Lived Technical Systems: Conceptualizing Technologies and Technology Policies for the Recesses of networked urban spaces in the Third World

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Abstract

Technology studies has recently tried to understand networks of urban infrastructure in the context of contemporary (affluent and poor) cities by exposing the intertwining of wider social and economic realities with urban technological network transformations. Without questioning the validity of the transformation of networks of urban infrastructure, this paper attempts to generalize the understanding of service delivery through urban technologies to include non-networked, non-formal, lived technologies and their layered, complex and highly differentiated relation with formal technical systems of service delivery. Such an inclusive focus is relevant to cities in lesser developed countries given the continuing inadequacy of formal networks of (water supply, sewerage and electricity) service infrastructure to meet the needs of a large proportion of the population. An examination of the fabric of networked technologies in less developed cities reveals tears and frays – messy, irregular recesses – within the regularity of the grid. This paper attempts to achieve two goals – employ a technology studies perspective to understand these holes in infrastructure provision and secondly conceptualize a technology studies informed means of intervention for service provision to these holes. In order to do this technologies of service provision need to be contextualized as being embedded within the postcolonial condition; as a site for users or their collectives to interpret techniques of service provision in diverse ways; as media that transmit responses and means for asserting their presence in a society and a political process in which they increasingly count for little; and finally as a means of negotiation and interaction with large technological systems of service delivery. These attempts to democratise the rationality of urban infrastructure needs to inform policy designs that seek to democratise the technical codes that govern the actions of system engineers.

Introduction

Science and Technology Studies has attempted to understand the role of technology within our technically mediated society. This essay will focus on the technology studies half of the field. By doing so it does not suggest that the demarcation between Science Studies and Technology Studies is clear and rigid in all cases. But the demarcation can be explicitly drawn when the objects of study are such 'black-boxed artifacts' as pipes, conduits and social arrangements that surround these artifacts in order to facilitate the provision of essential services for a modern human civilization. The interdisciplinary field of Technology Studies has attempted to raise two prominent meta-directions of inquiry about technologies in society –

the first, an increasingly well-travelled direction of the social process of technological development and its deployment in different socio-cultural environments which draws upon advances in the sociology and history of technology. The other direction of enquiry finds its base on the humanistic goals of the philosophy of technology and technology policy which in distinctly different ways see technology as a media to achieve certain normative social goals. This essay will attempt to bring together these two strands of inquiry in technology studies around the topic of provision of essential services through technologies of urban infrastructure in the Third World. Consequently the aim is to not only to understand the multilayered and complex social situation of infrastructure provision in the cities of the developing world but also to conceptualize directions of intervention that promote preferred means of social and technical change. This bi-pronged approach assumes importance in view of the continuing (if not worsening) crisis of infrastructure supported contemporary urbanization in less affluent cities of the world. This move therefore intends to not only draw an illustration of the patterns of infrastructure provision in cities but also prescribes conceptual directions in which to proceed to address the problem of provision of infrastructure.

This essay aims to address three main objectives. It will present recent explications of urban infrastructure within Technology Studies. These accounts describe technical infrastructure binding with social existence to constitute contemporary cities. The flux associated with contemporary urban processes – be it the movement of water and sewage through a conduit system; or the transport of people and their belongings through a transportation system; or the global transfer and exchange of digital signals – is comprised by "superimposed, contested and interconnecting infrastructural landscapes" (Graham and Marvin 2001). But in cities of the Third World, technologies for infrastructure provision assume additional dimensions in light of the inadequacy of technical networks to address the needs of a substantial fraction of the population. The concept of Technological Recesses is introduced to refer to those neglected spaces within the city where services are mediated through non-standardized forms of technical systems. The second section attempts to describe the complexity of the relation between these Technological Recesses and the technological supply network. The third aspect of the essay attempts to conceptualize, using a Feenbergian lens, the complexity of the Technological Recesses in the cities of the Third World as a process of democratic rationalization. The final section of the essay examines and critiques current policy directions which have a bearing on urban infrastructure. In doing so it attempts to conceptually develop a policy for urban infrastructure technologies in the recesses that grants its social shaping in directions that promote democratization.

