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edited by

Beth A. Bechky
New York University

Kimberly D. Elsbach
University of California, Davis

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CHAPTER 5

THE TRANSFORMERS

Immigration and Tacit Knowledge Development

Natasha Iskander
New York University

Nichola Lowe
University of North Carolina

The movement of tacit knowledge across contexts remains a central concern among scholars who investigate knowledge production in organizations and industries. Scholars have identified highly skilled migrants as one important vector for the transfer of tacit knowledge. As migrants move across contexts, they bring with them both the tacit knowledge they acquired in other settings as well as implicit understandings of the rules about how to apply their tacit skill (Basri & Box, 2008; Peixoto, 2001; Poot, Waldorf, & Van Wissen, 2008). Studies document the way that knowledge workers facilitate the movement of expertise among economies, and the strategies they deploy, often quite purposefully, to erect institutions that support knowledge creation, with an emphasis on those that enable them

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to translate their knowledge across contexts (Hunter, Oswald, & Charlton, 2009; Kapur & McHale, 2005; Manon Domingues Dos & Postel-Vinay, 2003; Saxenian, 2006; Saxenian & Sabel, 2008). In fact, institutional change—its magnitude and the break it represents with past arrangements—is often used as an indicator of how profoundly these highly-skilled migrants refashion knowledge creation practices.

The migrants featured in these accounts are lauded as "institutional entrepreneurs" (DiMaggio, 1988) or "exemplary protagonists" (Saxenian & Sabel, 2008)—exceptionally endowed with the ability to identify supportive institutional arrangements, exceptionally connected to well-placed social actors, and exceptionally skilled at translating knowledge and institutional understandings across contexts (see Obukhova 2011, for a related critique). However, in their celebratory tone, these analyses tend to sail over the gritty, gradual, and often political, process of *how* these migrants actually create change.

This explanatory gap may stem from a pronounced rift in current organizational theories about tacit knowledge, whether those theories are applied to the study of migrants or used instead to understand knowledge practices of autochthonous workers. The processes of knowledge transformation and those of institutional reform have been addressed separately in a divide that reflects a fundamental difference in the approach used by practice-based inquires and institutional analyses to understand tacit knowledge. Theorists using a practice lens focus on knowledge creation and have considered the way knowledge is produced through everyday action (Feldman & Orlikowski, 2011; Lave, 1988; Orlikowski, 2002). They have stressed the constitutive role of knowledge practices in structuring organizational life (Feldman, 2000; Gherardi & Nicolini, 2000a), and have shown emphatically that the ways that actors create organizational structure through knowledge practices is complex, always evolving, and often highly contested (Bechky, 2003; Brown & Duguid, 1991; Cook & Yannow, 1993; Tsoukas & Chia, 2002). Of late, practice theorists have broadened their analysis of knowledge practices to look beyond the confines of organizational settings and to consider the broader set of institutions with which people engage (Bennett & Feldman, 1981; Binder, 2007; Hallett, 2010; Hargadon & Fanelli, 2002; Kellogg, 2009). In contrast to their careful attention to contingent fluidity of practices in organizations, however, their take on institutions remains somewhat static. When considered, institutions are most often represented as macrostructures that provide a backdrop for the quotidian exchanges through which tacit knowledge is produced but that are largely inured from any transformative effect they might have (Bechky, 2011).

Institutionalists, meanwhile, have viewed tacit knowledge as the stuff out of which institutions are made (DiMaggio & Powell, 1983; Gertler, 2004). Institutions, which extend beyond the confines of an individual firm or

organization, are portrayed as the embodiment of tacit knowledge about how work should be organized, how labor markets should function, and economic exchange should occur. Of late, institutionalists have shown a renewed interest in the ways that actors create, maintain, and amend institutions through everyday practices (Heaphy, 2013)—an interest in how institutions "are made and unmade" (Barley, 2008). Accounts of this stripe portray institutions as contingent structures that can be remolded through social processes (Battilana, 2006; Ewick & Silbey, 2003; Jacoby, 1985; Reay & Hinings, 2005; Van Maanen & Barley, 1982). In this sense, their representations resonate deeply with the claims of practice theorists. Still, even as this vein of scholarship has explored various forms of agency through which actors can chip away at existing institutional structures and create new ones, the production of tacit knowledge as a transformative practice has been given short shrift.

The divide between practice-based theorists and institutionalists in their approach to tacit knowledge production is curious because Polanyi, who most influentially differentiated the tacit dimension of knowledge from its explicit forms, viewed the practices of generating tacit knowledge and the production of the social rules that governed its use as one in the same. For Polanyi, the act of engaging with tacit knowledge—enacting "tacit knowing"—was no different than engaging with the conventions around how that knowing could be appropriately deployed (1958). Polanyi's concern was *how* a person came to know more than he could tell (1966, p. 10). Rather than parsing out tacit knowledge from the rules that govern its application and development, he explored the process through which actors "interiorize" both (Polanyi, 1966).

In this essay, we draw on Polanyi's framework to analyze how migrants amend at once the practices of tacit knowledge production and rules that govern its use (Basri & Box, 2008; Peixoto, 2001; Poot et al., 2008). To elucidate the rich processes through which migrants author these changes, we present a qualitative study of Mexican immigrants in the U.S. construction industry. The immigrants that are the subject of our study arrive in the United States with limited formal education, indeed most with less than a high school degree (Kochhar, 2008a). Construction labor market analyses as well as employers and other industry actors consider these less-educated migrants to be low-skilled, conflating formal training with acquired skill, and as a result, their role in the development of new knowledge and new institutional pathways for learning tends to be sidelined in scholarship and industry practices (Borjas, 2003; Dong, Fujimoto, Ringen, & Men, 2009). Over half our sample, however, entered the United States with substantial building experience, with competence that was deeply tacit and embodied, expressed primarily through their physical actions, but were faced with institutional constraints that made their competence difficult to demonstrate

and defend in the labor market. In focusing on this group of migrants, we sidestep the hazards of the "exemplary protagonist" explanation and avoid conflating the privileged access to institutional resources that elite knowledge workers enjoy with skillful action in knowledge transformation and for institutional change.

We find that, much like their counterparts with advanced degrees, these particular migrants purposefully transform their expertise, developing new and innovative forms of applied knowledge in the process. Likewise, we show that as they author new tacit knowledge practices, they also engage with and alter the industry institutions that govern what is considered skill and how it should be used. However, we also discover that their practices for transforming knowledge represent skillful responses to institutional constraints. They are in effect strategies designed to dismantle institutional obstacles to employment security and occupational advancement that these migrants face, and their resourceful deployment of their tacit skill demonstrates the function of knowledge transformation as a vehicle for institutional change.

Our first section turns to Polanyi's characterization of tacit "knowing" as a fluid, contingent form of relational knowledge, where the practices of exercising tacit competence are fused with practices of enacting rules that direct its use. Section 2 outlines our study design and summarizes the ethnographic research we conducted in our two U.S. research sites, as well as in Mexico. Section 3 describes the situated understandings that shape the use and development of tacit knowledge in Mexico's construction industry. Sections 4 and 5 compare the processes of tacit knowledge translation and creation that Mexican migrants developed in our two U.S. research sites, Philadelphia and Raleigh-Durham, and show how local institutions informed the skill areas in which workers innovated most intensively. Section 6 describes the implications of our findings for considering knowledge transformation through an analytic lens that features the relationship between institutions and practice.

SECTION 1: TACIT KNOWLEDGE AS RELATIONAL COMPETENCE

Tacit knowledge is broadly defined as understanding which is impossible to articulate fully (Polanyi, 1966; Collins, 2010). Folded deeply into practices of acting and thinking, it is learned and accessed through the physical senses, movement, emotions, intuition, and lived experience in ways that make it both intimately personal and constantly emergent (Collins, 2007; MacKenzie & Spinardi, 1995; Nonaka & von Krogh, 2009; Tsoukas, 2003). So wedded is it to physical senses, emotion, intuition, and lived experience

that it becomes "imperfectly accessible to conscious thought" (Gertler, 2003). Still, actors do talk about the tacit knowledge they possess, and demonstrate their expertise in ways that are socially understood and valued (Collins, 2010). But what then determines what we can, in fact, tell? What shapes what is viewed as knowledge and what are consider appropriate ways to exercise it? Polanyi's original work on tacit knowledge—or rather tacit knowing—provides us with the beginnings of the answer.

