Globalisation, Societies and Education
Vol. 2, No. 3, November 2004

Carfax Publishing
Taylor & Francis Group

Technology policy as a stealth agent of global change

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Drawing upon a year of ethnographic research with the Los Angeles public school system, this article follows the translation and negotiation of several key technology grants and their policies. It argues that as a global trend, myths of technological neutrality and transparency merely cloud the panoply of negotiations taking place in public organizations, subsequently removing those decisions from public participation or scrutiny. Technology policy thereby becomes a stealth agent of global change, which, ironically in this case, reinforces Fordist rigidities in technological realms that are typically viewed as supporting post-Fordist flexibilities. Only by engaging with technology policy in all its complexity, the article concludes, can public institutions hope to achieve democratic participation and outcomes.

Introduction

> Irrespective of whether we choose to play the game or not, we are part of it simply because we *are played*. (Anders, 1999, p. 2)

Amidst organizational restructuring in public institutions, participation in policy-making processes is becoming increasingly codified, restricted and obscured. Especially regarding technology policy, the coils of which stretch across all domains of public education, individuals who fashion themselves as technical experts are absorbing control over many of the decisions about infrastructure design and, by extension, the attendant social relations that infrastructures govern.[1] This article shows how the centralized streamlining of technology specifications in Los Angeles Unified School District (hereafter 'L.A. Unified') places undue constraints upon design possibilities and that these constraints are proportional to the restriction of participation in policy-making processes. Policy design, in other words, embeds the values of its process into its outcomes, delimiting the range of future policies at the same time (Schneider & Ingram, 1997). This article takes this general argument one step further, drawing

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ISSN 1476–7724 (print)/ISSN 1476–7732 (online)/04/030355–22

DOI: 10.1080/1476772042000252489

upon field research on technology policy negotiations in L.A. Unified, to argue that non-democratic processes tend to yield not only constricted policy outcomes but also material outcomes of limited utility or flexibility.

The problematic pursued here is the construction of a policy arena for technology within L.A. Unified, including the territorial conflicts, which galvanize and/or foreclose modes of participation, and the material outcomes, which embed values into durable forms. The stress is upon the politics and contingent processes behind technology designs in this globally situated organization. The crafting of empowering policies rather than degenerative ones, I assert, hinges upon their openness to interpretation and reevaluation and this is achieved best when the policy arena itself is permeable and participatory, when it supports exceptions rather than enforces standards, when it is, in short, flexible.

This article will follow several translations of technology grants and their policies to demonstrate that the design of technological systems is entirely contingent and situated and not some neutral evolutionary progress toward an unavoidable outcome. First, I provide a general overview of the interrelated technology programs for wiring public schools for telecommunications access. Second, I describe the development of the federal government's E-Rate program (about which more will follow) in L.A. Unified and how the translation of rigid E-Rate policies generated uncertainty, stress and poor design outcomes. Third, and last, I relate contestations across the organization's social worlds over who should set specifications for a California technology grant and I trace some of the tactics and results of those conflicts. Whether discussing policy design, policy translation or policy negotiation, I contend that flexible and participatory structures catalyze more productive outcomes. That said, the trends outlined here point to less participation and increased centralized control in public institutions, in spite of the fact that new information and communication technologies (ICTs) are often viewed as catalyzing political inclusion and power decentralization.

The term 'design' is used throughout this article in several different yet overlapping ways. Foremost, design refers to the iterative planning process employed in the building of technological infrastructures to support Internet use in public education, indicating specifically the coordination of existing school facilities, computer hardware and software and network architectures. As the examples that follow will illustrate, the technical or material outcomes of design are entirely dependent upon and co-constructive of the social processes that shape them. 'Design' is used, therefore, in a second sense to describe the crafting of policies that, ideally, facilitate the effective coordination of social and technical components. While infrastructure design and policy design may be intimately related, it is important to flag that policies never clearly translate isomorphically or linearly into built form, thus, one important reason to pursue research on design is to better understand the dialectical interplay and mutability of policies and materialities.

The data for this study are derived from a year long ethnography of technological change in L.A. Unified. The city of Los Angeles was chosen as the location for this study, in part, because of its rich diversity as a lived place and a global city: it is a

powerful mediator of structural changes and cultural forces and, as many urban theorists have argued, a prescient indicator of social polarization and institutional transformation to come elsewhere (Scott & Soja, 1996; Monahan, 2002). From 2000 to 2001 I conducted fieldwork at a dozen school sites across the city, concentrating primarily on the development of infrastructure projects (e.g. wiring schools for Internet access), but also on the varied uses of computers by students and teachers. I also attended meetings of technologists at multiple organizational levels, from small groups at school sites to larger groups with representatives from multiple schools, to policy-making groups at the central administrative level. Finally, open-ended interviews were conducted with 50 individuals involved with technology development in L.A. Unified, including students, teachers, administrators, policy makers and contractors.

Policies for infrastructure design: the rules of the game

Think of the implementation of technology networks in public education as a game with continually shifting rules and resources, combative participants and tenaciously rigid yet life-changing outcomes. In this game, technologists in the District have a finite amount of time to fit the many jagged pieces of the funding puzzle together such that a passably coherent image of functional school communications networks emerges. There are several hands ticking on the game clock, what my informants call short- and long-term 'drop deadlines', compelling the players to make quick decisions or to simplify the process by removing others from the game, meaning cutting some previously included participants out of the policy setting process. As an additional stressor, capital is perceptibly drying-up for all technology projects; grants are short-term, non-renewable resources; support and training are the last pieces to arrive and the first to be taken away.

In this game there are several key players that I loosely refer to as 'technologists'. 'Technology coordinators' are school site personnel who typically draft technology plans for individual schools, manage telecommunications networks and maintain equipment. It is important to note that these positions do not exist at many schools and schools without them must find other ways, through part-time assignments, for example, to fulfill these functions. 'Instructional Technology Applications Facilitators' (ITAFs) are located at a middle level of the organization and individuals in these positions facilitate communication, translation and negotiation between school site technology coordinators and centrally located technology administrators. For example, when contractors fail to perform their tasks and leave schools with gaping trenches or non-functional networks for months on end, technology coordinators contact ITAFs who then find out what is going on and lodge complaints with technology administrators to get things moving again. The final group of players covered here are those whom I call 'technology administrators'. These people are centrally located in downtown Los Angeles offices and their functions range from coordinating external contractors and vendors, communicating with federal, State and local policy makers and, increasingly, setting specifications for technology purchasing.

