
Understanding the “National Innovation System” Conceptual Approach as a Social and Governmental Technology

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Abstract Drawing on pioneering work by Pinch and Foucault, this paper argues that the national innovation system (NIS) conceptual approach that emerged from innovation studies in the 1980s and 1990s constitutes a social technology intended to induce policymakers to adopt a sophisticated model of the role of innovation in a national economy when formulating policies for stimulating economic growth and development. In this respect the NIS approach has also served as an instrument of governmentality, making an emphasis on technological innovation attractive to the relevant actors in policymaking, industry, and related institutions. The paper draws on qualitative empirical research to show that, like any social technology, the NIS approach can be used for purposes other than those for which it was designed by revealing its use as a rhetorical device by Hong Kong policymakers for political purposes. The study reinvigorates the concept of a social technology for science and technology studies.

Keywords: National innovation system; technology; social technology; governmentality; Honk Hong.

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I. Introduction

In this paper I draw on pioneering work by the sociologist of science Trevor Pinch and the philosopher and intellectual historian Michel Foucault to argue that a conceptual approach to the study of innovation and economic development, one that has made its way from scholarly research and discourse into policymaking circles, functions as a social technology that has become what Foucault calls a governmental technology. I also provide empirical evidence of its use as a social and governmental technology in Hong Kong.

It is, to be sure, somewhat counterintuitive to conceive of an abstract construct in the social sciences as a technology. When most people think of a technology they imagine some new device or machine that makes a specific task easier to accomplish. Both Pinch and Foucault identify systems containing abstract elements as “technologies,” however, and I will attempt making a similar case that in regarding a scholarly conceptual approach as a social technology we are able to see the key characteristics of such a technology, which generally combines concrete with abstract elements to do what all technologies do: change how people behave in order to achieve some goal.

The scholarly conceptual approach in question, broadly understood, is that of a national innovation system (NIS). I will argue here that the manner in which this conceptual approach has been developed in the academic sphere and subsequently disseminated from there into educational, policymaking, and industrial institutions is characteristic of a social technology. In the course of my argument I will introduce the NIS conceptual approach, explain in what sense it has become a social technology, and reflect on what that implies, again by reference to Pinch’s analyses and Foucault’s thinking about what he termed “governmentality” in his work on the development of the modern state and its relationship with those whom it governs. When scholarly experts pass the NIS approach on to policymakers, it becomes a technology of government, applied either through government agencies or through non-governmental organizations that in some cases are funded by government. To illustrate a possible implication of my analysis I consider additional questions raised by Pinch pertaining to the testing and implementation of social technologies. These questions suggest that by treating the NIS conceptual approach as a social technology we can achieve a richer understanding of the process through which innovations are driven by and in turn drive developments in the wider context of public and private institutions with potentially far-reaching economic consequences.

When I turn to the use of the NIS approach as a social technology in Hong Kong, however, I show that, like any technology, its originally intended use may be superseded for another purpose. In the Hong Kong case, I offer evidence that government officials used the NIS approach for rhetorical purposes rather than as a model for generating economic development and growth (Sharif 2010). To be sure, this illustrates the broader purposes of a governmental technology, which often includes laying the groundwork for making government policies easier to implement by creating receptive constituents.

The NIS approach was introduced by researchers in the 1980s in the context of growing interest in economic development as international institutions studied the gap between the developing and the developed world. Among these institutions is the Organisation for Economic Cooperation and Development (OECD), which promotes financial stability and the global spread of market forces with the goal of enhancing the

economic status of developing nations. In broad terms, according to the OECD, an NIS comprises a “set of institutions that (jointly and individually) contribute to the development and diffusion of new technologies [... providing] a framework within which governments form and implement policies to influence the innovation process” (OECD 1999, 24). As we shall see, the institutions in question bring together actors in the public and private sectors by marshalling resources from universities, industry, research bodies, and government agencies in the course of which innovations are created and commercialized. The NIS approach provides a framework within which to comprehend the full scope of an innovation system against the backdrop of global economic trends while taking the play of historical and contemporary national specificities into account.

In developing the NIS approach, innovation scholars have replaced a linear, somewhat static model with a more dynamic model featuring interactive, multidirectional relations with feedback loops among the component parts or actors.¹ If there is reciprocity in these relations between actors, so there is, as Rose and Miller (2010 [1992]) argue, “reciprocity between the social sciences and government. As government depends upon these sciences for its language and calculations, so the social sciences thrive on the problems of government” (280). It is here that governmentality through “technologies of government” (281) comes into play. If the NIS conceptual approach is such a technology of government, then its function as such depends on a “complex assemblage of diverse forces” that enable “the decisions and actions of individuals, groups, organizations and populations [...] to be understood and regulated in relation to authoritative criteria” (281). As defined by the OECD, the NIS conceptual approach provides the criteria by which a government can channel advantages and resources towards actors it hopes will engage in the sort of innovation-related behavior that academic innovation experts assure them will fuel economic growth.

The NIS approach is a two-dimensional construct that has migrated from academic into policymaking circles as innovation policy is utilized increasingly to drive economic development. In this movement into the hands of government actors, scholars propounding the NIS approach reflect Rose and Miller’s (2010 [1992]) observation that “experts [...] ally themselves with political authorities, focusing on their problems and problematizing new issues, translating economic concerns about [...] innovation [...] into the vocabulary of management” (286). Indeed, as I will argue, the NIS approach has become a social technology to the extent to which it functions as a means of promoting innovation by *altering the behavior* of government policymakers and the agencies they represent, who in turn utilize the approach as a governmental technology. Conceived in

¹ This makes the Hong Kong case all the more interesting because its version of an NIS was more linear than holistic when I conducted research on this question. See section 4 in this paper.

this way, the NIS approach can be understood as an application of Foucault's analysis of power relations, that is, as an instance of the rational application of techniques of government to serve (in this case) an economic purpose.

Foucault's work on what many call the analytics of power led him, by the late 1970s, to coin the term "governmentality", providing him with a concept that brings together his thinking about what he termed the "genealogy of the state" and the "genealogy of the subject". As Rose (1993) puts it, on Foucault's analysis governing entails "a certain *mentality* of rule. *Governmentality* is a way of problematizing life and acting on it" (288, original emphasis). The need for governmentality, a rational approach to state governance, arose as a result of historical developments running roughly from the sixteenth into the twentieth century as previous modes of sovereignty gave way to the modern state. What Foucault calls the problematic of government involves the state's twin imperatives to control and care for its subjects, now reconstituted as a "population".