For Polanyi, tacit knowledge involves two terms, and the defining attribute of tacit knowing is how the relationship involving those two terms is constructed (Polanyi, 1966). In describing "the basic structure of tacit knowing," he asserts that one of these terms is "specifiably known" and can be clearly and explicitly identified as the focus on attention: This term is the subject of "focal awareness." The other term remains just below the line of consciousness, impossible to single out, and is the subject of "subsidiary awareness" (Polanyi, 1958). Knowledge terms in Polanyi's framework are inherently neither focal nor subsidiary but rather become so because of the way individuals engage with them (Polanyi, 1966). To illustrate this relationship, Polanyi himself provides an example involving construction work. The first time an aspiring novice picks up a hammer, he may be aware of its weight and of the sensation of the handle against his palm; in this first instance, these perceptions are new and foreign and thus, focal. He attends to his hand in an effort to understand the hammer as an object. Over time, as he learns to use it to drive in a nail, he focuses instead on the head of the hammer hitting the nail, and the feel of the hammer in his hand becomes familiar and intuitive—and thus, subsidiary. Polanyi explains:

> When we bring down the hammer we do not feel that its handle has struck our palm but that its head has struck the nail... The feeling in our palm and fingers... are not like the nail, objects of our attention, but instruments of it. (1958, p. 55)

He further specifies that in this process of transforming focal attention into subsidiary awareness, we make tools part of our own body: "We pour ourselves into them and assimilate them as part of our own existence" (1958, p. 59). The actor in his example comes to dwell in the hammer as if it were an extension of himself (1966).

The relationships that actors forge between subsidiary and focal terms of knowledge are contextual and make sense only within a situated set of practices and understandings: A hammer that is not conceptualized as a tool to hit a nail is reduced to a piece of wood and metal, and the relationship between subsidiary awareness of the handle in hand and the focal attention to the nail evaporates.

> I cannot identify the thing as a tool if I do not know what it is for—or if knowing its supposed purpose, I do not believe it to be useful for that purpose.... It may be an animal, like Alice's croquet hammer that walked away because it was a flamingo... or a peculiarly shaped object. (1958, p. 56)

The cognitive relationships that identify an object as a hammer and that support competence in striking a nail are at once individual accomplishments and collective achievements. A hammer being a hammer depends on a dense web of multiple connections between focal and subsidiary terms of knowledge in that space. Every act of tacit knowing, every attempt to forge a relationship between focal and subsidiary knowledge terms, according to Polanyi, is in effect an effort to comply with collective understandings about what constitutes a tool and what constitutes skill or expertise. Developing tacit knowledge requires both "the practical discovery of a wide range of not consciously known rules of skill and connoisseurship" (1958, p. 62) and an active support of those standards. In the exercise of tacit knowledge, people dwell not in the tool they use, but in the normative framework that govern its use. These collectively constructed "rules of skill" give social value to both tool and expertise: "The hammer, the probe, the spoken word all point beyond themselves and are endowed with meaning in this context" (1958, p. 65). When those collective understandings are disrupted, the competence that draws on this situated knowledge is affected: "This destroys one's sense of the context which alone can smoothly evoke the proper sequence of works, notes, or gestures" (1958, p. 56). Indeed, the very notion of what constitutes a tool may be undermined. "If we discredit the usefulness of a tool, its meaning as a tool is gone" (Polanyi, 1958, p. 58).

Polanyi observes how a web of cognitive relationships that coalesce into "rules of skill" apply directly to the movement of wielding a hammer, but also extend beyond this personal act and inform multiple interrelated levels of expertise. In this sense, these rules are what organizational theorist and industry analyst would define as institutions. "Take the art of making bricks," offers Polanyi to illustrate the salience of institutions to tacit knowing,

> It relies on its raw materials placed on a level below it. But above the brickmaker there operates the architect, relying on the brickmaker's work, and the architect in turn has to serve the town planner. To these four successive levels there correspond four successive layers of rules. (1966, p. 35–36)

Polanyi explains that skillful action at each level is shaped both by the norms that correspond to the expertise found there, but also by the norms that govern skillful action at the levels above. "Each level is subject to dual control; first, by the laws that apply to its elements in themselves, and second, by the laws that control the comprehensive entity formed by them" (1966, p. 35). Thus, the tacit skill involved in brickmaking allow a worker to tend to the consistency of the raw material, but also enables him to respond to building styles and conform to building codes that define urban form. Polayni's explication of the ways that norms at multiple registers inform a given artifact—a brick for example—is more specific than the broader constructionist view that artifacts embody not only knowledge directly related to them but also the history and social relations that pertain to their use (Gherardi & Nicolini, 2000b; Latour, 1987; Orlikowski, 1992). He specifies that the cognitive relationships between subsidiary and focal terms that make up the tacit skill required to complete a given task span multiple registers of knowledge. Some cognitive relationships pertain directly to the mechanics of an artifact or a task and others to the social and institutional conventions that govern its completion (Polanyi, 1966, p. 29–37). Actors can change focus depending on circumstances and the expertise called for. A brickmaker creating a new shape of brick may shift his focal attention several times, directing it to the physical properties of the raw material and the ways they might be manipulated to achieve a new brick design and then to the architectural drawings that specify the form and function of the new brick.

Polanyi trains his attention on the relative importance of different registers of rules depending on where actors place their cognitive emphasis. What he does not consider is what happens when people move across contexts to places where knowledge structured by rules are largely or wholly unfamiliar to them. Within his framework, immigration, which involves moving across situated knowledge contexts, can be thought of as disrupting the cognitive relationships that Polanyi views as necessary for competence. The process through which immigrants move situated knowledge can be thought of as the practices through which immigrants establish new relationships between the subsidiary, implicit knowledge that they bring with them, and the new focal terms they encounter. If immigrants engage with a new tool similar to but not the same as the one they have previously used—say a variation on a chisel that they have never seen before, for example—they may use their understanding of how to swing a hammer in order to use the new tool and in the process develop new techniques for deploying the new chisel. Yet even as they create innovative building techniques, they are also necessarily engaging with the other social and institutional conventions that govern the use of that tool, drawing on their subsidiary knowledge to connect to focal terms across multiple registers. In forging new cognitive relationships between their grip and the chisel, they may also be developing new social practices at the jobsite about how to share this new technique with coworkers. Likewise, they may be quietly challenging institutional norms about when a chisel should be used, about building forms, and about the role of workers in the process of construction innovation.

International migration is by definition the movement of persons, and as migration scholars have noted, this movement creates rich opportunities for the transformation of situated knowledge (Agrawal, Cockburn, & McHale, 2006; Kapur, 2010; Storper & Venables, 2004). Because accounts on knowledge transfer through migration focus on elite knowledge workers, the recognition that international migration also involves the movement of knowledge by people who lack a secure place within a given organizational or professional setting has remained marginal (Williams, 2007). For these workers, broader labor market institutions and the ways they reflect organizational or professional norms and routines can be especially influential on processes of knowledge transformation they undertake. These institutions affect which jobs are available to them as workers, the tenure and security of their employment, the wages and benefits they receive and the kinds of relationships they encounter with employers, co-workers, and other segments of the labor market (Cornelius, 1998; Milkman, 2006; Rivera-Batiz, 1999; Theodore, 2003; Waldinger & Lichter, 2003; Zlolniski, 2006). These factors can structure—and also curtail—immigrants' latitude for engaging in the experimentation and interaction necessary to transpose and transform the knowledge they bring to their work (Steiger, 1993). They may also inform how immigrants are able to use these practices to reshape conventions about how knowledge can be applied.

Viewing the creation of new relationships between subsidiary and focal terms with these constraints in mind raises the question of what for immigrants initially emerges as that focal term. We argue that although immigrants necessarily encounter a wide array of different situated practices, techniques, and routines when they move across labor market contexts, it is the institutions specific to the new place that make certain focal terms more salient than others. Moreover, those institutions, and the influence they bring to bear on immigrants' integration into local labor markets, also inform which register of rules governing the exercise of skill are most significant: They determine whether it is more urgent to attend to the rules or norms that pertain to the use and properties of a material or tool, or more pressing instead to focus on the rules or norms governing the organization of work at the jobsite or in an industry.