There is a complicated set of rules to this game and participants must figure them out as they go along. First, all the funding sources carry instructions pertaining only to them, such as what they can and cannot be spent on, how they must be distributed, when they must be used up and what constitutes completion. Second, grants are taken as contracts that require semi-strict compliance with their specific rules lest a host of perils descend upon the recipient: audits, law suits, loss of funds or loss of future funding. Third, grants can be played off one another as 'matching funds', but while this may be necessary for cash-strapped institutions, the practice increases the risk of loss should any single grant contract be broken, such as an unmet time deadline. Fourth, in the case of public education, all equipment and construction services must undergo a somewhat time consuming competitive bidding process. In a 'normal' situation, the competitive bidding process starts with the setting of specifications in accordance with the grant's stipulation. Next, vendors and contractors evaluate those specifications, submit official bids for that work and the District awards contracts to the lowest 'reasonable' bidder. Fifth, and finally, the execution of grants is negotiated in a very political local context, the result of which determines who sets specifications, which contractors service which schools, and which schools get wired first.

All the rules of this funding game, however, are subject to interpretation and even arrangements of questionable legality with vendors can be achieved provided that the process gives the appearance of propriety. Similarly, creative shuffling of funds between schools often occurs without too much protest because it is outside the primary interest of auditors, who are more worried about compliance with spending and specifications than with destinations. And because the technology administrators making these decisions are not elected officials, they are therefore insulated from public scrutiny.

The first section of this article will concern itself with interpretations, modifications and negotiation of specifications. As players vie for control over specifications or standards setting (i.e. what equipment will be purchased), they reveal a rich design process that flourishes beneath most people's awareness yet nonetheless structures the daily conditions of students' and others' lives. Science and technology studies (STS) scholars refer to this as the social construction of technology (Winner, 1986; Bijker *et al.*, 1987; Pinch, 1996; Bowker & Star, 1999), meaning the dynamic, mutually shaping relationship among technologies and social practices. In this case, the emphasis is on the ways that social values, institutional constraints and politics are embedded in technological artifacts and systems through a contingent and somewhat arbitrary design process. In other words, results are not preordained, even though they give the appearance of being so after the fact. The outcomes of technology design could always very easily have been different and it is in order to understand and evaluate the possibilities for difference that we study the process.

Of the many puzzle pieces of technology funding that are shaped, shuffled and forced into place, I will concentrate on the interplay of three that occupied the perennial attention of L.A. Unified technologists for the period of my fieldwork. First, the federal government's E-Rate (meaning 'Education Rate') discount

technology program, which was established by the Telecommunications Act of 1996, funds up to $4.25 billion annually for wiring public schools and libraries (New York State Library, 2003).[2] Second, California's Assembly Bill 2882 (AB 2882), which was passed into law in 2000, allocates $175 million for the purchase of computers for state public schools; the stated goal of this program is to establish a 4.75:1 student:computer ratio in public schools. Third, Los Angeles' local bond measure Proposition BB, which was passed into law in 1997, dedicates $900 million to new school construction and $1.5 billion for renovating existing school facilities (Deloitte & Touche LLP, 2002), including construction and renovation for wiring schools with telecommunications networks. In reviewing the negotiation and interrelation of these funding puzzle pieces, I hope to present the contingent and political nature of design processes and to direct inquiry into the flexible potential of technology policies.

Notes from the field: the unfolding of E-Rate policies

My primary field site, which I give the pseudonym 'Concrete High', was contending with the coordination of all three of the above technology grants (E-Rate, AB 2882 and Proposition BB) and was one of only a handful of schools in the District whose technology projects were simultaneously funded by E-Rate and Proposition BB. Schools and libraries that qualify for E-Rate technology discounts are funded based on the application year, so that 'funding year one' (FY1) designates those that were awarded grants in 1998, FY2 designates those awarded in 1999 and so on. Concrete High, like most schools in L.A. Unified, was a FY3 E-Rate school and was given a deadline of 30 June 2001 for completion of all E-Rate construction.

Because the construction of telecommunications networks in many schools was tied to this 30 June deadline and because if it was not met the total of $228.6 million E-Rate discounts (FY3) awarded to the District (Alther, 2001) would likely be forfeited, the technology community in L.A. Unified was under extreme tension for the entire duration of my fieldwork. Their stress was generated, in large part, by uncertainty about the status of construction projects at local schools, about what the specifications were for E-Rate contractors and whether or not they would be compatible with existing school networks (called 'legacy networks') and about the reliability of contractors assigned to individual schools.

This general state of uncertainty was compounded by several important factors. First, the organizational restructuring of the District in the summer of 2000 shuffled previous chains of command, leaving most people unaware of who was responsible for what or whom to contact to find that information out. Second, coincident with that restructuring was (and is) a shift in authority for managing technology projects in the District; the shift moved control away from individual schools towards centrally located administrators. Thus, amidst ambiguity about what was happening and when, technology personnel in L.A. Unified were undergoing struggles over who should be in charge of making decisions that tangibly affect schools but also legally implicate the District as a whole (e.g. for issues of grant compliance).

While tensions about the E-Rate deadline were palpable in almost all my interactions with District technologists, this general state of anxiety was seldom named directly except at monthly meetings held by the Instructional Technology Commission (ITC)[3] or at monthly 'technology consortium' meetings held by local District ITAFs. The attendees of these meetings, mostly technology coordinators from schools, would share their disparate experiences from local school sites and collectively concatenate this partial information into a workable model of the current state of technology construction projects in the District. Because there was no clear narrative of what was happening with E-Rate construction and because, just like my informants, I had to piece together a story based on incomplete and always already biased perspectives, this section is written with intentional gaps, pulling data from these monthly meetings, Board of Education meetings and other sources in order to convey the experience of uncertainty and the process of knowledge construction on the ground. What follows are excerpts from my field notes relating to the iterative development of District policies for E-Rate construction.

