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Picturing technological change: the materiality of information infrastructures in public education

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Information technologies are often depicted as possessing the potential to correct social inequalities by democratising information access and economic opportunity. This view of technology, however, tends to overemphasise virtual spaces to the neglect of the material and social conditions of technological infrastructures. The goal of this article is to explore visually the messy, situated materialities of information infrastructures in public schools – in places that have become both sites and symbols of economic inequality in the United States and elsewhere. Through photographic images, the contradictions of technological promises and changes are interrogated with attention to the lives of individuals moving through physical and virtual spaces – spaces that are always political and embodied.

Keywords: information technology; infrastructure; materiality; public education; space; photography

Introduction

What does it mean that dominant discourses about information technology (IT) stress the possibilities of virtual networks but seldom pay any attention to the embodied material conditions of those networks? The popular perception of network technologies is that they are somehow pure, untainted by messy materialities and social inequalities. Moreover, by means of this supposed disembodied purity, IT promises democratic access to information and resources, on one hand, and 'friction-free' exchanges of capital on the other (Gates, 1995). The worlds of public education are not immune to the power of these discourses. As one administrator in the Los Angeles public school system related to me:

> Now what we've done is that we have technology that can distribute *any kind* of education, no matter how sophisticated, to anyone, anywhere in the world, at any time … So the whole concept of education, delivery of knowledge, and thus producing educated individuals, is now suddenly free for all.

As this quotation implies, it is not contradictory to believe that IT can simultaneously create educational products that are free for everyone, while at the same time catalysing a market-based revolution where everyone can profit handsomely. When looking at the material embodiments and social contexts of IT use, however, these optimistic conclusions are less convincing.

The goal of this article is to explore visually the messy materialities of IT infrastructures in public education. By IT infrastructures, I am referring explicitly to the technological

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assemblage required for Internet access (e.g., computers, software, cables, switches, hubs, electrical outlets, security systems, air-conditioning systems, furniture, and so on) and implicitly to the social components necessary for those systems to 'work' (e.g., funding, policies, curricula, incentives, training, technical staff, contractors, etc.). Through photographic images, the contradictions of technological promises and changes are interrogated with attention to the lives of individuals moving through physical and virtual spaces – spaces that are always political and embodied. The underlying argument is that the wiring of schools for IT is part of a global production regime shift, from Fordist mass-production (of products or students) to post-Fordist flexible production (Harvey, 1990). Because architecture encapsulates dominant cultural ideologies and modulates them through time (Monahan, 2001, 2002), these shifts are readily apparent with the integration of newer technological infrastructures into older school buildings.

Methods

The photographs analysed here were taken throughout a year of ethnographic research with the Los Angeles Unified School District (see Monahan, 2005, for a full description of the project methodology). During this time, 459 of the district's 677 schools were undergoing major reconstruction for IT at a total annual cost of $403 million (Konantz, 2001). Most of the fieldwork on infrastructure construction and IT use in classrooms was conducted at a dozen school sites across the city and at meetings of technology administrators within the district. In addition to daily participant observation at school sites, board meetings, and technology committee meetings, a total of 50 semi-structured interviews were conducted over the course of a year.

Digital photographs were routinely taken at each of the sites researched, and the method of photographing classrooms, networking technologies, and construction sites was intentionally employed to elicit contextual descriptions and stories from informants. Similarly, when I sat in on classes, I would sketch room layouts and movements of people through the spaces. Students would often watch me and volunteer to sketch designs as well. As with 'informant photography' methods used in visual studies (Schratz & Steiner-Löffler, 1998; Wang, Burris, & Xiang, 1996), these sketches offered an opportunity to enter into conversations with students about how they view their world. *Shadow sampling* is the term that best describes the method adopted here of following informants throughout their daily activities, taking pictures and asking questions along the way (Barndt, 1997; Templin, 1982). What this study adds to shadow sampling is a focus on – or shadowing of – buildings and school sites as newer technological systems are integrated with them (see Barndt's (2002) following of the tomato through global systems, linking Mexican fields to Canadian dinner tables in complex relations of inequality and interdependency).

