dependence can be recognized in sequences of technological innovation, product development, entry to markets, standardization, regulation, and policy making. It can be discerned at the level of the firm, the region, the industry, the country, or even the global economy. Path dependence is a prominent component of the evolutionary economics program, providing an easily understood illustration of the theorized processes of innovation, rule adoption, and rule diffusion as social and collective processes that occur in a historical context and over time. It is both a feature and an outcome of dynamic economic systems and accordingly offers an approach for empirical investigation and elaboration of theory in evolutionary economics (Martin and Sunley, 2006).

As for much of the evolutionary economics program, the concept of path dependence is a borrowed metaphor; it draws from biology and nonlinear physics. Biologists recognize that evolution and adaptation are contingent and irreversible; the selection of characteristics is dependent on the range of currently existing traits. In chaos theory and complexity theory, physicists emphasize the importance of small events or minor variations in initial conditions that, through dynamic interaction over time, become important causal factors.

As a borrowed concept, there are pitfalls to adopting the metaphor of path dependence. In an introductory overview of cross-disciplinary approaches to economics, Wimmer (2006) touches on several hazards that face those interested in concept trading across disciplines. For example, scholars in a discipline may have insufficient background to avoid misunderstanding the original meanings and relationships in a metaphor. Metaphors and models may be mis-specified in their new disciplinary context, or the properties of the adopting discipline may not allow for correct re-specification. A further hazard is that the full nature of a discipline may not 'fit' a borrowed metaphor, and as a result, important aspects are left out of the subsequent analyses. Wimmer's critiques are leveled specifically at the use of chaos theory and evolutionary analogies in the social sciences and suggest caution in taking up path dependence as a central framework in economics. Despite these concerns, a borrowed metaphor can bring a fresh perspective to a discipline; stimulate new productive strands of work by shaking up established thinking, inspiring new research strategies and perhaps even new models re-specified for their new application and new empirical investigations. In short, the transfer of a metaphor from another discipline 'can represent . . . a "soft" initial stage in the process of scientific discovery' (Wimmer, 2006, p 16).

Still, path dependence has quickly gained traction in several economic subfields, including regional development (Iammarino, 2005), institutional evolution (Pierson, 2000), the economics of innovation and technological progress (Consoli and Mina, 2009), and economic geography (Krugman, 1998). Notably, the New Economic Geography takes path dependence as a central concept. Krugman (1997) describes how small differences in initial conditions can have large effects on long-run outcomes in, for example, Schelling's segregation model, base multiplier models, and his own Racetrack Model which connected equilibrium with spatial distribution. Acemoglu and Robinson (2013) use a path dependence approach in their popular and scholarly writings to explain global patterns of development and poverty. These authors highlight the importance of critical junctures, at which 'events or a confluence of factors disrupts the existing balance of political or economic power' and how such moments interact with institutions to create, destroy, or shift economic pathways (Acemoglu and Robinson, 2013, p 106).

Development and application of the path dependence metaphor

A recent example of the path dependence perspective is Simmie's (2012) case study of wind power technology development in Denmark. The analysis avoids the axiomatic explanation that 'history matters' and turns to a closer consideration of the dynamic, social processes at work. Simmie examines the nature of the 'initial conditions' that launched a path dependent process, the space where innovation is generated, and then describes the important role of 'niches' or incubator spaces that allow emerging technologies to gain momentum. Yet such spaces do not spontaneously produce innovation; innovation comes from the interactions between scientists, developers, firms, policy makers, and even potential consumers of an emergent technology. In short, innovation occurs at the 'generic level' of the economy (Dopfer, 2006). Simmie does not describe a deterministic process, but rather notes that even the self-reinforcing mechanisms initially set in motion can be either cultivated or dismantled. He also revisits the necessity of a significant external shock, and suggests that a simple recognition of some incoherence or incoordination can trigger a new path or displace or redirect an existing path. This conceptualization incorporates the role of power and agency, describing a process that is deeply social rather than mechanistic.

