The Transparency Paradox: A Role for Privacy in Organizational Learning and Operational Control

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Abstract

Using data from embedded participant-observers and a field experiment at the second largest mobile phone factory in the world, located in China, I theorize and test the implications of transparent organizational design on workers' productivity and organizational performance. Drawing from theory and research on learning and control, I introduce the notion of a transparency paradox, whereby maintaining observability of workers may counterintuitively reduce their performance by inducing those being observed to conceal their activities through codes and other costly means; conversely, creating zones of privacy may, under certain conditions, increase performance. Empirical evidence from the field shows that even a modest increase in group-level privacy sustainably and significantly improves line performance, while qualitative evidence suggests that privacy is important in supporting productive deviance, localized experimentation, distraction avoidance, and continuous improvement. I discuss implications of these results for theory on learning and control and suggest directions for future research.

Keywords: transparency, privacy, organizational learning, operational control, organizational performance, Chinese manufacturing, field experiment

Organizations' quest for worker productivity and continuous improvement is fueling a gospel of transparency in the management of organizations (e.g., Hood and Heald, 2006; Bennis, Goleman, and O'Toole, 2008). Transparency, or accurate observability, of an organization's low-level activities, routines, behaviors, output, and performance provides the foundation for both organizational learning and operational control, two key components of productivity that Deming (1986) identified. As an antecedent to enhanced organizational learning, transparency may improve some of the processes that scholars have shown to be important. For example, it may improve one unit's access to the expertise, experience, and stored knowledge of another (Hansen, 1999), thereby creating the potential to increase the quantity and quality of knowledge transfer (Argote et al., 2000) and shared understanding (Bechky, 2003), accelerate organizational learning curves (Adler and Clark, 1991), or increase network ties for the exchange of knowledge related to learning before doing (Pisano, 1994). Similarly, it could neutralize the skewing effects of impression management (Rosenfeld, Giacalone, and Riordan, 1995), facades of conformity (Hewlin, 2003), or organizational silence (Morrison and Milliken, 2000) on meaningful information flows up the organization, as well as reduce the risk that localized problem solving will fail to contribute to organization-wide learning (Tucker, Edmondson, and Spear, 2002). Transparency concurrently may enable operational control by ensuring access to richer, more extensive, more accurate, more disaggregated, and more real-time data by managers and employees, thus improving both hierarchical control (Taylor, 1911; Adler and Borys, 1996; Sewell, 1998) and peer control (Barker, 1993). Senior leaders are therefore redesigning their organizations to make more work more visible more of the time, embracing innovations such as advancements in surveillance and knowledge search technologies (Sewell, 1998; Levinson, 2009), open workspace design (Zalesny and Farace, 1987), and "naked" communication of real-time data via advanced information technology tools (Tapscott and Ticoll, 2003).

This trend toward transparency has been particularly evident in the design of the world's factories, where visual factory implementations have been "spreading . . . like a trail of gunpowder" (Greif, 1991: 1). Most modern-day facilities are designed to provide near-perfect observability of the actions and performance of every employee, line, and function. This observability serves as an important foundation for all aspects of the Toyota Production System DNA (Spear and Bowen, 1999) and is a necessary antecedent behind the seventh principle of the Toyota Way: "use visual control so no problems are hidden" (Liker, 2004: 149–158). Factory managers and employees need to see activity in order to improve it. Accurate observability also provides the basis for many of the widely accepted practices in total quality management (TQM) implementations (Hackman and Wageman, 1995), which target simultaneous improvements in both learning and control (Sitkin, Sutcliffe, and Schroeder, 1994). An emergent logic about the relationship between observability and performance has thus become dominant in theory and practice: organizations "that are open perform better" (Tapscott and Ticoll, 2003: xii).

Nonetheless, the implications for organizational performance of increased transparency remain surprisingly unstudied, both in factories and more broadly. Without sufficient empirical, field-based evidence of a causal relationship between observability and performance, uncritical assumptions about that relationship have germinated (Hood and Heald, 2006). Rarely does one hear about any negative effects of transparency or problems stemming from too much transparency.

There are, however, reasons to be skeptical that transparency is such a panacea: detailed field work from the long tradition of factory floor research in management science has documented instances in which observability has encouraged *hiding* behavior among organization members (Roy, 1952; Dalton, 1959; Burawoy, 1979; Hamper, 1986), producing only the appearance of enhanced learning and control without real benefits to organizational productivity, continuous improvement, and performance.

Dalton (1959: 47) described how managers, mandated by their superiors to conduct "surprise inspections," instead chose to "telephone various heads before a given inspection telling them the starting point, time, and route that would be followed" so that each inspection would simply "appear to catch the chiefs off-guard." Roy (1952) and Burawoy (1979), in reconfirming the "restriction of output" observations in the Bank Wiring Observation Room at the Hawthorne Works (Mayo, 1933; Roethlisberger and Dickson, 1939), provided substantial detail on the "quota restriction" and "goldbricking" activities in the Greer machine shop (Roy, 1952), which only became worse when managers were in sight (Roy, 1952; Burawoy, 1979). Subsequent insider tales from one of General Motors' largest and most open plants portrayed management's stance on various workarounds like "doubling up" as "a simple matter of see no evil, hear no evil," leaving workers with the challenge of hiding their self-defined "scams" within the context of an observable factory floor—the more observable the factory floor, the more effort "wasted" on hiding them (Hamper, 1986: xix, 35).

Each of those facilities was designed to be extremely transparent, yet those organization designs with high observability resulted not in accurate observability but, rather, only in an "illusion of transparency" (Gilovich, Savitsky, and Medvec, 1998)—a myth of control and learning—maintained through careful group-level behavioral responses by those being observed. Although observability was achieved through the removal of physical barriers like walls, *accurate* observability (transparency) was not. Goffman (1959) originally suggested that increasing the size and salience of an "audience" has the tendency to reduce sincerity, and to increase acting, in any "performance." Analogously, increasing observability in a factory may in fact reduce transparency, which is displaced by illusory transparency and a myth of learning and control, by triggering increasingly hard-to-detect hiding behavior—a result I term the "transparency paradox."

To untangle the transparency paradox, this paper presents a behavioral model of observability in organizational design, based on both qualitative and experimental field data, in an empirical setting that uniquely allowed me to investigate transparency within the locus of organizational experience and performance. I studied workers at the mobile phone factory of "Precision" (a pseudonym) in Southern China, which was the second largest mobile phone factory in the world at the time. Over the past century, factory studies have been central to building the foundations of organizational theory (e.g., Taylor, 1911; Roethlisberger and Dickson, 1939; Roy, 1952, 1960); however, I chose these workers not because of the type of work they did or because they worked in the epicenter of Chinese outsourced manufacturing but, rather, because organizational life for them was extremely transparent, in both actions and performance. In accordance with best practices for visual factory design (Greif, 1991) and TQM (Hackman and Wageman, 1995), visibility was everywhere. There was a clear line of sight across factory floors, each football fields long, such that learning could be quickly captured, distributed, and replicated by managers. Hat color signaled organizational role, function, and rank, such that expertise could be visibly sought when needed. Both output and quality were constantly monitored via very visible end-of-line whiteboards, factory floor computer terminals, and real-time reports to management and customers worldwide. If ever there were an organizational context in which existing practice demanded transparency, this factory in Southern China was the epitome, and management had implemented the best existing transparency tools with great diligence and success. I, in contrast, inductively explored the workers' behavioral responses, at both the individual and group level, to such stark transparency, while simultaneously controlling for any Hawthorne effects—circumstances in which subjects improve the aspect of their behavior being experimentally measured simply in response to the fact that they are being studied, not in response to any experimental manipulation (Mayo, 1933; Roethlisberger and Dickson, 1939). I use the resulting qualitative participant-observer field data in Study 1, and the empirical field experiment it informed in Study 2, to challenge some of the current, blanket assumptions about the value of transparency for productivity and organizational learning and construct a contingent, behavioral model of the relationship between organizational transparency and learning, control, and performance.

Research Overview

I studied PrecisionMobile's 14,000-person, one-million-square-foot manufacturing facility in Southern China, situated within Precision's 150-acre industrial park employing over 65,000 individuals in 3.1 million square feet of manufacturing space. Spread across roughly two dozen factory buildings, Precision's employees produced everything from injection molded plastics to video gaming consoles for original equipment manufacturer (OEM) customers. At the time of this research, Precision was one of the three largest contract manufacturers in the world, PrecisionMobile (its global mobile devices division) was the second largest producer of mobile devices in the world, and the Southern China mobile plant was PrecisionMobile's largest, with a capacity to produce up to two million mobile devices per week, or roughly one out of every 25 mobile phones sold in the world. As a contract manufacturer, Precision produced mobile phones and devices to defined specifications for well-known OEM brands.

Precision's management viewed transparency as absolutely essential to performance and survival. To achieve such large-scale manufacturing efficiently, PrecisionMobile simultaneously operated large numbers of identical production lines and implemented sophisticated systems and processes to ensure cross-line transparency for learning and continuous improvement. Precision's vision targeted "limitless scale managed by a system that delivers repeatable execution" (company materials). In the intensely competitive contract manufacturing industry, it was not uncommon for negotiations with customers over thin manufacturing margins to result in prices that assumed, without any direct evidence of feasibility, significant efficiency improvements during the ramp-up stage before the contract manufacturer could earn any profit at all. Therefore organizational learning and operational control within such "limitless scale" and "repeatable execution" were central to PrecisionMobile's survival (company materials). Given that mobile phone product lifecycles were steadily falling, with current models lasting only three or four months before being replaced by the next generation, the pressure for fast learning and tight control had only increased. When I first arrived at the facility, recent success stories included ramping up stable production of a new mobile phone model from zero to 96,000 units per day within four weeks for a tier-one OEM customer (the fastest ramp up ever completed by either PrecisionMobile or its customer) and shipping 36 million units of a different new mobile phone model (for a different OEM customer) in 36 weeks using production capacity distributed across four sites (China, Malaysia, Brazil, and Mexico) with total ramp-up time across all four sites of only six weeks.