26 October 2000

At a '[Proposition] BB and Facilities Oversight Committee Meeting' in downtown Los Angeles, Board of Education member David Tokofsky expresses concern that the E-Rate 'Army Corps' are notorious sticklers for timelines and that he is worried about losing all E-Rate monies if the District is late with construction completion. It is appropriate for him to discuss the progress of E-Rate construction in a meeting about Proposition BB because these two funding sources for technology are intertwined in the District: in some cases Proposition BB is used to match the funds provided by E-Rate and at some schools, like Concrete High, construction projects from both these sources are being coordinated. Tokofsky's reference to the Army Corps of Engineers is significant because they were hired by L.A. Unified to coordinate E-Rate projects among contractors. In his remarks, however, he incorrectly conflates the Army Corps with the federal government's School and Libraries Division (SLD), which oversees E-Rate, and his mistake betrays that Board of Education members are just as much in the process of figuring out what is transpiring with technology projects and policies as everyone else is.

25 January 2001

At a 'technology consortium' meeting of a local District, an ITAF reminds technology coordinators that every E-Rate school must have an Internet connection (a 'fiber drop') in every classroom by 1 July or lose out on matching funds. Those present, who work at schools rather than in administrative offices, wonder aloud where the power supplies to run these networks will come from, because E-Rate does not supply it and BB funds are already committed elsewhere. Pragmatic concerns about the functionality of computer networks and the risk or disruption for students and teachers occupy the minds of those on the ground at school sites.

15 February 2001

After attending a 'technology consortium' meeting of a local District, held at a middle school in Los Angeles, I run into several E-Rate construction workers digging trenches and laying cable in the dark of night. Their presence reminds me of the labor and material alteration that are needed to establish telecommunications networks: computer technologies, which are often described as clean and seamless by the media, are messy and materially embodied through-and-through. This is a fact easily overlooked when most people are removed from sites of infrastructure construction and most media sources, whether advertisements or editorials, equate the presence of computers with empowerment. I talk with these men for a while and they are good natured, communicative and relaxed in their nocturnal activities.

11 March 2001

A participant of the Instructional Technology Commission (ITC) Email listserv gives advanced warnings that the District is planning to remove the Army Corps of Engineers from their position of overseeing E-Rate construction:

> The latest change of course concerns the role of the Army Corps of Engineers … . [T]he Construction Manager for the fiber pulling project at my school is being terminated within the month. He told me that the district is replacing all the Army Corps hired consultants, who are serving as construction managers, with the district's own people, but only about one third as many. So the number of jobs per manager will be tripled. [The Construction Manager] told me that he does not think the district is displeased with the Army Corps, they're just trying to save money. This kind of mid-stream change is, of course, disruptive.

The response from another member:

> OH NO!!!! Save money at what expense?!?! It seems that each time we begin a major project at our school it gets halted midstream. Then we establish a good working relationship with one person, then he's gone and someone else shows up. I realize that in any major project, adjustments must be made as we go along, but I surely pray this personnel change is well thought out and not just a cost saving factor.

This on-line exchange between two technology coordinators reveals a growing level of anxiety over the unknown material effects of policy or management alterations made elsewhere. Not only do these interlocutors worry about meeting the E-Rate deadline, they are foremost concerned with reducing disruption in schools.

22 March 2001

The Los Angeles *Daily News* runs a front-page headline declaring: 'LAUSD's online bungle: 1 of 375 schools wired by deadline, $40 million in jeopardy'. The article continues:

> Los Angeles Unified School District officials promised to wire 375 schools for Internet access by March 1 when it got nearly $200 million in federal funding but bungled the project so badly only one school has been completed … . With a June 30 deadline looming for spending the 'E-Rate' funds to wire most schools, the LAUSD risks losing more than $40 million unless the Federal Communications Commission grants an extension, officials said Wednesday. In a frenzy now to finish as much of the work as possible before the cutoff, the LAUSD last week dumped the U.S. Army Corps of Engineers, which was brought in with much fanfare to oversee the program to prevent the kind of managerial breakdowns that have plagued many LAUSD building projects. (Barrett, 2001)

This piece palpably turns up the heat on District technologists and policy makers, as the public gets wind of the fears of insiders. By alluding to the Belmont Learning Complex debacle, where a $200 million L.A. Unified school was built on a 35 acre former oil field, the article situates E-Rate construction projects within a larger history of institutional mismanagement. Because this story follows so shortly on the heels of L.A. Unified's reorganization, which was, in part, a response to calls for the breakup of the District after Belmont, another perceived waste of taxpayer dollars could have calamitous effects on the organization, creating even more disruption for students and employees.

18 April 2001

At an ITC meeting at a South Central high school, an ITAF laments that vendors will not be paid if all the networks are not up by 30 June. Of the 459 schools to be wired, only two are now up; maybe 70 will be up by the deadline. 'This is a drop-dead date', he cautions, 'something that the District has never faced before'. But information is not flowing freely to contractors, he continues, mostly because plans to incorporate legacy (i.e. pre-existing) networks were not included in initial contracts. Moreover, schools that have to balance year round schedules with adult night classes are not giving contractors 'reasonable' work hours, so contractors may have a just case for suing the District if they perceive that school schedules are impeding their ability to meet the contract deadline. In any event, the ITAF prophesies that technology coordinators should expect last minute, 24 hour construction work as the deadline approaches.

19 April 2001

At a Business, Finance, Audit and Technology (BFAT) committee meeting of the Board of Education, staff members inform the committee that 20 schools are now wired with E-Rate funds and assure them that 70% of schools will be completed by the deadline. Board members nod their heads, completely unaware that this report directly contradicts what ITC people are saying at school sites. It is slowly becoming apparent to me that if construction work is not completed by the deadline, contractors will not be paid by the federal government. In that case, the school district would have to pay contractors out of their general fund.