Reviewing the path dependence literature, Paul A. David and W. Brian Arthur are repeatedly cited as having made seminal contributions to the concept of path dependence. David (1985) detailed how and why the QWERTY keyboard has become the standard design for writing devices, despite its intentionally inefficient design. The QWERTY layout was designed to slow down typists who quickly learned to type at speeds that caused early typewriter machinery to bind up. The design persisted even after typewriter technology improved and the mechanical limits of typing speed were overcome. These improvements meant that with the rise of touch typing as a basic professional skill, any of the various alternative, more ergonomic, keyboard designs might have become the standard. Yet the inefficient QWERTY layout persists, even today, although modern computers have no mechanical limits to typing speed. This is the result of the self-reinforcing interrelationship between typewriter purchases by firms and the choice of which keyboard a typist would learn to use. With each decision for QWERTY, the probability increased that the next decision would also favor QWERTY, despite its technological inferiority. For David, the causes of this suboptimal outcome are technological interrelatedness, scale economies, and the irreversibility of skills acquisition and habituation. David's 'QWERTY-nomics' offered an explanation of how sub-optimal technologies can gain traction, become 'locked-in', and prevail as the standard over extended periods of time. The path dependence thus created arose from a highly contingent early state, with a specific choice reinforced by a nonreversible and dynamic process that was captive to past states (David, 2001).

W. Brian Arthur's (1990) contribution was a theory about positive feedback mechanisms that lead to dynamically increasing returns. Arthur offered the example of the struggle between VHS and Beta to determine which format would become the standard for videocassettes. While either format could easily have been predicted as the

equilibrium outcome, early and small events gave VHS a slight advantage in market share, which was reinforced by recorder technology and pricing along with expanded selection at video sales and rental outlets. Each adoption of VHS made VHS more attractive to subsequent users. The self-reinforcing effect only grew the gap between those choosing VHS over Beta, and as a result VHS became the dominant technology. Thus the more people who adopt a particular technology, the more that technology will improve and in turn becomes even more attractive for wider adoption. Arthur extended his theory to how a particular firm could gain dominance in an industry through early and small advantage and even more broadly to how a nation can leverage an early advantage in trade to exclude other nations and reinforce its own leadership position. Arthur's ideas had parallels nonlinear physics and evolution's punctuated equilibrium.

Another important contribution came from Douglass C. North (1993) who developed an analytic framework for institutional change. He asserted that understanding the influence of ideas and ideology, which are carried and transmitted by institutions, can help explain human decision making. Further, institutions play an important role in regulating economic behavior. Thus understanding how institutions change and how they interact with other economic actors is an important part of economics. According to North, institutional change is slow and incremental, a path dependent process constrained by the interests of those benefitting from the existing regime of formal institutions. Similarly, informal institutions—norms, social conventions, social practices—gradually erode away or are slowly displaced by a new institution.

Earlier economists also used elements of path dependence in their work. In a historical overview Garrouste and Ioannides (2001) note that Veblen described the process of 'cumulative causation' or the importance of habits of thought developed over time, in shaping institutions. Menger's description of the emergence of money envisions it as a self-reinforcing process where the exchangeability of something is increased as more people adopt it as something for exchange (ibid). Certainly, Schumpeter's descriptions of the role of individuals in shaping social life support the idea that small shifts on the generic level matter for economic outcomes (Dopfer, 2006). Schumpeter also noted the importance of entrepreneurs as innovators and novelty-seekers in triggering economic change. Further, his 'creative destruction' is an important concept for path dependence, which necessarily involves *deselection* as well as selection. In this view, path destruction is generally credited to an exogenous shock powerful enough to disrupt an existing trajectory.

Criticism of the path dependence concept

In a 2006 review, Martin and Sunley (2006) note that economic geography studies invoking path dependence remained largely descriptive, often focused on small events while ignoring the importance of the adaptability and dependency of pathways and networks themselves, and the tendency to ignore power structures and intent. There is

a troubling pattern of using path dependence to explain both a cause and an effect by invoking the importance of history in any and all situations. Confusingly, path dependence is also an explanation for both dynamic change and rigidity (Vergne and Durand, 2010). Because an exact definition of path dependence remains unsettled, scholars grapple over whether path dependence should be narrowly defined and investigated by rigorous modeling and experimentation or whether it is an emergent feature, based on the agency of the individual and organizational actors involved, and thus best described by narrative, case study approaches (Garud et al 2010; Vergne and Durand, 2010).