Technology Studies and Urban Infrastructure Networks

There can be little doubt that networks of service infrastructure are an integral part of current urban life. As Stephen Graham and Simon Marvin, in their book Splintering Urbanism note – "infrastructure networks are the key physical and technological assets of modern cities" (Graham and Marvin 2001) – assets that ensure the survival of the urban civilization. These technologically reticulated urban services sustain modern cities by attempting to meet the escalating levels of exchange, transfer and transport of commodities, signals, and people. In fact contemporary urban society is so dependent on the presence of massive, spatially extensive networks of service infrastructure that their widespread infusion into the urban landscape, both visible and invisible, is accepted and taken for granted. Consequently their black-boxed artifactual presence has given rise to narratives about technical infrastructure that are excessively technical or technocratic – dealing primarily with technicalities of service such as system maintenance, expansion or

service pricing. Technology Studies following in the tradition of 'opening of technical black-boxes' has attempted to establish the sociotechnicality of 'taken-for-granted' networks of service infrastructure and of the urban territories that are constituted by these networks. Graham and Marvin have attempted to fashion a more complex socially situated understanding of infrastructure networks. They posit that infrastructure networks need to be conceived as a complex socially constituted technical system that contains an embedded politics. A politics (due to social, political and economic power differentials) that is revealed in the uneven configuration of and variable mobilities and flows in the infrastructure network. The selective creation of barriers during the introduction of infrastructure systems reflect the solidifying of social, economic and political imbalances into its materiality. "One person's infrastructure is another's difficulty" (Star 1999). By unevenly and non-uniformly binding social existence in cities through technical links, infrastructure networks can be said to represent "sociotechnical geometries of power" (Graham and Marvin 2001). Urban societies enrol these massive technical networks in order to support and extend their activities. By doing so technical infrastructure networks as "mediators [through which the perpetual process of transformation of Nature into City takes place]" (Kaika and Swyngedouw 2000) are constitutive of the urban. Changes in the networks (from social and political changes) are tightly coupled with the changes in the urban society. This close interweaving between the social and technical aspects require cities to be conceptualized as sociotechnical processes (Graham and Marvin 2001).

Graham and Marvin attempt to understand the relation between contemporary cities and networked infrastructures and technologies that penetrate the spaces above, within, and below cities. Processes that attempt to reconfigure urbanization can be seen to be related to a parallel reconfiguration of networked infrastructures. This is clearly understandable in the impact of two processes: in the planting of conventional notions of modern rationalistic planning onto the urban substrate and in the transfer and exchange of ideas associated with the process of globalization. Firstly, notions of conventional rational planning have left their impress on the form of the city by changing not only the built environment but also its supporting infrastructure – roads, water and sewage pipes, energy, and telecommunication. This we see in the construction of a modern ideal for infrastructure provision through technical networks. This ideal was constructed as one embodying the rationality of science and mathematics and emphasizing the sophisticated fabrication of engineering. This reliance on the creativity of the engineer was expected to embody the technical infrastructure with efficiency and technical superiority while at the same time making it politically aseptic. While the motif of sanitizing is appropriate to sewerage networks, it is a motif that has been associated with the task of the urban engineer employed to remove the chaos and corruption of the industrial city.

Secondly, the book makes the case that "a parallel set of processes are under way within which infrastructure networks are being 'unbundled' in ways that help sustain the fragmentation of the social and material fabric of cities" (Graham and Marvin 2001). "[M]obile interactions across distances and between scales" of bodies, information, commodities and products (referred to as the space of flows by Castells (1997)) that has come to characterize the process of globalization are being mediated by the "connective forces" (Graham and Marvin 2001) of telecommunications, transport, energy and water networks. But these "connective forces" are also being refashioned through socio-economic changes that accompany the globalization of capital. Globalization categorized as the internationalization of capital and the increasing global interests of a section of peoples is influencing the social and economic contexts in cities around the world. Societies in cities contain sections of the population – socioeconomic elites and professionals – who by virtue of their privileged position demand exclusive infrastructural access which meet globally

accepted specifications. These requirements include access to such facilities as high speed telecommunication, information connections, reliable energy supplies and in addition such requirements as transport and water services that meet global standards. Again, the imperatives of the glocal economies are shaping the infrastructural priorities of governments, utilities and corporations away from the universal ideal to increasingly serve the interests of these glocal centres. According to Graham and Marvin the wider trends towards social polarization and intensively connected glocal economies and the construction of secessionary network spaces index the claim of the authors that the process of infrastructural privatization and unbundling is paralleled by the trend towards the fragmentation of urban society and materiality.