Material disruptions

Disruption is the first thing that strikes me when witnessing IT construction projects underway in public schools. As bounded and protected social spaces, what occurs inside schools is seldom seen by outsiders, even by the parents of students. The constant state of disruption throughout the year of my fieldwork certainly never made any newspaper headlines, nor was it a topic that often made its way into educational magazines or journals. Indeed, when disruptions in timetables for infrastructure completion did make the news, they were always couched in terms of capital lost due to mismanagement, not in terms of student experiences (for example, see Barrett, 2001). Be that as it may, students, teachers, and staff members at

school sites are intimately familiar with and, by now, somewhat desensitised to technological disruptions in their everyday lives.

The first image (Figure 1) depicts part-time workers in the process of 'pulling cable' through the drop-ceiling of a high school classroom. This task entails stringing polyvinyl-chloride (PVC) conduit from one ceiling tile to another, placing the conduit at a careful distance from fluorescent lights (which can interfere with data signals), cutting it at an appropriate length, and securing it with plastic ties. Next, the workers take several strings of CAT5 copper cable from small, surprisingly heavy boxes; they triple-tie and tape the cable to the cord that runs throughout the PVC tubing; and then they grab the other end of the cord to literally pull the cable through the conduit – in longer 'pulls' than this one, quite a bit of pushing is done as well. The step following the process described here would include cutting the cable and 'terminating' it, meaning lining up the multicolour wires and placing them into plastic clips, much the same as those at the end of phone lines.

Whereas the cable-pull portrayed here was done after school hours, it is not at all unusual for projects of this sort to occur when classes are in session. In such cases, teachers instruct students to ignore the workers and continue with their activities. It surprised me to find out that many teachers did not even know who the part-time workers were or what they were doing. The otherwise territorially guarded spaces of teachers' classrooms were wide open to any intrusions in the name of technology.

The next two images provide a glimpse into the material disruptions occurring throughout school facilities in order to lay the fibre-optic cable needed for high-speed Internet access. Figure 2 reveals students circumventing one of the many trenches dug by professional contractors on the grounds of school sites. At this high school, the fenced-off area

Figure 1. The cable pull. (Photo: Author)

Figure 2. Navigating trenches. (Photo: Author)

encloses a deep trench like a gaping wound in the body of the school; in front of the trench, in the pattern of an X, scars from previous incisions are detectable by the different shades of concrete. The staff at this school told me that this trench, as well as others, had remained open for months and that the contractors working on the project had disappeared entirely, leaving the job incomplete and the school without a functional network.

Figure 3 illustrates several contractors beginning their night's work at a middle school. Because many schools in the LA school system are operated 'year round', meaning that classes are always in session, and because many schools hold evening and weekend classes, contractors are forced to work at night, under the glare of high-powered generator lights. Unlike the part-time workers depicted above, professional contractors like these men do not have the same degree of access, even if they do have greater legitimacy and more impact on the material conditions of school sites. For students and teachers, the night-time construction adds to the mystery of the disruption: trenches and debris appear in the morning like mushrooms that have sprouted overnight. The contractors, of course, are operating under their own temporal and financial constraints, so it cannot be said that they are simply insensitive to the disruptions their work causes.

Material disruptions of the kind pictured in this section represent one dimension of the changes underway to accommodate IT. Disruption, while an integral part of infrastructure design, is hidden from the public, and from policymakers, who seldom venture behind the gates of schoolyards. The reasons for widespread lack of awareness about material impositions are understandable. First, all infrastructures – from roads to telephones to sewer systems – become invisible when they are operational, and are rendered visible only to those for whom they fail to work, or when they break down (Bowker & Star, 1999). Thus, it is not surprising that those who do not rely directly on school infrastructures would be unaware of their problems. Second, this myth of 'pure' IT blinds outsiders from perceiving material disruptions as potential outcomes of infrastructure design processes. Therefore, questions about them never come up. Finally, according to my interviews with teachers and students, public education is seen by many as a mechanism for student containment and discipline, for keeping young people off the street rather than providing them with

Figure 3. Night labour. (Photo: Author)

conditions for learning. To the extent that this explanation is valid, the *conditions* of containment are secondary to the social control functions achieved by containment.