Apart from procedural criticisms from the sociology of science perspective, path dependency has been critiqued on its substantive applicability to economics. Perhaps the most cogent criticisms come from co-authors Stan Liebowitz and Stephen Margolis who challenge the utility of the concept for bringing anything new to economics. They argue that cases of true technological lock-in, like the QWERTY keyboard, are exceedingly rare (Liebowitz and Margolis, 2000). They further argue that in many cases where path dependence is credited as the causal process, the outcomes are just as well explained by more mainstream economic concepts including transaction costs, opportunity costs for market entry or exit, persistence of durable investments, sunk costs of R&D, incomplete information on investment decisions, network effects, agglomeration effects, or highly concentrated stakeholder interests (Margolis, 2009). Economics has long recognized that these features can dampen efficiency or impact the processes of innovation, adoption, and diffusion.

Other critics have voiced concerns about the use of the path dependence metaphor in economics. Glasmeier (2000) cautions economic geographers against uncritically accepting the notion of cumulative causation or reverting to the over-simplified and shallow explanation that 'history matters', thus leaving much unexplained. Writing from the perspective of institutional economics, Öberg and Adu (2009) warn that the appeal of path dependence can lead researchers to mistakenly identify 'critical junctures', points of change or triggering events. These authors point out that if a researcher presumes the existence of a 'critical juncture' she is likely to find one. These apparent 'critical junctures' can be constructions that lead the investigation away from robust explanations of influential forces and actors. Further, in a path dependence approach that seeks to delineate periods of stability and change, a phase of apparent stability may actually be a time of active, contentious renegotiation (ibid). This is in keeping with the concept of the durability of institutions and the model of incremental change proposed by Mahoney and Thelen (2010).

Perhaps the most serious critique is of path dependence as an approach to describe potential futures. Because path dependence relies heavily on the uncertainty and bricolage of past events, it has severely limited predictive power. Thus while path dependence supports historical explanations of economic and social processes that can explain outcomes, it has only a limited ability to support effective recommendations for future outcomes. Yet even if path dependence cannot yield the simplest, 'best' solutions,

it perhaps can at least help avoid the worst possible errors (Acemoglu and Robinson, 2013).

Path dependence and sustainability research

Leaving the methodologists and theoreticians to their debates, is path dependence a useful metaphor for researchers in sustainability? Can path dependence enrich descriptive case study research? Can path dependence help us understand the underlying institutional processes that sustain the unsustainable? Does it illuminate the alternatives that will promote sustainable outcomes? In this section, a path dependent perspective is taken to consider a sector with important implications for sustainability: transport.

In the area of technology and infrastructure, path dependence is a frequent explanation for the persistence of transport technologies, such as petrol-fueled cars in the U.S. The persistence of automobiles as the primary means of mobility is, in part, attributable to the durable nature of highway infrastructure and of cars themselves, but it also addresses the interrelationships among vehicles, highway systems, settlement patterns, and fueling station networks. Positive reinforcement processes are evident; enough drivers (and payers) are needed to create build and maintain a highway system that is large enough to make automobiles an attractive choice. High levels of motorization displaced horses and bicycles from road networks, further reinforcing automobile use. Of course, there is a threshold when these systems are over capacity and congestion impairs system function, but governments frequently respond by adding capacity to the network, thus sustaining the popularity of automobile use. Additional reinforcement comes from the ubiquitous fueling networks so that users have little need to carefully consider decisions to make journeys by automobile. At the same time, mass production systems made automobiles affordable for most households. Mass production, in turn requires large markets. Taken together, these various features create a well-trodden path that is difficult to dislodge, thus assuring the continued dominance of the automobile in the U.S.

Yet despite tendencies to persistence, the transport sector is also open to innovation. An example of a rule adoption and diffusion is the story of the freight container, which is extensively detailed by Levinson (2006). Freight containers are the large metal boxes that can be carried by ships, trains, and trucks, and are transferred among the different transport modes without unpacking and repacking the cargo. These containers greatly simplify freight operations and lower costs by reducing loading, unloading and transfer times. Initially, the container was a minor technological improvement for a single trucking firm in the eastern U.S. designed to make freight transfers to and from their truck fleet easier. Within a few years, the containerization 'revolution' restructured global shipping operations and generated new rules about freight operations, longshoremen's labor, and even global supply chain networks. Containerization technology did not, however, require massive construction of new rail

or highway networks (although changes to the freight network would naturally result from changes in freight flows). The shipping container offered an incremental change to the shipping industry that dovetailed with much of the existing system. Thus while transport infrastructure tends to be persistent, innovations may be rapidly adopted and diffused, particularly those that can be adopted incrementally.