22 May 2001

At a Board of Education meeting, Dr Paul Holmes, the Director of Modernization and Existing Facilities, provides an E-Rate update: the Federal Communications Commission (FCC), which is the main governing body in charge of overseeing E-Rate, has granted the District a 3 month extension, making the new deadline 30 September 2001. Three of the four contractors currently working on over 380 E-Rate schools will finish on time. Thirty-four schools have passed a 'ping' test (meaning that data is flowing across the network with few errors), and 73 other schools are being tested now. Ironically, this report of an FCC extension does not assuage tension over E-Rate but instead increases uncertainty for technologists in the District about which schools qualify for the extension, what will happen if this second deadline of 30 September is not met and whether schools where E-Rate construction never started, such as Concrete High, will be cycled to the following year's deadline instead. With this extension, anxiety grew even as the deadline mutated into a less dire imperative.

25 May 2001

In an interview with a technology administrator involved with E-Rate, I am told of the many inflexibilities that continue to obstruct E-Rate projects: (1) electrical insufficiencies pose problems because networks cannot operate without sufficient power, yet vendors are not responsible for providing adequate power; (2) health and safety issues over lead paint and asbestos slow processes down; (3) contractors had semantic differences with administrators and did not think that their contract for 'network integration' meant connecting to existing networks; (4) the Army Corps of Engineers told contractors to build 'illegal' parallel networks in some schools; (5) there is a shortage of equipment (such as fiber-to-copper converters) and 'manpower' because there are only so many qualified contractors in the area; (6) year round and night school schedules force contractors to work on weekends, but contracts did not include the overtime pay required for weekend work; (7) the SLD of the federal government does not allow any flexibility with E-Rate, every change in specifications having to be applied for and the District having to wait months for approval; (8) contracts are 'locked in', so that if the price of equipment goes down, which it invariably does over the course of a project, the higher price must be paid. These comments about policy and circumstantial rigidities partially explain the uncertainties and disruptions at school sites; for instance if administrators are waiting to hear from the SLD concerning a specification adjustment or if they are searching for scarce hardware, then it would be impossible for them to give technologists throughout the District a clear answer about the process.

29 November 2001

I am now out of the field and checking back with my informants to see how the extended 30 September deadline played out. A monthly 'E-Rate Program Progress Report' was presented at a Board of Education BFAT committee meeting today,

specifying that many 'year three' schools have been given new, apparently arbitrary deadlines for E-Rate completion, such as 28 February 2002 for Concrete High. Meanwhile E-Rate contractors will not begin construction at Concrete High until existing network construction paid for by Proposition BB is 'signed-off', otherwise E-Rate contractors could be held liable if the BB network fails in any way. However, since a completely unrelated problem of a faulty BB fire alarm system continues to jolt students and others at this school with daily ear-piercing false alarms, the BB network cannot be signed-off until this problem is corrected, because all the construction is included in the same contract. Thus, no one knows when E-Rate construction will really start at this school and students who have tolerated incredible campus disruption continue, for better or worse, to live without the Internet in their classes.

This section has employed a somewhat syncopated narrative to communicate the experiences of uncertainty and the process of knowledge construction concerning the wiring of telecommunications networks in L.A. Unified schools. In all cases, conditions of uncertainty coupled with an apparently strict deadline for E-Rate projects led to increased stress, discord and disruption in schools. With such a large-scale, complex technological project, it is little wonder that so many obstacles and contingencies could not be foreseen or planned for in advance. Clearly, strict deadlines, rigid contracts and intractable technical specifications are intended to prevent graft and mismanagement while providing technological equity for all students. However, the results fall short of these lofty goals. Paradoxically, as this section has demonstrated, inflexible policies about E-Rate spending yielded greater uncertainty rather than less. If uncertainty is a key element to employee stress and material disruption, as I have observed, then more flexible policies for spending and a more open deadline for completion would have helped the District implement networks with less employee antagonism and fewer disruptions.

AB 2882 and the social worlds of L.A. Unified

Building upon the last section, which illustrated how the interpretation and translation of E-Rate technology policies into built form is an iterative process through which employees constantly strive to overcome uncertainties and inflexibilities, this section describes polemical negotiations over the setting of equipment specifications for California's technology grant Assembly Bill 2882 (hereafter 'AB 2882'). To show the different dimensions of policy negotiation in L.A. Unified, I divide this section into three parts: social worlds, symbols as design agents and constructing an outcome.

The design of telecommunication infrastructures in L.A. Unified presents extreme coordination challenges to the multiple networks of individuals involved in the process. Given the size of the District (791 schools), its geographical dispersion (704 square miles), and the variety of complicated tasks entailed (evaluating needs, allocating funds, setting specifications, hiring contractors, wiring schools, inspecting work, etc.), no single group can achieve a complete understanding of this vast design process. To communicate how groups work together to establish infrastructures, I build upon 'social worlds theory' as deployed in the field of STS.[4]

Social worlds are groups connected through discourse and shared world views and not necessarily by geographical proximity or professional association (Fujimura, 1987; Star & Griesemer, 1989; Clarke, 1990). Whereas most STS social worlds theory is used to analyze the construction of scientific facts, my use conveys the construction of vast technological networks and is therefore more akin to the material focus of Howard Becker's research on 'art worlds' and Louis Bucciarelli's on 'object worlds'. Becker (1982) employs the term 'art worlds' to describe the indispensable contexts for art creation: the collective coordination of conventional knowledge, its embodiment in artifacts and practices and its dependency upon extended social networks (audiences, equipment providers, curators, performers, etc.). For Bucciarelli (1994), the term 'object world' describes the assemblage of social, technical and symbolic components that make design possible within specific engineering domains (such as the construction of X-ray inspection systems or photovoltaic modules).