My contact at Precision was a board member who worked closely with me first to make introductions to select global executives and then to open the door for me to PrecisionMobile in China, PrecisionMobile's largest site and therefore the one that would provide the richest source of data. As each factory is run fairly autonomously by a local general manager (GM), the GM and his senior team in Southern China facilitated nearly all of my on-site activities, allowing me to keep my direct connection to the board and senior management less visible. I was introduced to the GM, the head of human resources (HR), and the head of operations as a researcher conducting a study on transparency and human capital and was temporarily given nearly unlimited access to the site. I conducted two studies that involved data collection over the course of the next 18 months.

Study 1 was a month-long inductive qualitative study with data gathered by three embedded researchers who were simultaneously operators on the factory lines and participant-observers for the study. Study 2 was a field experiment using an intervention and, again, embedded researchers to collect data on the factory lines, this time for the first five weeks of a five-month study.

STUDY 1: PRELIMINARY QUALITATIVE RESEARCH

In a one-month preliminary visit to PrecisionMobile China, I adopted a special methodology to avoid contaminating the environment and the behaviors I was attempting to observe. My research team included three undergraduate students (two females and one male), all three of whom had been born and raised in China until at least the age of ten. The three students were inconspicuously placed on the factory lines as ordinary employees—only the GM, head of HR, and head of operations of the 14,000-person facility knew their true identities, which were carefully guarded. Given that PrecisionMobile experienced 6 percent monthly line operator turnover (the average for the manufacturing sector in Southern China), operators were constantly coming and going, and the integration of three new recruits was not out of the ordinary. As native Chinese born in regions that are common sources of the migrant workers who constitute nearly all of PrecisionMobile's workforce, the students' personal characteristics were typical of new recruits, and the extraordinary diversity of the migrant labor pool meant that the students' small idiosyncrasies and any potential lingual accents went unnoticed. As college students, the researchers' age approximated the age of the average recruit, allowing them to blend in.

PrecisionMobile's line operators were recruited from remote rural provinces to work and live at the factory. Most came from cities like Chongqing or Chengdu in Sichuan province or similar cities in Hunan, Hubei, and Canton provinces, while a smaller number came from the northern regions like Zhengzhou or Kaifeng in Henan province or Taiyuan in Shanxi province. Line operators were 72 percent female, 28 percent male, and 74 percent were 20 to 30 years old, 14 percent were 18 to 20 years old, and 12 percent were over 30. Line operators, who operated machinery or worked in assembly and packaging on the factory floor, and their direct supervisors (line supporters and line leaders) accounted for 85 percent of the employees and are considered direct labor. The remaining 15 percent of employees, including engineers, technicians, and senior managers like floor heads, are considered indirect labor.

Indirect labor tended to be a bit older—69 percent were 20 to 30 years old, 27 percent were over 30, and four percent were 18 to 20 years old—and included more men (59 percent female, 41 percent male). On the factory floor, however, uniforms consisting of antistatic scrubs, shoes, and hats masked most demographic differences. As a result, with the exception of proximate individuals, other employees were most easily identified by their hat color (e.g., white or brown for ordinary operators, blue for line supporters, yellow for line leaders, light blue for engineers, hot pink for quality control, light pink for floor heads), scrub color (e.g., white for operators, navy blue for technicians), or colored badges (e.g., trainees wore red armbands, materials operators wore blue armbands).

Because the behavioral questions I sought to answer concerning the impact of observability on performance were open-ended, this research phase was structured inductively, with the research team entering the field with the open mind characteristic of grounded theory building (Glaser and Strauss, 1967) in the qualitative tradition of embedded participant observation (Ely and Thomas, 2001). Prior to arrival, the three "embeds," who each had at least two prior courses in qualitative methods and some qualitative research experience, were trained in how to properly collect field notes (Emerson, Fretz, and Shaw, 1995) and the basics of the participant-observer craft. The training focused specifically on how to take both an appreciative and skeptical stance, distinguishing the "multiple truths" they would record while immersed as an active participant-observer (Mishler, 1979: 10). Upon arrival, embeds lived with and like those whom they studied: they were put through the PrecisionMobile orientation and then put onto the line just like new hires, living in the factory dorms, eating at the factory cafeteria, and working on assembly lines producing mobile phones at stations assigned to them by floor heads and line leaders, who were unaware of their status as embeds. After the introductory field visit of eleven working days on the lines, in some cases for as long as twelve hours per day, the team had already collected qualitative data, including transcripts and supporting materials, reflecting approximately 800 hours of observation in total.[1]

As my presence on the factory floor would have contaminated the study, I limited my factory floor visits to times when other foreigners were also on the floor, approximately twelve hours every two weeks. Otherwise, while the embedded operators were on the line, I waited in an isolated office on a separate floor, where the embeds would come to record their observations with digital audio recorders during breaks: 40 minutes every four hours, with occasional ten-minute bathroom breaks in the interim. To maintain the freshness and purity of observations, as well as to make the most of the time provided by short breaks, the embeds recorded their observations verbally, and I then transcribed the recordings while they returned to work on the lines. After daily production finished, we recorded any remaining observations and reviewed the day's transcripts as a team, giving the embeds a chance to confirm or challenge each other's perspectives.

Although this research design was born of necessity from my inability to fit in, the separation of researcher from participant-observer offered two other advantages. First, by forcing a disaggregation of the participant-observers (embeds) and the integrator (me), the research design helped to enforce discipline around entering the field with an open mind (Glaser and Strauss, 1967): the embeds were not instructed to look for anything but simply on how to look. Only through transcribing their observations, coding them, and discussing them afterwards did we integrate observations into theory. Second, consistent with the tradition of participant observation in industrial contexts, data in this context took full advantage of the embeds' dual role, consisting of both what was observed and the embeds' own

[1] For adequate protection of human subjects (IRB Approval #F16225-101), only four individuals—the three embeds and I—were authorized to access data with individual identifiers. As per the IRB approval, "a deidentified data set of factory line observer comments [was] created as soon as practicable, for analysis purposes," prior to sharing any results with anyone (including the board member who granted us access). Anonymity was practical only because of the size of the site: with 65,000 employees, it was quite easy to remove individual identifiers with no possibility of later discovery by management.

observations (e.g., Ellis and Flaherty, 1992; Ellis and Bochner, 2000). In the former case, embeds reported distanced observations of factory floor activity; in the latter, to borrow Sanday's (1979) terminology, the embeds were themselves "instruments" of the research, their reactions to factory floor interactions capturing observations that might otherwise go unnoticed.

At the end of the month, the researchers revealed their identities in debriefings held at their daily line meetings, permitting them subsequently to administer a survey of their end-to-end assembly lines and conduct in-depth exit interviews with several workers with whom they had built a high level of trust.[2] For Study 1, data include the embeds' transcribed participant observations, the assembly-line survey results, recorded and transcribed exit interviews with operators, and additional data about the site (e.g., workforce demographics, performance metrics, compensation structures) requested from management. Quotations were of three types: verbatim quotations from operators recorded during the exit interviews, operators' discussions reconstructed by the embeds during their breaks; and embeds' observations recorded during their breaks. All raw data in Mandarin were subsequently translated into English by the research team. I analyzed the transcripts according to grounded theory guidelines (Glaser and Strauss, 1967; Miles and Huberman, 1994), using open coding techniques and qualitative data analysis software to track the content of recurring themes. As themes emerged, the research team met to discuss the emerging themes and fine-tune our shared understanding of the transcripts.

Results

Hiding in broad daylight. During this first phase of the research, it became clear almost immediately that operators were hiding their most innovative techniques from management so as not to "bear the cost

[2] Operators' responses to the debriefings were surprisingly positive. In each case, one embed was placed near the debriefing so that the embed could observe the reactions of the other embed's fellow operators. On one line, the operators applauded for the embed, as if one of their own had just been admitted into university. On another, the embed in the audience heard the operators whispering that they did not "believe that [the embed] was really a college student" and actually laughed at the prospect.

of explaining better ways of doing things to others" or alternatively "get in trouble" for doing things differently. One of the first rules in which my researchers were trained by peers was how to act whenever a customer, manager, line leader, or any other outsider came in sight of the line. First the embeds were quietly shown "better ways" of accomplishing tasks by their peers—a "ton of little tricks" that "kept production going" or enabled "faster, easier, and/or safer production." Then they were told "whenever the [customers/managers/leaders] come around, don't do that, because they'll get mad." Instead, when under observation, embeds were trained in the art of appearing to perform the task the way it was "meant" to be done according to the codified process rules posted for each task. Because many of these performances were not as productive as the "little tricks," I observed line performance actually dropping when lines were actively supervised, a result I began calling a reverse Hawthorne effect because productivity fell, not rose, as a result of an observer. My embeds' privileged role as participant-observers, along with the substantial hours of research time on the lines, allowed me to collect numerous examples of these productively deviant behaviors, the performances that were used to hide them, and their antecedents, across categories of tasks. Table 1 provides some selected examples, and Online Appendix A provides even more. Meanwhile, suggestion boxes on every line remained empty.