Graham and Marvin suggest that given that the trends of splintering urbanism and infrastructure segmentation are emerging in all cities – be they developed or developing – globally (albeit at differing rates) it is no longer tenable to focus the study of socially located infrastructure technologies onto specific Western or developed cities contexts. However unlike the cities of the developed world, in cities of the developing world deeply fragmented technologies of infrastructure have been a reality for as long as the modern ideal of universal infrastructure constructed through received engineering notions was imported into these contexts. Balbo conceives of spatial fragmentation as perceptible in the built environment (the planned districts versus 'illegal' informal settlements) and in the differences in services and infrastructure levels and accessibility to the same (Balbo 1993). Balbo posits that the splintered nature of the contemporary urbanism in the Third World are due to a number of reasons but primary among them is the history of colonial segregation impressed upon these cities by colonizers employing structures and infrastructures (embodying Western engineering) of urbanism to reinforce their superiority. Other factors behind the fragmentation that are suggested include extremely rapid population growth, the functioning of the urban economy, the ideology of urban planning, and the role of the state (Balbo 1993). Graham and Marvin acknowledge that the processes of infrastructure dualism (or multiplicity) in developing cities are far from new, but the combined effects of privatization, liberalization and 'structural adjustment' have only exacerbated the already splintered infrastructural arrangement. While the thrust of the modern infrastructural ideal was for the ubiquity of standardized infrastructure arrangements, the increasingly dominant path towards infrastructure privatization and commercialization presents the prospect of shrinking coverage of the network as a result of considerations for increased profitability. The capital intensive nature of infrastructure expansion combined with increasing constraints on the availability of finances with governments and the conditionalities imposed by multilateral international donors have made the possibility of universal coverage of infrastructure networks in the developing world very remote (Kundu 2002; Mahadevia 2002).

Large Technical Systems and Technological Recesses

This essay has so far attempted to describe the current trends in urban infrastructure networks and its parallels with wider social and economic transformations. This section will attempt to apply a theoretical perspective that has emerged from Technology Studies in order to explain networks of infrastructure in their socio-technical complexity without resorting to a simplistic understanding where technical infrastructure appears to have an independent asocial existence that is driving the social sphere in a direction determined by technical imperatives. Large Technical Systems (LTS) presents a theoretical approach for understanding the seamless interweaving of the social and the technical that underpin a spatially organized system such as the water supply system, the electricity supply grid or even the road network. This approach thus has the potential to bring a more complete understanding of urban

infrastructure. However, as mentioned above, significant spaces within the cities of the developing world do not possess standardized 'black-boxed' connections to the LTS. A diversity of technical measures characterize this interaction. The concept of Technological Recesses (TR) is proposed to indicate these network holes where the relation with the LTS is mediated through non-standardized means. This section will try to sketch the complexity of the relation between the Large Technical System and the Technological Recess.

The LTS method proposes to bring a systems perspective to understanding technologies in society. This facet distinguishes the LTS approach from the study of individual artifacts that cannot be directly related to "larger wholes – material technologies, organizations, institutional rule systems and structures and cultural values" (Summerton 1994). Thomas Hughes (1987) originated the concept of large technical systems in order to propose an understanding of networks of (largely urbanized) services mediated by interlinked technologies and hierarchical organizations. Technical systems (especially LTS) are concerned with complex and seamless webs of technical artifacts, technical and managerial organizations and institutional arrangements that are established to surround these networked artifacts. As Hughes notes:

"Technological systems contain messy, complex, problem solving components. Among the components in technological systems are physical artifacts, such as turbogenerators, transformers and transmission lines in electric light and power systems. Technological systems also include organizations, such as manufacturing firms, utility companies and investment banks and they incorporate components usually labeled scientific such as books, articles and university teaching and research programs. Legislative artifacts, such as regulatory laws, can also be part of technological systems" (Hughes 1987).

Technological Recesses (TR) are those neglected spaces within the urban scene that do not possess standardized direct access to 'first order'[1] large technical systems like water, electricity and energy. The inhabitants of these technological recesses instead rely on a variety of user-mediated, and informal sociotechnical arrangements that act as an intermediary between the LTS and the users.[2] These arrangements range from small private vendors of services to community managed service provision. TR is conceptualized here to indicate two defining facets about the spaces where the LTS is unprepared to enter. Firstly, as obscure unimportant places located within the domain of the urban infrastructure network, the defining identity of these recesses is one of disconnection; and secondly the notion that these recesses are designed and managed with the active involvement of marginalized users. The urban space within the TR has characteristics that are substantially different from the LTS constituted urban space. While in the TR, the active involvement of the user in service provision ensures that that the infrastructure supply is not 'black-boxed' and forgotten but remains problematic. The recess thus becomes an ongoing site of contestation and negotiation between the users and the purveyors of service. The marginal position of the TR within the urban space is reinforced by the state of partial or complete disconnection from the LTS and from larger technical and bureaucratic networks.