In his later thinking Foucault came to view power or dominance as but one modality of governance, arguing that similar relationships occur at all levels of human interaction, among institutions as well as individuals. As the modern state evolved, a new category of analysis, that of political economy, emerged with the state's interest in duplicating in a whole society the "economy" of the family, taking on the traditional role of the father or household head, whose job it was to see to the orderly management of his property and its inhabitants. In this way the state assumed a kind of pastoral power over its subjects, which is as much about health and welfare as about subjugation, even as it sought to consolidate its political power. This means that the state's power relations with its population involve much negotiating over the terms of those relations through interactions between individuals and government agencies or institutions, thus requiring considerable individual autonomy even as it also seeks to mold individuals into proper citizens. The trick is to create a population of individuals, or selves, who are properly governable.

Governmentality thus signifies the development of the state as a source of technologies the purpose of which is to secure these two overarching ends. Rather than controlling subjects like a sovereign monarch through directly coercive "juridical" power, the state now seeks to inculcate in the population patterns of self-governance through "pastoral" power, using state institutions to steer the population towards health and prosperity. Foucault argues that in adopting this new role the modern state must deploy governing technologies that operate at the level of the individual subject, what he calls "individualizing" technologies, as well as at the level of the whole population, what he calls "totalizing" technologies. In this regard he is, of course, concerned about the fate of the autonomy of the subject, but for our purposes the important point is that governmentality, whether in the hands of the state or in the hands of private institutions through which state power is diffused, is about causing

other people to behave in particular ways that keep things running smoothly. In this sense a government technology, as I will argue presently, is also a social technology, a means of altering human behavior on a social level to serve particular ends.

At the same time, it is important to understand that although Foucault's work on governmentality resulted from a sweeping historical analysis of the genealogy of forms of state governance, the concept applies to any relationship between people or institutions in which persuasive discourse and other techniques are deployed in an effort to shape behavior, whether one's own or another's. Just as the modern "neo-liberal" state uses governmentality to create a population susceptible to its technologies of power, so individuals, and other non-state actors, use governmentality to affect the behavior of others and themselves.²

Accordingly, as the NIS approach has moved from academic to industrial to government policymaking institutions, it has become an instrument for engineering a particular set of social relations connecting actors in each of those domains, namely those that constitute inputs to and outputs from the process of innovation, even while shaping the process itself.³ In Foucauldian terms, the set of institutional and personal relationships, along with the material and abstract components that facilitate those relationships, constitutes a "*dispositif*", what Rose (1993) terms a "machine for government, each of which is itself an assemblage of diverse components, persons, forms of knowledge, technical procedures and modes of judgment and sanction" (p. 287). In thus framing the NIS construct, I am picking up a lost thread in the literature because the idea of a social technology has received limited attention in S&TS recently (after early work by, for example, Ashmore et al. 1989; Pinch et al. 1992; Mulcahy 1998).

Before I introduce the NIS conceptual approach properly, I will briefly mention the critique of the "social" levied by Latour (1993; 2005) and Callon (1986; 1987). In short, I do not take up this issue robustly in this paper, as I prefer to focus on how the NIS approach has been utilized irrespective of the appropriateness of the label "social" technology. I will be clear about what this means for my purposes, and I will note at least

² A concise but systematic introduction to Foucault's concept of governmentality is available in Burchell et al. (1991), which includes not only a lengthy introduction to the concept by Graham Burchell (Burchell et al. 1991, 1-52), but also excerpts from Foucault's lectures in which he introduced the concept, under the title 'Governmentality' (87-104).

³ An example of the way in which the NIS has become an instrument for engineering a particular set of social relations can be found in Finland, where connecting actors in the innovation system has recently become an explicit policy goal (see Schienstock and Hämäläinen 2001, 12 and 178-199). Within such a framework, "the widening and deepening of network-cooperation has become one of the central issues for the developing of innovation system" (The Science and Technology Policy Council of Finland 1996, 42).

one juncture at which there is some commonality between my account of a social technology and Latour's and Callon's approach, particularly regarding the role of material objects in an "actor-network". On my account social technologies – as is true of the NIS conceptual approach – very likely include material objects as components that act on other components. This idea is part of Latour's and Callon's critique of the social, but it would divert me far from my purposes to undertake a broad philosophical defense of the social in this paper.

2. The National Innovation Systems (NIS) Conceptual Approach

2.1. Two Interdependent Dimensions

To understand my focus on the *national* innovation system construct, it is worth noting that, within academic and policy spheres, the innovation system conceptual approach exhibits considerable variation with respect to an innovation system's scope or field of application – there likely are regional innovation systems as well as innovation systems tied to particular technologies or industrial sectors.⁴ In regarding the innovation system conceptual approach as a social and governmental technology, I am committed to following its use among policymakers, and by focusing on the effects of policy at the national level we can readily trace the influence of the conceptual approach as an instrument of social engineering. I therefore focus on the *national* innovation systems conceptual approach; when I use the briefer "innovation system" it should be understood as a reference to an NIS.

In spite of its recent advent and relatively low profile in the S&TS literature (for exceptions, see Miettinen 2002; Sharif 2006; Albert and Laberge 2007), the NIS construct has been used extensively in academic and government circles. In the academic domain, innovation systems are the focus of study in many scholarly research programs, especially across northern Europe and Scandinavia.⁵ In the government domain, the inno-

⁴ Innovation systems have been identified based on spatial, technological, and sectoral criteria. In addition to 'national' innovation systems, for example, we can identify 'regional' innovation systems (Silicon Valley is a clear example), 'sectoral' innovation systems, (such as is likely the case with energy-related industries); and 'technological' innovation systems (some would identify innovation in semiconductor manufacturing as such a system). I shall not in this paper consider the comparative merits of the delimiting criteria used in classifying innovation systems; what matters here is the structure and functioning of an innovation system, which in all its permutations exhibits similar properties.

⁵ England houses the 'Science Policy Research Unit' (SPRU) in Brighton, and in Manchester the 'Institute of Innovation Research' and the 'Center for Research

vation systems approach began to exert considerable influence during the 1990s. As a result, public policy in many countries and public institutions shifted in orientation from supporting science and technology *per se* to supporting the broader innovation process. That is, instead of supporting science and technology for their own sakes, by channelling that support through the innovation pipeline governments target economic development or growth as the intended outcome of innovation policy. Led by such international bodies as the OECD (OECD 1996, 1997, 1999) and the European Commission (European Commission 1994, 1995, 1996, 2002), a number of government agencies have followed suit. As I will show, the prestige of the OECD has drawn interest to its version of the NIS approach beyond its European sphere of influence, specifically, in Hong Kong. Yet the OECD's conception of an NIS arguably loses its purchase there, as Hong Kong government officials use it less to shape than to sell its development policies.