Table 1. Selected Examples of Hidden Variance on the Lines (Quotes from Operators and/or Embeds)

Task	Process when observed	Process when unobserved	Operator rationale for productive deviance	training
Attach protective chip covers with unique, identifying bar code stickers	"The correct way would involve using both hands to remove one label from the roll, picking up a lid, taking out a board from the rack and then setting it down and putting the cover on with both hands. Then you need to set the board down, pick up the roll and repeat that process three more times. Finally, you have to put the board back onto the rack. After the whole rack is done, then you have to take each board out to scan into the computer." (Embed, based on the total quality control (TQC) chart)	"My job and my trainer's job was to take these stickers that were given to us, keep a record of how many stickers we got, keep track of the numbers on those stickers. We take logs of those. Then we scan every single one of those stickers into the system and . . . put each sticker onto these little metal casings. The metal casings come in big trays of 64. The other two women, the women from Sichuan, would stack all of the boards that they had checked in a shelf-like thing in groups of 15, and I would take those boards and put the casings with the stickers on." (Embed)	"The short cut is significantly better because, first, all the bar codes can be applied with one hand at an amazing speed. At least four times faster than if you were to apply one by one. Second, it is ten times easier to scan when all the bar codes are aligned on the roll [of stickers] than already on boards--we don't need to flip the boards, and we save time otherwise lost to aiming the laser (UPC reader) correctly. Third, we take the boards off their racks only once instead of twice (i.e., first time to apply the covers, second time to scan)." (Embed) "If you didn't do it their way, they say you didn't follow the rules and you should do it their way. If we follow their rules, there would be a whole lot piled up and they would complain about us being so slow. If we tell them that this is going to pile up doing it their way, they'll say that they will just add one more person, and if there are two people at a station, then there won't be enough to do, so we'll be standing around a lot, and so they'll come and complain." (Operator)	"Basically, she [the floor head] took me to the line and told the line leader that I was being put into their line. Nobody questioned that or said anything, they just said okay. And then she randomly picked out this one girl who was standing at the end of the line and said, 'Are you putting covers on those boards?' and she said, 'Yes.' And then the floor head said, 'Take off your training badge and give it to JH, and teach her everything your teacher taught you.' And then she left and my day started." (Embed) "This morning when I was putting the lids on, my trainer told me to do it their way, as told to me yesterday by the . . . pink hat. So I put the lids on, and then put the barcodes on. I asked her why we were doing that, and she said: 'Well, she's hovering around. If we're not busy, we'll do it her way so we don't get yelled at again, but if we do get busy, then we'll go back to doing it our way.' And if we do it their way, it does create two more procedures and is a lot slower." (Embed)
Manual inspection of printed circuit boards (PCB)	"We were supposed to look at the board and the model, compare, and if it matched, put the cap on." (Embed)	"The others were trying to teach me how to check two cell phones at the same time, which I don't think you are supposed to do. The girl was all for it, because then I would be faster and she would have less to do, but the guy said, 'No, she's new, you don't want her messing things up,' so I didn't do it." (Embed)	"Faster, less taxing production." (Embed)	"Some lady just came around and said 'Oh you guys got a new person?', they said 'Yeah,' and she said 'Be nice to her, teach her well, be very detailed, don't teach her all your bad habits, teach her the right things' and everybody laughed." (Embed)
Protective gloves	"Everyone on the line is supposed to wear gloves on both hands and/or rubber fingertip covers." (6S Rules)	"People usually wear their gloves in their own ways—either they wear a glove on only one hand or they cut their gloves so their fingertips stick out, giving them a bare hand or bare fingertips so when they are doing little things it goes a lot faster." (Embed)	"Not all tasks require protective gloves—the management just do that for show. And for tasks that don't need gloves, production goes much faster and more effortlessly with bare fingertips." (Operator)	"Once when the customer came, people were passing around the word, so they all changed gloves. So you could then see that everybody was wearing a full pair of gloves. And then once the customer was gone, they just went back to the way they were wearing them before." (Embed)
Line operator allocation	"Each station is allocated one operator." (Management)	"I counted today—on the backend portion of the line, we had 17 people and 13 stations on our line today." (Embed) "There are many stations that are supposed to be	"They expect us to finish so much in so little time. We need these extras to actually meet the target. Think about it, when they increase our units-per-hour (UPH) targets, the kaizen engineers,	"The floater took us along with four others to the end of the floor. She explained that someone is coming to visit the lines, and because we are the new workers, we are the 'extra people'

		managed by one person, but in fact we have to put an extra operator at each of those stations in order to get work done. These stations are the engraving / accessories, boxes / sticker, and away-from-line jobs (putting instruction and cables in the boxes). All of these stations are supposed to only be operated by one person, but we assign two at each one every day. When management comes around and check, we have to get the 'extra' operators away from the line so not to be discovered." (Line supporter)	supporters, and line leaders come and help us with production. Once we reach the target, they all leave. For that UPH to be sustainable, we sometimes have to have extras. The total quality control (TQC) charts say that each station can only have one worker, but what's wrong with people helping each other when they have extra time? But these things we need to hide from the management." (Operator)	on the lines and need to be taken away. She took us to this rest area and we were supposed to stay there as long as that important someone is still around the lines. Someone asked the floater again why we had to leave, the floater said, 'We really are only supposed to have 4 people on each line, but there are about 6 people on the lines, obviously more than necessary according to the rules.'" (Embed)
		"There was the first girl, then the second girl, and then me. And the second girl said to the first girl, 'Why are you working so fast? You've got to wait—I'm not keeping up.' And then the girl did slow down. Because they don't want there to be a lot of 3G data cards on their table, because that looks bad for them." (Embed)	"Because each station is only supposed to have one operator, they cannot help each other when they fall behind, at least when someone is watching—instead, they have to slow down." (Embed)	"I had put so many boxes on my table, so it looked a little messy, and the girl right next to me poked me and told me that I need to clean it up . . . otherwise, the production leader is going to yell at you.' So I started putting things back . . . and the production leader came over and told me, 'Don't accumulate this many boxes on the table.'" (Embed)
Line reporting	"In front of each line, there is a production status indicator and a whiteboard with the hourly production (targeted and completed) for the shift. It also includes reporting for any quality failures (rejects) on the line." (Floor head)	"What I thought was really strange is that there was a chart in front of the line that's supposed to say how many you have produced this hour and what your goal is, and she updates that every hour. And I thought it was very strange the numbers are perfect, everything was 100% —it was just perfect. I asked the operator writing on the board where she gets her data from, and she said she gets it from the guy at the last post in the line. He makes the final check on the phone and scans the barcode into the computer. And he keeps track of how many boards he puts out. . . . And he definitely verbally tells people when we aren't producing enough. He would say: 'Hey, speed it up.' Or 'Hey, slow it down.'" (Embed)	"I have a feeling that he tampers with the numbers, because only 2 days ago, I was one station away from him. I don't think he's actually counting them one-by-one, I think he controls the numbers throughout the day—sometimes they produce more, sometimes they produce less. Our blue hat always writes down 240. And he never . . . I actually pay attention to what he does . . . he never actually looks at what it says on the Precision IT screen. He just notices that it's about the right time—let's say it's 9:56—and he will write down for the block from 9–10 that we made 240." (Embed)	"When I asked [the operator writing on the reporting board] about the validity of the numbers, he said, 'If the actual doesn't equal the target, then managers will come over to complain. But overall, we're on time, aren't we?! We never fail to have enough at the end of the day—we always meet our goals.'" (Embed)

The gap between observed and actual behavior was intensified by the fact that these workers, though unskilled, were by and large "very clever and driven," according to the embeds' observations. As one of my researchers proclaimed, "If they want to hide something from you, they will succeed." In a conversation after a line visit by a global manager, one embed seized the opportunity to ask her fellow operator and trainer about this hiding behavior. In her response, the operator referred to it as the "privacy" operators needed to keep production moving sufficiently smoothly to meet ever-increasing management targets. The research team, which had not used the term prior to that worker's comment, adopted the word in turn.

The qualitative evidence of hiding behavior to maintain privacy was prevalent in the transcripts. In fact, although they hid it from others, workers were very open with their peers about it and described it in great detail with the embeds during the exit interviews. The embeds even observed lower-level line management ("line supporters") helping operators maintain privacy, as the supporters often warned, "Hey, you're doing [this] . . . don't do that when [so and so] comes around!" and would let them know when management or other observers, such as Six Sigma (6S) auditors, would be within observation range, much like as in Dalton's (1959) account. Because the materials team was the most mobile, materials operators were important in providing warning signals, and one embed described her materials operator as the line's "CNN." The materials team always seemed to know what was going to happen before it did.

Ironically, the extremely high level of visibility across the factory floor was perhaps the most important enabler of this behavior, as lines could see managers coming long before they arrived. The research team called this "double-sided transparency." As one line operator put it, with what the embeds understood as well-meaning intentions, "Of course we prefer that the managers wear different colors and are easy to spot. That way, we know they are coming. Otherwise, you can't even prepare for their arrival." Visual factory tenets, intended to enable operators to seek needed expertise (Greif, 1991), were instead enabling hiding behavior.

Informed by these data, a bird's-eye observer of the floor could indeed observe bubbles of less productive behavior surrounding any outsider walking the lines. With the benefit of the embeds' experiences, behaviors that had previously been quite hidden were relatively easy to see as long as you were not one of the individuals from whom the behavior was intended to be hidden. In most cases, the hidden behavior involved doing something "better" or "faster" or to "keep production going," often by engaging in activities that operators claimed were "not hard" and had been learned by "watching [others] do it," a form of tribal knowledge on the factory floor. What operators described as "their" [management's] way of doing things often involved "more procedures" and was "a lot slower," whereas the improved, more "fluid" methods were necessary to avoid complaints from management about the line "being so slow." In an operator's words, the deviance doesn't "cause any [quality or safety] problems and it keeps production moving."

Such private deviance in workplaces is common and well documented (Roy, 1952; Burawoy, 1979; Mars, 1982; Anteby, 2008). What made the deviance in this context so interesting is that so much of it appeared to be productive for line performance—and that such productive deviance existed even though the workers, who were paid a flat rate by shift and not piece rate, had no financial incentive to enhance performance. A shift's quota was set by production managers for clusters of similar lines based on demand for the products being produced, and performance expectations (e.g., the number of defect-free devices produced per hour) were based on a combination of engineers' pilot testing of lines during the initial ramp-up of that product's production and an assumption of learning over time, based on previous PrecisionMobile experience with similar products and tasks. Exceeding expectations resulted in waiting time, standing at the stations, at the end of a shift, but there was little more positive incentive than that. Nor did negative incentives, such as disciplinary methods or penalties, explain the productive deviance. When lines failed to meet performance expectations, traditional Toyota Production System or TQM methods—poka-yoke, in-station quality control, jidoka, five why's, kaizen, small group activities (SGA), Ishikawa fishbone diagrams, among others—were employed to find the root cause and correct the error. Discipline of individual operators could range from simple warnings to removal, but though the embeds witnessed a few warnings, they witnessed nothing more significant than that. In contrast to several other large contract manufacturers in the region, PrecisionMobile had a reputation among the workers for being one of the best local places to work, and at least one operator cited fairness in discipline as part of the reason. Nothing we witnessed about the incentive structure explained the workers' motivation to be productively deviant. Although the factory was located in China, its management systems and approach were quite standard globally or what the company called best practice. On visits to similar PrecisionMobile facilities elsewhere in the world, I found that the systems were nearly identical.