While the above two approaches begin with discreet artifacts and seek to explain the conditions that bring those artifacts into existence and sustain them, my use of social worlds focuses on groups that must collaborate to build non-discreet infrastructures that always extend beyond the purview of individual designers; the product itself (infrastructure) bridges the different social networks. Star and Griesemer (1989) have employed the term 'boundary objects' to describe such bridges between social worlds, but what Fujimura (1992) coins 'standardized packages' probably more closely captures the structuring role of technological networks that I am specifying:

> '[S]tandardized packages' is a concept which handles both collective work across divergent social worlds and fact stabilization. A package differs from a boundary object in that it is used by researchers [policy designers in my case] to define a conceptual and technical work space which is less abstract, less ill-structured, less ambiguous, and less amorphous. (Fujimura, 1992, p. 169)

This distinction between an object that circulates and a materiality (or package) that literally extends into social worlds is important, because how each group defines goals or problems depends upon its disposition and perceived responsibility toward other designers and the larger infrastructure project.

A shortcoming of social worlds theory is that through its emphasis on cooperation and social cohesion, it tends to neglect issues of conflict within fields of power and to neglect macro-structural restraints on social action. Yet, social worlds theory has the potential to explain conflicts among groups in relation to social structures, such as organizations (Clarke, 1990). This is the approach attempted here: to draw upon social worlds theory to explain design cultures within communities of practice but also to analyze conflicts and systemic power relations among such groups.[5] Naturally, there are many social worlds at play in the school district and the boundaries between them are frequently blurred. That said, what follows is an investigation of two relatively distinct, competing social worlds, central and local (technology administrators and technology coordinators, respectfully), and their negotiation of technical specifications for California's Assembly Bill 2882.

In 2000, the California State Legislature unanimously passed AB 2882 and Governor Gray Davis approved the bill with the objective of reducing student:computer ratios to 4.75:1 in all classrooms and in all public school districts across the state. Because computer access is extremely varied in schools, in part because of the varied specifications of funding sources, this legislation was intended to correct technological inequities existing among schools. Some schools have partial networks from E-Rate or Proposition BB, for instance, but few schools have complete networks, i.e. network drops in every classroom, connecting computers to the Internet. However, when the legislature appropriated only $175 million of the requested $800 million for AB 2882, the objective of total technological parity quickly changed to providing computers for high school students alone.

My interviewee in the Governor's Office of the Secretary for Education claimed that the decision to prioritize computers for high school students over other grade levels was made with the interests of business in mind. He explained that business has immediate needs for a technologically literate workforce so that they, and the state of California, can compete globally. The framing of this decision in terms of business needs illustrates how discourse establishes its own symbolic infrastructure that reinscribes students' needs as those of business while eliding other educational goals.

District technology administrators, located centrally in downtown Los Angeles, are the first social world with a stake in infrastructure planning. Technology administrators in L.A. Unified are associated with the Information Technology Division (ITD) of the school district as a whole and they oversee a range of technology projects: the District's web pages, student information system, instructional technology training, network infrastructure coordination and more. District administrators frame problems in terms of the district as a whole, whereas school site technology coordinators prioritize projects at their particular schools.

Local technology coordinators and their staff represent the second social world at play in this story. In L.A. Unified, previous technology funding sources such as Digital High School and E-Rate were managed by technologists at individual schools. This meant that technology coordinators at school sites assessed the technological needs of the school, applied for money to meet those needs, arranged the purchasing of equipment, software and services and oversaw the establishment of school networks. When technology staff exist at individual schools, which is not always the case (especially not for lower grade levels), they often consist of other teachers, network administrators and student teaching assistants (TAs) both from the local school site and from outlying colleges. Although there are certainly many other groups involved, my analysis will stick to actors within the central and local groups because they were the most active parties in the policy negotiation.

With AB 2882, the Governor's Office of the Secretary for Education decided to award technology funds to districts as a whole and not to individual schools. They did this so that they would not have to deal with the inconvenience of coordinating multiple grants and presumably so that districts could help all schools apply. This centralizing maneuver left L.A. Unified scrambling to figure out who should be responsible for spending the money. Because the money allotted to each school was determined

by the ratio between student populations and existing computers, this was not specifically a disagreement over money. Still, school site technology coordinators alleged that because individual schools qualified L.A. Unified for the funds through their poor student:computer ratios, individuals at these schools had a right to make purchasing decisions. Downtown administrators disagreed, saying that they could make decisions with a holistic view of the District's needs in mind.

A summary of the arguments between these central and local social worlds will set the stage for analysis of this policy's negotiation. District administrators claimed that central control would (1) ensure equity, (2) achieve purchasing leverage through greater 'economies of scale', (3) reduce school site labor and class interruptions because vendors would set up all the equipment and remove all the boxes and (4) would safeguard the District from lawsuits and fraud through stern management of school and vendor compliance. Technology coordinators responded that (1) meeting students' needs requires local autonomy, (2) schools could get the same deals from vendors without central control, (3) central control would introduce unnecessary labor for schools that have to correct technology incompatibilities and (4) central control violates fair process by excluding school participation in determining specifications. It is important to note that while these two social worlds happen to reside at opposite ends of the organizational spectrum of L.A. Unified, their disagreements stem from different approaches to problems of infrastructure planning, building and maintenance. Before telling how this controversy over the setting of specifications for AB 2882 was resolved, we need some background on how each of these social worlds differentially perceive the task of infrastructure building.

AB 2882: symbols as design agents

If social worlds are tied together through discourse, as was stated earlier, then one can learn about what unifies and motivates them through the language they use. This section identifies dominant symbols mobilized by members of central and local social worlds in the District and then evaluates the force of these symbols for regulating participation in technology policy.

When I interviewed central information technology administrators about central/local conflicts over network infrastructure design, such as AB 2882, they frequently employed plumbing metaphors to explain their perspectives. In these exchanges, plumbing metaphors were used to simplify the infrastructure problem by sketching out its technical aspects while ignoring its social ones. This problem framing is especially important because it demonstrates how symbols become design agents that shape desirable processes and outcomes for this social world. Take the following quote from an administrator as an example:

> Don't get me wrong, I think school site people need to understand the technology, to understand the issues to make better decisions, but the IT people should be there to implement it. I think the tech coordinator and the ITAF should understand why I need a switch versus a hub, but they should not have to worry about installing it and configuring it. That should be an IT technical person. If I'm at a school site and I'm an administrator,

> I need to understand that: why I want hot and cold running water. But I don't need to understand [the reasons behind it] or why I want a water heater and what's a good place to put it.