The NIS conceptual approach in practice exhibits two interdependent dimensions – one descriptive and the other prescriptive – and to understand it holistically we must understand how it has come to serve both descriptive and prescriptive purposes. The descriptive dimension and the prescriptive dimension co-determine one another, because how we describe and analyze an NIS is in part a function of the outcomes we pursue with innovation policy, while policy options are delimited by what we learn in analysis and description. In particular, targeting positive economic growth and development drives the description of an NIS insofar as it channels analysis to identify social and productive relations that conduce to such growth and development. On the other hand, effective innovation policymaking depends on accurate identification and analysis of existing conditions. It is difficult to move an economy from point A to point B if you do not know where point A is. In Table 1 below I summarize the key characteristics of the two dimensions of the NIS conceptual approach.

on Innovation and Competitiveness' (CRIC). Germany hosts the 'Fraunhofer Institute for Systems and Innovation Research,' while the Netherlands has the 'Maastricht Economic Research Institute on Innovation and Technology' and the 'Eindhoven Center for Innovation Studies' (ECIS). Scandinavia boasts the 'Centre for Technology, Innovation and Culture' (TIK) in Norway, and the 'Danish Research Unit for Industrial Dynamics' (DRUID) in Denmark, largely populated by researchers from Aalborg University. Denmark also features the 'Copenhagen Business School', which studies innovation systems. Sweden features the 'Centre for Innovation, Research, and Competence in the Learning Economy' (CIRCLE) at Lund University and the 'R&D and Innovation with Dynamics of Economics' (RIDE) research center at the Chalmers University of Technology in Gothenburg. At Linköping, the Center for Studies of Humans, Technology, and Organization also conducts innovation systems research. Across the Atlantic, Canada has the Centre for Policy Research on Science and Technology at Simon Fraser University (at Harbour Centre) in Vancouver, which employs the NIS conceptual approach as its underlying framework.

	<i>Descriptive Dimension</i>	<i>Prescriptive Dimension</i>
<i>What is done?</i>	Identification and description of innovation system inputs, outputs, and relationships among institutional components	Analysis of the system's components to map their interrelations and trace innovation flows
<i>Why is it done?</i>	Accurate representation of inputs, outputs, and institutional components is necessary to ensure effective analysis	Effective analysis of linkages – including their nature and intensity – among factors that affect inputs so as to maximize outputs
<i>What are the results?</i>	Well informed innovation policymaking	Policy recommendations that lead to positive economic growth

Table 1 – Two Interactive Dimensions of the NIS Conceptual Approach.

2.2. Distinguishing the Descriptive from the Prescriptive Dimension of the NIS Approach

How scholars describe the constituent elements of an innovation system partly determines how such a system is analyzed and subsequently treated by policymakers. Here, then, we review the defining characteristics of an NIS-based descriptive analysis in order to understand what it means to adopt the NIS approach within the academic domain – comprising a set of interrelated academic disciplines – as well as within the policymaking domain in which government agencies operate.

As noted by Edquist and Johnson (1997) and Edquist (2005), defining the science and technology components of an economy in NIS terms serves two primary functions. Within the academic domain, the NIS approach creates boundaries by reference to which NIS practitioners and policymakers can differentiate how they use the approach within their respective domains from the ways in which others who study technological change conceive of innovation. Second, the NIS approach establishes a set of criteria on which to base assessments of the effects of innovation on competitiveness and economic growth. In the policymaking domain, applying the NIS approach to a national system of innovation provides an alternative to the outmoded linear model of innovation that lingers in pol-

icymaking circles, capturing the multidirectionality of institutional relations whereby initial inputs beget intermediate outputs as well as back-flows of information that inform ongoing innovative work.

From a theoretical perspective the boundary issues raised by the NIS approach shed light not only on its role in the transition through which research breeds innovation that is eventually commercialized, but also on the social constructivist approach to technology. In this latter connection, Gieryn (1983; 1995), in addition to considering how boundaries in science are used to demarcate science from non-science, emphasizes the 'work' conducted in creating boundaries. That is, boundaries are practical achievements that need continual maintenance, and this is particularly true of the nexus that links research to the commercialization of innovations, since the NIS conceptual approach carries over from the academic domain to the policymaking domain, providing a lingua franca that serves as a medium of communication through which knowledge flows. The descriptive characteristics of the innovation systems conceptual approach are conceived and defended by innovation systems practitioners to protect their particular ways of thinking. We see this not only in the academic sphere but also in the policymaking sphere, where NIS-style thinking has influenced government technology policies. As Gieryn suggests, the communities of scholars and policymakers who use the NIS conceptual approach set boundaries in order to access resources, protect autonomy, and maintain control over their domain of intellectual thought.

In addition to serving as a boundary object, the NIS construct also provides "a way of seeing" or a way of conceptualizing an economy that facilitates both research about and intervention in innovative activity. We cannot understand the NIS construct if we forget that, as it has made its way out of the academy into the market, it takes on a prescriptive or normative dimension in supporting recommendations to policymakers by making an in-depth understanding of any given innovation system accessible to non-scholarly actors, who are able to use it in comparing their national innovation systems with those of other countries in what has become, since the Cold War ended, "a world of international technology competition" (Elam 1999, 18). In this respect the NIS conceptual approach in effect induces governments to integrate technology and innovation policy into their broader economic policies. In so doing, governments avail themselves of a new tool, a governmental technology, for managing knowledge on an economy-wide basis. That it has also been used for rhetorical purposes might alter its influence on policy design, but it also illustrates another aspect it has in common with all technologies, namely being open to interpretation and a multiplicity of uses (see Mietinnen 2002, Sharif 2010).

3. The National Innovations Systems (NIS) Conceptual Approach as a Social Technology

Over its relatively short history, the NIS conceptual approach has become well established in innovation studies and in policymaking circles as a way of analyzing an economy to determine how innovations can be promoted for the purposes of economic growth, particularly in the OECD and European Commission, where growth and development are compared on a country-by-country basis. To show that the NIS conceptual approach has been deployed as a social technology, I first recall conventional characterizations of what makes something a technology, and then concentrate on features that pertain specifically to social technologies. In particular, I adopt the view that social technologies are designed explicitly and primarily to alter human behavior, which, in the case of the NIS conceptual approach, means first the behavior of government policymakers and the agencies they represent, and ultimately the behavior of actors at all levels of an innovation system, from technology researchers to designers to entrepreneurs – in short, everyone who plays a role in bringing innovative products to the marketplace. In Foucauldian terms, the NIS approach in effect reconstitutes all these academic, industrial, financial and government actors as innovation actors, and in so doing it harnesses both “individualizing” and “totalizing” technologies to boost economic growth.

Before exploring these and other implications of my characterization of the NIS conceptual approach as a social technology, however, we begin with a broad characterization of a technology *per se*. The difficulty of defining the term “technology” has been noted often by S&TS scholars (see, for example, Bijker et al. 1987; Kline 1995; Oldenziel 1999; Mackenzie and Wajcman 1999). To flesh out the idea that a technology is a practical application of a scheme for achieving a productive goal, I follow Wajcman (1991, 14-15) and Mackenzie and Wajcman (1999) in characterizing a technology in terms of three principal elements. First, a technology involves artifacts and systems that constitute what is primarily a material element, as it were the concrete objects and physical processes used in producing and applying the technology. Second, a technology includes an informational element, a combination of knowledge and skills that support specific techniques employed in producing and implementing it. The informational element of a technology provides the abstract structure that characterizes the productive relations through which the material components are manufactured. The third element of a technology is the set of social practices and relations that provide the framework within which the technology serves the purposes for which it was devised. In characterizing the NIS conceptual approach as a technology, I am committed to an analysis according to which it features all three of these elements – the material, the informational, and the social.