When the embeds casually probed operators about their motivation to hide productive behavior from management, operators' most common first response involved a perceived lack of capability on the part of management, particularly middle management: "People from above don't really know what they are doing. They set all these rules, but they have no idea how it actually operates down here. Sure, process engineers time these things and set all of these requirements, but they have no idea how people operate." When the embeds pushed a bit harder, suggesting that one reason that management might have "no idea how it actually operates" was because operators were actively hiding it from them, they received a consistent response: experimentation and the communication of new knowledge to management was costly. As explained by a nine-year veteran of the factory who had worked her way from ordinary operator to line leader and now to a training coordinator in the HR department,

> It's easy for workers to find something that works better. They have very valuable input. As someone who is in close contact with the line, I know what works well. But when you tell others, they'll say, "How do we know how much value this has?" We don't have the kind of data they want, and we can't make a case for our findings.

For an operator, successfully transferring knowledge highly situated in his or her task first required transforming that knowledge into common language (Bechky, 2003), namely, data-driven analytical language that spanned organizational divides between roles (management or operator), functions (engineer or operator), training (skilled or unskilled), or tasks (line designer or line operator). But for an operator in this facility, busily doing one set of tasks 2,400 times per shift, it was far less costly to hide that knowledge than share it—keeping it private meant, in one operator's words, "Everyone is happy: management sees what they want to see, and we meet our production quantity and quality targets." Line leaders, who had to manage across this divide in understandings, described themselves as having the hardest jobs, needing to "make the impossible possible." But as one line leader told us, the best line leaders did so by always "keeping one eye closed and one eye open"—maintaining a privileged position of awareness on both sides of the privacy boundary while being careful not to pierce it, for fear of the negative performance implications of doing so. When line leaders were with supervisors, they pretended not to see the productive deviance; when surrounded only by their team, it was okay for them to quite obviously observe it. As one line leader put it, "Even if we had the time to explain, and they had the time to listen, it wouldn't be as efficient as just solving the problem now and then discussing it later. Because there is so much variation, we need to fix first, explain later."

Discussion

Privacy and the reverse Hawthorne effect. The participant-observers' experiences at Precision were not consistent with prior theory that transparency enables performance. Instead, transparency appeared to *keep* operators from getting their best work done. The operators' choice of the word "privacy" went to the core of my observations of these behavioral responses to transparent factory design. Mechanisms for achieving transparency not only improved the vision of the observer but also of the observed, and increased awareness of being observed in this setting had a negative impact on performance, generating a reverse Hawthorne effect.

This unanticipated outcome may, in part, be explained by Zajonc's (1965) finding that mere exposure to others affects individual behavior by activating dominant, practiced responses over experimental, riskier, learning responses, possibly more so in an evaluative context (Cottrell, 1972), and has been found to encourage a number of other social facilitation dysfunctions (Hackman, 1976; Bond and Titus, 1983). Similarly, at the group level, increased observability can lead to less effective brainstorming (Paulus, Larey, and Ortega, 1995), blind conformity (Asch, 1951, 1956), and groupthink (Janis, 1982). But qualitative data collected at Precision suggests that the reverse Hawthorne effect went beyond passive social facilitation effects to something more intentional and strategic, thus necessitating a look at the full implications of what the operators referred to as the need for and value of "privacy" on the factory floor.

A vast interdisciplinary body of theory, located primarily outside of the management sciences, argues for the existence of an instrumental human need for transparency's opposite, privacy—what Burgoon et al. (1989: 132) defined as "the ability to control and limit physical, interactional, psychological, and informational access to the self or to one's group" (see also Westin, 1967; Altman, 1975; Parent, 1983; Schoeman, 1984; Solove, 2008). The need for privacy exists at both individual and group levels. Simmel (1957: 1) stated that normal human behavior involves cycles of engagement and withdrawal from others—"directly as well as symbolically, bodily as well as spiritually, we are continually separating our bonds and binding our separations." Boundaries providing freedom from transparency, creating a state of privacy, have been found to enable the authenticity required for meaningful experimentation (Simmel, 1950), the generation of new ideas (Eysenck, 1995; Hargadon, 2003; Simonton, 2003; cf. Sutton and Kelley, 1997), the maintenance of expertise attached to professional identity (Anteby, 2008), the capacity to trust others (Scheler, 1957), and the maintenance of long-term meaningful relationships and group associations (Mill, 1859; Simmel, 1950; Schwarz, 1968; Ingham, 1978; Kanter and Khurana, 2009), all behaviors associated with effective knowledge sharing (Edmondson, 2002) and "enabling" operational control (Hackman and Wageman, 1995; Adler and Borys, 1996). In this body of literature, privacy is the solution for those who identify a panopticon-like awareness of being visible (Foucault, 1977: 201–203) to be a problem.

While use of the term "privacy" has not diffused broadly from the jurisprudential and philosophical literatures into the management sciences, a number of pivotal studies in organizational behavior have touched on the value of privacy without using the term itself. Rich discussions of the value of boundaries in both the sociological and networks literatures (for reviews, see Lamont and Molnar, 2002; Lazer and Friedman, 2007, respectively) suggest that forming productive individual and group identity requires four components, the first of which is "a boundary separating me from you or us from them" (Tilly, 2003) or what the PrecisionMobile operators called the "privacy *we* need to get our work done" (emphasis added). Although a highly productive literature has emerged on the management of knowledge across such boundaries (e.g., Carlile, 2004; O'Mahony and Bechky, 2008), few management scholars have focused on the strategic placement or creation of the boundaries themselves. Yet if privacy breeds authenticity, and authenticity enables engaging in hidden yet beneficial behavior, the creation of organizational boundaries should be of great strategic importance. “Boundary objects” are required for defining different social worlds (Star and Griesemer, 1989), can take the form of “material objects, organizational forms, conceptual spaces or procedures” (Lamont and Molnar, 2002: 180), and have been found to be important for supporting coordinated action and common knowledge at the group level (Chwe, 2001). There are, of course, group and individual boundary objects that do not involve physical perimeters or “borders” (e.g., race, gender, status), but those that do rely on some degree of visibility-based privacy (e.g., a wall, fence, cubicle) to demarcate “us” from “them” (Lamont and Molnar, 2002). Where such boundaries are permitted, and how permeable they are, has profound implications for one’s feeling of privacy and, therefore, behavior. Where such boundaries are prohibited, at least in the case of Precision, the implication appears to be rampant, creative, and costly hiding of deviant behavior, precisely the kind of hiding that transparency is theorized to avoid.

STUDY 2: FIELD EXPERIMENT

Methods

Viewing PrecisionMobile’s lack of transparency as a failure of organizational learning and operational control (Tucker, Edmondson, and Spear, 2002), I returned to the site with two different undergraduates to be embedded in the lines, one male and one female, and the intention of implementing a field experiment. I again chose to study the lines representing the largest volume product, this time 3G USB datacards, as the mix of the factory production had shifted substantially from phones to wireless data devices over the ten months since the first study. Although the number of operating lines varied by day depending on production needs, on average there were 16 lines producing nearly the same products across two shifts (day and night), or 32 line-shifts total, representing a total production capacity of roughly half a million 3G USB datacards per week. Two lines (four line-shifts) were randomly selected for the experimental condition, leaving 28 line-shifts in the treatment control. Operators had been randomly assigned to lines when the lines were initially staffed, thus ensuring no systematic differences at the outset, and operators rarely permanently switched lines before the end of a product's production life cycle, containing diffusion of the treatment condition across lines. Through the management information systems, I tracked detailed hourly production and quality data for all 32 lines. To supplement the quantitative data, I assigned one embed to a treatment line and one embed to a control line, although neither embed was told details of the treatments prior to implementation. The embeds were onsite for the first five weeks of the five-month experiment, conducted a series of exit interviews, and subsequently stayed in touch with several operators on the line via periodic phone calls to get updates. As before, all conversations were transcribed and translated.