SECTION 2: STUDY DESIGN

Tacit, situated knowledge is a critical asset to the construction industry, so critical in fact that some industry analysts have argued that construction is a "knowledge-intensive" industry and its laborers are "knowledge workers" (Chen & Mohamed, 2010; Pathirage, Amaratunga, & Haigh, 2007). During the 2000s, the workers whose tacit knowledge determined the performance

of the industry were increasingly Latino, and more specifically Mexican, immigrants. In 2006, Latino immigrants represented more than 20% of the U.S. construction industry's workforce, with Mexican workers accounting for more than two-thirds of the Latino workforce (Kochhar, 2008a). When the construction industry entered a nationwide crisis in 2007, Latino immigrants, including Mexican workers specifically, saw a proportional reduction in employment, but they nevertheless remained a significant presence in U.S. construction, with some areas of the country seeing larger drop-off in Latino construction than others (Kochhar, 2008b).

Between 2006 and 2010, we conducted a micro-level analysis of Latino immigrant knowledge development at specific worksites, examining the socio-spatial context that shaped and reinforced that process. Our primary research sites were Philadelphia, Pennsylvania, and the Raleigh-Durham area of North Carolina. Both places experienced significant growth in their construction industries throughout the early 2000s, and both saw a downturn at the end of 2007. During the period of industry expansion, both cities experienced a rapid increase in the number of new Mexican immigrants, who provided a ready labor force for local construction jobs. In Philadelphia, a reemerging immigrant gateway, the initially small Mexican population grew by roughly 400% between 2000 and 2007, according to city estimates, to well over the 12,000 estimate of the 2005 U.S. Census Bureau's American Community Survey. Similar population trends exist in Raleigh-Durham, which according to the 2005 Census survey saw a 44% increase in the Latino population since 2000, up to an estimated 76,000, over two-thirds of them Mexican-born.

The way that these new arrivals were integrated into local labor markets differed markedly due to the institutions that governed the construction industry in the two cities. In Philadelphia, where construction labor markets are tightly controlled by labor unions, new Mexican immigrants were relegated to non-union construction jobs at small-scale housing rehabilitation projects in historic, center city neighborhoods. We concentrated our research efforts on those sites, which we observed were largely unregulated and had short project timespans. In contrast, Mexican immigrants faced fewer barriers to job access in North Carolina's Research Triangle region and thus were well represented on large-scale, highly-visible construction sites. While we documented a range of work experiences in the North Carolina case, including those at smaller-scale home renovation projects, the majority of our interviews were concentrated at commercial and institutional building sites and within large-scale residential developments.

Our research consisted of four main components. In the first component, concentrated in 2006 and 2007, we conducted in-depth open-ended interviews in both locations with "strategic institutional actors," defined as actors that are well positioned to preserve institutional norms or foster

change (Dorado, 2005). We interviewed representatives of industry associations, construction managers, and employers with considerable industry experience, building trade union officials, and directors of vocational training centers; we spoke with government officials, focusing especially on agencies that regulated construction trends and work processes on job sites; and we consulted with service providers for immigrants, including worker centers, local Mexican consulates, and churches. These interviews addressed the structure of construction labor markets, local industry growth patterns, relevant regulatory frameworks, construction techniques and innovation, and formal training and informal skill development processes.

The second component of our research, conducted from 2007 through 2010, involved interviews with Mexican immigrants in the construction industry. In Philadelphia, we completed more than 100 interviews with Latino workers, almost exclusively Mexican in origin, including three focus group sessions where we brought workers together to reflect on their work practices collectively. In Raleigh-Durham, we completed 115 interviews with Latino workers, the overwhelming majority of them of Mexican origin. We employed both semi-structured and open-ended interviewing techniques, and all interviews were conducted in Spanish. In both semi-structured and open-ended interviews, we explored three major themes: employment trajectories, skill development practices, and working conditions. We asked workers to detail their employment histories in Mexico and in the United States, including employment outside the construction industry. We asked workers to identify their areas of competence in construction and to self-assess their skill before migration and at the time of the interview. We inquired about the techniques used to complete given tasks, how those differed from accepted practice in Mexico, and how the workers had developed the situated competence required to perform at their U.S. job sites, both individually and collectively.

The third component of our research consisted of on-site observation of work practices, and was carried out concurrently with our interviews, from 2007 through 2010. Cognizant of the importance of context to the way that skill was understood and constructed, we observed practices through which immigrants deployed their skill and trained their colleagues as those practices unfolded on worksites in both cities. Workplace observation proved particularly helpful because immigrants could point to specific materials, tools, or spaces they felt were salient to their learning. Additionally, some opted to use hand-sketched illustrations or demonstrative gestures—equivalent to the act of playing an "air guitar"—to help us better understand their relationship to a particular material, tool, or practice. On-site observation also allowed us to witness interactions between workers and to compare those exchanges with the descriptions of collective learning that immigrants recounted in individual interviews (Lave, 2011).

We found that the majority of the workers we interviewed in both cities brought significant construction knowledge with them from Mexico. In Philadelphia, a little more than 60% of our sample had worked in construction before migrating. Similarly, in Raleigh-Durham, just over half the immigrants we surveyed had acquired construction experience before migrating. Moreover, we found, by and large, that the construction experience Mexican workers had developed before migrating was extensive and sophisticated. While virtually all those who had worked in construction in Mexico had helped build family homes, including their own, a significant majority had also worked on high-end residential, commercial, or infrastructure construction in large metropolitan centers. Their tenure in Mexican construction varied from several months to several years, with many working in the industry to earn funds to cover the costs of migrating.

Workers frequently referred their experiences in Mexico to describe attributes of construction approaches in the United States and the skills required to carry them out. In order to understand the situated, tacit knowledge that immigrants brought with them and how it informed their skill development practices on U.S. work sites, we conducted parallel research in Mexico, in three separate research visits spaced through our research span in the United States, with research in March 2009, July 2009, and June 2010. This represented the fourth component of our research strategy. Without an understanding of the fundamental but largely tacit traits of construction knowledge in Mexico, it would have been impossible to discern how Mexican workers transformed their expertise in order to apply it to U.S. construction styles.

In Mexico, we observed building practices on a range of projects, from self-built houses in immigrants' communities of origin to high-end residential and commercial construction in large urban markets; however, our research on large-scale construction focused on Mexico City, Puebla, and Monterrey, where a sizable share of the workers in both our U.S. study sites had held jobs before migrating. We used a research approach that mirrored the strategy that we used in the United States to explore processes of skill development, relying heavily on worker interviews and on-site observations. In addition, we interviewed foremen, supervising architects, and engineers about Mexican construction techniques and skill development practices, inquiring specifically about how Mexican construction approaches differed from those in the United States. We also interviewed a variety of strategic industry actors including developers, the local and national chapters of the national construction industry associations, union representatives, building material suppliers, and training institutions. We attended trade shows of building materials, and queried producers of building materials about the evolution of their products over the last two decades and the kinds of skill required to use them. We complemented over 70 interviews with

documentary research about the organization of the Mexican construction industry and institutional pathways for skill acquisition.

SECTION 3: FEATURES OF MEXICAN CONSTRUCTION KNOWLEDGE

While migrant interviews highlighted institutional variation across the U.S. labor markets we studied, their accounts of the institutional structures governing construction in Mexico's urban centers were remarkably consistent. Secondary accounts of the organization of the construction industry in both urban and rural settings in Mexico confirm this finding (Arcudia, Enrique, & González, 2004; Bueno, 1994; Dieste, Zorilla, & Gabayet, 1992). In large part, this may be due to longstanding nationwide dominance of a single centralized union representing construction workers (Confederacion de Trabajadores Mexicanos) and of one main industry association (Camara Mexicana de la Industria de la Construccion) representing larger developers (Ziccardi, 1992). Both were tightly allied with the Institutional Revolutionary Party (PRI), which was in power for over seven decades until it was finally voted out of office in 2000 (Levesque & Murray, 2005). Although the political clout of both organizations has diminished somewhat under the government of the National Action Party (PAN), new formal or decentralized institutions have yet to emerge (Aragón Martínez, 2006).