The relation between the LTS and the users of the TR are mediated by non-standardized sociotechnical arrangements. It is these arrangements that are particular interest to this essay. The system builder occupies a prominent place in the LTS literature. The system builder or other "super persons" (Joerges 1999) – technical organizations or governmental bureaucracies – ensure the continued successful operation of LTS and its interaction with the external environment. But this focus on the actions of the system builder has given the LTS dramas the appearance of a conventional technocratic narrative where the evolution of the LTS is determined by the system builder. As a result the role of the user in shaping

the evolution of the system has been neglected (Joerges 1999; Summerton 1994). By focusing on the relation between marginalized users in the TR and the LTS, it is possible to indicate directions through which users attempt to negotiate with the LTS and in so doing open pathways for transformations in the socio-cultural and technical components of the LTS.

The relation between the LTS and the TR can be conceptualized along several dimensions, but of particular relevance to the project of mapping the pressures coming to bear on the totalizing rationality of the system are the cultural, socio-political, topological (or spatial) and techno-organizational dimensions. Conventional discussions of the recesses and the LTS have usually been conceptualized from the perspective of the LTS. Thus the discussion usually touches upon the economic or technical aspects by framing it in the perspective of the system builder or super persons. The one-sided economic and technical framing of the relationship makes the recess the target of a purely mathematical balancing exercise between the technical imperatives behind the expansion of the network and the economic imperatives of costs and benefits. The multidimensional relationship between the TR and the LTS is conceptualized here from the perspective of the users of the recesses. Thereby it replaces the technocratic framing of the relationship with a contextual framing that incorporates social and cultural particularities of the recesses. By framing the issue from the perspective of the users, this research will hopefully address the neglect of the user in the literature on LTS.

The topological and spatial dimension of the relationship between the LTS and the TR can be conceptualized at two planes – first, at the micro-level by understanding the mesh of formal and informal social interactions that surround the non-standardized technical linkages between the TR and the LTS. A microlevel topological map of the TR can be seen to have a dense mixture of technical connects with the technical capillaries of the LTS and social and organizational links. The social/organizational links could range from formally established and recognized committees that liaison with the LTS to informal associations that develop from the social and political capital of the inhabitants of the TR. Second, at the system level the interaction between the LTS and the TR can be understood as systemic interaction where the characteristic of each system influences the other. Beckman has attempted to conceptually map systemicy of technology by focusing on generalizable measures of systemicy, its basis and approaches to social regulation of systems (Beckman 1994). Joerges notes that the functionally established systems like LTS possess systemic characteristics that can be attributed to the engineering idea of steerability and controllability while at the same time paradoxically also possessing a sociological notion of systemicity that implies self-organization and therefore uncontrollability (Joerges 1999). This interplay between control and its lack in the LTS has a bearing on the behavior of the system and the regulation of its actions. In the TR too the notion of systemicity faces the competing notions of control and lack of control but the location of TR within "spontaneous settlements" (Barros and Sobreira 2002) in the urban scheme suggests a qualitative difference in its systemic characteristics from the LTS.

The techno-organizational dimension of the relation between the TR and the LTS can be understood at the level of daily practices and system cultures that govern the operation of these systems. This dimension of the relationship explores how the technical operation and behaviour of the system is affected by the social and cultural norms of engineers and managers. At the technological level the linkages between the LTS and the TR can be informed by issues of compatibility and coupling. The issue of compatibility assumes importance when technological codes are governed by competing imperatives – cultural and social in addition to technical – that affect the design and organization of the technology. Von Meier suggests that supple energy technologies and 'hard' energy technologies are not technically incompatible

but are hampered by perceptions of incompatibility of supple technologies among engineers that are rooted in cultural biases (von Meier 1994). Coupling between technical systems could be seen to indicate the level of causal reaction and determinacy that exist between the actions within one subsystem and its repercussions in another subsystem. Juhlin and Usselman in their studies explore the relation between subsystems and the larger system (Juhlin 1994; Usselman 1994). The levels of inter-component coupling within different LTS vary considerably, but the authors find the concept of determinacy to examine the repercussions of systemic changes on subsystems or vice-versa. However, the degree of coupling that exists between systems is a social process in which politics and the interests of different social actors play an important role (Joerges 1999). The organizational perspective on the relation between the LTS and the TR examines the pressures that impact and modify 'standardized' operating procedures of engineers and managers. Chatzis notes three stages in the fluidization and congealing of standard engineering practice in the face of a changing social and normative context (Chatzis 1999). Moss and Elle highlight the inability of an organizational conversation taking place between the LTS and grassroots groups that are intent on modifying the practice of energy supply in the larger system (Moss and Elle 2001).