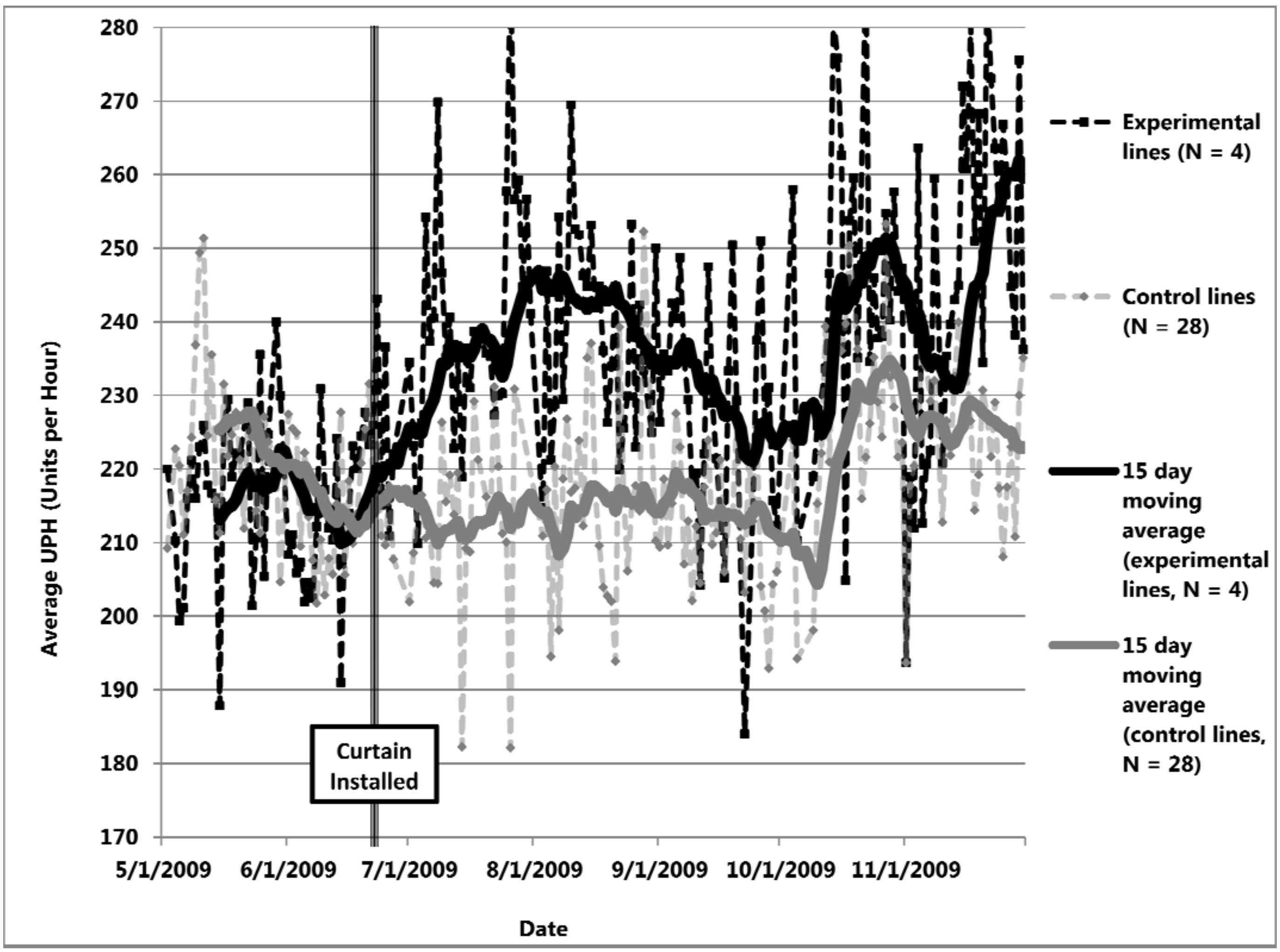
At its best, executing a field experiment is an inductive process that iteratively incorporates the input of the individuals involved (Perlow, 1999). In preparation for the experimental treatments, I asked PrecisionMobile's engineering department to put up a curtain between an adjacent pair of experimental and control lines to avoid cross-treatment contamination. In this setting, changes to the factory environment are common, so a change such as the curtain was not out of the ordinary. Given the repetitive nature of the work tasks, however, environmental changes typically serve as topics of conversation, as did this one. The embeds reported multiple theories circulating among the operators on the purpose of the curtain. When the curtain bar was initially hung from the ceiling, "people joked that they could hang their clothes on it." When the curtain went up, an operator "made a swine flu joke out of it, saying that people with the disease will be quarantined on the other side." And then the operator adjacent to one embed said, "Wouldn't it be nice if they hung up curtains all around the line, so we can be completely closed off? We could be so much more productive if they did that." Although the originally planned intervention involved increased transparency, not less, I decided to implement her idea in place of our own. Starting several days later, for five consecutive months, the four experimental lines operated inside the equivalent of a hospital bed curtain.

To ensure a clean experimental design, in which the relationship between privacy and performance was accurately instrumented, I painstakingly controlled for Hawthorne effects. A Hawthorne effect, first understood through the research done at the Western Electric Hawthorne Works in the 1920s and replicated elsewhere, refers to a circumstance in which subjects improve the aspect of their behavior being experimentally measured simply in response to the fact that they are being studied, not in response to any experimental manipulation (Mayo, 1933; Roethlisberger and Dickson, 1939). Although the presence of a Hawthorne effect has been called into question (Carey, 1967; Jones, 1992; Levitt and List, 2009), anticipating a potential Hawthorne effect, I carefully designed this field experiment to avoid it. Because the same space is used by the day and night shifts, the curtains—once installed—were present for both shifts, but the night shift was under the clear impression that the curtains were "for something that the day shift was doing," an impression the research team heard about but neither created nor disproved. The proliferation of that impression among the night shift thereby eliminated the possibility that changes in the night shift's performance were a response to feeling special or believing that they were being studied, because they did not think they were. Rather, any changes to the night shift's performance could be tied to the reduced transparency afforded by the experimental treatment, i.e., the curtain.

Results

Performance on each of the four lines surrounded by curtains, measured in defect-free units per hour (UPH), increased by as much as 10–15 percent after the first week and maintained a lead over the 28 control lines for the remaining five months of the experiment. Figure 1 provides a graphical representation, as well as reflecting changes in operating days over the study period. The pre-curtain period includes 55 operating days from May 1, 2009 through June 27, 2009. The post-curtain-installation period includes 142 operating days from June 28, 2009 through November 30, 2009. There was no production on May 1, May 28, and October 1–3 due to national statutory holidays in China. There was no production on June 28–30, August 1–2, August 29, October 6–8, and November 9 due to line maintenance and inventory counts. There was no production on May 3 and July 19, both Sundays, due to insufficient production demand to drive Sunday overtime.

Figure 1. Line performance on experimental and control lines.*



* Performance was measured as defect-free hourly output (units per hour) during full hours of production.

Table 2 gives descriptive statistics for each relevant grouping of lines. Operators rotate, as a line, between day and night shifts roughly every month. From May 1 to November 30, 2009, the lines being studied shifted between day and night shifts on May 28, June 30, August 1, August 29, October 6, and November 9. The "rotating" figures in table 2 reflect production keeping the operator group constant (i.e., it tracks the production of a specified set of people who were initially on the day or night shift at the start of this study). The "day" and "night" figures in the table track production on those shifts, regardless of the rotation of the operators. The descriptive statistics demonstrate the degree of improvement on the experimental lines. Because accepted wisdom at Precision held that the night shift's performance at this site was lower, table 2 breaks out the day and night shifts individually. Because operators on the line cycle from day shift to night shift monthly or semi-monthly (i.e., operators on Line F60-Day rotate together to Line F60-Night and vice versa), for purposes of excluding the

Table 2. Line Performance Descriptive Statistics in Units per Hour (UPH), Grouped by Treatment and Control Groups

	Mean	S.D.	Median
All shifts			
Control lines, pre-curtain	219.071	12.679	219.359
Control lines, post-curtain	218.158	16.359	217.881
Treatment lines, pre-curtain	216.013	16.212	217.820
Treatment lines, post-curtain	240.027	24.924	238.352
Day shift			
Control lines, pre-curtain	219.230	11.352	219.927
Control lines, post-curtain	215.400	16.046	214.394
Treatment lines, pre-curtain	220.122	13.984	222.161
Treatment lines, post-curtain	233.052	21.454	232.200
Night shift			
Control lines, pre-curtain	218.913	13.986	218.025
Control lines, post-curtain	220.917	16.260	220.573
Treatment lines, pre-curtain	211.739	17.369	213.752
Treatment lines, post-curtain	246.949	26.245	246.370
Initial day shift (rotating)			
Control lines, pre-curtain	219.534	12.033	220.646
Control lines, post-curtain	216.579	19.982	217.620
Treatment lines, pre-curtain	215.350	17.036	217.639
Treatment lines, post-curtain	237.983	22.843	238.352
Initial night shift (rotating)			
Control lines, pre-curtain	218.609	13.390	218.750
Control lines, post-curtain	217.271	16.869	217.582
Treatment lines, pre-curtain	216.675	15.487	219.583
Treatment lines, post-curtain	242.056	26.765	238.661

Hawthorne effect as a potential explanation for the performance improvement, it was necessary to follow the groups of people as they rotated back and forth. The last two sections of table 2 show descriptive statistics for those groups. Even as lines rotated, my embeds confirmed, operators did not communicate across shifts, as one shift was sleeping while the other was working.

A difference-in-differences estimation model confirms this performance improvement result and permits a more disaggregated, hour-by-hour analysis of the data. Difference-in-differences estimation has become an increasingly popular way to estimate causal relationships (Bertrand, Duflo, and Mullainathan, 2004) and consists of first identifying a specific intervention or treatment and then comparing the difference in outcomes, before and after the intervention, for groups affected by the intervention to the same difference for unaffected groups. Difference-in-differences estimation models have three primary advantages: simplicity, the potential to circumvent many of the endogeneity problems characteristic of cross-sectional analysis, and robustness, assuming appropriate corrections for serial correlation are made (Bertrand, Duflo, and Mullainathan, 2004). The basic estimation model is:

$$Y = \beta_0 + \beta_1 * dExp + \beta_2 * dTime + \beta_3 * dTime * dExp + \varepsilon \qquad (1)$$

where Y is the units per hour produced on the line, dExp is a dummy variable expressing whether a line is an experimental (1) or control (0) line, dTime is a dummy variable expressing whether the time is before (0) or after (1) the intervention, and dTime*dExp is the interaction of the two. I avoided selection endogeneity by randomly selecting treatment and control lines.