The plumbing metaphor reduces the problem to technical choices that can be best made in standardized ways that serve all schools; running water and data should be made available for everyone and in equal amounts. However, plumbing also becomes a fetish that both mystifies and dominates its creators (Edelman, 1988) such that it fabricates fixed boundaries, restricts participation and diminishes possible outcomes. The above quote betrays this conflation of the symbol (a simple technical system that can be managed externally) with what it represents (a complex social and technical infrastructure that exceeds any given social world and requires continuous maintenance), and this conflation justified the eventual exclusion of technology coordinators from participation in setting specifications for AB 2882. The metaphor, in this instance, performs a boundary drawing function that allows only one type of professional expertise (the 'IT technical person', meaning technology administrators, not coordinators) and discounts the technical expertise of those at school sites, implying that they are superfluous and probably disruptive to the system being engineered.

The physical and social world distance between downtown information technology administrators and school site technology coordinators is great, however, and the metaphoric infrastructure of plumbing loses persuasive force along the way. In spite of the fact that allusions to plumbing came up repeatedly in interviews with administrators, none of the technology coordinators I asked had even heard of that comparison before and they were surprised to hear it from me. Instead, the social world of technology coordinators relies upon other metaphors to help them conceptualize the larger project while lending legitimacy and meaning to their individual practices. One example I heard departs from human-made, artificial approaches to infrastructure altogether and instead compares infrastructure building to the creation of organic exoskeletons, like those of beetles, that can be abandoned and re-occupied by other creatures at a later date.

The power of the exoskeleton metaphor for infrastructure rests in its humble orientation toward the future, for when no one can accurately predict future needs, then it becomes imperative to create contexts that can be adapted for many purposes. Furthermore, exoskeletons are built from the inside out and this resonates with how technology coordinators envision their own work: based upon continuous proximal assessment of school site needs, they build platforms for student and teacher actions. One can interpret this approach, then, as an inversion of the plumbing metaphor's insistence on materialities determining social relations; with exoskeletons, the social secretes the material. Nonetheless, this exoskeleton metaphor is limited because it neglects to articulate relationships of dependency across multiple infrastructures or social worlds; it reflects and reproduces an attitude of complete self-reliance that belies existing conditions of extended social networks: ties to other schools, communities, the District, the state, etc. Finally, as with plumbing, in its strong oversimplification the exoskeleton metaphor detracts attention away from the ongoing maintenance that network infrastructures require in order to remain functional.

Both the plumbing and exoskeleton symbols serve as agents for the central and local L.A. Unified social worlds, respectively. They are necessary cultural lenses that these groups use to render their tasks more understandable and manageable, but these lenses reinforce singular approaches to infrastructure building and this sometimes leads to poor outcomes. In sum, metaphors are unavoidable but ultimately inadequate for understanding infrastructure design and their naturalization allows them to perform as agents that restrictively define the problems that individuals should solve and the processes that individuals should follow. I argue that an appreciation of multiple metaphorical viewpoints by social world inhabitants would flexibly expand the productive potential of symbolic design agents.

AB 2882: Constructing an Outcome

The previous sections have described the central and local social worlds involved in building technology infrastructures in L.A. Unified and the symbols that each group uses to make sense of the complexity of this project. This section relates the resolution of the controversy over who should set the technical specifications for AB 2882, central or local technologists, and some material outcomes of that resolution. I argue that good material outcomes depend upon maximum participation in technology policy-making and that participatory policy-making can be achieved by intentionally bridging the multiple social worlds in the District.

When centrally located technology administrators revealed their plan for standardizing AB 2282 specifications so that all computer purchases would be made centrally by them and then shipped off to the schools, the primary forum for others to question this plan was the school-run Email discussion group of the ITC. This group began as a grass roots coalition of school site technology people but has recently expanded to include IT administrators in discussions. The organizational conflicts among information technology groups in the District are refracted by this on-line list and are shown in the structure of textual exchanges. The usual discursive pattern in this forum consists of technology coordinators challenging centrally made decisions or articulations, technology administrators rebuking these claims by calling them 'misinformed' and/or 'intemperate' and then other technology coordinators admonishing administrators for policing the list and discouraging open communication. Such exchanges betray a kind of ritual where symbolic capital (Bourdieu, 1977) is mobilized and each group tests the vigilance of the other over design territory, rights and expertise.

The following quote from a school site technology coordinator, posted to the ITC list, represents the challenges raised by the social world of local technologists to the centralization of the AB 2882 policy-making process:

> I still do find it difficult to swallow that, after so many difficult struggles to decentralize decision-making, to bring these decisions to the site level where local site-based leaders can design and build programs that make the most sense to those of us who will have to execute the programs, that we're now back to having the District make these purchasing decisions for us.

> I still believe that (a) prior consultation with the end-users (the schools) was sorely lacking in this process and (b) that it would have been prudent on your part to have engaged us in the schools in a conversation about how this grant might be handled: if your 'one-big-buy' idea is indeed a good one, you could have and should have convinced us of it in advance and, in the process, allowed us to positively critique your approach and measure it against our own needs.

> [I]f the local plans are well defended and seem reasonable, then the District should provide support and resources, not dictates, in these matters. I think that it is too bad that individual schools' hard fought and highly individualized plans were not taken into account in this process … . I think District appropriation of the process, however well intended, is not the best approach to providing the equity the state is plainly seeking.

These interpretations of process by someone in the local social world are remarkably different from the plumbing metaphors deployed by information technology administrators. In contrast to the Fordist, centralizing maneuvers of downtown information technology administrators, local technologists articulate a need for what I will call structural flexibility: a polyvalent context that enables (1) alteration and modification, (2) multiple forms of individual action, interaction and expression and (3) power equalization among actors in the system. Together, the conflicting Fordist and post-Fordist positions described in this conflict reveal one situated act in the ongoing play of global capital and local resistence.