Note that such a combination of elements exhibits the heterogeneity that Latour and Callon attempt to capture with the concept of an actor–network, which typically includes nonhuman animate and inanimate objects as actors. Actor–network theory (ANT) thus posits that “an actor could be either a human or non-human entity and it could have both material and “social” components” constituted “by a shifting network of connections with, and differences from, other entities. [...] Instead of speaking of actors and their networks as if they were distinct objects, this approach suggested that it would be more appropriate to speak of “actor–networks”” (Berry and Slater 2010, 177). As I have noted, I am not addressing the applicability of ANT to the NIS conceptual approach here because I do not wish to address the question as to whether the nonhuman or inanimate elements of a technology, social or otherwise, constitute actors, or to take up an explicit defense of the social. As to whether a given technology has social effects, the effects that I describe later in the paper occur whether or not they are properly labeled “social”.

In distinguishing the NIS conceptual approach considered as a social technology from material or machine technologies I nevertheless acknowledge its material elements, including the mundane physical items used by researchers and policymakers, such as computers, printers, communication devices and other forms of office infrastructure – paper, ink, etc. – as well as other physical manifestations – printed academic papers, policy documents, and so on. This paper is not the site for an extended discussion of differences between the role of material objects in what I am defining as a social technology and their role in a Latourian actor–network, but I will note that I am perfectly comfortable with the idea that each of these components plays a particular role only within the overall context of the way in which a social technology is applied to achieve its designed purpose. A particular configuration of ink on a page, for example, becomes part of a social technology because the context in which it is used in part determines what it means to other actors in the system through which the technology is applied.

In addition to the research-based content of the NIS conceptual approach – scholarly papers and the theories they expound, diagrams and other figures, for example (noteworthy for the role they have played in Hong Kong, which I discuss below) – we should also include in the informational element the software that computers and other devices run as well as the channels of communication through which content is passed from one actor to another. There is in this respect a rhetorical element through which NIS practitioners employ its descriptive and prescriptive dimensions in attempting to realize the objective of harnessing innovation to drive an economy’s economic growth and development. That is, the rhetoric of the NIS concept when used as a social technology – the ways in which the particular configuration of components I have catalogued here are harnessed to act on human behaviour – determines how it is interpreted as a model of innovative activity at the national scale (or at

whatever scale it is calibrated at). The material and information elements act as technological components to the extent that they serve a technological purpose.

The *social* element of the NIS approach, then, resides in a set of institutional and personal relationships – some more formal than others – through which academics, business interests, and policymakers work together in conceiving, sharing, and implementing it in practice. What matters for my purposes is that it is through these institutional and personal relationships, facilitated by its various material and abstract or rhetorical components, that the NIS conceptual approach finds practical expression.

While the last two elements of a technology – informational content and social relations – may seem too human-centered or “low-tech” to fit our idea of a technology, they cannot be ignored because they change the organization of work as well as the organization of society and social relationships. The three principal elements of a technology may produce unintended consequences that undermine or alter the application of that technology, but they converge on an explicit purpose or pre-determined goal, and it is in terms of that goal that we should understand such a technology. I contend that the NIS conceptual approach is a form of knowledge, applied through the abovementioned combination of elements, that is used to conceptualize and analyze the ecology of an economy’s institutions that affect innovations and on that basis it is also used to construct policy recommendations intended to alter the behavior of those constituent institutions and the actors who work within them. It is, therefore, a form of technology. It remains, then, to explain more fully why this particular technology is best understood as a *social* technology in the sense in which I am using that term.

To demonstrate that the NIS conceptual approach is a social technology, I refer to Pinch’s research, in which he identifies several examples of social technologies that, in his words, include “artifacts, processes, or procedures (or combinations of these) which are built around or have embedded within them a systematic attempt to change human behavior” (Pinch 1987a, 2). To be sure, *any* technology once deployed influences human behavior in the trivial sense that, for example, we now use wireless communication devices instead of wired devices on a daily basis. Such a technological shift might well alter behavior on a social scale, of course, but there is no particular pattern of behavior beyond that of a new consumption behavior underlying the development of wireless communication devices. To say that the NIS conceptual approach is a *social* technology is therefore to say that its purpose is precisely to bring about new behaviors on the part of a class of actors taken as a population or significant segment of a population. In Foucauldian terms, as I have noted, when innovation actors operate within the framework of the NIS conceptual approach they have been reconstituted as members of a particular population or social class, as a totality that can be directed towards a common goal. To illustrate this, then, I shall briefly discuss two of Pinch’s exam-

ples, showing how they meet the above-mentioned criteria in virtue of which they are indeed technologies, and then consider his characterization of a social technology as one that is intended to affect behavior on a social scale.

Insofar as our characterization of a social technology builds on the aforementioned characterization of a technology *per se*, it also faces the difficulty of clearly distinguishing the various elements of a technology from one another. Distinguishing artifacts, processes, and procedures from one another can seem arbitrary. To illustrate this, we first briefly revisit Pinch's account of an attempt to change the behavior of prisoners in the British penal system in the eighteenth and nineteenth centuries (from around 1770 until around 1840). The so-called "Separate System" of prison reform that was implemented during the Victorian era is, in Pinch's view, "a classic attempt to change the behavior of prisoners within the framework of a technological system" (Pinch 1987a, 2-3).

The idea of the Separate System was to keep prisoners in complete isolation from one another at all times of the day and night while subjecting them to a regular dose of Bible-bashing. The goal was to replace a prisoner's criminal personality with an open, "impressible" temperament that would render him susceptible to what we might now call behavior modification in the course of which the prisoner would be transformed into a person whose disposition would now be conducive to learning and practicing appropriate self-regulation and interpersonal behavior.

In this example, the social technology works within the framework of a largely material technological system (the prison). The component parts of this social technology included therefore many material artifacts: the prison itself, elaborate equipment that enabled wardens to usher prisoners in and out of group assemblies without seeing one another, and several machines that performed no useful work but nevertheless occupied prisoners' time in physical labor. To these material objects Pinch adds the personnel responsible for applying the Separate System, adding that "the Separate System *along with* the "technicians" [wardens, inspectors and the prison chaplains] who operated it comprised a potent social technology" (my italics; Pinch 1987a, 5). Finally, we must also include as essential components of this technology the set of abstract processes that specified the use of the physical components as well as the supervisory roles played by prison personnel as they regulated the behavior of the prisoners.