Table 3. Difference-in-differences GLS Fixed-effects Models of Performance in Units per Hour*

Variable	Grouped daily average (1)	Grouped daily average w/ night/day (2)	Daily average w/ line fixed effects (3)	Daily average w/ line and day fixed effects (4)	Hourly w/ line fixed effects (5)	Hourly w/ line and day fixed effects (6)	"Pre" vs. "post" average line performance (7)
dExperiment	-3.0589	-3.0031	-13.8405***	-12.8712***	-10.8821***	-11.0778***	1.9609
	(2.0120)	(2.1103)	(4.1962)	(4.4123)	(4.2604)	(4.3133)	(6.7335)
dTime	-0.9136	-0.9136	-1.0369	-1.0297	-0.5343	-3.6684	-5.2705
	(1.5711)	(1.5897)	(2.0320)	(6.2442)	(1.4557)	(34.1629)	(3.9941)
dExperiment * dTime	24.9283***	24.8616***	16.2871***	16.7360**	14.5674***	14.5173***	21.2457**
	(2.7269)	(2.7729)	(3.6463)	(3.6777)	(2.6433)	(2.6998)	(9.5666)
dNight		5.6835***	-10.2238*	-8.8509	-67.1293***	-65.3274***	
		(1.4087)	(6.1304)	(6.4850)	(6.2139)	(6.7010)	
Constant	219.0714***	216.2296***	217.4635***	216.0429***	215.8333***	195.2289***	203.2387***
	(1.2176)	(1.4055)	(2.8986)	(6.3682)	(3.4439)	(12.5507)	(2.7490)
R-squared	0.2307	0.2474	0.1084	0.2186	0.0299	0.0531	0.2206
Observations	741	741	2799	2799	25040	25040	46

* $p < .10$; ** $p < .05$; *** $p < .01$.

* Models are GLS fixed-effects models with heteroskedasticity-robust standard errors in parentheses. Models 3–6 include fixed effects for lines, which are not shown. Models 4 and 6 include fixed effects for day, which are not shown. Model 7 is a robustness check based on Bertrand, Duflo, and Mullainathan's (2000) suggested remedy (for a small number of groups) for potentially inflated standard errors of difference-in-differences estimates due to serial correlation with data from a large number of periods.

Table 3 reports the results of the difference-in-differences estimation models. In model 1 and model 2, performance is measured as an average of the units per hour produced per day on the experimental and control groupings of lines. Model 3 and model 4 disaggregate the groups into individual lines, using instead the average unit per hour production of each individual line as the dependent variable. That disaggregation also permits controls for line fixed effects in both models 3 and 4 and day fixed effects in model 4. Models 5 and 6 disaggregate the daily production averages into actual hourly production, again controlling for line fixed effects in both models 5 and 6 and day fixed effects in model 6. In each model, the interaction term dTime*dExp is highly significant and positive, indicating a sustained and significant improvement in production on the lines surrounded by curtains.

As difference-in-differences estimates have been shown to suffer from inflated standard errors due to serial correlation with data from a large number of periods (Bertrand, Duflo, and Mullainathan, 2004), I used Bertrand, Duflo, and Mullainathan's suggested remedy of collapsing the time series information into a "pre" and "post" period by group, which they argue to be valid when a small number of groups is involved. Doing so, in effect, takes into account the effective sample size and thus avoids over-estimation of significance levels. In this study, each of the 32 lines represents a "group" as defined by Bertrand and colleagues, with "pre" and "post" periods defined as the time before and after the curtains were installed. As shown in model 7, the dTime*dExp variable remains significant at a 5-percent significance level.

The qualitative data collected by the embedded participant-observers on the line during the first month of the experiment, supported by a series of 15 detailed interviews conducted by the participant-observers after the experiment, offer highly detailed accounts of the mechanisms behind this performance improvement. According to the operators on the line, three categories of changes contributed roughly equally to the boost in performance: (1) privacy to permit *tweaking* the line as temporary issues arise (productive deviance); (2) privacy to permit *experimenting* with new ideas prior to explaining them to management; and (3) privacy to permit *avoiding interruptions with negative consequences* from outside of the line without engaging in value-reducing hiding activities.

Tweaking: Real-time, Temporary Adjustments to the Line

The manual assembly of 2,400 devices per shift involves the timely and intricate mixture of three sets of ingredients: roughly a million components, approximately 100 assembly tools, and roughly six dozen people—half line operators, half functional support (e.g., materials, quality assurance) or experts (e.g., process engineers, industrial engineers, or technical engineers). There can be great variance in each of those ingredients: components can be defective, assembly tools can break down, and human beings can have bad days. As one line supporter explained,

> When unexpected things happen, operators need to tweak the line to solve the problem, minimize its impact, and stay on track to meet our production target. But if anyone outside of the line catches us operating in non-TQC ways [i.e., not according to the total quality control charts posted in front of each station], they will blame the problem on the fact that we are not following the TQC, even though that's the solution to the problem and not the problem itself.

When problems arise, problem-solving activities attract attention to the line, thereby making it harder for operators to tweak their activities. Instead, they end up "slowing down or even stopping the line and waiting for experts to come and solve the problem," which "can take a long time," according to several of the operators the embeds interviewed. For example, one embed witnessed the emergence of a significant bottleneck on her line that "drew management attention immediately but then led to a two-hour wait before the correct process engineer could authorize an official fix to the problem."

The curtain changed this dynamic significantly. Whereas privacy to tweak the line had previously been achieved through carefully hiding the adjustments, the privacy curtain substituted for that hiding behavior, making tweaking *within* the curtain far more transparent to other operators on the line. The curtain provided privacy for "incubation" and "elaboration" of their ideas with relevant others (Csikszentmihalyi and Sawyer, 1995: 340, 344). Tweaking was particularly prevalent with respect to allocating tasks to workers, one traditional form of productive deviance. As temporary bottlenecks arose, "workers moved fluidly to reduce them"—the line's own form of organizational improvisation (Barrett, 1998). Having previously observed workers dedicated exclusively to one station for months or even years, after the installation of the curtain, the embeds were "surprised at how many of the operators had cross-trained themselves on other stations, especially those immediately adjacent to their own." The workers reported this fluidity to us as “making the line feel more like a team.” In fact, the operator who originally suggested the curtain, when interviewed at the end of the experiment, told us that “when I brought up that suggestion, I was thinking that the curtain could potentially make our line look more like a team, so that the whole production can be team work.” The curtain transformed the work from individual to collective via common knowledge (Chwe, 2001), even without changing the tasks themselves. Just as strategic alliance teams are more successful with space to “learn to work together away from the spotlights” (Doz, 1996: 68), team learning at Precision benefitted from the curtain’s shield against the spotlight of the factory floor. The line leader was clear that serious line problems, including persistent bottlenecks, would still be resolved by “opening the curtain and escalating the problem to engineering or management,” since that was “their job” to fix. But temporary issues that could be solved or at least mitigated locally would be handled by the line, through line-level learning, “to avoid slowing down production in the short term.” The engineers were still observing the performance of the lines electronically at their server stations, so when the line went down, “they would arrive on their typical schedule,” no faster or slower than before the curtain. Although not all tweaks were beneficial, the performance data are unequivocal in demonstrating, on the whole, that they were positive for line performance, both for the day shift and the Hawthorne-controlled night shift.

In addition to static line improvements upon installation of the curtain, the effectiveness of tweaking also improved dynamically over the five months of the experiment. The curtain, while shielding tweaking from immediate interruption, simultaneously provided the privacy necessary for operators to engage in activities intended to improve their capability to tweak. For example, one embed reported that “when people weren’t as busy [during unavoidable production downtime and/or lower target production days], I saw people switch roles a lot so that they can learn multiple tasks.” This sort of cross-training would have been nearly impossible in the visible condition because it would “draw attention to the line," but with visible privacy, operators were able to self-train in order to make the line more fluid for future tweaking.

Self-training extended beyond switching tasks to attempts to increase the scope of what could be safely and effectively tweaked. For example, one of the challenges for operators was that "most of the computer-based tasks, including stations designed to load software onto the devices, test the software, and test the send/receive transmission functions, was run using English-based software"—an unavoidable circumstance for PrecisionMobile, as the proprietary software was provided by an English-based engineering division of this customer's (OEM) organization. As a result, "computer training for operators involved memorizing a specific set of actions": when the embed was trained on the computer, she was told "click the first button here, and the second button here, when this menu comes up, click this button, and then pick the third one from the top." Because she understood English, the embed learned it quickly. But for the average operator, "the process involves rote memorization." When the process works properly, a green "OK" pops up on the screen and is recognizable. But error messages in red are typically "undecipherable to operators, requiring them to stop and wait for an engineer to come fix the problem for them"—a problem they could often fix themselves if they understood the error message (often as simple as "software upload failed—please try again"). On the first day after the curtain went up, an embed observed the line supporter on one of the curtained lines instructing

> . . . everyone, especially those at the computers, to copy down error messages they don't understand while they were working. So a couple of women who work with me at the scanning stations were copying down words constantly. Anything red came up, she was writing them down and trying to figure out what they mean. They were being very diligent about that . . . I was really impressed.

The line supporter subsequently "brought that list to a cooperative English-speaking engineering manager, who helped him translate. He posted the translations next to the computer so that operators could problem solve themselves," when possible. For a different computer terminal, which spit out error messages in programming code, they pursued a similar strategy. As a result, the line became better and better, over time, at tweaking the process such that they could maintain production speed in the event of temporary issues, which were reported to the engineering department in parallel (automatically via the IT system) for ultimate resolution.

Ironically, operators explained that although the privacy curtain permitted tweaking, it was the resulting transparency that emerged inside the curtain that allowed it to be effective. The purpose of tweaking was, as before, to "ensure that production and quality targets were met." For the "team" to be effective in knowing when to tweak, progress toward targets needed to be transparent. The operators' solution to this was also noteworthy: first, they moved the production reporting whiteboards outside of the curtain and continued to "smooth" the hourly reporting such that targets were consistently and smoothly met; then, they put the actual production, as tracked in real time by the IT system, on several computer monitors around the line "so that members of the line would always know whether they were actually on track to meeting targets." Carrying that idea one step farther, they subsequently asked the engineering department to "install a large monitor at the end of their lines [inside the curtain] to show simply their shift's production target [manually entered] and their real-time progress towards that goal." Online Appendix B provides photographs of the whiteboard outside the curtain with the smoothed hourly reporting and the computer monitor inside the curtain that was tracking real-time production.