Arguably as a consequence of this institutional consistency (Connolly, 2001; Germidis, 1972), the features that characterized construction knowledge in Mexico were remarkably similar across the contexts and types of construction projects that we examined. Two broad traits distinguished the Mexican knowledge base as compared to competence that shapes construction practices in the United States. First, skill categories in Mexico tended to encompass a broader range of task-related ability. Second, a central component of Mexican construction skill was the conceptual understanding of the relationship between tasks in the building process. In a reflection of their importance to the organization of production on construction sites, social practices in the industry were organized primarily to support the development of these two kinds of knowledge. Mentorship in particular focused on helping workers develop the competence to apply these two types of skill to multiple different building problems. In keeping with Polanyi's observation about the interplay between knowledge at different registers, and the relationship between task-specific tacit knowledge and broader norms about expertise, industry institutions and the worksite practices they fostered enforce the centrality of these two skill types to Mexican construction.

The breadth of skill categories—the first skill trait we observed—was reflected in building knowledge that was at once generalized and highly

attuned to detail. It depended on a deep tacit understanding of the relationship between the multiple tasks within skill categories. Workers who fit into, for example, the broad category of *albañils*—masons—became very versatile in the uses of concrete, adept at manipulating its different consistencies to do everything from structural work like laying floors and erecting walls, to detail work like applying plaster washes, creating moldings, and producing effects like color and texture (Bueno Castellanos, 1994). They also became attuned to the particular ways that knowledge about the properties of concrete necessary for detail work is related to the knowledge required for more structural tasks. Likewise, carpenters in Mexico developed an array of skills more sweeping than the range typical of many construction carpenters in the United States. They acquired proficiency in tasks ranging from building wooden molds for concrete to finer work such as building cabinets and ornate furniture, but they also developed the ability to translate knowledge about the properties of wood acquired when constructing temporary scaffolding to finer carpentry tasks.

The broad knowledge workers developed was combined with the second type of tacit knowledge we identify: a larger holistic grasp of how the elements of a structure fit together and the ways a skill area fits into the larger building process. To some extent, the importance of such knowledge was informed by the Mexican construction industry's heavy reliance on concrete. A concrete structure is constructed from the bottom up, rather than outward from a structural frame, like wood-framed houses or steel-framed buildings. In bottom-up construction, all the building elements, from steel rebars to air-conditioning ducts, have to be integrated from the very beginning, and the soundness of the structure depends on how different elements are constructed in relationship to one another. Thus, a mason whose tasks included working on foundations, floors, and walls also developed the ability to conceptualize the rapport between how deep a foundation is dug and how it is poured to the structural integrity of a second-floor load-bearing wall. Similarly, masons had to allow for the electrical wiring and plumbing to be embedded in concrete walls as they built them, and thus they tended to develop a familiarity with those elements complete enough for them to understand how they related to the building's overall structure and function, even though configuring the wires and running the pipes did not fall directly under their purview.

For both types of skill, the processes through which knowledge was cultivated were interactive and situated (Aragón Martínez, 2006; Bueno Castellanos, 1994; Ziccardi, 1992). On projects ranging from small-scale residential to luxury commercial, the primary mode of skill development was guided on-the-job learning, in ad hoc arrangements that were essentially informal apprenticeships. Formal training programs, whether short modules or longer skill-building arrangements, were not well established in Mexico,

and were, according to formal evaluations as well as our own observation, marginal to the performance of the construction industry (Ziccardi, 1992).

The informal apprenticeships that helped build competence in each of the two areas we identify as important features of Mexican construction had different emphases. The broad skill areas we describe were delimited by building materials. Consequently, the learning process involved an interaction with materials, as well as the tools used to manipulate them, that was intensive and exhaustive enough for workers to develop a detailed understanding of the qualities those materials should display to meet various construction challenges. For example, by mixing cement and observing its performance under various conditions, workers learned to evaluate the correct consistency for functions as varied as creating a plane floor or a sticky mortar and learned how concrete changes under varied climactic and topographic conditions. They developed the tacit capacity to judge materials "by feel" and to intuit how they might behave in circumstances not yet observed. This competence was important in Mexican construction because the range of tools used was significantly narrower and simpler than in the United States, even on large-scale or high-end projects. A worker's expertise stemmed from his intimate understanding of the behavior of concrete, steel, or wood, rather than from the precision of his instruments.

The ability was developed collectively, through on-going and repeated interactions among workers. As the more experienced trained less-skilled colleagues, they reported that they would carefully calibrate the acuity with which apprentices observed the qualities of materials they were using, and look at whether they were able to identify when small, just-in-time adjustments in construction practices were needed. "You need to be able to tell when someone is ready before you teach them something new," said one worker when asked about on-site training. "Do they understand concrete? Do they listen to its moods, and how it's different when it's cloudy or when it's a hot day? . . . You have to watch really carefully, because sometimes it looks okay, it looks like they know what they are doing, and then two years later, the [concrete] floor cracks and you have the [home] owner or the architect yelling at you on the phone. It's not good for business." In one series of interactions we observed at a construction site in Monterrey, a mason showed his apprentice how to gauge how viscous the mortar needed to be to build a wall. The apprentice held the mortar in a flat wide trowel so that the mason could scrape off the necessary amount to apply between bricks without having to bend down to collect it from the trough where the cement had been mixed. As the mortar was exposed to the air, it hardened, and the mason pointed out to his helper that he needed to put it back into the trough and scoop up a new batch. "See, look, it's getting hard, the edges are starting to crack," he said as he pointed. "Pinch it and you'll see, it starts to crumble." As the wall rose up and the day wore on, the mason no longer gave verbal descriptions of the material but instead expressed exasperation when the apprentice did not scoop up a new batch at the correct time. "It's hot today, so don't just stand there." Although the interactions grew progressively non-verbal, and increasingly textured with gestures, grunts, and facial expressions, they remained deeply interactive, and the mason expected his helper to develop an intimate understanding of the material they worked with through their exchanges.

The conceptual understanding of the interrelationship between the different parts of a building was also cultivated through social practices at the worksite, specifically those through which production was organized in Mexican construction. Compared to formal construction sites in the United States, Mexican projects tended to have fewer occupational lines, with each line covering a wider array of tasks: The category of mason covered everything from structural construction, roofing, and insulation to moldings and window installation. Moreover, the organization of work within each occupational category tended to be horizontal, with a relatively simple and compressed supervisory structure regardless of the size of the construction site. Typically, jobs were structured loosely in three levels: the *oficial*, a skilled craftsman in his area, roughly equivalent to a journeyman in the United States; the *medio-oficial* (sometimes called *media-cuchara*, literally "half a spoonful"), a worker with significant experience in his area but who had still not mastered all skills covered by the occupational category; and the *peón*, a label that covered everything from complete novices to workers with some skill but not enough to supervise a task or vouch for the quality of the finished product (Bueno Castellanos, 1994). Above these workers was the *maestro*, roughly equivalent to a field superintendent, and his direct assistants, called *segundos*.

These levels were skill-specific, rather than worker-specific, and workers had little trouble moving up and down this hierarchy to meet the fluctuating skill and staffing requirements at different phases of a project. They shifted status based on their expertise in the task being completed: on the same job site, a *peón* in bricklaying one day could easily be a *medio-oficial* in pouring concrete the next (Aragón Martínez, 2006; Bueno Castellanos, 1994). If more workers were needed to help with bricklaying, a *medio-oficial* might join in the manual labor of the *peónes* on-site, and if a given worker laboring as a *peón* in bricklaying one day was a skilled painter, he would return to his position as a *medio-oficial* when the finishes were applied to the structure. As workers cycled through different skill areas, they participated in the social exchanges through which skill in each of these areas was developed. In the process, they gained an understanding of the connections between the various techniques and materials used in building. Juan Pablo, a mason in Monterrey, described how cycling through a position as an apprentice carpenter revealed to him the importance of paying attention to

the interdependencies among elements of a building structure: "Leveling [a wall] is leveling, but wood scaffolding [to support a brick wall that is being built] has to be leveled for the wall. The point is the wall. You can't level the wood on its own." Constructing an effective scaffold to support a structurally sound wall required his attention to the wall as it was going up, and not solely to the wood lattice that he was hammering together.