Selective appropriations of technologies by consumers and their re-deployment by supposedly passive users present a socio-political dimension in the relation between the LTS and the TR. Standardized descriptions suggest that engineers and designers exclusively produce technology while consumers passively receive, incorporate and consume technologies in their daily lives. This one-way, hierarchically organized deployment of technologies had resulted in the polar dichotomy between producers and consumers of technology. The concept of appropriating technologies questions the existence of the neat polar dichotomy and in its place suggests a consumer who actively reshapes the deployed technology through not only its associated semantics but also in its structure and use as well (Eglash 2004). Explorations could reveal that divisions between the user and the designer/engineer are no longer clear and distinct but a continuum. Eglash proposes a consumer-producer axis of technology appropriation. On this axis he situates reinterpretation, adaptation and reinvention as analytic categories that indicate differing degrees of appropriation ranging from the weak to the strongest assertion of a productive quality in the consumer. Eglash notes that while appropriations of technologies "do not have an inherent ethical advantage" they retain the potential to make "contributions to a stronger democracy". The technology-mediated relationship between the expert and the lay user needs to be seen as an axis of "dependence/independence fostered by various appropriated technology strategies" (Eglash 2004). An agenda for increased democratic technology would require the expert/user relationship to negotiate the independence/dependence spectrum according to their particular contexts. Di Chiro also concludes that "[u]nlike the 'technology transfer' model of technological development, which articulates the trajectory of the products of scientific research as moving unidirectionally from the laboratory to the public, the emerging community-based research model makes those boundaries more permeable and portrays the scientific research process as one of knowledge exchange for environmental improvement" (di Chiro 2004).

The cultural aspect of the relationship between the LTS and TR can be conceptualized in light of the different positions these systems occupy within the postcolonial reality. The LTS is populated by a web of engineers, managers and artifacts that display the mastery of Western Science and Technology. The TR, on the other hand, is inhabited by people who are the products of the modern city – deriving their employment and sustenance from it – but who dwell in situations that are the target of humanistic improvement and reform. Nalbantoglu in her study of the architecture of squatter settlements in Ankara

suggests that the "carved dwellings of the squatters never came to the architect's attention" since "they produced new and hybrid articulations" that "defy conventional architectural analysis" (Nalbantoglu 1997: 99). This is so because these squatter settlements defy bracketing within clearly defined architectural categories of 'modern' or 'primitive and pre-architectural'. Analogously, the technical systems of infrastructure provision within the TR escape attention within the engineering discourse constructed very much to colonially received notions. The blindness to the "lived spatiality" of squatter housing by the architecture discipline is mirrored by the blacking out of "lived technics" from consideration by the engineering discipline. By transcending fixed disciplinary polarities of traditional/modern, these sites "reveal the partial, precarious and limited nature of disciplinary truths" (Nalbantoglu 1997) – disciplinary truths that are reinforced by the obsession of the discipline with formal studies to the exclusion of the notion of "lived technics" (Nalbantoglu and Thai 1997).

The picture that emerges from the previous discussion of the interrelationship between the LTS and the TR is a complex one. The multidimensional relationship presents different pathways for understanding the transmission of "anti-programmatic" (Feenberg 1999) messages mediated by technologies of infrastructure provision. But a mere understanding of the complexity of the reality of infrastructure provision alone is insufficient if it is not accompanied by a conceptualization that attempts to frame the multidimensional actively user mediated relationship as an effort for democratic rationalization of technical systems of urban infrastructure.

Democratic Rationalization of Urban Infrastructure

The Technology Studies literature is expansive in scope and in its disciplinary ambitions. Apart from the sciences and engineering that create the technological black-box rather than study it, technology has been the object of humanistic study in a number of fields ranging from economics and business, policy-linked studies, history, sociology, political science and philosophy – each with its distinct focus on a particular aspect of technology and its relationship with a modernized human society. Other interdisciplinary fields like Cultural Studies and Women's Studies have also attempted to engage with technology in order to understand its role in the constitution of cultural or gender polarities and differences (Bijker & Law 1992).