Railways have been extensively studied from a path dependence perspective. In a review of technological and institutional path dependence in the railway sector, Andersson-Skog (2009) asserts that the path dependence metaphor is quite appropriate for network industries subject to extensive regulatory regimes (e.g. railroads, electrical power, pipelines). She explains that the railroad industry is characterized by durable investments, long planning horizons, strategic decision making, network effects, and a complex institutional environment, all of which make path dependence likely. Interestingly, her review of studies of railways notes substantial differences in how the industry has evolved in different countries, despite a common technological base. This is attributed to differences in institutions that affect ownership structures (public or private), the spatial dimension of regulations (local, state, federal), and the propensity for regulation (ibid). These institutions both sustain and control the technology, while they are themselves shaped by political and technical systems they regulate. This reinforcing relationship illustrates the multilayered nature of path dependence and the richness lost when an analysis focuses only on technological aspects. It suggests an alternative conceptualization that considers the technological and the institutional as separate yet related levels for analysis.

The path dependent nature of railroad technology and institutions offer latent potential for sustainable transport. Sustainable transport is generally recognized to be mobility systems that address social and economic welfare and express a conservation ethic, with consideration for current and future generations (Litman and Burwell, 2006). From this perspective, the persistence of the physical railway network itself is an opportunity. Railroad companies and governments display remarkable reluctance to abandon or remove railroad lines or replace them with some other technology (e.g. highways). When tracking is left unused, or even removed, the 'right-of-way', the dedicated corridor of land, usually remains intact. Where settlements were designed around having good rail access to their industrial districts, these corridors retain the historical connections between urban centers and their hinterlands. Can these corridors be repurposed for modern and sustainable mobility? Can transport institutions evolve toward a greater sustainability orientation and build more sustainable systems? Indeed, there are examples where this is occurring.

In the 1990s the Research Triangle Region of North Carolina initiated plans for a commuter rail system. The plan envisioned a system that would link major employment zones of the polycentric region. The commuter service would operate alongside freight rail trains in existing railroad corridors. The concept would provide an attractive commuting alternative in a region where nearly 100% of commuters drove to work alone.

The rail project was designed to take advantage of a unique feature of railroad institutions in North Carolina: railroad right-of-way is owned by a public agency similar to a public utility. In all other US states except Alaska, railroad right-of-way is owned by the organizations operating rail service, whether private railroading companies or public rail transit agencies. North Carolina's unusual situation dates to the 1850s when rail development in the state lagged far behind that in neighboring states. North Carolina decided to organize its own railroad company to build rail connections in support of the state's economy (Heller et al, 2007). These historic corridors remain assets of the North Carolina Railroad Company (NCR) today, which leases long-term use rights to a private freight railroad company. The NCR's early rail connections in the Triangle linked major industrial facilities (tobacco warehouses, textile mills) that were built close to the centers of cities. These links remain relevant for today's mobility needs; old industrial zones have been redeveloped as light industry, high tech, and services centers. In considering possibilities for mass transit, the continued existence of rail technology and the locations of rail corridors made a commuter rail plan far more feasible than other possible modes of transport such as monorail, personal rapid transit (PRT or small 'pod' systems), or aerial tram.

Since the 1800s, North Carolina has had a robust rail freight sector, although passenger rail service remains sparse, as in most other parts of the US. Yet North Carolina is a rapidly growing state and the Research Triangle region among the fastest growing regions in the country. With few transport alternatives, the growth in population and resultant economic activity has placed severe strain on the region's highway network and dramatically increased environmental impacts to air and water. In an attempt to address these problems, the region's transit agency (bus only) responded by developing a concept plan for commuter rail in 1990s. The plan took advantage of the persistence of historic rail corridors as well as the public ownership of rail rights-of-way in a plan to connect the region's major employment centers with a more sustainable alternative than the automobile.

As the plan advanced toward implementation it was met with serious institutional challenges at the federal level. First, were challenges in securing funding for the project. Federal thresholds to qualify for federal funding were altered midstream. Without support from Congress, the federal reviewers applied the new rules under which the Triangle proposal failed to qualify for federal support. The second challenge was a ruling on what federal agency would have oversight of the new system. U.S. passenger rail systems answer to one of two federal regulatory agencies depending on whether their service is deemed 'intercity' or 'intracity'. Regulations differ for these two categories; most importantly for the Triangle case were design standards related to the crashworthiness of passenger railcars and specifications for minimum spacing between parallel sets of tracks. Ruled an 'intercity' plan by the courts, the applicable requirements increased costs by mandating heavier and costlier railcars and greater track separation distance which required purchasing additional right-of-way. The combination of increased costs and reduced funding put the system out of reach.