In the above passage, the local technologist queries the justness of democratic process and its potential for translation into equitable learning environments. This democratic approach to design resonates with the organizational experiences of technology coordinators, because for them inequity is not an abstract concept but rather something they contend with everyday in their workplaces: dilapidated inner city schools serving low income, minority students. Institutional parity is also a concern for school site personnel who do not have the status or income of downtown administrators. It is telling that none of the technology administrators I interviewed recognized power distribution as an important issue, whereas this was a common source of aggravation for technology coordinators.

Challenges by technology coordinators, like the ones quoted above, destabilized the centralized and standardized position of information technology administrators and administrators suddenly found themselves defending their decisions by claiming that there was an open process. This move backfired when list members noted they were never invited to participate in what administrators called an open process (a State organized meeting to discuss specifications). In the end, information technology administrators claimed on the discussion list that 'they really listen' and made a small concession of expanding their previously set specifications to include four platforms instead of two [adding Mac iBooks (laptops) and IBM laptops to the previous choice of Mac or IBM desktops], but this alteration neither shifted decision-making power to schools nor did it address the more fundamental issue of democratic process.

After this exchange, members of the local social world ceased to push the issue further and members of the central social world remained silent, not encouraging any more discussion or debate. The 'resolution', then, was one of further entrenched

central control over technology policy and several minor changes in computer hardware specifications for schools. Needless to say, both groups were dissatisfied with the process. Central administrators told me that they felt wrongly abused and needlessly distracted from their technical jobs by social problems. Coordinators, on the other hand, said that they felt frustrated that their social complaint about design process was treated as a technical complaint about specifications. Mutual dissatisfaction is easily explained: the conflict between these groups was really a conflict between social worlds. Both parties were speaking past one another, perhaps intentionally, because of their different interpretations of what good design should be. For administrators, good design manages the distribution of standardized resources and protects the District from lawsuits. For coordinators, good design catalyzes democratic participation to achieve flexible technical options for individual schools. The tensions between these groups were only compounded by territorial claims to decision-making power.

While technology coordinators verbally recognized the validity of administrators' management practices (especially for delivering computer packages to understaffed schools), it is not certain that information technology administrators grew to appreciate any of their opposition's views. When I asked one key administrator what he had learned from the process, he focused on a technical rather than a social issue, saying that he would not dismiss a laptop option right away next time. He then proceeded to enumerate the many reasons why he is more convinced than ever that laptops are a bad choice for schools (they have a quicker obsolescence rate, are too individual centered, are too fragile, etc.), so this was hardly a convincing response about how he would alter future design processes.

The plumbing metaphor used by information technology administrators symbolized the kind of control-at-a-distance that they sought and achieved, but it weakened the design process for setting the specifications for California's Assembly Bill 2882. The ways that administrators responded to opposition, with accusations of misinformation or with technical compromises, left the technology community in L.A. Unified (including themselves) dissatisfied and jaded. The outcome also resulted in poor infrastructure design for many schools. For example, Concrete High was given 467 computers with Microsoft Windows ME operating systems through AB 2882 in spite of the fact that their entire network runs Windows 2000. Because the school cannot afford the software licenses to upgrade these new computers, they are stuck maintaining disparate platforms. This is a large task for this understaffed school and many other schools were placed in similar predicaments of needing to shoulder the labor burden of rigid specifications set by District technology administrators.

In this case, I assert, design outcomes were poor because the boundaries between design communities were not permeable or flexible enough. If administrators had solicited and embraced the flood of technology suggestions from other technologists in the district, they could have taken full advantage of local expertise in making decisions. If coordinators had better appreciated the legal and managerial challenges faced by administrators, they could have suggested several standardized packages for school sites to choose from. If each group had periodically spent time in each other's social world, they could have maintained a sympathetic understanding of the other's

responsibilities and constraints.[6] Each of these recommendations for flexible participation and information flows would improve communication and design processes in the future.

Instead of adopting malleable political stances, however, both social worlds adopted all-or-nothing postures: central control versus local control. The oppositional framing of the issue generated pressure that led to certain productive exchanges (information dissemination and small compromises), but it simultaneously fostered antagonism and blocked greater collaboration between these groups. The few concessions made in this hostile climate were trivial compared with other obvious options, such as allowing schools to maintain responsibility for and control over their own technological infrastructures if they wanted it and letting the District negotiate a standard package for all other schools. The AB 2882 design process was simply not flexible or inclusive enough.

The increasing centralized control of decision-making power over technology, as shown in this social worlds conflict, presents further evidence of the fragmented centralization of public institutions under globalization, where by fragmented centralization I mean that decision-making power is becoming more centralized while accountability for centrally made decisions is becoming more distributed (Monahan, 2003). Technology serves as a vehicle for transforming organizations like L.A. Unified into post-Fordist entities, solidifying structural inflexibilities that, in turn, demand further individual flexibility to keep the systems operational, as shown, in this particular case, with the labor intensification required to maintain multiple computer operating systems. Administrators mobilized symbolic power to gain further control because emergent macro-structural conditions (of audit cultures, digital divides, privatization, organizational restructuring and so on) encouraged them to do so.[7]

Conclusion: technology policy as a stealth agent of global change

This article has explained some of the constricting rules and power-plays of the policy game of wiring US public schools for Internet access. First, I traced the development of the federal government's E-Rate program in L.A. Unified, illustrating how the translation of rigid E-Rate policies generated uncertainty, stress and poor design outcomes. Second, I related contestations across two of the organization's social worlds (central and local technologists) over which group should set technical specifications for California's technology grant AB 2882. Regarding both E-Rate and AB 2882, policy design, translation and negotiation were certainly not static, but they were unnecessarily rigid, leading to antagonism between groups, poor design outcomes and restricted environments for future participation in policy-making. I have argued that with each of these technology grants, more flexible policies and inclusive policy-making processes would have catalyzed better outcomes, both in terms of technological infrastructures and social relations within the District.[8]

In this ongoing technology policy game, the design process is constituted by District technologists negotiating over specifications and managing the details of funding stipulations, contracts and local materialities. Rather than the design of technological

systems being predetermined, rational and neutral, the interchanges between District technologists show a process that is entirely political and socially constructed. Because educational environments are being radically transfigured by the building of these technological infrastructures, one would expect an in-depth public conversation or debate over the implementation and the intended outcomes of these policies, yet that is not the case. Technology policy is hidden behind a cultural veil of arcane technical details, on the one hand, and political neutrality and necessity, on the other.