This description of the Separate System does seem to match our characterization of a technology, comprising the material, informational, and social elements. What makes it a *social* technology is its purpose, which as we have noted was to alter the behavior of the prisoners, to turn each prisoner, in Pinch's words, from "criminal man" into an ordinary citizen" (Pinch 1987a, 19). It is this objective that made the Separate System, according to Pinch, a "classic example" of a social technology.

Foucault, of course, famously analyzed the emergence of the modern prison system (Foucault 1978 [1975]), but as he developed the concept of

governmentality his analysis of power relations underwent considerable refinement. In his later thinking domination becomes but one type of power relation among others, not all of which are intrinsically bad for either party (governing other people's behavior sometimes requires empowering them), and his new lines of thought superseded key elements of his earlier analysis. In later Foucauldian terms, the Separate System clearly wields both individualizing and totalizing technologies. The elaborate lengths to which the system goes to prevent prisoners from interacting with one another isolates them as subjects of the pastoral function of the emerging modern state, rendering them more susceptible to the individual moral uplift that the system was meant to facilitate. At the same time, however, the system also works at transforming the entire prison population, treating every case similarly, and glossing distinguishing features of their individual cases or personal histories in an effort to create a new class of citizens.

We have seen that, in the description of an NIS that follows from the NIS conceptual approach, we find counterparts to the components of a technology *per se*, but what makes the NIS conceptual approach a *social* technology is ultimately its purpose, which is to change the ways in which economic and innovation-related policymakers act in setting and revising economic policy and in turn to encourage innovation-oriented behavior on the part of actors throughout a national innovation system. In Foucauldian terms these policymakers and associated actors and stakeholders constitute a population, albeit a small one, that becomes the target of the NIS conceptual approach. In particular, the NIS approach operates by shifting the focus of policymakers from conventional policy frameworks (which often approach innovation policy with a largely repudiated linear model of innovation) to one that privileges innovation as a key driver of growth and development. It is this emphasis on shifting the framework within which policymakers and other associated actors operate as a population that has convinced me that the NIS conceptual approach is a social technology.

We can bring out some interesting consequences of this position by considering now another example of a social technology that Pinch has studied. Pinch et al. (1992) discuss an example that is perhaps more like the NIS case than the Separate System during the course of their analysis of the introduction of "clinical budgeting systems" into the British National Health Service (NHS) in the 1980s. Here they focus on an analytical technique that was intended to be applied to a large system that is, in terms of the scale involved, more on a par with a national innovation system, namely the NHS.

The clinical budgeting system was conceived as a way of bringing medical practice in the NHS into something akin to a market framework. In this sense it might represent what Berry and Slater (2010) have noted as "the role of economics in the constitution of markets" (175-176). In the face of a budget crisis the idea was to establish a new system for the

allocation of medical resources that would replace the old model, under which the ability of patients to pay for services played no role in determining that allocation. In analyzing this attempt, Pinch, Ashmore, and Mulkey committed themselves to treating “clinical budgeting as a “social technology” [...] clinical budgeting incorporates some material technological artifacts – in this case the micro-computers and associated hardware and software. Again, however, such artifacts only take on meaning within the overall system. And again within this system is embedded a particular view of social behavior – the aim of clinical budgeting being to change the behavior of clinicians and to a lesser extent managers” (Pinch, 1987a, 17).

Here again this example of a social technology intersects an important point in Foucault’s thinking, as he argued in an early work (Foucault 1973 [1963]) that clinical medicine had reconstituted the subject of medical practice with the elevation of the medical case as the primary focus of treatment. To be sure, Foucault’s conception of power evolved considerably after this early work as a result of the self-criticism to which he subjected himself in the mid-1970s. As I have already noted, his expanded analysis of power and governing relations acknowledges non-judicial relations that involve more than simple domination. In its pastoral modality, Foucault argues, the modern state has assumed responsibilities for the welfare of its subjects that were akin to those assumed by pastoral Christianity for its parishioners. Here in the example of the British clinical budgeting system we have a social and governmental technology that clearly adopts the case as the determinant of medical treatment, a trend that is lamented by Tierney (2004), who argues that a recent movement to restore “the voice of the patient” to medical practice involves both the juridical power of the physician to judge the patient’s responsibility for her own health and the pastoral power that individualizes a patient’s specific history and health status.

In the clinical budgeting system example, the efforts on the part of the British NHS to identify cost-effective treatments of medical cases reoriented the pastoral responsibility of the state while reconstituting the individual patient as but one component of a system that would make costs easier to manage. In a study of nursing practice in the Australian health system that references Foucault, we find a similar reconstitution, as the hospital bed becomes less a place of caring than a commodity to be allocated:

Though current nursing textbooks affirm the bed as a materialised location for nursing practice, its temporo-spatial representation now forms part of patient-management practices [...]. Beds are a discursively contested location for nurses. Like patient medical records and the whiteboards used to map patient bed allocations, hospital beds are increasingly understood to have become rule bound as spaces for the administration or disciplining of time. (Heartfield 2005, 23)

This shift of focus to the case has in turn redefined the terms by which a successful disposition of a case is measured. Now length of stay, as indicated by bed turnover and re-allocation via whiteboards, becomes the key performance measure:

As an intellectual technology, the whiteboard transforms the bed into a resource-space in which nurses enact managerialist administrative responsibilities to ensure smooth, stable, predictable and preferably brief patient hospital stays (Heartfield 2005, 25).

This process through which the bed is commoditized in an economy of resource allocation, which as we can see involves a range of mundane technologies such as medical records and whiteboards, parallels the intended effects of a reform such as clinical budgeting on the British NHS and exemplifies the results of the governmentalization of medicine.

The clinical budgeting system deployed by the British NHS can be seen as part of a general trend towards the replacement of individual patient care in which practitioners treat individual subjects as it were at ground level with a system in which administrators determine regimes of care based on population-level data on risk factors, and the administrators whom the reforms were meant to turn into budget-minded efficiency experts would through their efforts reconstitute the individual patient as an incidental statistical adjunct to the case. Here the social technology was meant to operate by turning medical professionals into experts on risk and cost-benefit analysis.

Applying this model of a social technology to the NIS conceptual approach, it is not difficult to identify in both the clinical budgeting system and the NIS conceptual approach the elements of a technology, with the former falling into the category of a social technology in virtue of its purpose, which was to alter the behavior of a subpopulation of actors within the British NHS. To see this, however, it is first necessary to distinguish two interrelated facets of the NIS conceptual approach. On the one hand, a national innovation system considered as an entity in *itself* is a system of objects and institutional/personal relations that operates within the geographic boundaries of a particular nation. A nation's innovation system thus comprises material and human elements such as firms, universities, research organizations, public and private laboratories, government agencies and facilities, and so on. On the other hand, the NIS *conceptual approach* aids in the understanding of innovation, technological change, competitiveness, and growth in the framework of theoretical or economic *analysis*. As an analytical tool, the NIS conceptual approach – as we have noted – is utilized not merely descriptively as a kind of inventory of material and human resources, but also *prescriptively*, with the express purpose of producing change in the way scholars and policymakers understand an economy's functioning, how innovations can be promoted (or inhibited), and how contributions to economic growth can be made

through the pursuit of innovative activity. In other words, as a policy tool it engenders changes in behavior in a small but influential population. Thus its role vis-à-vis a national innovation system is similar to the role of clinical budgeting vis-à-vis the British NHS.