Political support evaporated and the entire project was tabled, shredding the transport agency's credibility with the public and politicians. Thus at two critical junctures, institutions reinforced the status quo of continuing to invest in highways and automobile transport in the Triangle region. Realizing a more sustainable regional system would require federal institutions with a stronger sustainability orientation.

Yet population, pollution, and congestion continued to grow in the region, and the concept of commuter rail was revisited in 2006. New consultants and new organizational partners were brought in to reinvigorate the dialogue. Models of ridership projections were updated and respecified. A citizen group was convened to create a new 'vision plan' for regional transport (STAC, 2008). Drawing from experience in other parts of the country, an alternative strategy for funding was developed that proposed a dedicated sales tax within the region rather than reliance on federal funding. The transit agency 'rebranded' itself, investing in new buses and station facilities, and gained experience in cross-regional management by launching express bus services. Later that same year, a new federal government with an interest in rail transport had come to power. As a result, federal transport funding programs were changed to be more flexible in their requirements. A period of renegotiation followed during which design requirements were revised and new rail safety technology incorporated into regulatory regimes. Although these institutional and technological adjustments represented substantial changes for the actors involved, the revised 'vision plan' itself was not substantively different from the 1990s plan. The changes were in the areas of funding and regulations, changes that in effect reinforced the previous plan. The plan itself was proving to be a durable thing.

Since 2010, the Triangle rail project has progressed steadily through approval and design phases. The new funding plan was approved by voters in two of the three regional jurisdictions (the third has not yet voted on the issue); these votes were 'critical junctures' that secured the necessary robust, long-term funding sources for the project. With funding committed, construction of the first phase of the plan is expected to begin before 2020, more than 25 years after the plan was first adopted. Despite the uncertainty at several junctures, where the path has stalled or bent away from the trajectory established in the original plan, the current momentum indicates that there will be commuter rail service in the Triangle.

Once in service, commuter rail is expected to deliver a range of sustainability benefits. It will moderate the need for massive highway expansion projects which are economically and environmentally unsustainable. It will reduce air and water pollution, improving environmental quality. Human health will also benefit from the increase in physical activity (walking) that will become part of rail commuters' daily routine. Social sustainability and equity will be improved by creating regional resilience to any future oil price shocks as well as by providing a less costly commuting alternative to low income households. Over time, the presence of a commuter rail system will influence today's sprawling land development toward more compact patterns.

The development of the Triangle commuter system exhibits several features of path dependence:

- Seemingly unrelated historic events affecting outcomes
 - public ownership of rail rights-of-way, initial routing decisions, and reinvestment in old industrial areas make old rail corridors attractive for commuters
 - change in federal government opened opportunity for advancing the project
- Technological persistence reinforcing a trajectory
 - basic features of rail technology are unchanged, increasing the likelihood of using rail technology for future transport needs
- Incremental technological innovation sustaining a trajectory:
 - system monitoring technologies for safer operation of freight and passenger service to overcome safety problems in shared corridors
- Institutional innovation sustaining a trajectory
 - new funding mechanisms proposed and implemented
 - organizational learning through development of new services
- Institutional persistence sustaining a trajectory
 - resilience of the transit agency
 - durability of the regional plan

As is the case with all large infrastructure projects, the Triangle rail project has a complex history. Although case studies of similar projects are commonly framed as a story of the (un)availability of project funding and how design specifics were negotiated, the path dependence metaphor may be a better approach to understanding such long-term, large-scale projects. Bringing the historical, technological, and institutional context to bear provides a fuller picture, revealing not only the processes driving the operant or physical outcomes but also the generic level where change and future states are envisioned.

For the field of sustainability, the Triangle experience suggests the importance of plans and plan making. Planning processes can serve as incubator spaces for the generation of new ideas and new relationships. Plans for improving sustainability can generate and sustain the forces that challenge existing unsustainable pathways, as they create new branches from existing conditions or perhaps altogether new trajectories. Of course, the existence of a plan does not guarantee its realization; institutions and individuals must act to advance the plan and historical events must be such that the planned outcome is possible. Still, the contents of a plan are persistent and can be the focal point of institutional change; lines drawn on maps are durable. A plan can assemble the ideas, the relationships, the existing and as-yet-unavailable resources needed for greater sustainability, the bricolage for a sustainable future.

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