Perpetual change

A reasonable response to the scenes of disruption related above is that they represent a discrete moment in the larger process of technological change, and that the instability they depict will soon subside. What this response neglects to take into account, however, is the underlying logic of technological imperatives, whereby infrastructures require continual attention and constant alteration, even as they normalise the unequal distribution of resources (Graham & Marvin, 2001). First, the perceived imperative for integrating IT into public education also requires continual funding and maintenance in order to keep it operational. Indeed, even achieving 'operational' status in the first place is a costly and lengthy endeavour: most of the schools that I studied had been working on setting up networks for half a decade or more at the time of my research, and the networks were only partially functioning by the time I left. Second, the technology itself becomes quickly outdated and – according to interviews with administrators – will need to be replaced in its entirety (including the hard-wired networks) within the span of 10 years. Even wireless technologies, which could be seen as solving some of the material disruption problems outlined here, impose a host of other dependencies – as with all technologies – that preclude final solutions. For example, wireless networks introduce the need for carts and/or cases for laptops, policies for replacing the fragile devices when broken, higher repair and maintenance costs, periodic battery replacements, electrical charging facilities, daily labour routines for charging them, and so on. Therefore, as the images in this section will illustrate, the task of integrating information technologies is never finished, and therefore neither is the state of disruption.

Figure 4 frames a part-time network administrator in a server room at a central Los Angeles high school. This 8′ × 10′ room houses all the monitoring equipment and print servers for the local area network (LAN) running at the school. It is also home to a number of switches, pictured rack-mounted within a tangle of cables on the left side of the frame, for distributing network access to the computers in the rest of the school. Because the electronic equipment radiates so much heat and is so costly, a separate air-conditioner unit has been installed in this windowless cubicle. The network administrator isolates himself in this room, usually with the lights out, watching network flows, tracing error messages, updating drivers, assigning IP addresses, maintaining security through network firewalls, watching live surveillance camera feeds from the computer lab, and occasionally playing video games through the network with some of the other technical staff at the school. While the position of a dedicated network administrator at a public school site is a rarity, even as a part-time one, this worker's job is more than justified because the system would literally screech to a halt, tangled up in error messages, without his constant monitoring and intervention.

Figure 5 shows a part-time technician upgrading video cards in desktop computers at the same high school. At any given moment, dozens of inoperable computers are stacked up in this makeshift repair room, awaiting the attention of one of the half a dozen 'TAs' charged with maintaining all the hardware in the school of 4000 students. Remarkably, because they are compensated under the federal Title I program for student workers, student TAs performing these highly specialised technical tasks receive significantly less pay than California's minimum wage (at the time of the research, Title I pay was $5.15, compared to the state minimum wage of $6.75). The constant barrage of malfunctioning equipment is not an anomaly, nor is it the result of sabotage by students; it is simply the outcome of moderate use and planned obsolescence. The concern of technical workers at this school centred on labour intensification with the maintenance of multiple platforms and operating systems. The constant upkeep described here was occurring *before* the school's network for Internet access was functional and *before* teachers were regularly using the computers in their classrooms. The labour intensification promises to continue disproportionate to the financial or even social compensation for these student workers.[1]

Figure 4. Just-in-time network design. (Photo: Author)

Figure 5. Computer repair: technological needs. (Photo: Author)

One day when shadowing part-time workers at a high school, I accompanied them as they junked large piles of technological trash, tossing computers, VCRs, monitors, keyboards, printers and the like into a holding area for later 'salvage' (see Figure 6). Because the workers refused my offer of assistance during this periodic equivalent to spring cleaning, I stood to the side in a connected, massive unlit room and almost placed my hand into the whirring gears and belts of a previous industrial infrastructure that I can only guess was used to cool the interconnected buildings of this school site. The technological waste of this salvage room symbolises the constant change of societal commitment to electronic hardware and software, in contradistinction to the ancient cooling machinery still running close by

Figure 6. Technological trash. (Photo: Author)

after decades of use. Workers and administrative staff confessed to me that they wished they could simply throw away all the worthless equipment, but that since it was purchased with public funds, they must undertake arduous bureaucratic steps in order to dispose of it legally. Contrary to popular opinion, school-site personnel loathe corporate donations of computers because the machines are almost always outdated. Workers' perceptions are that corporations are simply seeking to externalise the costs of proper disposal by making such charitable donations. Space for equipment in cramped public schools is a much scarcer resource than the equipment itself.

This section has illustrated some of the ways in which constant flux and disruption are part of larger, ongoing processes of technological change. Whether through required constant maintenance or planned obsolescence of computer equipment, disruption and deferral are dominant lessons being communicated by technological infrastructure in public education. This state of flux is seen as both exceptional and routine by informants: every new infrastructural intervention is unique and delimited, yet interventions are the rule rather than the exception, and they are anticipated far into the future.

