Getting In: Integrating Environmental Considerations Into Ongoing Organizational Activities

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Abstract

This paper describes the practices used by members of a high-tech manufacturer to bring considerations of environmental impact into the design of new manufacturing processes. Drawing from ethnographic, archival, and interview data on seven projects over an eight year time span, I demonstrate that contests over the meaning and legitimacy of the environmental issues were significant, but were overcome over time by practices of framing, negotiating support, and mobilizing resources. The practice of framing as a mechanism to create shared meaning emerged as the key factor that led to the successful integration of environmental considerations. I use this finding to build theory on how fundamentally new knowledge is introduced into ongoing organizational practice by relatively powerless groups. (117 words)

(key words: organizational adaptation, knowledge boundaries, environmental management)

Suggested Track:

C. Knowledge sharing within and across organizations and cultures

E. The relationship between knowledge and power

G. Practice-based perspective on knowledge and learning

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Integrating new considerations and new knowledge into ongoing practice is considered essential to the success or even survival of organizations in today's increasingly complex operating environments (Grant, 1996; Volberda, 1996; Brown and Eisenhardt, 1997). A great deal of work ranging from that on fit, congruence and internal configuration (Lawrence and Lorsch, 1967; Thompson, 1967; Tushman and Nadler, 1978; Schoonhoven, 1981; Siggelkow, 2002), to the integration of knowledge across boundaries (Dougherty, 1992; Leonard-Barton, 1992; Carlile, 2002; Bechky, 2003), and emergent organizational change (Pentland, 1992; Orlikowski, 1996) explores how aspects of the external environment, organizational structures, procedures, norms, and situated practices of knowledgeable actors come together to produce various forms of organizational adaptation. Structural, procedural and cultural changes have all been advanced as possible solutions to the general problem of designing organizations for adaptability (Volderba, 1996; Dougherty, 2001; Rivkin and Siggelkow, 2003; Siggelkow and Levinthal, 2003).

Despite the sheer quantity and range of work on these questions, many researchers continue to call for more attention to the processes by which adaptation actually occurs and to the role of context in shaping such processes (Pettigrew, 1990; Miller, 1996; Orlikowski, 1996; Sigglekow, 2002). This paper takes as its point of departure the assertion that we still know relatively little about the actual practices through which new considerations are brought to bear on ongoing organizational activities, contested, and ultimately integrated over time. In particular, it explores practices and interactions spanning eight years in order to understand how integration of new considerations proceeds over time. Only by attending to repeated interactions where organizational members must share and assess each others' specialized knowledge (Carlile, 2004) can we come to understand the dynamic acquisition of an organization's capability to adapt.

I use longitudinal ethnographic, archival and interview data to explore what happens when fundamentally new claims are brought to bear over time on complex, ongoing process development activities in a major semiconductor manufacturer. Against a backdrop of relentless product and process innovation, Chipco[1] sought to better address the impact of its manufacturing processes on the natural environment. To do this, various structural and procedural changes were made or emerged over time. While these were important, a detailed analysis of seven projects over an eight year time span reveals that change was gradual and halting, and littered with overt or covert contests over the meaning and legitimacy of the new claims. Three types of practice emerged from the data as important to the gradual integration of environmental considerations over time: framing, negotiating support, and mobilizing resources.

Framing helped those advancing the environmental considerations build shared meaning, negotiating support helped them establish the legitimacy of their claims, and mobilizing resources helped them build power with which to influence others. While all three types of practices were used in each project, there were differences both within and across projects.

Framing as a practice emerged as a key factor that led to the successful integration of environmental considerations, and, ironically, increased rather than decreased in use as formal mechanisms for environmental work were developed. Framing was used to represent both how the environmental considerations resembled core concerns in process development and how they differed from those core concerns. It was a critical practice because it contributed to the development of shared understandings of what was at stake in particular projects; without it, negotiating support and mobilizing resources were less effective. The data demonstrates that the group advancing the environmental considerations gained competence at framing, negotiating support, and mobilizing resources over time, further suggesting that the capability to integrate new knowledge is accumulated, rather than inherent, in an organization or group.

These findings contribute to the literature on knowledge integration in several ways. First, the detailed examination of multiple process development projects and the practices identified point to the importance of considering both the evolution over time and active construction by participants of meaning surrounding new considerations. We know a great deal about the processes and activities of innovation (Dougherty, 2001) and the difficulties surrounding the integration of specialized knowledge (Tyre & von Hippel, 1997; Szulanski, 1996; Dougherty, 1992; Leonard-Barton, 1992). While other work considers knowledge integration in projects with relatively stable players and concerns (Bechky, 2003; Carlile, 2002; Carlile, 2004; see Leonard-Barton, 1992 for an exception), this data affords the opportunity to see how the process unfolds over time through the actions of participants who deliberately create, sustain, or change shared meaning and shared norms (Maguire, Hardy, & Lawrence, 2004; Creed, Scully & Austin, 2002).

Second, the analysis focuses on the integration of fundamentally new considerations. Others have studied the implications for product or process design of new technologies (Leonard-Barton, 1992; Christensen, 1997) or new standards (e.g., regarding safety, see Carlile, 2004). Environmental considerations show up differently, however, because they demand new technical mastery, adherence to new metrics and standards, *and* tend to involve new normative considerations (Hoffman, 1999; Bansal, 2003). Environmental issues are both symbolic and material (Watts, 1998; Peluso, 1992) and can invoke passionate negative or positive responses from individuals in an organization (Bansal, 2003). These characteristics make the integration of environmental considerations particularly problematic, bringing to the fore issues of legitimacy, interests and power that have historically not been central to the literature on knowledge integration (Contu & Wilmott, 2003).

In the next section I describe the research setting and the method used to gather and analyze the data. I then work back and forth between the data and theory to build a grounded theory of how fundamentally new knowledge is integrated into process development activities over time. I describe formal changes in procedures and roles adopted at Chipco and focus on a set of practices that emerged from the data as central to integrating the new environmental demands. I then develop an explanation for the shift in practices over time and the consequences of this shift. Finally, I explore the implications for the theory and practice of organizational adaptation to new demands in general, and organizing for environmental sustainability in particular.

SETTING AND METHODS

Chipco is one of the world's largest manufacturers of microprocessor "chips" used in computers. The company is generally regarded as setting the industry standard for new process development because of its historic success at developing and deploying new state-of-the-art chip manufacturing plants, or "fabs," roughly every two years. With hundreds of individual process steps required to manufacture a chip, new process development is a permanent and significant aspect of Chipco's operations and about 1,500 "Tech" engineers are engaged in it. New process development activities are considered critical to retaining Chipco's market leadership as new processes directly enable advances in chip speed and power. As a result, Tech is a central and powerful group within Chipco.