This article has built upon a larger research project that argues that the design of technological infrastructures in public education embeds globalization ideologies and logics into institutional and material forms such that individuals are forced to adapt to inflexible structures. In this study at least, the flexibility associated with globalization and post-Fordism is entirely of a kind that demands adaptation by individuals but does not provide polyvalent conditions to support a diverse range of human action and interaction. Technology policy is a stealth agent of global change because it provides a vehicle for advancing fragmented centralization in public institutions, yet it operates outside public scrutiny or participation (because technical experts make the decisions, not elected representatives or some other democratic body).

Fortunately, there are conceivable flexible alternatives for technology policy and policy-making. For starters, technologists putting the funding puzzle together in order to wire schools could benefit from less rigid constraints. Technology grants could allow recipients some leeway to determine their needs and apply the monies accordingly; for instance, a commonly voiced frustration was the incredible influx of financial support for equipment but only a meager trickle for network support or staff training. Districts should be able to redirect grants to the areas of greatest need as they perceive it. Furthermore, grants could be more flexible in their deadlines and other restrictions. If meeting a deadline means rushing a job and limiting input from schools, then the deadline works against the long-term goals of the grant; likewise, if it is extremely difficult or impossible to change equipment specifications midstream, then this allows no room for error correction. In these cases, grants that gave more control to the recipients in determining needs and establishing deadlines and specifications would contribute to conditions for functional, sustainable and appropriate designs.

A similar argument could be made for relations among technologists in L.A. Unified. Many times the social worlds of central and local technologists clash, erupting into territorial disputes that deter collaboration and lead to poor designs. If the barriers between these groups were more permeable, allowing the flow of ideas and individuals across organizational domains and geographical regions, then prescripted roles of conflict and antagonism would likely dissipate, leading to better outcomes. Moreover, the local knowledges of those at school sites should always take precedent over the predilections of centrally located administrators. The reason for this is to motivate power equalization among actors in the system so that the fullest range of design participation can be guaranteed into the future; leaning toward local control accomplishes this so long as there are more localities than centralities. This does not necessarily mean that specifications cannot be finalized at a central level, but school

site technology coordinators should be the ones writing them. This would require a reconceptualization of central administrators' responsibilities, toward facilitation and synthesis instead of fiats, but if grants were simultaneously made more interpretable, the social world ethos of administrators would likely shift to support these modified roles.

In conclusion, as Anders (1987) shrewdly observed about capitalist and technological systems: 'Irrespective of whether we choose to play the game or not, we are part of it simply because we *are played*' (p. 2). In this article's context, technology policy is the game that we are all a part of because it establishes the rules and sets the board that we, as the public, are played upon, even if some of us choose to break the rules, play against these globalizing trends or not play at all.

Notes

1. By technological infrastructures, I am referring to all the integrated technical and social components that establish a context for networked computer use in classrooms: school construction projects, technological hardware and software, funding, policy-making negotiations, organizational readjustments, audits, curriculum alterations, security apparatuses, public and corporate pressure and many individuals working together, and apart, toward what are sometimes quite different goals. As can be seen from the examples provided in this article, when technologists define infrastructure purely in technical terms, there are often political motivations for them to do so, such as justifying the exclusion of others from the design process. As with other science and technology studies scholars (e.g. Bowker & Star, 1999), I opt for a more inclusive definition in order to keep the theoretical frame open and attuned to the politics of technological systems.
2. The federal E-Rate program, which grew out of the Telecommunications Act of 1996 and is administered by the Federal Communications Commission under 'universal service', is ostensibly funded by the telecommunications industry in the USA, but the costs are simply passed on to consumers through additional, mandatory 'taxes' on phone bills, for example. The E-Rate program provides discounts on a sliding scale between 20 and 90% on telecommunications costs, hardware and wiring based upon school need, which is determined by the number of students eligible for the National Free Lunch Program, a widely accepted index of poverty. While the US Department of Education touts the E-Rate program as a success (Puma *et al.*, 2000), other studies stress that the program may not be sufficient to overcome digital divides (Macias *et al.*, 2001) and that it is especially prone to mismanagement and fraud (Sarkar, 2003). For a more critical analysis of rhetoric on the 'digital divide', however, see Monahan (2001).
3. The Instructional Technology Commission (ITC) is not really a commission in any official sense but is instead a loose and informal group of technologists that run a discussion listserv and meet on a monthly basis to share information. The founders of this group told me they chose the name in order for their acronym to appear before the acronym of the District's formal Information Technology Division (ITD) on meeting agendas and minutes. One can speculate that the District formed the Instructional Technology Branch (ITB), another centrally located and formal technology group, to one-up the ITC in this ongoing symbolic competition.
4. While used in the field of science and technology studies, social worlds theory has its origins in the Chicago School of symbolic interactionist sociology (Shibutani, 1955).
5. A similar approach is taken by Hess (2002) in his study of 'technology-oriented social movements' and the conflicts that occur when alternative technologies in areas such as organic foods, recycling and renewable energy are incorporated into major industries.
6. Suchman and Trigg (1991) emphasize this point in their study of design practice and proximity: 'the closeness of designers to those who use an artifact (including the possibility that designer

and user are one and the same) directly determines the artifact's appropriateness to its situation of use' (p. 74). I would expand this thesis to include the importance of close proximity in the design of infrastructures and policies as well.

7. See Burbules and Torres (2000) for an invaluable collected volume on globalization and education. More generally, the kinds of institutional shifts alluded to here are well articulated by Harvey (1990), Castells (1996), Strathern (2000) and Graham and Marvin (2001).
8. Similarly, Woodhouse and Nieusma (2001) suggest four goals for making technology policy processes more flexible: 'minimize up-front capital investment, keep lead time short, keep unit size small, minimize infrastructure dedicated to the new endeavor' (p. 89).

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