Group-level privacy was effective in creating a knowledge-centric in-group and out-group (McGrath, 1984), although the qualitative data suggest that the productivity improvement was due more to the benefits of privacy itself than feelings of in-group and out-group. In the embeds' view, cultural norms in China made it particularly inappropriate to point out others' mistakes publicly, especially when those others were not junior to the individual in question. By adopting processes that were better than others' plans, "an operator would essentially be pointing out another's mistake publicly, if observed by others—and especially if observed, by chance, by the person who came up with the original process." The more culturally appropriate approach was to hide the improvement. The curtained boundary, by providing visible privacy, had removed the need for encryption, but only within the curtain, where the individual was certain that the original inventor would not see.

Experimenting with New Knowledge before Sharing It

In concert with temporary tweaking, visible privacy appears to have encouraged operators within the curtain to "experiment with an increased number of permanent improvements to the line." Upon the curtain going up, one embed commented that the supporter on her line "walked around the line and was being very quiet, staring at every single station, pondering it for a while, looking for any possible improvement." The embeds, for example, tracked a list of 16 innovations with which the operators experimented during the first week of the five-month experiment. Based on the embeds' experience on the line, they reported that the "innovations were a mix of preexisting and new ideas: some of these were ideas that were just waiting for an opportunity at experimentation, while others reflected novel learning on the line through the increased levels of experimentation the curtain enabled."

The visible boundary provided by the curtain enabled experimentation through two mechanisms. First, it "allowed the line to collaborate on new ideas." As one line supporter explained prior to installation of the curtain, "When we experiment with changing these things, when we are in a small clump discussing issues, or when we help each other when we move around and do things that we are technically not allowed to do, how do we stop the 6S people, the QA people, and the general managers from coming around and questioning us? Sometimes [observers] don't even have authority over our line, but they still intervene." Second, the curtain provided the flexibility that has been deemed necessary to create successful prototypes of process innovations before sharing them (Thomke, Hippel, and Franke, 1998). As an operator who contributed a number of new ideas explained after the experiment, “We have all of these ideas . . . but how do we feel safe to try them? We’ll experiment as long as the consequences aren’t so great. As long as the price we pay isn’t so great.” When senior managers later heard these quotes, they were surprised. Precision not only encourages learning on the line, but they are constantly searching for productivity improvements, as every little idea contributes to their razor-thin margins. Senior managers immediately questioned “why middle managers were not taking advantage of these ideas.” But a question made them pause: how was middle management to evaluate whether these ideas were good or not? The only way to evaluate these sorts of manual process innovations is to prototype them, analyze the performance changes, and then make a decision. Trying new ideas, however, could happen only at the expense of variation from exploiting existing best practices, and that was a tradeoff that middle management had insufficient incentives to make (March, 1991). The best people to make such judgment calls were those individuals who actually completed these tasks 2,400 times per day: the operators.

The privacy curtain provided operators with just enough privacy to experiment within the bounds of acceptability, enabling on-the-line experimentation. Having produced 2,400 units per day, often for months or even years, individual workers had developed a number of bottom-up innovations to improve existing processes, which needed trial-and-error experimentation to prove, disprove, or develop further. Under the observation of management, the cost to the workers of sharing, explaining, and/or fighting for their innovations “simply outweighed the benefits,” a finding consistent with organizational learning failures previously observed in nursing operations (Tucker, Edmondson, and Spear, 2002). Some degree of privacy was required to experiment, develop a prototype process, and prove the concept prior to sharing. Online Appendix B provides photographs showing operators at their own stations and operators in the curtained line congregating at one station to solve a problem, something that would not have happened when the line was always observable.

Even with the curtain, sharing remained an important part of the process, not just for organizational learning but also for the operators themselves. The "pride of using an improvement to produce faster than the other lines" was at least a part of the motivation driving operators to experiment. Operators from different lines would often compare, late in the shift, various lines' production for the day, with "admiration" offered to the top achievers followed by peer-to-peer demonstrations of "how they made so much so quickly." Even the embeds picked up this habit: evening debriefings naturally tended to start with some form of the phrase, "we made [this many] devices today." While the factory provided excellent working conditions for China, factory life was not easy, and a great deal of encouragement took the form of peer-to-peer factory floor wisdom. When one of the embeds asked why she should bother to do any more than the minimum, one of the factory women responded, "if you quit, then they have won. If you want to win, you stick here and you work your hardest and you prove to them that they are wrong [about your lack of ability to make it in this environment]." Sharing a real improvement, home-grown by an operator on the line, was one of the best forms of winning.

Even when pride was insufficient to motivate sharing, good ideas spread quickly. While activity on the line became less visible with the curtain, line performance and quality remained extremely transparent. According to an operator after the experiment, it "took about a month for the analysts to notice, in their monthly report, the performance improvements" that resulted, but once they noticed, there were "plenty of people going inside the curtain to see what was different." A line leader told us that the analysts also noticed the increase in variance on those lines, but any concerns about the increased variance were quickly "overlooked in light of the interest in the increased performance." The curtain provided sufficient privacy to keep the unwanted variance under the radar long enough to generate a proof of the benefits from experimentation.

Avoiding Interruptions with Negative Consequences: The Benefits of Management by Standing Still

A third source of the curtain's performance boost came simply from removing the need for operators to engage in many of the non-value-added hiding activities. The system of codes and hiding behaviors that operators adopted when being observed reduced productivity, and those non-value-added hiding activities were both systematic and non-trivial. As one embed explained,

> The wording that the supporter used for watching out for managers was "fang shao." In Chinese, that phrase refers to the lookout person traditionally assigned to watch out for cops during an illicit activity, or during war to watch out for enemy activity while the rest of the unit is doing something. So the supporters think that's part of their job—that's part of what they are supposed to do in their daily organizational lives.

And when the signal is given, everyone assumes the hidden, less-productive version of their working task. From a productivity standpoint, both the lookout and hiding activities represented a waste of time and effort. As one operator said simply, "If we didn't need to hide things from the management levels, we could finish production so much faster." That indeed appears to have been true.

Even if visits by managers with formal authority over the line were relatively infrequent, others could provide an equivalent interruption. Categories of work interruptions include both intrusions and disruptions (Jett and George, 2003), and the curtain enabled the reduction of both, especially those that had a negative effect on productivity. As one line leader explained, "People who have nothing to do with this line need to get away, because materials people, random engineers, random management . . . they come around and distract you. That's the first reason—because they come and chat with you, they chat with your neighbor, and that distracts you. And sometimes they play with your material . . . it's distracting." As an operator added, "It's already hard to keep track of everything and make sure I do everything correctly. They come around, they pick up a card, they play with it . . . then I have to pay attention to the card that they are playing with, make sure they don't break it, make sure they don't walk away with it . . . it's just extra wasted time that I don't have." The privacy of the curtain thus permitted added concentration on the tasks of the line. With fewer visual distractions and physical intrusions, it also focused operators' attention on the social unit inside of the curtain (Dunbar, 1992)—on both the people and the tasks contained on the line—much the way psychotherapists set up therapy environments to keep patients "on-story" by shutting out extraneous stimuli (Gabbard, 2005). This, one operator explained, is what led to a stronger sense of "team spirit" on the line. Perhaps the best indicator of this spirit was the fact that the curtained lines quickly also became the loudest, with the most talking inside. While one senior leader from a different line "really dislikes people talking during production because she thinks it slows down the production," the curtain provided a boundary to minimize her impact on the line that was not hers to manage.

Interruptions can also have a positive impact on productivity (Jett and George, 2003: 497; Staats and Gino, 2012) by providing variety, motivation, stimulation, or valuable perturbations, so a blanket removal of intrusions could have a negative effect on organizational performance. Interestingly, the curtain appears to have been sufficiently permeable to block many negative intrusions and disruptions without impeding all positive ones. Managers could still come and go as they pleased, and those interruptions—although now perceived to be "less frequent"—were reported to be "more valuable," on average. As one line supporter explained, "When management comes into the curtain now, it is more often for good reasons. People only come to this line when it is a purposeful destination, not when it is a convenient place to stop, look busy, and be an imposition." Although PrecisionMobile, like many organizations, encouraged management by walking around (Peters and Waterman, 1982: 121), an incremental increase in the time management spent standing still, due to the reduced observability and access enabled by the curtain, appears to have had a positive impact on performance.

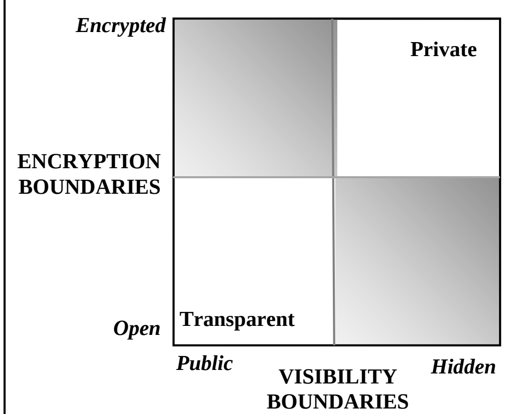
Ironically, operators also saw a downside to this aspect of the curtain. In interviews after the experiment, several operators mentioned that the curtain prevented them from "seeing the management coming as quickly" and therefore occasionally put them at greater risk of being "caught doing something [they] were not supposed to be doing." But here, too, operators learned to improvise. Movement of the curtain by the entrance to the line became a signal of possible intrusion and triggered caution on the line. To avoid triggering that response themselves, operators started using the back or side exits rather than the front. Beyond the curtain, nothing had changed. Inside the curtain, however, transparency replaced the previously prevalent and highly guarded hiding behavior.

GENERAL DISCUSSION

The research at PrecisionMobile illustrates the transparency paradox: observability may *reduce* performance by inducing those being observed to conceal their activities through codes and other costly means; conversely, creating zones of privacy may, under certain conditions, increase performance. Existing theory predicts that reduced observability will reduce both organizational learning and operational control, at a detriment to performance. At Precision, however, reducing observability simply dissolved the myths of control exposed in Study 1, while improving mechanisms for learning. As a result, through improved tweaking, experimentation, and distraction avoidance, group privacy enhanced performance.