Several features of the industry and company make it an attractive setting to study the integration of fundamentally new knowledge into ongoing organizational practice. First, because process development is a core activity in the industry, most companies, Chipco chief among them, have well-developed procedures and norms for process development. These include Tech's procedures for determining when process equipment needs updating, practices used to explore and evaluate alternatives, decision-making procedures to guide selection among alternatives, and experimental techniques used to qualify selected equipment or process configurations. In other words, there is a well-established baseline against which members can assess excursions from typical practice in process development.

Second, while Tech dominates new process development, numerous other groups are involved. For example, a typical new process development activity might include members from an early-stage research group ("Research"), a group specializing in process chemicals and materials ("Materials"), a group specializing in equipment specification and acquisition ("Equipment"), a group responsible for the design of factory-scale support systems such as gas delivery lines and waste treatment systems ("Factory"), representatives from the manufacturing fabs ("Manufacturing"), and external suppliers of materials or equipment. With members of both core and peripheral groups working on common projects we might expect considerable challenges because each member possesses specialized, situated knowledge (Lave, 1988; Brown and Duguid, 1991; Lave and Wenger, 1991). Differences in expertise and status only complicate the sharing and integration of knowledge (Leonard-Barton, 1992; Nelsen and Barley, 1997). The introduction of fundamentally new considerations of environmental impact, represented by a new group, "EnviroTech," provides a good "extreme case" (Eisenhardt, 1989; Pettigrew, 1990) for studying how differences are overcome in the process of getting new considerations in to ongoing practice.

Finally, environmental issues were brought onto the agenda and addressed deliberately, but they were neither predictable nor easily controlled. Chipco's executive management began to pay much closer attention to such issues following a handful of prominent episodes where process chemicals had been banned or restricted because of their environmental effects, or fab development delayed due to environmental permitting or community concern. Several key formal changes to roles and procedures followed. First, a senior management body was formed in 1992 with high-level decision-making responsibility for environmental issues related to process development. The Strategic Chemical Council (SCC), saw proactive environmental stewardship of chemicals as an approach that would ensure availability of new chemicals critical to Chipco's future processes. As such, it adopted policies and guidelines to encourage environmentally favorable chemical treatment, such as the pollution prevention hierarchy,[2] but the SCC itself had little direct influence over individual process development projects. Two years after the formation of the SCC, more specific environmental goals were set for the new process generation under development, and these goals were refined and re-set for each new process generation developed every two years.

In the mid-1990's a small group of managers with process development, environmental, and factory systems experience started working on environmental process development projects and by 1996 they had created a formal group, EnviroTech. Three managers and eight engineers were members of EnviroTech. The SCC was dissolved in 1996 and a new body, the EnviroCouncil, formed with the intention that it would closely resemble a standard Tech decision-making body. Where the SCC's membership had been drawn largely from senior and executive level management, the EnviroCouncil was made up of middle managers and chaired by an EnviroTech manager, but was nonetheless given considerable latitude to make decisions on environmental process development needs and choices. Importantly, the EnviroCouncil was cross-functional, consisting of members from Tech, the corporate and site Environmental groups, EnviroTech, Factory, Manufacturing, Equipment and Materials. Despite these formal changes, the goal the EnviroTech group, which was to drive consideration of environmental impacts directly into the selection of new process equipment and parameters, had yet to be fully realized. While some projects had certainly been deemed successful, one EnviroTech manager observed in 1998 "most of what we do are still tack-on solutions." The formal changes give only a partial explanation for why this was so. But they also represented a deliberate effort to more fully integrate environmental issues into process development. This combination of intentional, sanctioned change, and challenging, contested implementation of the change provides fertile ground for studying what was a stake for participants in the change, and how these various interests were negotiated.

Data Collection

I collected data over the course of a nine-month period during which I was a full-time (45+ hours per week) participant observer at Chipco. As a participant, I was a student intern member of EnviroTech,[3] and I interacted regularly both formally (through participation in process development activities) and informally (through location at the Tech process development site) with Tech employees. The primary method I employed for data collection was ethnographic observation, entering the field with a goal of understanding how environmental issues were being surfaced, articulated, and acted upon within Chipco's process development activities. I wrote field notes daily during the course of observations (for example, during project meetings) and for several hours at the end of each day to capture observations in more detail. The field notes comprise the core of the data used, but were supplemented by several other important sources, including semi-structured interviews, documents, and case studies written on specific projects.

Semi-structured interviews. I performed several dozen semi-structured interviews with members of the Tech, EnviroTech, Factory, Materials, Research, and Equipment groups to gather data on particular process development projects. Some of these projects predated my fieldwork by up to ten years, and I was able to speak with those involved at the initial stages to fill in historical detail, as well as those who continued to be involved in the later projects. I also used semi-structured interviews to better understand projects that I was observing at the time of the fieldwork. Several of those interviewed became regular informants with whom I was able to follow up informally, filling in gaps in my data, and checking discrepancies arising from multiple sources.

Documents. I collected all manner of documents, both those related to my participant role, and those quite unrelated. For this paper, the most useful documents were those that related to specific process development projects, such as project update presentations, meeting agendas and minutes, and email messages regarding project developments. I also gathered documents (presentations, reports, technical specifications, and copies of email messages) on past projects from those I interviewed. These documents were critical data on practices that had been used prior to my participant observation period and were essential to analyzing the earlier projects where I did not want to rely on interviewee's retrospective accounts alone (Golden, 1992).

Case Studies. As part of my participant role, I prepared four case studies of particular projects for EnviroTech's internal use. All of these case studies covered projects that had been initiated four to ten years prior to the start of my fieldwork; three of the four projects were ongoing, or had ongoing repercussions that I could study through observation. Data collection for these case studies enabled much of the interviewing and document collection just mentioned, and after writing the case studies each one was read by several of the individuals who had been involved. This allowed me to garner additional detail and gain further insight into discrepancies or different perspectives that had surfaced.

Data Analysis

For this particular study,[4] I began by listing all of the specific projects I had encountered that attempted to incorporate an environmental issue(s) into process development. Of the 28 projects that I had some data on, 18 were traditional process development activities in which new equipment was being developed that needed some form of modification to reduce environmental impact. The other 10 were not traditional process development activities but decision tools, strategic plans, or models that were intended to improve the consideration of environmental factors in process development overall. I selected seven of the 28 projects[5] for further analysis after eliminating those for which I had insufficient data, or those that were in such an early stage that their development and outcomes were unknown.

A brief description of each of the seven projects is given in table one, along with the participants' evaluation of the project's success. The latter was determined by carefully attending to the prognoses and evaluations coded for in the within-project analysis (see below). In particular, I sought to understand whether participants felt an appropriate decision had been made (e.g., to adopt or not adopt a particular approach or technology), whether the chosen approach had been developed appropriately, and (if applicable) implemented appropriately.