The conceptual understanding of the relationship between the different parts of a building enabled workers to modify an element even as they were constructing it. As part of their skills repertoire, masons had the ability to adjust a wall, even as they were erecting it, to accommodate changes in the electrical layout. If experienced enough, these masons were able to identify miscalculations in the architectural plans or resolve problems that the blueprints did not anticipate. As one architect in Monterrey explained, "The maestros, or even the *oficiales*, they catch mistakes [in the plans]. They are like your safeguard, your insurance. Sometimes, they will tell you "this wall needs more steel rebars," or "the drainage in this area is pure fantasy, it won't work." They are usually right." A *maestro* on another site concurred,

> You look at the plans, and you look at the building structure that you have already laid down [*obra negra*], and you see the wall go up in your mind's eye and you know it won't work. You know that it needs more support if it's going to stand . . . It's something you learn with experience. I've worked on so many jobs . . . you look at the wall going up and you just know, you can see it.

This understanding about the interdependence of construction elements is highly valued in the Mexican construction industry, so much so that it is an informal, but vital, prerequisite for professional advancement. To advance to the position of *maestro*, for example, workers generally had to have developed the skills of *oficiales* in the full range of task areas on a job site: in structural construction, in finishes, in carpentry, in plumbing, and so on. This broad but deep competence was considered critical because it enabled *maestros* to ensure that workers completing one process, like erecting a wall, did not damage or impede other processes, like the insertion of plumbing or electrical wiring (Aragón Martínez, 2006; Bueno Castellanos, 1994). Skilled workers with this knowledge were called *maestros todólogos*—a term roughly translated as "specialist in everything" and a moniker that recognized their hard-earned expertise (Bueno Castellanos, 1994).

Both the skill traits we identify as characteristic of Mexican construction—broad skill categories and a holistic understanding of building structures—rested on the kind of relational knowledge that Polanyi describes. They depended on strong conceptual connections between knowledge terms that were subsidiary and implicit, such as sensations in the body and suggestive hunches, and knowledge terms that were focal and tangible, like tools, construction materials, and structural components of a building. The social interactions at Mexican construction sites cultivated skill by forging robust relationships between subsidiary and focal awareness. To develop breadth of skill, social exchanges between experienced workers and novices centered on nurturing a relationship between subsidiary intuitive knowledge about how a material is supposed to behave and a focal attention to the material in hand, as used on a specific building, one that was deep and nuanced enough to adjust to myriad building challenges and conditions. To foster a conceptual understanding of the interdependence of different building elements, exchanges on the worksite cultivated a subsidiary intuition, through guided observation on multiple construction sites, about the necessary relationship between construction components. The focal term of this expertise became the observed relationship between components in the particular building under construction.

SECTION 4: KNOWLEDGE TRANSFORMATION IN PHILADELPHIA

Tools and Structures

In Philadelphia, the immigrants in our study worked on housing construction and renovation in a fifty-block area south of the city center that begun rapidly gentrifying in the early 2000s after close to three decades of decline; between 1999 and 2006, the area saw 200% rise in the cost of housing stock and a 50% increase in sales (Center City District and Central Philadelphia Development Corporation, 2008). The pace of rehabilitation work on the older housing stock in this neighborhood was frenzied and unregulated. Officials in the city government reported believed that the overwhelming majority investors lacked the required permits for renovation. Houses were resold quickly—"flipped"—sometimes within weeks after having been renovated. Likewise, the labor market for this segment of the construction industry was informal. Employers, small-scale contractors or professionals in fields such as architecture or engineering, drew on the influx of new Mexican immigrants to work on their projects. They recruited workers through nearby places of business like restaurants and laundromats and through immigrants' own social networks. In small teams of two to six people, workers were generally employed for the duration of the housing project, which could last anywhere from a few weeks to a few months, at which point they found work on any one of a dozen of nearby construction sites, joining another semi-permanent team. Workers were employed "off-the-books": they were paid in cash, having negotiated their wages at the time of hire, and their access to legal recourse in the face of unpaid wages or injury on the jobsite was limited.

Employers were rarely on the worksite itself. They typically arrived in the morning one or more days a week, delivering materials and instructions for the task at hand before leaving to work at their day jobs as professionals or field supervisors on large-scale construction projects. During the course of a project, employers expected workers to complete a wide range of tasks—everything from demolition to detailed finishing work to basic plumbing and electrical installation. As immigrants in our sample reported, failure to complete tasks assigned on any given day, and at a quality level deemed adequate by their employer, could result in the non-payment of wages or summary dismissal. Employers' supervision and support for skill development, however, were minimal and sporadic. In fact, the construction expertise of employers varied widely. Contractors who had worked as journeymen construction workers were highly skilled, but many others had only rudimentary or theoretical construction knowledge. The language barrier between employers and workers added a further challenge: contractors who spoke Spanish were few, and among new Mexican immigrants, English abilities were limited.

Instead, much of the construction knowledge required to complete the housing renovations was embodied in the materials and tools at the jobsite, and in the physical structure of the houses being remodeled. The power drills and drywall panels on housing renovation sites reflected certain understandings of how construction should occur and of what constituted competence in the trade; likewise, the structural interdependence of the elements in the wood-frame townhouses reflected norms about how construction processes should be sequenced. Although the majority of the immigrants we interviewed came to Philadelphia with significant building experience, they did not recognize most of the tools and materials used, and they reported being perplexed at the structural organization of historic row homes and had trouble initially identifying how building elements were interdependent. They had to interpret both the knowledge they brought with them and the construction challenges they now faced and then use the insights they generated to develop a new form of knowledge specific to housing renovation. In order to do this, we argue, in a return to Polanyi's framework, they had to draw on the subsidiary knowledge they had acquired in Mexico to forge new conceptual relationships with the tools and buildings that had in Philadelphia become the objects of their focal attention. In the process, they also amended conventions about what constituted competence in the execution of construction tasks and developed new norms about how skill should be cultivated.

The autonomy immigrants enjoyed on the jobsite enabled them to organize work practices in any manner they felt would best enable them to complete the tasks assigned. As one immigrant observed, "the boss comes at 4 p.m., and even if you have no idea how to do what he asked, let me tell you, you figure it out by 4 pm." Workers in our study reported drawing upon important aspects of the collective mentorship practices common in Mexico to interpret the unfamiliar aspects of housing renovation in the United States that were now the objects of their focal attention. In particular, they drew on the pattern of social exchanges through which more experienced workers—the *oficiales* or *medio-oficiales*—would supervise and train novices. In a pattern that emerged on jobsites throughout Center and South Philadelphia renovation projects, crews selected leaders from among the group based on who among them was most familiar with the task before them that day. When the task changed, teams re-organized themselves and workers took on roles analogous to *oficiales, medio-oficiales,* or *peónes* depending on familiarity with their new assignment. The casual peer-to-peer mentorship and problem-solving practices they developed, however, were both more contingent and fluid than apprenticeship arrangements typical in Mexico. Abelardo, an immigrant from Pueblo who had worked on infrastructure projects in Mexico City, explained,

> Everybody just pitches in whatever they know to get the job done. If you know something about drywall, you help your compadres. If you fixed the bricks on another house, then you are in charge and you show your team how to do it.

When asked about skill development on Philadelphia job sites, one worker summed up the topic by saying: "Seeing, doing, and practicing—*viendo, haciendo, y practicando*—together: that's how we learn." Another worker, participating in the same conversation, underscored the extent to which this collaborative strategy for skill development had become a norm:

> sometimes people are jealous of what they know and they don't help out, they don't show you how to do things. But the next time there is a job, you are not going to call that person, because all he does is take. It is not good for the team.

The collective processes of learning, interpreting, and experimenting were particularly focused on the highly specialized tools on U.S. job sites, which immigrants in our study did not recognize. "The tools we are used to from Mexico are simpler, they are more rustic," explained Carlos.

> Here, there are so many of them, a tool for every little thing you do on site, and they are mechanized . . . One of the hardest things for me was to learn the names of all these tools and remember what they were for.

Although many immigrants spoke of the specialization of tools as a confounding feature—"For every screw, there is a different screw gun," said one—others clarified that it was the foreignness of tools rather than their complexity that posed the greatest challenge to knowledge transfer.