The object of a contemporary stream of humanistic study of technology has been to open the black-box of technology to reveal that in addition to its materiality, the social and political are also embedded within the black-box. Many recent empirical studies have employed history and sociology to excavate the social construction of technologies – be they individual artifacts or large technical systems. Social Construction of Technology (SCOT) marks a distinct departure from earlier studies of technology and society that were predominantly philosophical if not even speculative. These classical philosophies of technology, epitomized by the works of Hiedegger, Ellul and Mumford, have attempted to juxtapose their excavation of the essence of modern technology with the perceived depredations of modern existence on human culture. The view that emerges is one of technology as a sphere autonomous from social existence that through its insistence on efficiency and exactness is subordinating humans into being mindless slaves rid of any competing culturally-rooted rationality. SCOT attempts to reveal the internal social intricacies that interweave the process of technological development of actual technologies like bicycles and bakelite. In order to do so the constructivists employ a borrowed methodological model called the "empirical programme of relativism" commonly used in the sociology of scientific knowledge. In using this model they are "opening the black box of technology".[3] By illuminating the internal complexity of the process of

technological development, SCOT makes a strong statement against the determination of technological development purely on technical aspects. They argue that the closure of the interpretative flexibility of the artifact under development then opens the way for the widely assumed technically determined development path for artifacts (Pinch and Bijker 1987). By inadequately exploring the social and technical supports behind the congealed technological choices, the social constructivists tend to see classical philosophies of technology as displaying very unrealistic often technically determinist models of science and technology. The SCOT itself has been the target of critique from contemporary philosophers of technology for employing a relativistic methodology that infuses the constructed process of technological development with normative or moral relativism. By focusing on displaying the complexity of the social process of technological development, the constructivists fail to unearth the implications of their study – they choose not to take up an evaluative stance (based on a moral or political position) on technologies; secondly they fall short of unearthing the deeper structural and cultural considerations[4] that underlie the relationships between relevant social groups; thirdly drawing upon a parallel with pluralist politics, the notion of relevant social groups ignores the voices and choices that have been suppressed and have never entered into the technological logrolling that is a part of the SCOT methodology; and finally social constructionist research suggests a total disregard for social consequences of technological choices (Winner 1993).

The attempt here has been to craft a conceptualization that needs to move beyond the polar extremes of a technocratic belief in the development of technologies as black box, completely autonomous from the social, and of an out-of-control technology interminably taking over humanity. What is required is to carve the space between these polar extremes where democratic control of technology becomes a pathway to preferred directions of social and technical change. Feenberg employs the concept of technological ambivalence in order to crystallize the third space. According to Feenberg the ambivalence of technology embodies two attributes – new technologies conserve existing social hierarchies and the potential for democratic rationalization exists within technologies (Feenberg 1999). By suggesting that the social process of developing technologies will conserve (and reproduce) existing social hierarchies, Feenberg brings to bear a strong critique of the SCOT conception of political relativism. He proposes technical micropolitics as a means for destabilizing the extant social hierarchies and employing material technologies as sites for the democratization of technological interventions. By technical micropolitics, Feenberg refers to the non-ideological resistances and negotiations that take place between users and networks of technologies and the rationality that governs these networks. In successfully maintaining the operation of networked urban infrastructure and other large technical systems, system managers enrol devices and human actors like the users into the system. But the actions of system managers represent only the perspective of the managers while ignoring the engagement of the unofficial actors through a technical politics with the LTS. The actions of the actors in the technological recesses within the LTS have been described above as a multidimensional bi-directional relationship. This relationship contains the potential to redefine the technical designs instituted by the rationality of the system managers and impose through the anti-programmatic actions a democratic rationality onto the system. As Feenberg notes, non-official humans entangled within the system through "[t]heir tactical resistances to established designs can impose new values on technical institutions and create a new type of modern society. Instead of a technocracy in which technology trumps human communication, we may yet build a democratic society in which technical advance serves communicative advance" (Feenberg 1999).

Democratic Interventions in Technologies of Urban Infrastructure

This section will examine the predominant policy interventions that directly address the process of technological change in urban infrastructure in cities in India. In addition to developing critiques of the existing policy prescriptions, the essay will attempt to conceptualize an intervention that is informed by the multi-path process of development of technologies and by the need for enhanced democratic control over the deployment of technologies in society. Two broad directions of intervention can be discerned in addressing the issue of inadequate access and improving provision of essential services like water supply through technical infrastructure. The first approach is the commercialization approach that attempts to improve performance of supply systems in urban areas. The second policy intervention direction attempts to stimulate technical innovation at the grassroots level with the explicit objective of transforming India into an innovative society and to bring about socio-economic prosperity. This paper will engage with these two directions next.