While evaluations differed slightly between individuals and groups, it was striking how similar they were for virtually all of the projects. Those advancing the environmental considerations were as apt as others to label a certain project a "disaster" if it had not gone well, and consensus between members of Tech and members of EnviroTech on which projects were failures and which successes was virtually unanimous.

Project	Project Goal	Project Start	Project Evaluation by Participants
"Destructor"	Develop waste treatment system for new highly toxic liquid waste.	1992	Failure
"Greenhouse"	Reduce use of class of process chemicals identified as greenhouse gases.	1993 (ongoing)*	Failure
"Recycler"	Develop recycling approach for acid used in processing.	1994	Failure
"Decision Tool"	Create tool to improve decision-making on environmental process development projects.	1997	Success
"Clean Air"	Reduce hazardous air emissions associated with new process equipment/approach.	1997	Success
"Blue Skies"	Decide on approach to reduce non-toxic air emission considered a visual nuisance.	1997 (ongoing)	Success
"Capturer"	Develop equipment to enable technical solution underway for Greenhouse project.	1997 (ongoing)	Failure

* Indicates project was still underway at end of data collection period in late 1998, but it was late enough in the project for participants to have gauged its success.

Table 1: Summary of Projects

Within-Project Analysis. I assembled all of the documents, interview notes, case studies (where available) and relevant original field notes for each of the seven projects chosen for analysis. To perform a detailed within-case analysis (Eisenhardt, 1989; Miles and Huberman, 1994) that would allow me to consider the complexity and preserve the narrative sequence of each project (Abbott, 1992), I coded the data by project using emergent themes (Glaser and Strauss, 1967; Miles and Huberman, 1994). I simultaneously created a timeline of key events and decisions, and a context chart showing who (sorted by both group and geography) was involved for each case. Because I was looking specifically at how each project proceeded and how those involved sought to overcome challenges to the integration of environmental considerations, I coded for practices, as well as for what was at stake in the projects for the various participants (coded as diagnoses and prognoses), and the outcomes (coded as evaluations). After coding, I created a table for each project that summarized the key findings, as well as other important data such as who initiated the project, who supported it, who the audience was, and when it was initiated. The within-project analyses and the chronological and other connections between the individual projects gave the richest view of the data from which to understand what was at stake and how differences were overcome for each project.

Between-Project Analysis. I compared projects using a mixed strategy (Miles and Huberman 1994) which involved moving back and forth between the types of practices that had emerged and how these practices were used in particular projects. As I moved between these I modified and refined the descriptions of the types of practices, ensuring that each type of practice was consistent and coherent across its occurrences in the projects. I also developed a sense for how the use of particular practices changed over time and between projects, and for how particular practices influenced project outcomes.

KEY CHALLENGES TO KNOWLEDGE INTEGRATION

Before turning to the practices used to integrate environmental demands into process development over time, it is essential to get a sense of what was at stake for the participants. The within-project analysis revealed that each project was characterized by contests over the meaning of the environmental considerations, their legitimacy, and the legitimacy of the EnviroTech group itself, or others who were advancing the claims. The following vignette from the Recycler project offers a glimpse at the nature of these differences, how they were represented, and why they were consequential.

> In the mid-1990's, in anticipation of the next generation of process changes, a small team was formed to decide whether to recycle a chemical used in a core process step. For the first time, environmental goals had been set and were carefully considered among the criteria used to make the decision. Data on the process impact, cost, environmental performance, and supply options for five alternatives were considered as the team drew on expertise from ten functional areas and seven of Chipco's geographical sites. The process was inclusive and thorough, closely following Tech's tacit norms for analysis and decision-making, with the goal of recommending a course of action that would be consistently followed across all of manufacturing facilities, or "fabs."
>
> Despite an inclusive process and the use of explicit decision criteria, considerable differences persisted. One environmental manager observed that "the main environmental problem appears to be added sulfates and salts going to the AWN," and another that "discharge to POTW for [site A] is a problem. TDS is an issue."[6] Meanwhile, a Manufacturing manager asserted that, "the ultimate question is do we need [chemical recycling] … the finance people are doing a model that will show there is no ROI." These team members were not only talking at cross purposes, but appeared either unable or unwilling to translate their concerns into terms that were more easily understood and valued by others.
>
> But efforts to clarify differences were made. For example, a manufacturing manager emailed environmental specialists to ask for "an absolute ruling, legal or otherwise," on Chipco's responsibilities if a chemical waste was shipped off site. He asked, "what are [Chipco's] real risks (not perceived)?", noted that this chemical was widely used in the industry, and questioned why it should be treated any differently from other wastes. A reply from an environmental

> manager outlined regulations governing hazardous waste transfer and disposal, and commented that the rules are "not necessarily logical and must be carefully reviewed and understood for each case." But his message closed emphatically with: "the liability potential is not 'perceived.' It is real and [Chipco] has experienced it!!"

These exchanges are far from simple transfers of information, but instead are characteristic of what happens when organization members must work across complex knowledge boundaries, where they not only lack shared interpretive schemes (Dougherty, 1992; Bechky, 2003) but, more fundamentally, lack common interests because they are invested in their own knowledge and practice (Carlile, 2002). At issue in the final exchange are the meaning of hazardous waste regulations, their relevance in this case, and, by implication, the relevance of "perceived" environmental risks to a process development decision. The manufacturing manager seeks to position the environmental aspects of the decision as no big deal, questioning why this chemical needs special treatment. The response from the environmental manager lays claim to specialized knowledge (defending his group's expertise in interpreting confusing hazardous waste regulations) and asserts its validity through reference to a prior incident which, presumably, ought not to be repeated.

While boundaries created by differences in interpretation can be overcome by close, frequent interactions between groups (Hansen, 1999), co-location (Tyre and von Hippel, 1997), the use of boundary objects for joint problem-solving (Bechky, 2003), or the work of individual knowledge brokers who translate meaning (Hargadon and Sutton, 1997), such practices may not be sufficient to overcome complex boundaries characterized by differences in interpretive schemes *and* interests (Carlile, 2004). The creation of common ground for action turns not just on the resolution of differences in meaning, but also on acknowledging and overcoming differences in levels of trust and motivation (Brown and Duguid, 2001). It demands that participants make trade-offs, negotiate alternatives, and, critically, that they engage in repeated attempts to share and assess each others' knowledge (Carlile, 2004). However, there are few empirical studies that look at boundaries over time (see Leonard-Barton, 1992 and Dougherty, 2001 for studies of different projects in different organizations), and, in particular, the interaction of similar individuals around similar issues over repeated projects. In the next section, I turn to how members actually engaged practices, over multiple interactions and projects, as they sought to integrate environmental considerations into process development at Chipco.