At the heart of this finding is a question: when desired, how is group privacy achieved? A review of the philosophy literature on privacy supports the logical conclusion that it is accomplished in only one of two ways: either by blocking observability of people's actions through visibility boundaries, such as private offices, team meeting rooms, war rooms, or phone booths, or by blocking understanding of people's actions through encryption boundaries, such as the codes used by the mafia (Blok and Tilly, 1975; Gambetta, 1996), finals and eating clubs (Karabel, 2006), and the CIA (Marchetti and Marks, 1974). We either close the door, window, or curtain, or we speak in code that only chosen others can interpret. Because these two forms of privacy are substitutes in most cases, few organizations find the need to construct both. In either case, we achieve privacy and reduce transparency by creating either visibility boundaries or encryption boundaries to separate the private from the transparent. Figure 2 diagrams the means of achieving privacy by creating such boundaries.

Figure 2. Forms of privacy.



Why would groups, such as the lines studied at PrecisionMobile, choose one mechanism of privacy over another? Though the literature is silent on that question, this research suggests that encryption boundaries are costly to construct and deconstruct, given operators' complaints about the energy they needed to invest in efforts to hide behavior. Logic would therefore dictate that encryption boundaries would be reserved primarily for illegitimate hiding—as Schwartz (1968: 742) stated in paraphrasing Simmel (1964: 347, 364), "where [visibility-based] privacy is prohibited, man can only imagine separateness as an act of stealth." When privacy can be legitimized through physical boundaries, the need for costly "stealth" encryption dissipates.

How group privacy is achieved in organizations is therefore both a behavioral and a contingency-based phenomenon. Organizations decide how much visible group privacy to support; then groups decide how much code to implement to make up for remaining, unmet privacy needs. Ultimately, there may be agency at both senior levels (design) and lower levels (code) of the organization, with the lower level's code contingent upon the senior level's design.

PrecisionMobile is no exception. Prior to the installation of the curtain, transparency imposed through public visibility encouraged individuals to create privacy through encryption—a code that only peers could decipher—without the knowledge of management. With the installation of the curtain, a boundary to visibility was created, allowing operators to unencrypt their communication. For operators, encryption was a cost-benefit decision: with the installation of the curtain, the benefit of encryption was reduced, while the cost of maintaining the code remained the same. Thus the data demonstrated a contingent model of transparency: operators determined how to satisfy their instrumental needs for privacy depending on how transparently management designed their environment. At least at Precision, aiming for the high-visibility, low-encryption quadrant of figure 2 (bottom-left) would simply result in a high-visibility, high-encryption outcome (top-left), while aiming for the low-visibility, high-encryption quadrant of figure 2 (top-right) would result in a low-visibility, low-encryption outcome (bottom-right). In summary, only two of the four total outcomes were realistically achievable equilibria at Precision, as illustrated by the shaded quadrants in figure 2: high visibility, high encryption (top-left) or low visibility, low encryption (bottom-right). While most prior management scholarship (cf. Bechky, 2003; Gibson and Vermeulen, 2003) has assumed that visibility of action and accessibility of knowledge are logically collinear (Private-Transparent diagonal), this result provides evidence that they can be behaviorally orthogonal.

That result has implications for organizational theory, given that much of the existing discourse has focused on the movement from "private" to "transparent" organizations (cf. Best, 2005). At least at Precision, however, efforts to move to high visibility, low encryption, as established management precepts dictate, would result in the original status quo: a highly transparent organizational design with significant encryption in peer communication. Instead, a more valuable question is which of the two off-diagonal cells—privacy by encryption or privacy by visibility—are preferable for organizational learning, productivity, and performance. As demonstrated by this research at Precision, the choice of one type of boundary or another has profound implications for behavior and performance.

For Precision, movement from privacy by encryption to privacy by visibility through visible privacy—via curtains—resulted in valuable behavioral changes that made workers more productive. Although outside the scope of this work, existing literature would suggest that other interventions might have had similar effects, including the degree of workgroup autonomy (Hackman and Oldham, 1975), the presence of self-managed teams (Barker, 1993), or the use of autonomous workgroups (Pasmore et al., 1982). The links between this research on transparency and related aspects of those theories remain topics for further research. What is important to note here is that the curtain, as a weak, non-invasive intervention, held the above mostly constant: the qualitative data offered no evidence of changes in power, status, authority, or organizational culture as a result of the curtain. In a context in which real-time performance is so closely and transparently monitored by both Precision analysts and customers in real time, the curtain actually offered individual operators very little—only privacy of activity was granted, and a permeable, temporary, and delicate privacy boundary at that. Compared with significantly more invasive interventions such as those above, this intervention reflects a change of minimal cost. But the impact at the group level was substantial: a sustained marginal performance increase as large as 10–15 percent, induced from such a minor privacy intervention, is a testament to the potential value of zones of privacy.

Future Research

The field-based nature of this experimental research required focusing on a single site, making generalizability this study's largest potential limitation. This site is notable for both its Chinese location and its manufacturing focus. Several recent books and articles have described in detail the personal ambitions, challenges, successes, and failures of migrant workers in China who have fueled the Chinese outsourced-manufacturing miracle (Chang, 2008; Chen, 2008), while a number of other authors have contributed significantly to our understanding of management and organizational challenges specific to China (Tsui, 2007; Barney and Zhang, 2009). To the extent that the results presented here are influenced by the unique characteristics of Chinese manufacturing and migrant workers, generalizability beyond that context will be limited, although these features now characterize a majority of manufacturing production in the world.

There are, however, reasons to believe that these results are more universally applicable to organizations in other contexts. This highly operational context is one of the more conservative settings for an experiment of this kind. More so than most other areas of management theory, operations theory would predict transparency to be valuable for learning and performance, particularly on a factory floor, offering some indication that similar logic would hold in less industrial settings. Future research, either in other contexts or in the laboratory, can be used to study more scientifically how the results here may or may not generalize to other settings and geographies.

Similarly, because this research was limited to one organization to maintain the rigor and comparability of the field experiment, there was no variance in organizational culture and therefore no data to investigate the influence of organizational culture on the relationship between transparency and performance. There are reasons to believe that organizational culture could significantly affect that relationship. Research on Toyota, for example, suggests that knowledge transfer and organizational performance benefit from transparency in the presence of a complementary “culture of transparency” (Spear and Bowen, 1999). Given the inability of most organizations to replicate the success of the Toyota production system (Spear, 2009) and Toyota’s own recent inability to sustain it, organizational culture alone does not resolve the transparency paradox, but there are likely to be significant opportunities for future research on the role of organizational culture in moderating this relationship among transparency, learning, and control, on one hand, and performance on the other. Precision's managers believed they supported an organizational culture that encouraged speaking up (Detert and Edmondson, 2011) and discouraged organizational silence (Morrison and Milliken, 2000), but without comparison across sites, an empirical evaluation of the culture, either organizational or national, and its impact on the relationship between transparency and performance remains an opportunity for future research.

These findings about privacy are also specific to the group level of analysis. Privacy at the individual level may have different performance implications. Mas and Moretti (2009), for example, have found through a very careful study of supermarket checkout workers that individuals became more productive when they were within direct sight of higher-productivity workers, while recent work by Cain (2012) suggests that the opposite may be true for introverted individual types in other settings.

Finally, I was unfortunately unable to take the experiment full cycle by removing the curtains and observing the impact on performance. August through November is the busy season for PrecisionMobile, as over one-third of annual sales of mobile devices are estimated to occur during the winter holiday season. As cooperative as PrecisionMobile executives were, they were understandably reluctant to make any major modifications to the lines during peak season. Once the window for making changes reopened in December, product cycles had run their course, the product mix was changing rapidly, and the factory was once again reconfiguring itself—of the 32 lines I studied, only eight were scheduled to remain operational by the end of the month. In January, ordinary attrition also ran its course: after the Chinese New Year holidays, when all workers traditionally go home to visit family, fewer than half of the operators on the studied lines returned to the factory, with new operators taking their place. As a result, comparability between time periods became impossible to achieve. Future research may be able to examine the on-and-off cycling of visible privacy to understand more precisely the relationship among forms of privacy, learning, and organization design. A particularly fertile avenue of investigation would appear to be a study that investigated not whether there should be a curtain but, rather, when and for how long particular kinds of groups should be given their time inside the curtain.

The Paradox of Transparency

We typically assume that the more we can see, the more we can understand about an organization. This research suggests a counteracting force: the more that can be seen, the more individuals may respond strategically with hiding behavior and encryption to nullify the understanding of that which is seen. When boundaries to visibility fall, invisible boundaries to accurate understanding may replace them at a significant cost. In this research, that cost was a 10–15 percent detriment to performance.

Hence the transparency paradox: broad visibility, intended to increase transparency, can breed hiding behavior and myths of learning and control, thereby reducing transparency. Conversely, I have observed that transparency can actually increase within the boundaries of organizational modules, or what the operators called zones of privacy, when the visible component of transparency is decreased or limited between them.

This paper does not challenge the value of transparency. Instead, it challenges what, and how much, individual observers should see in order to achieve it. Because the mere presence of a manager, in line of sight of an employee, may affect employee performance in negative ways, management by walking around may sometimes be inferior to management by standing still. In this study, creating zones of privacy around line workers' activities did not result in slacking off or cutting corners. Instead, the zones of privacy improved transparency within the line and, with it, improved productive deviance, experimentation, and focus on productive work. While hourly defect-free production results remained transparent to all via the IT system, line activities remained visible only to those who were best suited to innovate: the line operators. The establishment of a zone of privacy around the line allowed improvement rights to be owned by those on the inside, encouraged more transparency within the visibility boundaries, and ultimately enabled an increase in organizational performance.

Visual privacy is an important performance lever but remains generally unrecognized and underutilized. Paradoxically, an organization that fails to design effective zones of privacy may inadvertently undermine its capacity for transparency.

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