In fact, as scholars of globalisation have articulated, the state of flux becomes a value in itself within new economies mobilised by information technologies (Hardt & Negri, 2000; Martin, 1994). The low-wage, part-time workers who keep the systems functioning are the ideal type of flexi-workers who can adapt to the rigidities of infrastructural demands and policy mandates without benefiting in any direct way from their labour. As with the promises of infrastructural completion and educational equality, technical workers in schools commit themselves to a deferred promise that these work 'experiences' will someday translate into stable jobs and tangible rewards.

Picturing the future

The materiality of IT infrastructures and the labour needed to maintain them challenge conventional assumptions about the unfettered possibilities of virtual spaces. The virtual is always embodied somewhere, in a messy reality. For the inner-city students living with both the promises of virtual worlds and the realities of embodied inequalities, the future itself is seen as something beyond their reach. They conveyed to me, in focus group interviews, that they feel they are falling behind society, watching the future pull away in front of them. Technological literacy, they continue, might help them to catch up, but it is probably too late. It is intriguing that students see the future as having passed them by, as if they are somehow outside of time and the benefits it might bring. Perhaps more troubling is students' impression that they have fallen behind society, that they are somehow outside society which has pulled ahead of them. This section explores this tension by looking at student sketches of what they imagine future learning spaces to look like.

The first student sketch depicts a common, rectangular-shaped classroom with a dozen tables for computers and students (see Figure 7). Located front and centre and faced by all the students is a single desk, marked by a 'T' to indicate the teacher's desk. Routes of possible mobility in this room are shown by lines and arrows traced down each of the aisles. Apart from the computers, which are implied here, nothing differentiates the design of this room from the traditional Fordist, assembly-line rooms prevalent at this high school. The linear and compartmentalised spatial orientation reveals not only a disciplinary design but an internalised discipline in representation on the part of the artist of this sketch, who was a 16-year-old male from Sri Lanka. In this instance, one could say that the everyday lived experience of this student in similar educational spaces has imposed constraints on his imagination for difference as well.

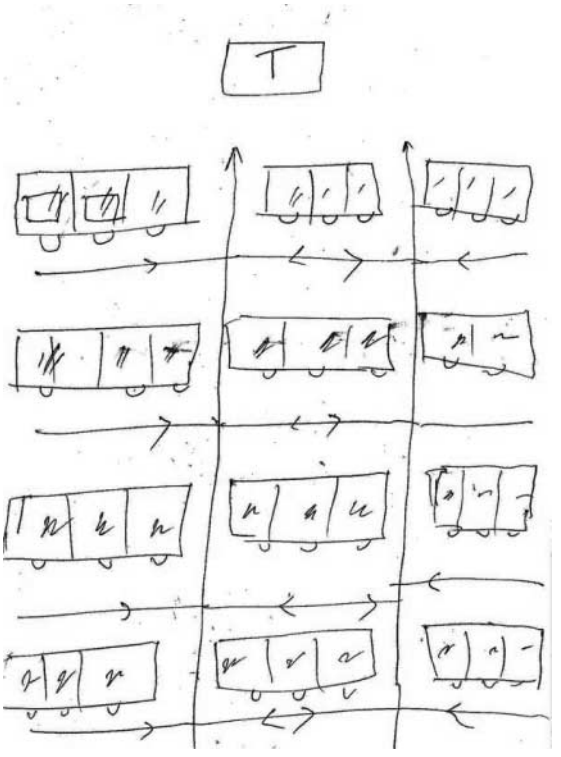

Figure 7. Student classroom design (A).

The second student sketch of a future learning space achieves surprising parallels with Jeremy Bentham's classic design for penitentiaries, but this time in the shape of a triangle (see Figure 8). The panopticon depicted here by a 15-year-old Russian student places the teacher on a raised platform in the centre of the triangle and students around the periphery at computer stations along the walls. For the sake of improved observation, the screens of the computer monitors face the centre, while the students are positioned with their backs to the teacher. The work of students, one can imagine, is under constant scrutiny, but the students are kept unaware of when the gaze is turned their way. Unlike Bentham's panopticon, however, the captives in this space do not in turn observe each other, except through sideways glances or audible keyboard clicks. Surveillance operates at the level of informatisation of work and atomisation of individuals so that no opportunities are given for the cultivation of human agency or collective consciousness. Whereas dominant and standardised spatial *forms* were replicated in the previous student's design, prevalent educational *concepts* of discipline and control are translated and extended with this panopticon design.