PRACTICES USED TO INTEGRATE ENVIRONMENTAL CONSIDERATIONS

The practices used by those advancing the new claims were quite diverse. They involved both connecting issues and approaches to existing concerns and procedures, and also distancing or differentiating the issues and approaches from standard ones. They involved gradually building coalitions between disparate parties and also taking control and firmly championing an issue. No simple display can do justice to the combination of practices used in a given case as each project has its unique narrative and its own connections to earlier projects and events.

But, taken together, we learn from this set of practices the range of ways people acted to overcome differences in meaning, legitimacy, and interests when injecting new considerations into ongoing, well-established organizational activities. In analyzing the seven projects, I identified eight primary types of practice that were used to advance the environmental considerations. The practices are listed in table two along with an indication of the relative frequency of their use. Outcomes that resulted from the use of each practice are indicated.

Practice	Use of Practice*	Outcomes
Provide data	Very High	Transfers information on environmental impact and performance. Conveys rigor and objectivity of analysis of environmental issues.
Manage expectations	Very High	May redefine parameters considered in a decision to include environmental concerns. Alerts others to complexity of environmental issues.
Draw analogy	Medium	Helps others interpret implications of unfamiliar issues. May legitimate use of other criteria (not hard data) in decision making.
Managing constraints	Very High	Demonstrates capacity to work with situation at hand to meet Tech or external requirements while advancing the environmental issue.
Appeal to commitments	Medium	Builds awareness of and support for inclusion of new norms (e.g. external standard, internal environmental commitments) in decision making.
Assert expertise	Medium	Legitimates specialized knowledge, possibly by demonstrating understanding of its intersection with process knowledge.
Assert decision procedures	Very High	Legitimates the decision methods of EnviroTech & EnviroCouncil by drawing attention to their similarity with those used by Tech.
Take control	High	Demonstrates cultural competence by mimicking Tech approaches. Can reorient the debate over the issue and/or alternatives considered.

* Very high = greater than 45 occurrences across all projects, high = 30-44 occurrences, medium = 12-30 occurrences.

Table 2: Practices Used to Advance Environmental Considerations in Process Development

After identifying the eight practices, I searched for commonalities among them, or between cases in which certain practices were most prevalent. In doing this, I recognized that the some of the practices involved quite local interactions, aimed primarily at conveying information about a specific technology or practice, its conditions, or constraints. Other practices seemed to carry more reference to existing or newly adopted norms or commitments that guided action and pointed to how the environmental considerations either fit with or departed from them. Still other practices relied much more explicitly on reproducing or challenging existing organizational procedures.

In searching for a way to distinguish and explore these types of practice further, I turned to structuration theory and in particular to the distinction between structures of signification, legitimation, and domination (Giddens, 1993). Giddens' structuration theory has been used in several studies of organizations (Ranson et al, 1980; Pentland, 1992; Orlikowski, 1992; Orlikowski, 2000; Perlow et al, 2004) to draw attention to the recursive relationship between action and structure, whereby actions are constrained or enabled by existing structures, and structures, in turn, are recreated or revised by actions. Structures are not material but are "the set of rules and resources instantiated in recurrent social practice" (Orlikowski, 2000: 406). Giddens distinguishes between structures of signification as semantic rules or conventions, structures of legitimation as systems of moral rules or norms, and structures of domination as systems of resources (1993). None of these structures can be separated from the actions that produce and reproduce them. Structures of signification, expressed as "mutual knowledge" (1993: 113), must be demonstrated, actualized, and occasionally fought for by actors. Structures of legitimation, expressed as norms must be "made to count" in actual interactions (Giddens, 1984: 30). And structures of domination are expressed in the differential resources actors possess and can bring to bear on practical activities (Giddens, 1993: 120).

While in practice each type of structure is present in every interaction (Giddens, 1993), the analytic distinction between the types, as well as the emphasis that each structure may be negotiated during interaction, is useful for sorting through the types of practices I observed. Working back and forth between the details of the coded practices and the three types of structure, I categorized the eight practices into three broader types that I use to organize the discussion of practices. I labeled as *framing practices* those moves that primarily challenged, altered, or built on existing interpretive schemes, or structures of signification. Practices labeled *negotiating support* involved efforts to create shared or acceptable justifications for actions or interpretations by explicitly or implicitly drawing on structures of legitimation, or norms that guided existing activities within or outside Chipco. Finally, certain practices helped actors to *mobilize resources* by approaching, representing, and solving problems in ways that drew on, and at times challenged, structures of domination or patterns of material and cultural resource use. Of course, any single move may have invoked all of these types of practice, consistent with

Giddens' assertion that the types of structures and their recreation through action are inseparable. But the analysis here also accounts for the fact that at some times one dimension of practice, and hence one dimension of structure, may be more salient than others. Calling out for attention these three types of practice should therefore be viewed more as an exercise in discerning "figure" from "ground," with shifting attention to figure, than it is an exercise in sorting practices in distinct "buckets."

Framing

Framing involved offering information or explanations for including environmental considerations in a given project. The particular practices observed included providing data, managing expectations, and drawing analogies. The practices I include in the framing category typically involved quite local action in the sense that they focused on advancing particular aspects of issues and dealt with immediate rather than longer-range or "strategic" concerns. Of the framing practices observed, providing data and managing expectations were two of the three most commonly used practices of any type in the seven projects studied.

Providing data. Providing data took the form of sharing information on the current environmental performance, process performance, cost, and other parameters, and making projections about expected values of these parameters under various alternatives. Data was typically provided through presentations at EnviroCouncil meetings, through email interchanges between project team members, or through direct conversations with those affected. For example, the EnviroCouncil chair noted in a presentation on the status of the Clean Air project that

> Significant progress has been made on recipe optimization ([chemical f] emissions of 0.204lbs/ws are now at about 0.12 lbs/ws) and at identifying two candidate technologies for emissions treatment which appear to operate at least at 95% removal efficiency.

Perhaps because Chipco, and the Tech group in particular, was strongly committed to "data-driven" decision making, those advancing environmental considerations were particularly concerned with presenting their arguments to others in a way that conveyed rigor and objectivity. There was a marked shift over time in how they treated data, and even what counted as data. For example, in diagnosing reasons for the failure of the early Destructor project, both Tech and Environmental managers pointed to the poor initial evaluation of alternatives, referring to it as a "cursory assessment" constrained by the timing of the new process. Five years later, on the Blue Skies project, providing data took on heightened importance. Among themselves Environmental specialists labeled community concern over visible, but harmless emission plumes as "emotive" for certain communities, exchanged anecdotes about public queries regarding the plumes, and observed that "the public affairs people don't want to have to explain it anymore." But during one meeting of the EnviroCouncil, members questioned spending money on equipment simply to address a public perception issue. As one Manufacturing manager observed,

> It seems to come down to whether public perception is worth $500,000 per plant. Chipco would get better press by putting the money into the local schools.