This prescriptive dimension seems clearly to exemplify Foucault's central assertion that knowledge when harnessed in a social technology always involves power relations or governmentality. The informational elements of a social technology serve to empower experts (prison wardens, hospital administrators, influential academics specializing in innovation studies) to apply the technology to target populations (prisoners, medical care providers, economic policymakers) with the intention of building new efficiencies or orderliness into the institutions in which they operate.

Perhaps it would strengthen the intuitive appeal of the concept of a social technology and its application to the NIS conceptual approach to remember that, as I have described it, the components of both an actual national innovation system *and* of the process of analyzing such a system under the NIS conceptual approach include material elements. Whereas the material elements of the former include a set of institutions and organizations (for example, firms, research labs, government facilities, university facilities, and so on operating within a framework of laws, regulations, practices, and channels of communication), the latter – the NIS approach when deployed as a policy tool – also includes material elements such as papers, policy documents, and the computers used in the process of formulating, issuing, and implementing policy recommendations as well as the people associated with policymaking. Thus, while a national innovation system comprises among other things the material elements of a comprehensive multisectoral system, ultimately the purpose of the NIS conceptual approach (with its own material components) is to provide an analytical framework within which to understand those elements – material, information-related, and social – so as to change the behavior of targeted actors, institutions, and organizations primarily in a way that alters the nature and strength of their linkages through policy intervention.

Once we conceive of the NIS conceptual approach as a social technology, we can apply other S&TS theories, models, and tools to it in new ways as we analyze its advantages and disadvantages. For example, one such promising S&TS approach applicable to the study of an NIS is called the Social Construction of Technology (SCOT) model, with which it is possible to deconstruct the NIS social technology and examine the extent to which it has stabilized (Pinch and Bijker 1984, Bijker, Hughes, and Pinch 1987). It should be possible, using the concept of a social technology, to expand the domain of NIS analysis within S&TS yet further, perhaps in reference to other widely applied terms such as the “Triple Helix”, the “Knowledge-based economy”, and so forth. Surely there are, as well, other social technologies that would interest scholars in social studies of science and S&TS, and part of my purpose here is to remind scholars of this possibility.

I close my argument that the NIS conceptual approach constitutes a social technology with an observation apropos of Pinch's original work on technologies. The research agenda pursued by scholars interested in technology studies has included analysis of the conditions under which technologies are tested. Pinch (1987b) examined, for example, the investigation of the failure of O-rings in NASA's space shuttle *Columbia* in 1986, concluding that interpretations of tests of the O-rings on the part of engineers and NASA management were at odds. Some of the engineers, based on their interpretation of O-ring test results, had wanted to alter the criteria for launch pertaining to air temperature by applying limits to individual parts of the space shuttle rather than to the ship as a whole. Management overruled, with tragic consequences, fearing long delays in the flight schedule as a result. As Pinch describes it:

It seems that two different interpretations of the [Launch Commit Criteria] were available. This, of course, is a point familiar within the sociology of science – rules have to be interpreted and it is this which allows interpretive flexibility to enter [...]. Whether or not the Space Shuttle was in a working condition such that it could be launched depended on which of these two interpretations won out (Pinch 1987b, 12).

Pinch argues that “negotiations over the “workability” of a piece of technology do occur and this is a fruitful location for what he calls in that work the new sociology of technology. It is also another illustration of governmentality, insofar as every aspect of a social technology may be negotiated and such negotiations inevitably involve power relations and the defense of boundaries. Until disaster struck, NASA accepted a degree of risk that accommodated its need for launch and mission efficiency and defined what constituted a successful testing outcome accordingly.

In reference to the clinical budgeting case that I have mentioned here, Pinch and his colleagues observed that, even though few if any of the desired outcomes of the trial were realized, higher-level policymakers essentially ignored these outcomes because they were under budgetary pressure and they believed that clinical budgeting made sense “in principle.”

The point here is that the testing of a social technology, like scientific testing and the testing of a machine technology, involves both interpretation of results and persuasive discourse. By the time a social technology reaches the stage of being tested in practice, there is often a social imperative behind it (Miettinen 2002, Sharif 2010; I show in the next section that government officials in Hong Kong felt such a social imperative when they adapted the NIS conceptual approach to their purposes, but it had less to do with shaping economic policy than with legitimizing their role as policymakers). Moreover, the testing environment of a technology is highly public, which distinguishes it from the testing of scientific hypotheses within the scientific community. Even a machine technology (such as an O-ring) is tested in a much more public arena than a typical

hypothesis in the physical sciences, but the testing environment of a social technology is by definition in the public arena. Yet the difference between testing a machine and a social technology is one of degree only:

This difference in the testing of machine and social technologies is only a matter of degree and not one of principle. Indeed the whole weight of my argument is that for analytical purposes the underlying rhetorical and persuasive processes in science, in machine and material technologies, and in social technologies, should all be treated in the same way. (Pinch 1987a, 13)

Thus the British authorities in the NHS largely dismissed the negative results of their trials of clinical budgeting. They argued, first, that the testing environment was irremediably compromised by its being, in effect, the real world of clinical medicine, in which it was virtually impossible to control for a host of variables that might affect the results. Second, it was argued that because it was so difficult to change the culture of medical care within the testing environment, only a deracinated version of clinical budgeting was tested. Most social technologies, designed to alter human behavior in the service of some policy imperative, will be similarly difficult to test.

In the case of the NIS conceptual approach, we have already seen that the original research program out of which the conceptual approach emerged to be made into a social technology has not determined the form in which the conceptual approach has been adopted by the policymaking community. In some cases policymakers have referenced the NIS conceptual approach without fully appreciating the multidirectional complexity of the model. In Hong Kong, for example (which I discuss at greater length below), the NIS conceptual approach has served primarily a rhetorical purpose independently of the intent of those who formulated and developed it in academic work (Sharif 2010). Since the NIS conceptual approach has come into the policy arena with the express purpose of changing the behavior of key actors so as to encourage innovations that drive economic growth and development, the ultimate test of an NIS that reflects the conceptual approach is whether or not the economy adopting it experiences new or accelerated growth and development as a result. Clearly the public nature of the “testing” environment will make it difficult to control for a host of factors as well as to maintain the original content of the NIS conceptual approach itself. In such an environment, every political faction is likely to interpret the economic outcomes of innovation-related investment differently. Such is the effect of governmentalizing innovation.