The objective of this section is to understand the dominant compunctions that motivate the framing of policies for infrastructure development in India's new liberalized economic context. The focus will specifically be on the policy innovations that are being presented by the Ministry of Urban Development, Government of India. In India's federal structure with division of functional roles between state and federal governments, urban development and water supply lie within the jurisdiction of the state government. The role of the union ministry in urban development, among other roles, is restricted to formulate broad policy guidelines, propose constitutional amendments, support institutional finance for urban infrastructure. Since the early 1990s the federal government has adopted a liberalized macro-economic model that sees the government in the role of facilitator of an appropriate investment climate for private sector entry into the economy. Liberalization of the national economy prompted moves in the urban sector that sought to comprehensively devolve autonomy in governance on local issues to urban local bodies (ULBs). The objective was to allow decision makers at the local level to "formulate programmes and schemes for meeting their own developmental and infrastructural needs, something impossible in [the previous] centralized regime" (Kundu 2002). But at the same time, infrastructural needs became closely linked with creating an attractive investment setting and consequently with boosting economic growth and national GDP. The prominent agenda of supporting development of infrastructure development in urban settlements can be thought of as having a number of subsidiary steps – establishing credit worthiness of the local body attempting to raise private capital, the process of borrowing institutional or private financing for infrastructural development, and the process of instituting contracts to private entities to manage or operate portions of existing infrastructure systems. The inability of governments to continue financing infrastructural developments through public means is cited as the primary rationale for the current reform process. As a result the local bodies in cities are now increasingly responsible for the development of infrastructure from internal resources or from external private sources with little or no support from higher levels of government. Local governments, thus, liberated from regulatory and legislative controls of the state find themselves increasingly under the control of external financial institutions whose commitment to public and social obligations is suspect. Such a scenario has very disturbing implications for the majority of poor in urban India who possess marginal access to regular supply systems and find this access diminishing under the increasingly governing rationality of economic efficiency and total cost recovery.

The other policy intervention that has relevance to the development of infrastructure technologies focuses on technology policies at the national level in India that are designed to address social issues. The Department of Science and Technology (DST), within the union Government of India, formulates policy statements and guidelines in science and technology and coordinates S&T interventions in several sectoral areas with other departments. Science and technology in the rhetoric of policy statements appear as truly liberalizing factors that will contribute to a national environment of social security founded on democratic values. The push towards a socially relevant deployment of science and technology is very evident in recent broad policy directives. The National Innovation Foundation is an important policy intervention that attempts to foster an atmosphere for the deployment of socially relevant grassroots-based technical innovation. The National Innovation Foundation was established by the Department of Science and Technology in 2000 with the main goal "of providing institutional support in scouting, spawning, sustaining and scaling-up grassroots green innovations and helping their transition to self-supporting activities" (NIF 2003) with the objective of helping India become an innovative and creative society, to build linkages between excellence in formal scientific systems and informal systems (NIF 2003). The focus of the NIF has been to seek out individual resource-poor but knowledge-rich innovators who through their creative intelligence have solved a technological problem. The attempt is to move away from a top-down obviously technocratic outlook where expert engineers problem solve in order to address people's problems towards a bottom-bottom approach where knowledge-rich creative lay-experts solve their own problems. Thus the focus is on such individuals as lay innovative farmers, artisans, or women who during their daily practice in their respective life worlds solve technological problems they face through a combination of lay-knowledge and simple skills. This model of grassroots innovation skirts addressing socially collective problems which cannot be adequately addressed through simple decontextualized technical patches that are propagated through the network of innovators under the guiding interest of efficiency. The grassroots innovation model, as understood here, appears to have limited relevance when addressing technical problems that involve the larger society rather than the individual's good.