Following this meeting the environmental specialists regrouped, gathering information among themselves about the frequency of complaints and the cost of a similar issue that had been poorly handled some years earlier. At the next EnviroCouncil meeting, the manager opened his presentation with the following:

> [Chemical N] reacts with [chemicals F and C] to form visible plumes, typically when [chemical F or C] > 1ppm (current average is 0.5ppm), so plumes are an intermittent problem. Scrubber performance is poor in the presence of [chemical N] and this is complicated by the dilution of the exhaust. … [the first reason for the Blue Skies project is] to improve house scrubber performance (currently average 50% and should be above 90%).

This time, the point about eliminating visible plumes because of public concern was found on the second page of the presentation, following more data about particulate and other emissions. Three weeks prior, the earlier version of the presentation had shown public perception as the first reason. Intentionally manipulating the message in this way framed the issues as valid considerations in process development; the use of technical data helped to portray issues as "real," rather than "perceived."

Managing Expectations. Those advancing environmental considerations didn't just blindly bombard others with technical data. They also acknowledged limitations, both in the data itself and in their capacity to act on certain issues. Managing expectations was another very heavily used practice. Related to providing data, managing expectations took the form of more explicit strategizing about how internal or external audiences would be approached, and reflected efforts to help others see the complexities of a given effort. Whereas providing data often highlighted where environmental considerations *converged* with the concerns of others, managing expectations often highlighted where, how or why they *diverged*. For example, in presenting his work on the Decision Tool to the EnviroCouncil, one manager stated that

> The document should be seen as one that identifies key issues and stakeholders rather than something that one could feed into a computer and have it spit out an answer, because that's not reality. There are all sorts of different strategic reasons for doing things that can't be captured in a model.

As in the example of the Blue Skies project, there is evidence of people adjusting this framing practice to respond to problems or criticisms. Following an awkward presentation of the Decision Tool to the EnviroCouncil in which the group spent considerable time discussing whether the environmental guidelines referenced in the document were environmental "policies" or "philosophies" and the subsequent implications, the manager reframed his next presentation, focusing on the assessment tool itself and stepping through an example.

Managing expectations also involved external stakeholders. On the Greenhouse project, an EnviroTech manager and a Manufacturing manager were attending a conference to present results of a difficult equipment pilot project because they "needed to show the EPA (Environmental Protection Agency) that you don't just throw $30 million at it and get it working overnight."

Drawing Analogies. Explicitly drawing analogies with earlier successes or failures, or with existing approaches used in other parts of Chipco was used to provide somewhat ready-made interpretive schemes for new approaches. In presenting the Decision Tool the second time to the EnviroCouncil, the manager noted that it "is based on chemical assessment forms so there is a precedent for using this type of approach at [Chipco]." Framing the Blue Skies project involved drawing attention to three different prior incidents, although one was used much more than the others. Reflecting on this at a meeting of senior environmental specialists, the EnviroCouncil chair reported that the EnviroCouncil had "finally agreed on a recommendation for implementing [the Blue Skies project]" and that,

> The key factor was recognizing the similarity to the … odor issues in [a certain state] as well as an approximate cost of that solution ($11 million).

Negotiating Support

Practices aimed at *negotiating support* involved efforts to create shared or acceptable justifications for actions or interpretations. While related to framing, these practices frequently drew more explicitly on broader norms – whether the norms that guided Tech's actions and decisions, Chipco's formal or internal environmental commitments, or external regulatory or industry considerations. In negotiating support, those advancing environmental issues did not necessarily agree with these norms, but they implicitly or explicitly accounted for them. As such, they drew on structures of legitimation and advocated for actions that were either consistent or at odds with these structures. Particular practices categorized as negotiating support included: managing constraints, appealing to commitments, asserting expertise, and seeking information.

Managing Constraints. This practice was very highly used and involved recognizing contingencies that influenced the type and timing of action on environmental considerations, and adjusting practices accordingly. Frequently, this involved drawing on norms that guided the timing, sequencing and technical rigor of process development at Chipco. The pace of process technology development, and the widely accepted fact that environmental alternatives could only be developed once process details such as chemical type and quantities were known, led to contingencies being built in to the environmental projects.

In the Capturer project, for example, the development team built in “provisions for additional capacity to be included in the design depending on the [next process generation] [toxic air] emissions, which aren’t fully understood at this time.” Understanding constraints had been more reactionary for the earlier Destructor project where a Tech engineer reported that, “after Fab [nn] ramped up [we] were not getting complete removal of [chemical Y] in the [wastewater].” At that point, engineers could not introduce complete changes to the system, but could only develop “operational improvements but no real blockbusters.” Reflecting on the initial choice of the Destructor, the engineer added that “alternative destruction technologies would have taken about a year and half to develop so [Destructor] was the best choice because it was ready.”

The process technology itself, and continuous changes in it, also shaped they way those advancing environmental considerations worked. An EnviroTech engineer working on the Greenhouse project observed that,

> Because you need [chemical F] to clean [compound S], you are operating within a box; with [chemical F] you are either going to get lots of [toxic air emissions] and a little [greenhouse gases], or lots of [greenhouse gases] and a few [toxic air emissions] – [chemical F] has to come out one way or another.

An EnviroTech manager working on the same project observed that Tech engineers were working with suppliers to replace one of the greenhouse gases, while a joint EnviroTech/Tech team was working to develop equipment to capture and recycle the very gas being replaced. Because of the uncertainty around how each project would unfold, and the fact that old processes would continue to use the old gases even if a new gas was introduced, he noted,

> We had to do both at the same time, even though [the replacement chemical] makes capture less efficient, its in opposition to capture.

Appealing to Commitments. Whereas managing constraints reflected a pragmatic stance that largely accommodated the nature and timing of Tech’s process development needs, appealing to commitments drew attention to different kinds of constraints. This practice involved drawing on commitments made by Chipco management (e.g., the SCC’s endorsement of a pollution prevention hierarchy) or industry groups, or simply invoking a regulatory requirement. Appealing to commitments was used especially when the proposed actions would depart from those typical within Chipco and justification was needed for departing from these norms.

For example, EnviroTech managers working on the Greenhouse project were highly involved in efforts to “ensure industry unity on [chemical P] reduction targets” and referred to an industry-wide consensus on a “hierarchy of solutions” when they argued internally that

> Higher order solutions take more time to develop and solutions for existing fabs and [equipment] will likely be different than those for new.