The new instruments were most frustrating to the immigrants when their unfamiliarity with them interfered with their ability to manipulate construction materials they felt they understood well, like concrete, tile, and wood. Jesús, who had worked as a carpenter in Mexico City, observed

> The tools for wood, to cut wood for framing [in preparation for drywall installation], they are very dangerous. You learn to use them without training or safety instruction. You've never seen these tools in Mexico. You only learn how to use them safely with practice, and too bad for you if you make a mistake. Also, they only let you cut a single way. . . . My molding and cabinets in Mexico were beautiful. The bosses are not interested in this here. Coaxing designs from wood takes time and subtlety.

Similarly, Memo recounted how unfamiliar tools confounded his ability to mix concrete, a material he understood well from several years of working as a mason in Mexico City:

> I was on this job with a contractor, who told me he needed some concrete mixed. I just stood around for a while, looking for a shovel. In Mexico, you mix cement on the ground, using a shovel in a circular motion. Depending on the consistency, you add more water if you need it. On this job, there was a large tub in which you poured the sand and the water. There is a stick that attaches to what looks like a wide flat blade. You have to move the blade back and forth—not in circles—through the tub with the sand and the water. I had no idea what to do with this [blade] at first.

For Memo, the meaning of the tool was inaccessible and prevented him from enacting his deep knowledge of the properties of concrete. Once Memo drew on his teammate's expertise to decipher the mixing blade—"I asked one of the guys what I was supposed to do, and he showed me while explaining it"—Memo was able to connect the new tool to his tacit understanding about how cement should feel when being mixed, and what the sensations of resistance and give against his palm revealed about the viscosity of the mixture.

In this way, the teams' self-supervision and self-training gave workers the ability to integrate the new tools into their previous understandings of the relationship between tools and materials. They came to regard U.S. tools in much the same way they understood tools in Mexico: Rather than instruments designed for highly specific purposes, they could be used in any manner that would allow them to produce the desired effect on the material. Miguel, an immigrant who had worked as a mason in Puebla before arriving in Philadelphia, described learning how to use an angle grinder, a tool used in the repair of brick facades. He recounted how the team leader, the informal *oficial*, at his worksite showed him how to use the tool, which

he called "a round electric saw with teeth" to clear out lines of old mortar between bricks.

> You switch it on, and run this along the grooves of cement in between the brick to take out the old cement. This job can get really messy, because there is dust everywhere . . . You do the horizontal rows of cement first, then take out the smaller lines of cement that lie vertically in between bricks.

After developing the ability to use an angle grinder and especially the finesse required to use it on the small vertical lines of mortar between bricks, some of Miguel's co-workers began experimenting with using the tool to score cement walls. "When you cut superficial lines into the [cement] blocks, the plaster sticks better. It is easier to resurface the walls." In other words, once workers incorporated a new tool as a subsidiary term of their tacit knowledge, they were able to turn back to the material as an object of their focal attention and use the tool however they saw fit. Once they developed a subsidiary understanding of the nail gun or the power drill, they were able, for example, to turn their focal attention to the drywall they were hanging and observe the properties of this material when manipulated in different ways.

By combining their "off-label" use of tools with their deep knowledge of materials, Mexican workers in Philadelphia were able to create new construction knowledge. Gregorio, for example, observed, "The concrete mixtures that are used here are too wet because they [contractors] are used to workers that are slow." He went on to explain that a drier mixture of concrete or plaster created using a technique he and his co-workers devised ("a flick of the wrist upward with the pointy trowel"—a trowel not designed for that particular purpose) allowed for results he found more precise, especially for detail work like plaster restoration and brick mortar repair.

Other techniques Mexican workers developed reflected their attention to the peculiarity of the 19th century row homes they were remodeling. These included a strategy for framing drywall that combined leveling "by feel" with leveling by measurement to compensate for the slant of houses that had settled; a method for taping drywall so that it appeared flush with old walls of horsehair plaster; an approach to laying down tile such that the patterning picked up the rhythm of earlier tiling but also reinforced the floor's structural integrity; and others. Thus, by forging new knowledge relationships between the tools they encountered and the materials they worked with, immigrants created new knowledge adapted to the context in which they worked.

A similar pattern of knowledge transformation occurred with the holistic understanding of building structures that characterizes Mexican construction expertise. Many workers reported feeling lost when they began working

on U.S. construction sites. "I couldn't orient myself," explained Edgar. "I didn't understand how everything fit together." Working in a completely different context from what they were accustomed to, disrupted their intuitive knowledge of the relationships among the elements of a building. No longer was that knowledge part of the subsidiary repertoire that allowed them to identify quickly, often by sight, when the interface of components was not structurally sound. Mauricio, an immigrant from Northeastern Puebla who had worked on residential and commercial construction sites in Mexico City, explained how the interface of construction materials had to be understood in an abstract manner and the challenge this represented for him. "The hardest thing about construction in the U.S.? Arithmetic. You have to measure everything in your head, everything has to be cut very precisely. You have to stop listening to your hands and your eyes, and you have to listen only to your head. A fraction of an inch wrong, and you have to start over. You have to rip it all out." Another worker described construction in the United States as "putting together a puzzle, not building."

To acquire a structural understanding of Philadelphia row homes, workers reported observing building practices for the specific purposes of deducing how they related to other aspects of construction. As Remedios recounted, for example,

> When [a licensed] electrician came to lay down new wiring, I followed him around all day. I just stayed stuck to his shoulder all day. . . . Not because I wanted to learn how to install wiring—I already have some experience as an electrician [in Mexico]—but because I wanted to understand where the wires went, where you place them.

Workers also studied construction plans that were borrowed from the contractor or even retrieved from the trash. Rigoberto recounted how he brought blueprints home to teach himself how to read them.

> The hardest part was learning how to interpret the plans on multiple levels—you have to understand each page and how the systems laid out on each page work with the others, how all parts of the plan relate to one another. And then you have to imagine how this all looks when you build it.

Viviano reported going through the same interpretive exercise with his teammates: "We would sit around with the blueprint. . . . and try and figure out what we had done that day. Where was the drywall [on the drawing] that we hung today?" The knowledge that had been intuitive in Mexico was now codified in the United States in complex construction documents.

Immigrants in our study blended a comprehension of how components were assembled to build houses in the United States with a practical sense, acquired in Mexico, of how to adapt a building when the elements did not

quite fit together as specified in the blueprint. This ability proved valuable in retrofitting historical housing stock, which rarely matched existing architectural plans and construction documents. Moreover, as the remodeling progressed, workers ran into unexpected problems that were difficult to fix, especially as they integrated new construction materials and techniques with pre-existing ones. As Julio explained,

> Sometimes you tear down a wall, and you find a fireplace behind it, and the fireplace is falling down, or you rip out the linoleum floor and you discover that the linoleum was holding up the whole floor. The floorboards beneath it are rotten.

By tending to the interaction between elements that might not have ordinarily been considered together in a U.S. building context—considering, for example, the interdependence between a floor joist and a bearing wall or between plumbing fixtures and sheetrock—immigrant workers were able to develop solutions specific to the row home they were renovating. Viviano characterized the difference between the workers' site-specific approach to these types of problems and the more standardized approach favored by their employers:

> The bosses only know the theory of building—they don't really know how to do things. Sometimes you have to correct their measurements or their ideas. Especially when you find something that you weren't planning on. A lot of employers think you need to do things in a certain order. But you can't stick to one way of building; you have to listen to the structure. And the thing is you really can't explain it. You have to do it, and then show it to them. And then they believe you.

So central did Mexicans in Philadelphia consider this structural understanding of a building in practice that more experienced workers on the job site routinely organized the training of new recruits around the development of this knowledge. Moises, for example, explained that he considered this holistic understanding of construction to be the basis of all other building skills and he mentored new workers accordingly:

> On my job, everyone works equally—we all work together to get something done, whether it's installing sheetrock or pouring concrete in a yard . . . But when someone is new, the very first thing he does is use a broom. Even though you are not working with tools, this is very important, because you are getting to know your surroundings, you are learning how things work together [on the site].

In Mexico the heavy reliance on concrete would have forced the development of this holistic building knowledge; the properties of the material—its

rules, in Polanyi's terminology—shaped understandings of what was considered essential competence and the norms about how that skill should be cultivated. In Philadelphia skilled workers who recognized its value fostered it among their peers.