Though it was clearly not on the radar screen of the student sketching the triangular computer room, this room is almost an exact homology of Nazi concentration camps such as Sachsenhausen, located just outside of Berlin (see Figure 9). With the perceived threat of students as criminals, surveillance technologies and police presence have intensified, especially over the last decades, at public school sites throughout the United States, increasingly transforming the function of schools and school actors into those of risk management, policing, and social control (Kupchik & Monahan, 2006; Monahan, 2006). Given the popular discourse of school violence and students' experiences of everyday disciplinary practices, it

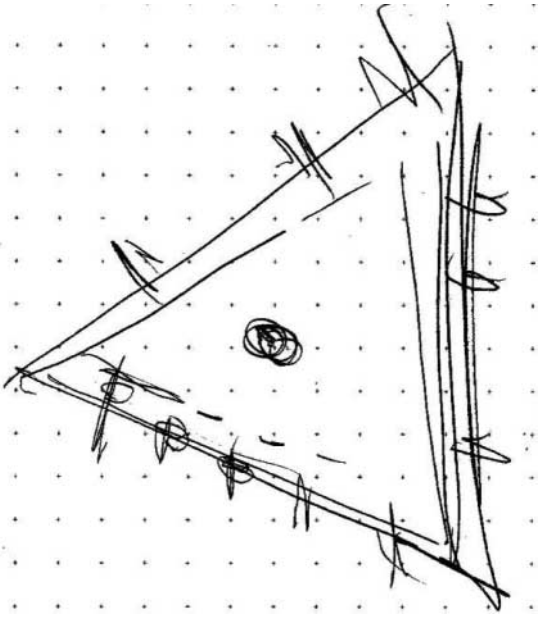

Figure 8. Student classroom design (B).

should not be surprising that students (or others) would stumble across historically proven designs for efficient containment and control. I do not interpret this student's sketch to mean that schools might become the equivalent of concentration camps of the past. Rather, this sketch reveals the ways in which dominant rationalities – in this case, of control – can foster the reproduction of conceptual and physical forms across space and time.

Through analysis of student sketches, this section has posited that imaginations about what the future might be like are inseparable from the endeavours to integrate IT into the educational life-worlds of students in public schools. In opposition to the proclamation of the administrator quoted in the opening of this article (about the free-flowing distribution of education in the future), the students living through the current changes have much more constrained visions about what education is becoming. This is not to say that the students are correct and conversely that the administrator is incorrect, but instead the intent is to call attention to the discontinuity between these visions. Discontinuity can be productive, in the sense that it fuels adaptation and innovation because utopian visions of the future are not achieved *yet*, nor will they ever be. At the same time, discontinuity can be damaging when it diverts attention from the social and material realities and inequalities of students, allowing them to have concerns about falling behind the future or outside of society.

Conclusion

This article began by asking what it meant that discourses about IT focus on disembodied virtual environments while ignoring the necessary material counterparts to those virtual worlds. Pragmatically, it means that states of material disruption, perpetual change, and disconnect among visions of the future are occluded – hidden from public awareness and policymakers' agendas. This material void serves a political purpose of feeding private technology industries' lucrative contracts at the same time that tangible indicators of educational commitment are delivered to the public in the form of computers in classrooms. As scholars

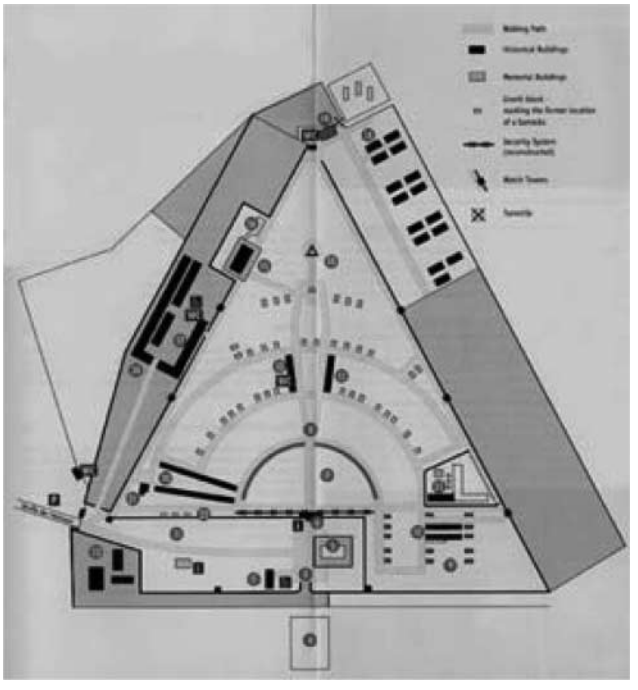

Figure 9. Sachsenhausen concentration camp.