By appealing to the importance of industry consensus and noting that the industry as a whole saw the best solutions as ones that were harder to develop, EnviroTech members in essence “bought time” by setting the expectation with Tech that work on the Greenhouse project would not follow the typical pacing of process technology development. Indeed, as the technical solutions proved much more difficult to successfully develop than anyone had anticipated, the message of doing “the right thing” was continually reinforced by EnviroTech. Late in the project one EnviroTech manager lamented that others within Chipco “don’t believe we have these dilemmas and don’t believe we don’t have the power to solve them,” suggesting that raising awareness about commitments and constraints was essential to overcoming differences in interpretation, as well as to legitimate action on these issues.

Of course, commitments were not always unambiguous. On the Blue Skies project an Environmental manager characterized the regulations on the issue as “clearly ambiguous,” noting that the company could get “pushed on one of these regulatory gray areas.” As a result, to be successful, the practice of appealing to commitments had to draw on norms that were external to Tech, but also draw on Tech’s norms for data-based decision-making, as the earlier illustration of framing in the Blue Skies project illustrated.

Asserting expertise. Asserting expertise was a practice that enabled those advancing environmental considerations to be regarded as competent and legitimate players in process development. Negotiating support for consideration of these issues over time included both demonstrating that environmental specialists could understand and appreciate process development demands, and that they could represent and defend their own specialized knowledge and expertise in the face of these demands. For example, one EnviroTech manager referred in detail to the evolution of process changes and how they influenced conditions for the Recycler project:

> “we didn't ash photoresist back then because the ashing process had a lot of instabilities and we couldn’t do a full ash without affecting the electronic capabilities of the devices, so we ended up with a lot of organics in the [chemical bath].”

Another example that shows the close connection between framing and negotiating support puts asserting expertise in a different light. One Tech manager who was a member of the EnviroCouncil and highly committed to integrating environmental considerations into process development was also known for his blunt nature and sarcasm. He devised his own unit of measurement for greenhouse gases, dubbed it “bull years” (allegedly the number of years it would take a bull feedlot to produce methane equivalents of the gas in question), and translated all the relevant data on the technical approaches for greenhouse gas emission reduction into this new metric. Replacing the standard "MMTCE" (million metric tons carbon equivalent) may have been intended to help others better interpret a confusing unit of measurement, but the message sent about the manager's personal views on the subject of global warming was far from subtle. Yes this manager worked diligently on the project, and perhaps was able to convince more skeptics of its value because of his flippant approach rather than in spite of it. By acknowledging the uncertainty around the larger issue in this way, he seemed to say "I'm not sure I believe it either, but here's what we're doing..."

Mobilizing Resources

Finally, certain practices involved *mobilizing resources* for action where resources were both material and cultural. Mobilizing material resources consisted of allocating money or personnel to work on particular problems, whereas mobilizing cultural resources involved an individual or group's facility with and authority over established procedures or norms. Particular practices included asserting decision procedures and taking control.

Asserting decision procedures. Adhering to decision procedures used in Tech and communicating this adherence to others was a very prevalent practice. Those advancing environmental considerations took pains to mimic the decision procedures, including the representation of data, the careful evaluation of alternatives according to multiple criteria, and the setting of and adherence to goals, that were so central to process development work in Tech. For example, in one EnviroCouncil meeting where the equipment for the Capturer project was being selected, two Tech managers agreed on the recommendation but demanded that the data be provided, noting that,

> "if this was [a Tech equipment recommendation] and they didn't have the data we could look at then we would not consider it."

EnviroTech engineers agreed to display the data in a certain format so it could be formally approved at an "emergency meeting" called by the Tech managers two days later.

The gradual development of formal bodies and stringent adherence to widely practiced procedures led many to claim that the development of environmental solutions was increasingly resembling mainstream process development. One EnviroCouncil member concluded that "in general facility-related systems have been a disaster" but the choice of equipment for the Clean Air project was more successful and he asserted that it would shape the approach for all environmental process development projects in the next process generation. The EnviroCouncil chair reported that he'd received "very strong feedback from the [Tech senior management group] that they wanted more solutions like [the Clean Air project]." The equipment had been selected and its operation demonstrated in only four months time and it was to be integrated directly into the process equipment. An EnviroCouncil manager had been able to secure one-third of a Tech engineer's time to work on the environmental solution as well as get money from Tech to support the development process. Further bolstering the group's perceived effectiveness was its members' fit with cultural norms. One manager, commenting on the Tech engineer assigned to the Clean Air project said, "in all my years at Chipco, I have never seen someone be so firm with a supplier." Toughness, focus, and determination were highly prized attributes in the process development culture.

But while successful engagement of procedural and cultural resources increased the power and legitimacy of the environmental specialists, some worried that mimicry of Tech could go too far. One EnviroTech manager who had worked for years in the corporate environmental group argued that the Decision Tool "doesn't allow us to look at things in a very complex way" and he worried that the tool would be used by others who wouldn't be able to judge environmental considerations. "The problem," he added, "is that Manufacturing, Tech, and Equipment don't have the same decision points we do" and he observed that they answered to fewer stakeholders, particularly outsiders, than EnviroTech did.

Taking Control. The practice of taking control involved making a firm decision and moving ahead with a plan of action, even in the absence of complete information. It was related to but broader than appealing to commitments and asserting expertise. The focus of taking control was on actions, and, while it tended to move away from the norm of relying on data for any decision, it was highly consistent with the culture of Tech and Chipco as a whole. Power accrued to those who were decisive and took calculated risks. Challenges were regarded simply as opportunities to "make it work." So the decision to pursue and pilot a costly, emerging gas recycling technology early in the work on the Greenhouse project comes as no great surprise. A manager involved at that stage, and well aware of the ongoing technical problems some years later explained,

> When [Chipco] was first looking at [greenhouse gas emission] issues we didn't know whether we would have to do something or not, but we didn't want to be in a position of having to do something but not being ready with a technical solution.

Because the technical solution for the Greenhouse project had been delayed so long due to very challenging development, extra pressure was placed on the related Capturer project. The solution in this case was also to take control of the development, as an engineer reported,

> We went to [the supplier] for a membrane system and it was going to take them six months (a long time) to build. So we decided to go ahead with the duct work and pretreatment. This was not [the supplier's expertise] and we felt we could do as good a job or better.

Taken together, both adhering to procedures and taking control were practices used to draw directly on the material and cultural resources important within Tech. Unlike framing and negotiating support where certain practices served to distinguish environmental considerations, mobilizing resources sought to demonstrate how similar environmental considerations could be to mainstream activities within Tech.

PATTERNS OF PRACTICE AND THEIR CONSEQUENCES

How were the practices described above invoked in particular projects? How did the use of practices shift over time and between projects? And what were the consequences for project outcomes and the integration of environmental considerations overall? Table three shows that the practices were not used identically across the projects, and it also suggests a shift in the relative use of the types of practices over time. The lower portion of table three suggests that projects deemed successful involved a relatively larger share of framing practices. Furthermore, projects initiated later in the time period studied were more often deemed successful, although not exclusively so. In this section, I work back and forth between the data and existing literature to develop explanations for these patterns of practice and for how they contributed to environmental issues "getting in" to ongoing process development activities at Chipco.