SECTION 5: KNOWLEDGE TRANSFORMATION IN RALEIGH-DURHAM

Routines and Hierarchies

In North Carolina, the structure and organization of work differed considerably from that observed in Philadelphia and greatly affected processes of knowledge translation. Whereas in Philadelphia Mexican immigrants were primarily relegated to informal or low-end housing rehabilitation, in Raleigh-Durham they represented a significant share—in fact a sizable majority—of workers at commercial and large-scale residential construction sites. At first glance, these numbers might suggest greater opportunities for wholesale deployment of existing construction skills. However, a closer examination reveals important institutional and worksite differences that affected the manner in which immigrants were able to draw on their expertise and combine it with new practices.

The most significant factor that shaped how immigrants used the knowledge they had acquired in Mexico was active top-down site supervision in North Carolina's construction industry. Unlike in Philadelphia, where employers were essentially absent from the job site, North Carolina's construction projects—especially those in commercial, institutional, and large-scale residential buildings—were closely monitored, with numerous non-immigrant supervisors on hand to oversee most aspects of the work. This not only affected which experiences and routines learned in Mexico became contextually relevant but equally shaped which kinds of challenges became the focus of immigrants' attention and which elements of their prior knowledge they used to resolve them. In Polanyi's framework, the institutional "rules" in Raleigh-Durham often functioned as rigid structures. They determined which aspects of construction processes emerged as focal terms of immigrants' awareness and which aspects of their subsidiary knowledge from Mexico were most useful for interpreting those focal terms. This differed greatly from the Philadelphia case where rules and norms were emergent and in many cases were shaped by immigrants themselves.

One critical element of this highly regulated environment involved a detailed division of labor in which building tasks, even those closely related, were essentially treated as separate or distinct work functions. This structure was reinforced by project managers and field supervisors, who

expected each task to be performed by a separate work crew. In contrast to Philadelphia—and also Mexico—where the same team of immigrant workers had an opportunity to rebuild or renovate a home from start to finish, multiple work crews cycled through North Carolina's large-scale building sites, focusing on distinct tasks, such as framing, drywalling, roofing, electrical wire pulling, or window installation. For certain building trades, such as drywall installation, different crews sometimes specialized in specific procedures, with one crew focusing on drywall hanging, another on taping, and a third on finishing. Even for brick masonry, tasks were often similarly subdivided; one crew might specialize in building straight wall sections while another completed detailed finishes or more complicated angles or curves.

Furthermore, within each task there was the expectation that procedures would also be separated, ordered, and carefully sequenced. This was enforced through a rigid job hierarchy in which employers and supervisors would assign individual workers a specific task or area of concentration, and which they would use to control and monitor workplace advancement. Alejandro, a Mexican immigrant, described the process for siding installation. Within his North Carolina-based siding company, he initially was assigned the task of laborer, clearing the worksite and moving materials and garbage. Next he was promoted to the position of helper, which allowed him to assist workers above him in the job hierarchy; he might help with preparing materials or finding specialized tools. With time, he was able to start applying the siding under close supervision, and in the process learn additional task-related skills, such as taking measurements and handling a pneumatic air gun, in a carefully determined order.

Workers were expected to adhere to this tightly structured job hierarchy irrespective of experience. One immigrant worker, Faustino, expressed some frustration at being relegated to helper for a North Carolinian framing crew despite his vast knowledge of carpentry. Nevertheless, his supervisors would not permit him to put this knowledge into practice until he advanced to the next position on the job ladder associated with his assigned task. He concluded that—as a helper—"it was not [his] official duty to do so." Juan, another Mexican immigrant, corroborated this observation, noting that in North Carolina this hierarchy reinforces individual responsibilities and job definitions: "Each function is different—you're essentially not working as a group but separately. There is only one person who uses the machines—that's it. And they don't like that another person uses them." This hierarchy not only determined which job you performed, but equally eliminated most opportunities for knowledge sharing and task-rotation.

Given this highly structured work environment, it was not surprising that the learning process associated with task deepening often unfolded in a prescribed and controlled fashion. Learning in North Carolina was largely top-down, in that information and instructions were passed down

the hierarchy from supervisor to worker or from a highly ranked worker to his subordinate. Rarely did knowledge flow in the other direction. As one Mexican immigrant explained, "Initially, when they hire us, there is someone who knows how to do it. You better listen to the guy who knows what he is doing." Samuel, an immigrant who specializes in laying tile, reiterated the importance of following a structured protocol. He explained that at first, he was only permitted to grout, then was authorized to set tile, and finally was allowed to draw the lines himself for determining tile placement and pattern. Until he was given the opportunity to show ability in the final task in this sequence, Sammy said, "they set the lines for me and I just set the tile."

Immigrant workers reported feeling great pressure to follow an ordered sequence of procedures and also to secure authorization before using a specialized piece of equipment. One worker explained that when he tried to use his existing knowledge to complete a task, his supervisor quickly and firmly intervened, "No. Do it like this." Furthermore, there was little opportunity to make or learn from mistakes—nor was there latitude for improvising a new technique or tool or experimenting with a new sequencing of tasks, as we found in Philadelphia. In fact, there were real and lasting consequences for those who failed to follow procedures or codes, including dismissal from the project site or being fired altogether, which entailed exclusion from all of a contractor's project sites. The seriousness of the penalties for not following procedures meant that immigrants not only had to engage with new physical elements at the building site; they also had to navigate unfamiliar, rigid workplace hierarchies. "The truth is that I never wanted to be separated from another worker," explained Faustino in describing how difficult he found the adjustment to new work norms. "I had to endure two long years of working and learning in order to be independent. And I didn't do it voluntarily. Practically, they ordered me to do it."

Still, despite these constraints, Mexican immigrants who arrived in North Carolina with construction experience were able to draw on their existing expertise to master new task sequences and advance quickly up the career ladder. Essentially this required them to splice Mexican-style knowledge into a precise progression of actions that fit the North Carolina organization of work. This meant that tasks that were regularly performed in Mexico, in quick succession and without much forethought, now had to be uncoupled and treated in isolation. As Paulino, an immigrant with eight years of construction experience in Mexico City, explained "In our country, one comes to understand a trade, but it's very different than here." He reflected on the spectrum of knowledge required to install plumbing in both contexts.

> In Mexico, the pipes run inside the wall. Here it's more practical because they don't go inside walls. You just have to make sure the pipes are aligned and that the outlets for hot and cold are installed correctly. Here, running plastic pipe in a bathroom takes you three hours. And there, it would be nearly 2 or 3 weeks.

Similarly, procedures leading to task completion had to be parsed out and separated. Skilled immigrants sometimes talked about having to "memorize" a new sequence for completing a given task, which in Mexico had essentially become second nature. Even the most basic and routine tasks, such as mixing cement, setting brick or cement block, and building scaffolding, often had to be relearned and reordered. Such narrow specialization of tasks and strict sequencing of procedures were essentially foreign to Mexican workers; this unfamiliar way of dividing up and ordering their skills thus became the subject of their focal awareness, and their previous work experience became a source of subsidiary knowledge for reordering and remastering an assigned task sequence.

The more strategically workers managed the workplace hierarchy, the more rapid their advancement. On the vast majority of job sites we observed, jobs were segmented so finely that supervisors would assign workers small tasks that could be completed in a short time and then return to inspect the result. "Do this. I'll be back in an hour to check your work," was a refrain that immigrants frequently heard. If they performed consistently well on what was essentially a spot-test, they were allowed to advance to the next task in the sequence. Experienced Mexican workers reported that they would strive to finish their assignment quickly so they could ask their supervisor for additional work as a way to demonstrate both proficiency and eagerness to learn. "I go up to my *patrón* and I tell him, 'I've finished. What else would you like me to do?'"

As this implies, North Carolina's work environment was structured in ways that rewarded individual workers and their achievements. Still, it is important to recognize the role that social exchanges between immigrant workers played in supporting knowledge development and career advancement and in the process reproduced social norms and practices common to Mexico. As immigrants moved up the job hierarchy and secured the title of task expert, they increasingly found themselves in a powerful position to shape learning and training practices among North Carolina's growing immigrant workforce. In this position of authority these immigrants had the breathing room to reproduce social processes that were used to facilitate collective knowledge sharing and problem solving in Mexico, including introducing variants of team-based knowledge sharing mentioned earlier.