Considering the complexity of a national innovation system, there would seem to be many processes and social transactions to which scholars in both social studies of science and S&TS might apply their analytical tools in order to understand the full range of issues that affect the invention and implementation of this social technology.

4. The NIS Conceptual Approach at Work as a Social Technology

Analyzing the NIS conceptual approach as a social technology commits me to the claim that, in the hands of academic experts and government policymakers, the framing of the relationship between innovation and economic growth and development through the concept of an NIS has influenced both the policymakers who are in a position to apply it to their work and the actors in an NIS who carry out economic activities. In this section I discuss evidence of this influence that I have discovered in past research, but I also note that several countries have adopted some form of the NIS conceptual approach in their policymaking agencies, including Sweden, through its “Systems of Innovation Authority” (known as VINNOVA); Finland, through its National Technology Agency of Finland (2002); the Government of Canada (2002); the Government of New Zealand (2002); the UK Office of Science and Technology (2002); the Government of the People’s Republic of China (International Development Research Center, 1997); and Hong Kong, through the Innovation and Technology Commission in the Hong Kong Special Administrative Region Government (2004). In what follows I discuss in greater detail the case with which I am most familiar, that of Hong Kong, where ultimately the NIS approach seems to have played a different role from that which characterizes its application by the other aforementioned governments.

The case I discuss involves the use of the NIS approach by Hong Kong policymakers primarily for rhetorical purposes, but as I have noted I am not the first to study the rhetoric involved in the NIS conceptual approach. For example, Miettinen (2002) focuses on the political rhetoric involved in applying the concept of an innovation system to national economic policy. Albert and Laberge (2007) conducted an ethnographic study of how international organizations (in particular, the OECD) and regional public administrations (in their case, that of the province of Quebec, Canada) apply legitimation and dissemination processes, elucidating the socio-cultural processes that have led government officials to adopt the innovation systems approach in policymaking.

As I have noted, the brief account of the use of the NIS approach by policymakers in Hong Kong I now offer summarizes a study I have published elsewhere (Sharif, 2010). In the context of the present study the outcome may well seem ironic, because my research demonstrated that Hong Kong policymakers indeed used the NIS conceptual approach as a social technology to support its policymaking posture, but not as it was intended or expected by the scholarly experts who developed it (see Sharif, 2006, for an account of the development of the NIS conceptual approach) or as it was utilized by the OECD as a guide for policymakers.

Following the Asian financial crisis of 1997, Hong Kong’s government struggled to reorient its economic policy so as to reinvigorate economic

growth by entering the emerging global knowledge economy. Hong Kong sought to plot a new economic policy by emphasizing technology and innovation, producing a series of policy briefs, forming commissions, and funding development institutions all aimed at generating economic growth through innovation and new technology. This new policy direction played out against a history of weak research and development (R&D) and innovation activity in Hong Kong’s industrial sectors, comprising mostly small-to-medium-size enterprises that were reluctant to commit resources to risky endeavors such as new product development. They profited mostly from low-cost manufacturing operations and borrowed innovations.

Evidence of the Hong Kong government’s awareness of the NIS conceptual approach took explicit form in a 2004 report issued by the Innovation and Technology Commission, titled *New Strategy of Innovation and Technology Development* (HKSAR 2004). To the best of my knowledge the term “innovation system” was used for the first time in an official Hong Kong document in this report, or consultation paper, and it was accompanied by a diagram of Hong Kong’s innovation system (fig. 1).

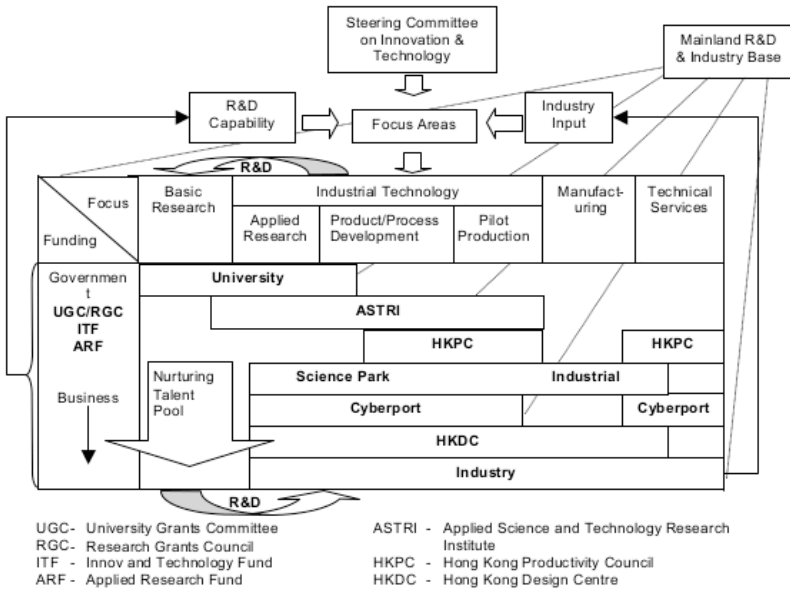


Figure 1 – Diagram of Hong Kong’s innovation system from 2004 Innovation and Technology Commission consultation paper, under caption “Figure 3: Innovation under the New Strategy” (source: Sharif, 2006, from HKSAR, 2004, p. 18).

This diagram appeared in chapter three of the report, “New Strategy of Innovation and Technology Development”, accompanied by the following brief paragraph, which appeared under the heading “Innovation System”:

Under the new strategic framework, it is hoped that various elements of the innovation and technology program could work closely together to generate greater impact along the R&D value chain from basic research to commercialization and production. [The] figure below illustrates the innovation system [...] under the new strategy (HKSAR 2004, 17).

That this represents the entirety of any reference to Hong Kong’s NIS in the paper informed my conclusion that in the government’s hands the NIS conceptual approach was indeed a governmental and social technology.

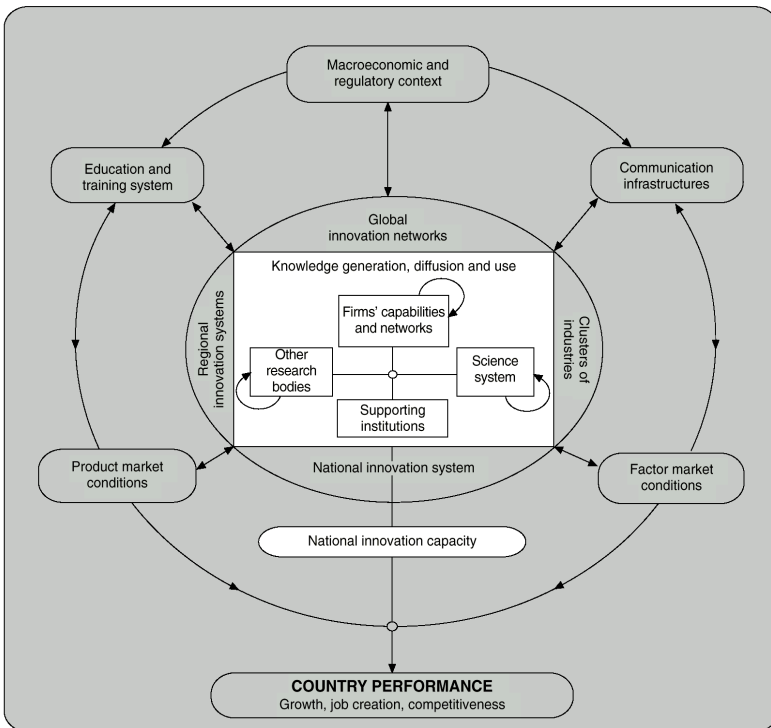


Figure 2 – OECD representation of a NIS (source: Sharif, 2006, from OECD, 1999, p. 23).