have noted about discourses of the digital divide, a focus on 'universal access' tends to deflect attention away from persistent social and economic inequalities, modes of technology use (or lack of use) in the classroom, and degrees of existing information expertise on the part of target populations who are constructed as 'information-poor' (Eubanks, 2006; Monahan, 2001; Selwyn, 2004).

Theoretically speaking, when researchers eschew a substantive interrogation of materiality, they effectively 'black box' technologies as neutral artefacts, subsequently ignoring the ways that technologies act as political agents that shape lives and establish social orders (Winner, 1986). Some of the orders being established in public schools, as elsewhere, are global systems of inequality and control, predicated upon flexible production, labour outsourcing, multi-tasking, low wages, and few or no job benefits (Castells, 1996; Harvey, 1990). The disruptions at school sites, the labour conditions for technical workers, and the dystopian visions of students each represent folds in this emerging paradigm of post-Fordist production, folds that cannot be seen without delving into the messy materialities of technological systems on the ground.

The final image offered here stands as a symbol of the connections yet to be made with information technology in public education (see Figure 10). This photograph is of a surprising assortment of clocks found in the 'telephone room' of one high school, a room with added importance because it is where the T1 line enters the school to provide Internet access for the entire school site. The digital clock in the middle is running alarm and electrical systems, which are obviously central to the functions of the school. The analog clocks around the periphery are also operational and hooked into the system, but they are superfluous, capriciously 'connected' for some indeterminate reason.

As with students in urban public schools (or within the US public school system as a whole), the relationship of the analog clocks is one of dependency, one of trying to catch up

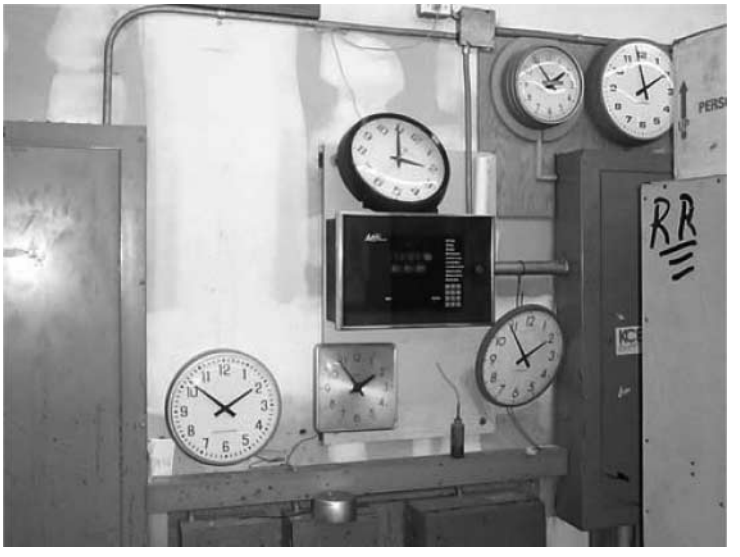

Figure 10. Timing the future. (Photo: Author)

with the future whose protocols are digitally set in power centres elsewhere. But it is uncertain whether those protocols are the right ones or whether they should be set through different processes or in different locations. The connections yet to be made with IT in education, then, are those that enable equal power relations between nodes on the network, minimise disruptions in the integration of analog and digital worlds, and ground popular notions of digital purity in the material realities of everyday life.

Acknowledgments

I thank my informants in Los Angeles Unified School District (LAUSD) for generously including me in their lives and allowing me to shadow them and take photographs during their daily work activities. I also thank the students of LAUSD for providing me with sketches of their imagined future learning spaces. The reprinted map of the Sachsenhausen camp appears courtesy of the Sachsenhausen Concentration Camp Museum, Oranienburg, Germany.

Note

1. By 'social compensation', I am referring to the status privilege – or symbolic capital (Bourdieu, 1991) – afforded to TAs working in the school's computer lab. For instance, when they supervise other students in the computer lab or when they run instructional classes on software applications, they gain momentary control over fellow students and status over less knowledgeable teachers.

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