Category of Practice	Practice	Destructor (1992)	Greenhouse (1993)	Recycler (1994)	Dec. Tool (1997)	Clean Air (1997)	Blue Skies (1997)	Capturer (1997)
Framing	Provide data	*	*	***	*	***	***	**
	Manage expectations	–	***	*	***	***	*	*
	Draw analogy	*	–	*	*	*	**	–
Negotiating Support	Managing constraints	**	***	*	***	**	*	*
	Appeal to commitments	–	**	**	*	*	*	–
	Assert expertise	*	*	*	*	*	*	–
Mobilizing Resources	Assert decision procedures	***	*	**	*	*	*	**
	Take control	*	***	*	*	*	*	**
Total Coded Practices by Project		28	50	41	40	51	39	23
% Framing		21%	30%	**37%**	**48%**	**55%**	**67%**	30%
% Negotiating Support		32%	**36%**	**37%**	33%	29%	21%	13%
% Mobilizing Resources		**46%**	**34%**	27%	20%	16%	13%	**57%**
Project Evaluation by Participants		**Failure**	**Failure**	**Failure**	**Success**	**Success**	**Success**	**Failure**

– practice not used in project
* practice 5 or fewer times on project
** practice used 6 to 9 times on project
*** practice used 10 or more times on project
Bold shows most prominent category or categories of practice for each project.

Table 3: Distribution of Practices Within and Between Projects

One possible explanation for the shift toward more successful projects is simply that the formal changes in roles and procedures resulted in an internal capability to address environmental considerations. The founding of the Strategic Chemical Council in 1992, its replacement with the EnviroCouncil in 1996, the simultaneous formation of EnviroTech as a distinct group to interface with Tech and the development of environmental process goals, were all significant changes that certainly supported integration of environmental considerations. This kind of story is consistent with organization design literature that posits that internal organizational configurations are arranged and rearranged to achieve a degree of internal fit appropriate to the issues at hand (Miller, 1996; Siggelkow, 2002). But such an explanation has several shortcomings for this data. First, it can't explain why some projects (e.g., the Capturer) failed even after the internal changes had been made. Second, and, more critically, it can't explain a decline in the relative use of practices to mobilize resources, and a concurrent increase in the use of framing practices. If appropriate formal changes are made to support the integration of environmental concerns, one might expect exactly the opposite – a relative increase in the mobilization of resources through these formal channels, and a relative decline in the use of framing to create shared meaning.[7] This paradox suggests that there is more going on in practice with the integration of new considerations than can be understood by looking only at formal reconfigurations.

The within-project analyses, as well as the data summarized in table three, suggest that framing was an essential practice associated with successful integration of the environmental considerations. Framing took the form of both connecting the environmental considerations with the core concerns of Tech and also differentiating them as somewhat unique. Successful framing shapes meaning by articulating what is at stake and it also legitimates certain stories within the debate by elaborating plausible cause and effect linkages (Fligstein, 1997; Benford & Snow, 2000; Lounsbury & Glynn, 2001; Greenwood, Suddaby & Hinings, 2002). While it was primarily focused on elaborating meaning in situated exchanges at Chipco, framing also served to legitimate the consideration of the environmental issues by couching them in a way that appealed to Tech. Providing data, even if it was derived from different sources, lent the environmental specialists credibility as data-driven decision making was so central to work within Tech. The symbolic value of framing cannot be underestimated at Chipco where the statement that "the gathering of information provides a ritualistic assurance that appropriate attitudes about decision making exist" (Feldman and March, 1981: 177) is particularly fitting. While all three types of practice – framing, negotiating support, and mobilizing resources – were used in all seven projects, each of the failed projects show a lower proportion of framing practices than the successful projects. While framing alone does not make a project successful, it seems essential to its success.

Framing as Practice

The use of *framing as a practice*, as opposed to simply the creation of formal roles and structures, appears to be the key capability that enabled members of Chipco to represent and act on the environmental considerations. In order to overcome differences and work on a common project, people must first be able to represent and appreciate the novel circumstances that arise in the project (Carlile, 2004). If they are unable to represent their differences or unable to understand the consequences of these differences, they will either misrecognize the nature of the differences (Levitt and March, 1988, Carlile, 2004) or fail to adequately assess what is at stake when differences arise (Weick et al, 1999). Framing is one way of making explicit not only differences in meaning, but also differences in interests, that surround the integration of new considerations.

Indeed, in projects where framing was used relatively little, there was little broad agreement on what the environmental issue was, and why it needed to be addressed. The Destructor, one of the earliest projects, was characterized by very different interpretations by participants of what was at stake. Two Tech managers recognized that a chemical compound needed to be removed from a slurry waste for environmental reasons, but one noted it was because the chemical "had a scary name" and regulations governing it were unclear. Environmental specialists characterized the problem as both environmental and related to safety, while Tech engineers working on the project saw technical and operational issues as critical. The Destructor was labeled a "disaster" because poor development led to considerable operational problems, including frequent fab shut-downs. One Tech manager who had been closely involved remarked that "we dropped the ball on the waste system" but concluded that

> if we had staffed it from the beginning like we staff [Tech] stuff I am convinced we would not have had a problem. If we had to do it again, [Tech] would have owned the waste system.

Reflecting the same overall conclusion, an engineer who worked closely with the Destructor noted, "to make the system bulletproof, everything has to be run like [Tech]."

Where the Destructor is an example of misrecognizing novelty and attempting to impose procedural fixes, the Capturer is an example of recognizing novelty but failing to appreciate its importance. Work on the Capturer was started when a technical solution for the Greenhouse project was being developed, and the Capturer was seen as an enabler of this project as well as a solution to an ongoing problem that would eventually have been addressed on its own. A senior manager approved the development of the Capturer when EnviroTech realized they "could kill two birds with one stone." Perhaps because of the high-level endorsement and the presumption that the need for the Capturer would be self-evident as the Greenhouse project developed, more attention was paid to following procedures and gaining resources than to framing the project. However, when the Greenhouse project faced serious technical difficulties, as did the Capturer itself, there was little support outside EnviroTech for the project.

Finally, framing as a practice developed over time among the members of EnviroTech and others who worked to integrate the environmental considerations into process development. Over time and even within projects (as the earlier Blue Skies example demonstrated), framing was refined and adjusted. The Clean Air project, initiated late in the period studied, relied heavily on framing, and was widely heralded as an enormous success. Although it had been called "probably the biggest environmental problem we have ever faced" by a Tech and EnviroCouncil member, a technical solution was developed and successfully implemented within a matter of months. EnviroTech focused considerably on framing the issue as one that was a critical to the timely development of the process itself. The EnviroCouncil chair, in preparing for a meeting with a senior management group observed that

> This may be the first tool where the environmental implications are the biggest technical hurdle to bringing it in.