Two paths of policy interventions were briefly described and their shortcomings in effectively addressing the issue of uneven access to infrastructure networks of water and sanitation, were touched upon. If the dominant economistic and linear technocratic models appear to be insufficient to address an issue that has both social and technical dimensions then an alternative is required that incorporates these dimensions into the intervention. Research in the social shaping of technology is of relevance in guiding policy interventions along paths that can produce desirable social and technical change. Sorensen summarizes the policy inputs that can be extracted from SST research: (a) Technology needs to be seen as an object of policy intervention rather than just as a source of economic growth; (b) technology policy needs to be extended to more contextualized spaces and more groups need to be perceived as policy actors; (c) redefinition of problems and concerns away from individual technologies towards techno-cultural clusters of practices; and finally (d) a broadened view of the tools potentially available for making interventions (Sorensen 2001). These criteria lay the groundwork for an alternative formulation of policy prescriptions which constitute a technical democracy around the development and operation of urban infrastructure in technological recesses. The objective of technology policy then becomes not just prescribing actions that facilitate technical changes in the development and operation of infrastructure but also become a means for organizing a process of democratic engagement where a more inclusive group of policy actors bring their influences to bear on the intervention.

Broadly, two formulations are commonly associated with the constitution of democracy in the technological arena as in the political – the representative and direct schemas. Direct democratic (also called "strong democratic") arrangements constituted around the social-technical sphere attempt to make local communities the sites of deliberation over technical affairs (Sclove 1995). Technological design and innovations happen to meet the requirements of a strong democratic community. However, reconciling a "strong democratic" arrangement with the existence of a Large Technical System is a challenge. Sclove does not argue for the complete elimination of LTS and its replacement with community based technical efforts, but he recommends an expansive local self-reliance technical decision making. Such schema are often portrayed as impractical given the fragmentation of technical publics along a number of social and cultural fault lines, and as a result of the possibility of implausible technical decisions arrived from populist considerations. Feenberg postulates an alternative to the 'strong' democratization of the technical sphere. He presents technologists as representatives analogous to elected representatives in a political representative democracy. He sees the actions of technologists governed by technical codes that can be seen to "crystallize a certain balance of social power" (Feenberg 1999). Efforts to democratize technical representation would involve altering the technical codes that oversee the practice of technologists. He sees this happening from embodying technical codes with both scientific interests and participant interests so that preferred social and political values are embedded within the technical rationality that makes the codes acceptable. This is a break from the populist rationality of strong democracy that subsumes the technical rationality so that it has limited acceptability among technologists. However the question remains whether this conceptualization can bring about any genuine democratic control of infrastructure from the perspective of the inhabitants of the technological recess. The conclusion of this essay will describe a map which draws upon the bi-pronged Feenbergian conceptualization of democratic rationalization and democratization with regards to technologies of infrastructure in the technological recesses of cities in the developing world.

Conclusion

This essay has attempted to explore conceptually the domain of urban infrastructure provision in Third World cities. Of specific interest are those neglected, unimportant spaces that do not possess uniform, standardized, connectivity to the technological networks of primary infrastructure like water supply and sewerage. The objective of this exercise was to bring the technology studies perspective to bear on an issue of central importance to urbanization in the Third World. In conceptually mapping the recessed spaces within the technological networks of urban infrastructure, the essay attempted to achieve three objectives – present an overview of a complex sociotechnical understanding of the relation between infrastructure and cities, specifically in the developing world; secondly, describe the multidimensional relationship between the recesses and the large technical systems of infrastructure as an embodiment of active users introducing alternate rationalities into the system, and finally prescribe a pathway towards a democratization of infrastructure interventions in the recesses. These objectives include an agenda for preferred social and technical change in the context of the technological recesses. The agenda for change is lodged upon twin thrusts - the technical micro-politics at the level of users who actively attempt to subvert and resist the program of the system engineers; and the macro-policy interventions that attempt to bring user interests into the framing of technical and policy prescriptions.

Notes

[1] "First-order large technical systems refer to the familiar, relatively easily delimited all-purpose infrastructures such as the road, railroad, energy and telecommunication systems" (Braun & Joerges 1994). I have included the water supply system to this list.

[2] The concept needs to be differentiated from the more common concept of technological niches. Technological niches are sites of development for alternative technologies that exist within the dominant regime of technology. Smith (2003) and Kemp et al. (1998) view technological niches as "instrumental in the take-off of a new regime and further development of a new technology" since "niche formation occur[s] against the backdrop of existing technological regimes" (Kemp et al. 1998). The definition of technological niche provided above suggests that niches are a potential future technological regime and a site for technical innovation that will be guided by new norms like environmental sustainability.

[3] A black box in many studies of technology been conceptualized as a "device or system that, for convenience, is described solely in terms of its outputs and inputs" (Winner, 1993).

[4] Klein and Kleinman expose SCOT's agency centered approach and its neglect of the influence of social structures (Klein & Kleinman, 2002).

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