Yet another critical component of my research, which involved interviewing relevant figures in and out of the Hong Kong government who were involved in designing and carrying out its technology and economic development policies, led me to the conclusion that its purpose was primarily rhetorical. Based on these interviews I learned that Hong Kong policymakers were interested primarily in leveraging the prestige of the OECD to enhance the credibility of the government in its efforts to promote technology and innovation, not in following the model of the NIS approach that its academic progenitors or its advocates at the OECD would have recommended. Figure 2, which is a diagram of an NIS published by the OECD, makes this clear.

The OECD diagram depicts an NIS holistically as a nonlinear process involving actors from multiple sectors in complex interrelationships involving knowledge transfer and feedback. By contrast, Hong Kong's diagram of its own NIS represents a primarily linear process that proceeds from inputs at the top of the diagram to outputs at the bottom. I have shown (Sharif 2006) that the NIS conceptual approach was developed in the 1980s and 1990s precisely to supersede such an understanding of an innovation system. To be sure, the Hong Kong diagram depicts some degree of reflexivity in the system, but it depicts firms (represented by "Industry" at the bottom of the figure) almost as passive recipients of innovation outputs rather than as central actors in the heart of the process, as depicted by the OECD.

Thus although the designed purpose of the NIS conceptual approach would have been to help policymakers direct, or persuade, a wide range of actors to adopt practices that would strengthen links of the sort that are depicted in figure 2, instead its purpose was to persuade the public at large, which had lost confidence in the government, that it could be trusted to develop effective economic policy. To this end Hong Kong policymakers made a show of following OECD guidelines, something that I was told by one of my interviewees (this is a paraphrase of the remarks, not a direct quote, as none of my interviewees agreed to be identified or recorded):

We do not just act blindly in arriving at our policy formulations. Our policies usually follow internationally accepted practices as found in the major publications, such as the OECD. When we see that the OECD and its member countries are adhering to certain guidelines, it helps – for international comparisons – that Hong Kong also follows the same international guidelines. Hong Kong is an international city! This helps when we want to compare ourselves to, say, Singapore or Taiwan or any of our other neighbours [...]. The OECD has published reports on the innovation systems model showing it is an important model (Sharif 2010, 425).

Thus, while policymakers published their own version of Hong Kong's innovation system that misrepresents how those who developed the NIS approach understood it, they also in the abovementioned consul-

tation paper referenced the OECD to assure its readers that their plans for promoting economic growth through technology and innovation conformed to international norms.

This case illustrates the interpretive flexibility of the NIS conceptual approach as a social technology, but apart from the circumstances of its actual use by Hong Kong policymakers – who departed from its designed-for use – we see here also that the NIS approach features the signature elements of a governmental technology. As it migrated from academic studies to a non-governmental development organization to a government agency, it involved a heterogeneous “assemblage” (Rose 1993) of human, material, and abstract components – or actors – including the diagrams reproduced in figures 1 and 2, which illustrate the rhetorical component of the NIS approach.

5. Conclusions

In arguing that the NIS conceptual approach is a social technology, I have attempted to revive a largely forgotten category of analysis. This should benefit, I believe, both those who are interested in innovation as a driver of growth and development and scholars in the sociology of technology and S&TS. The former, an interdisciplinary and multisectoral community of scholars, engineers, corporate strategists, and policymakers in government and the public sector, may be able to pursue their common interests more effectively with a shared understanding of the NIS conceptual approach as a social technology. All actors interested in leveraging innovation to drive growth and development would profit from a better understanding of the ways in which their narrow interests might lead to interpretative conflict as they work together to allocate resources and implement strategies towards their ultimate goal. Similarly, scholars in sociology of technology and S&TS should achieve new levels of understanding by applying the concept of a social technology to a wide range of social phenomena and public policy initiatives.

By framing the governmentalization of the NIS approach partly in Foucauldian terms, I hope to have provided a familiar theoretical context within which to understand social technologies. These technologies fall into the broader class of governmental technologies, serving in this case to empower or reward individual and institutional behavior in a way that serves the state’s economic purpose of fuelling growth. As actors in academia, industry, and government are reconstituted as actors in a national innovation system, as their roles are redefined and the terms over which they negotiate resource allocation and successful outputs evolve, scholars may benefit by situating these developments within a Foucauldian framework, in which they are seen as part of a wider genealogical fabric that weaves together individualizing and totalizing technologies in the state’s ongoing historical development.

Whether or not one accepts the broad sweep of Foucault's analysis of the genealogy of the state, one need not view my analysis of the NIS conceptual approach as a social technology as suggesting an ominous extension of state power into the economic sphere. In its mature form Foucault's analytics of power, as we have noted, acknowledges beneficial outcomes of power relationships and the emergence of positive values in spite of the inherent dangers represented by totalizing technologies. By emphasizing the two-dimensional character of the NIS conceptual approach – consisting of both descriptive and prescriptive phases – I argue that it enables a new perspective on the process of innovation. This new perspective makes it possible to achieve a more complex understanding of a national innovation system with a multidirectional model that more clearly demarcates and delineates the various components and actors in an NIS, as knowledge flows and innovative developments travel back and forth along channels of communication and collaboration involving the higher education, industrial, and public sectors. By adding to this analysis the classification of the NIS conceptual approach as a social technology, I have made it possible to begin a new phase in innovation studies in which a better informed innovation community might more effectively utilize the resources available in order to modify the behavior of those actors and agencies who are best able to affect the outcomes of the innovation process.

More broadly, I have not only brought a specific area of study into the social studies of science arena, but I have, I hope, provided a basis upon which to add (or restore) the social technology construct to the conceptual toolkit of the sociologist of science and S&TS scholar. With this tool in hand, such scholars can open up new areas of study across a wide range of subject areas involving the public interest and sociological analysis. It may also provide a means by which to narrow the frequently wide gap between scholarly knowledge and policymaking reality as scholars, industrialists, and government agents pursue disparate interests for the sake of the common good.

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