But as in Philadelphia, knowledge brought from Mexico was actually transformed in the North Carolina context. Immigrant task experts drew on their subsidiary understanding of how to teach and mentor, often developed through their experience in Mexico, and adapted it to formalized

top-down approaches common to North Carolina. In the process, they produced blended versions of teamwork, which maintained symbolic aspects of North Carolina's job hierarchy—for example, keeping a fixed and identifiable team leader and having that individual initially lead the training, yet also facilitating cross-training as a means to avoid costly mistakes. Describing one such hybrid team, an immigrant team leader explained that individual workers on his particular crew did not remain at one task. Rather, they rotated through various tasks in order to learn the complete process. The intent was to show how these tasks were interrelated and to emphasize the importance of correctly completing the first task of a sequence. As he put it,

> One changes position with another one so everybody knows how to get it done. We make sure that everyone is doing it right because if the one in the front is doing it wrong, the three in the back are going to follow him, and it's going to be bad.

Another immigrant team leader described the benefits of a less hierarchical team model that he and other experienced workers from Mexico had helped to devise in North Carolina. He openly criticized other immigrant and non-immigrant crew leaders for failing to actively encourage and reward learning and knowledge sharing. As he put it, "[Crew leaders] just say 'bring me this' or 'carry this over there' but never say 'grab this tool and do this' or show workers within their crew how to make a measurement." As a result of his training method and the resulting broad-based knowledge of his crew, he was often able to leave the job site without putting anyone in charge. Rather, the group "moved together to complete the work." Still, while he did not view himself "above anyone else," his official status as team leader was reinforced by the fact that his non-immigrant supervisors still gave him all the orders, which he would pass along to other members of the crew. Additionally, he was given the authority to hire and fire members of his crew. Still, by using his employment status to flatten the traditional workplace hierarchy, he ultimately helped to transform and embed the Mexican work model to fit North Carolina's particular institutional context. Like his counterparts in Philadelphia, he was an innovator—reinterpreting Mexican workplace practices and social structures for a North Carolina job site in order to facilitate the knowledge contribution of his fellow Mexican immigrants.

SECTION 6: IMPLICATIONS

The Mexican immigrants in our study were knowledge transformers, reinterpreting and adapting the construction knowledge they acquired before migrating. Specifically, they reshaped two central facets of Mexican construction knowledge that they brought with them: skill categories that were broad, and a holistic understanding of the relationship between different elements in a building structure. In the process, they collectively developed knowledge that was distinct both from the construction know-how prevalent in Mexico and from building approaches in the United States. Their practices revolved, in Polanyi's parlance, around establishing a series of new cognitive relationships between the subsidiary knowledge immigrants brought with them and the unfamiliar focal terms with which they engaged. Immigrants drew on their subsidiary understandings to engage with focal terms at multiple levels, interpreting everything from the properties of the construction materials that were so immediate to the completion of their tasks to the broader norms that governed the organization of work within the industry. Furthermore, the new conceptual relationships that immigrants forged spanned multiple registers, connecting their innate and embodied understanding of construction materials with their interpretation of industry-based definitions of skill and institutionally established patterns of work organization that were new to them.

In both cities, immigrants focused first on those aspects of localized construction—unfamiliar tools and materials in Philadelphia and hierarchical structures and highly subdivided tasks in Raleigh-Durham—which prevented them from drawing on the full store of their expertise and, as a result, from securing employment commensurate with their skill. They turned their attention to the knowledge terms that would enable them to demonstrate and defend their competence at the jobsite and the labor market, but also that would allow them to draw on their skill into a resource for institutional change.

They made conceptual connections that would allow them to reconcile and conjoin their expertise with the knowledge embodied in local industry institutions where possible, and to amend those institutions where necessary. In Philadelphia, where institutions were nascent and informal and where immigrants enjoyed corresponding organizational latitude at the jobsite, workers prioritized interpreting the new materials and tools and unfamiliar architectural structures that prevented them from drawing readily on their deep understanding of materials and the interdependence of building elements. As they linked unfamiliar terms back to their subsidiary understandings of building materials and structures, they developed unorthodox and innovative uses for material and tools and created nuanced problem-solving strategies for the renovation of historic housing stock. In Raleigh-Durham, where immigrants confronted work environments characterized by a strong supervisory presence and well-established hierarchical job ladders, immigrants learned to splice their existing knowledge into finely delimited task specializations; they engaged with localized industry norms to recast their

knowledge into categories that their employers could decipher. Moreover, they used their breadth of skill, now parsed into multiple discrete sets of expertise, to progress quickly up the job ladders and into positions where they were able to support advancement opportunities for new arrivals.

The migrants in our study also reinterpreted their tacit skill and the institutions they encountered to create syncretic training systems in which they applied institutional structures for skill development to skill challenges they encountered in the United States. Those mentoring approaches became proto-institutions; they were practices for teaching and learning that quickly became established as normative among workers in the segments of the construction industry in which immigrant workers were dominant.

Applying Polanyi's view of tacit knowledge as a relational form of knowing to this case allows us to consider at once the practices through which actors at once create new knowledge and amend institutions—and indeed, reveals these processes to be inseparable. As actors forge new conceptual relationships, they transform both their tacit competence and the social norms that define expertise and govern its use. Additionally, Polanyi's framework suggests that the processes actors use to acquire and express new areas of tacit knowledge through everyday practices are fundamentally identical to the processes they use to reform localized institutions. Thus, rather than privileging either the process of knowledge creation or process of institutional change, a more fruitful analytical strategy is first to consider where actors place their interpretive emphasis—to investigate whether they focus more urgently on the tool in hand or on the institutions that shape its use—and then to examine why.

This requires broadening Polanyi's relational definition of tacit knowledge production outward to look at the ways that actors actively draw context into cognitive relationships. As our comparison between Philadelphia and Raleigh-Durham demonstrates, the tacit knowledge immigrants generated could not be traced back to any one localized attribute in isolation: not to competence immigrants had acquired in Mexico, not to the building practices they met in the United States, not to the institutions they encountered, and not even to the actions of immigrants themselves. Instead, the knowledge they generated in both cities was the product of the interactions that migrants fostered between localized industry features and the practices through which they enacted their competence. This case suggests that to understand the role of context in knowledge creation, we need to explore which cognitive relationships actors forge to respond to the localized constraints they face and why. We also need to investigate how actors use new concepts and new ways of defining competence as a resource for institutional change.

In suggesting these directions for inquiry, we reach beyond the observation that tacit knowledge is situated, "sticky," and difficult to move across settings (von Hippel, 1994). Instead, we maintain that tacit knowledge is

expression of the way that people engage with and refashion localized institutions in an ongoing way. Our case demonstrates that to understand how tacit knowledge is moved, neither the emphasis of practice-based theorists on the processes of knowledge creation nor the institutionalist concern with the ways actors modify institutions is enough in isolation. What is required is an analysis of the connection between these two processes, and of tacit knowledge as the bridge between them. Tacit knowledge is the stuff out of which institutions are made but it also the stuff that people use to make and remake institutions.

Even as our case suggests the importance of considering process of tacit knowledge production and institutional reform, it also suggests that neither process is a strict proxy for the other. Actors can and do engage with the tacit knowledge they have and the tacit knowledge they encounter in order to create the resources they need to change institutions. But there is also an element of strategy in determining which knowledge they intensively engage with. In deciding which knowledge terms to interpret, actors may focus on those that will provide them with the most leverage to amend institutions they confront and that initially constrain them. In this sense, it is not incorrect to consider institutional change as an expression of knowledge transformation, as studies of highly-skilled migrants do. However, it is important to move beyond the use of institutional change as an indicator of the magnitude of knowledge transformation, and to look at which institutions were amended and what those changes might mean. In exploring what these changes reveal, we may glean insights about how actors—migrants in this case—may use the knowledge transformation involved in the movement of knowledge as a form of agency.

This relational view of knowledge highlights the significance of the cognitive relationships forged by workers generally considered "low-skilled" (or otherwise unqualified for the title of knowledge worker as it is generally understood in the scholarly literature) and the ways these relationships fuel processes of knowledge creation and institutional change. The ways that workers develop new competence, define expertise, and cultivate practices to support learning and innovation has important, but understudied, implications for the organization of work at a workplace and in the broader industry (Leana, Mittal, & Stiehl, 2012). It also prompts to ask why these immigrants, who transform knowledge and rewrite the social rules governing its use, should not also be considered "exemplary protagonists."

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