The group displayed the consequences of not acting on the environmental issue in stark terms of how it would limit eventual manufacturing output, not in terms of a standard air emissions metric. The Clean Air project's success, one EnviroTech engineer remarked, was due to the fact that "it was the first time we treated an [environmental device] like a process tool." The group's successful framing on this project was explicitly transferred to other projects – the same display that showed how the environmental issue would limit fab output started to show up in other presentations on other projects.

The Development of Framing as Practice

Seeing framing as a practice developed by a group of people over time speaks to the *accumulation* of a capability for knowledge integration. In other words, integrating a fundamentally new consideration into ongoing practice is not something an organization categorically can or can't do, but rather something that its members may or may not achieve effectively over time. Recent work on knowledge in practice (Brown and Duguid, 2001; Orlikowski, 2002) and innovation (Dougherty, 2001) draws attention to the emergence over time of capabilities to represent, share, and integrate knowledge both within communities of practice (Brown and Duguid, 1991; Wenger, 1998) and between them. While the presence of a community of shared practice is shown to enable and, at times, constrain the integration of complex, often tacit, knowledge (Orr, 1996; Hargadon and Fanelli, 2002), we know little about how communities of practice get started and emerge. The Chipco data, focused on the early stages of the organization's efforts to integrate environmental considerations into process design, affords a glimpse into what may be the emergence of a community of practice. And this glimpse suggests that the work involves not only developing a shared identity and shared knowledge (Brown and Duguid, 2001) but it critically involves representing one's identity and knowledge to others in a way that deliberately shapes shared meaning and attaches new practices to existing ones (Dutton & Ashford, 1993; Maguire, Hardy, & Lawrence, 2004; Creed, Scully & Austin, 2002). Successfully doing this involves a degree of "bricolage" (Levi-Strauss, 1966), or improvisation in which actors work with the opportunities available in the moment and adjust practices and frames to best fit the situation at hand, rather than waiting for the ideal conditions to act. Hence the integration of new considerations, and the emergence of a community of practice is not a linear, predictable process, but one that responds to and incorporates external events, formal changes, and unforeseen consequences of earlier actions.

DISCUSSION AND CONCLUSIONS

The Chipco analysis highlights several key implications for the integration of fundamentally new knowledge into organizational activity. First, the findings point to the particular importance of framing as a practice of developing shared meaning around new considerations. Framing involves both demonstrating similarities between the new issues and those that are central to groups within the organization, and drawing attention to differences. Insufficient attention to framing seems to undermine further attempts to build support for or mobilize resources because of a lack of consensus about what is at stake and why it is important. But overzealous use of framing is not a panacea, either. The data from Chipco suggests that some members of EnviroTech were aware of the costs of framing problems in ways that gained traction within Tech. One manager observed, "sometimes you end up trying to solve yesterday's problems (gave example of the Destructor) and you don't deal with today's issues which might be quite different." Another worried that the Decision Tool was a mistake because it reduced the complexity of inherently complex decisions.

Framing carries with it both the promise and threat that approaches adopted will address the problem only as it is framed. The old saying that if all you have is a hammer, everything starts to look like a nail comes to mind. In a place like Chipco, and Tech in particular, where very strong norms shape work, the need for framing and its associated costs are perhaps highlighted. Central to work in Tech was the use of data to drive decision-making. As one manager commented, "the way [Chipco] normally works is we define a numeric metric and fix on it and work towards it." Consistent with this, a focus on "making it work" – making data-based decisions and then driving equipment development quickly through to completion through focus and engineering rigor – created strong norms for what constituted work and how this work was done in Tech. "[Chipco] tends to focus on things that limit performance, the whole corporate psyche is around problem-solving," explained one Tech manager. Finally, the allocation of resources reinforced the meaning of and norms surrounding work in Tech. People and money followed the key technical challenges, and personal power flowed from this. One Tech manager noted "the critical players are those who take on the biggest challenges." In such a setting, framing would be expected to be of particular importance to getting new considerations in. In an extreme case (Eisenhardt, 1989; Pettigrew, 1990) both the benefits and costs of framing may show up as more significant than they would in a setting where work is regarded as more flexible, emergent and centered on practice and less focused on "keeping the system going" (Dougherty, 2001: 618). But regardless of the image of shared work in an organization, developing a shared sense of what is at stake and why it matters is critical to the integration of new considerations.

A second contribution of this work is the finding that capabilities for integrating new knowledge emerge over time across repeated situated engagements on multiple projects. EnviroTech did not *have*, rather it *accumulated*, an ability to frame environmental considerations, negotiate support, and mobilize resources in a way that enabled successful completion of projects. But framing did not operate or accumulate in a vacuum. The development of formal groups, roles and procedures was also important, as was EnviroTech's experience with negotiating support and mobilizing resources. None of these alone would have led to the particular project experiences and outcomes observed, nor can future project experiences be fully predicted from these. While the interactions between practices, changes to formal organizational elements, external events, and the projects themselves cannot be fully explored in this paper, further study of these interactions would be fruitful for exploring how organizational capabilities are "generated in" rather than "transferred to" groups or organizations (Cook and Brown, 1999: 398).

Finally, while the findings here could apply to other types of new knowledge or new considerations, it is important to consider the unique implications of this work for understanding the integration of environmental knowledge into organizations. Until recently, very little work has considered how internal aspects of organizations influenced their response to environmental issues, assuming that an organization's activities in this area reflected external pressures or conditions (Porter and van der Linde, 1995; Russo and Fouts, 1997). Recent work asserts that an organization's specific capabilities, the issues it regards as important, and the organization's context can shape its environmental practices (Aragon-Correa & Sharma, 2003; Bansal, 2003; Reinhardt, 1999) and some scholars have called for increased attention to internal organizational factors (Andersson & Bateman, 2000; Egri & Herman, 2000; Sharma, 2000 Bansal & Penner, 2002; Forbes & Jermier, 2002) to help tease out explanations for seemingly idiosyncratic organizational actions on issues of environmental protection. Focusing in detail on the process by which environmental issues enter core organizational activities over time, and understanding how organizational actors interpret, account for, and ultimately work on these issues is critical to deepening our understanding of organizing for environmental responsibility.

Taking environmental issues seriously in their own right, as organizations today increasingly are doing, but also seeing them as intimately tied to a core dilemma in organizational studies – how organizations integrate fundamentally new knowledge – is a key goal of this paper. Through its focus on the practices by which environmental issues "get in" to ongoing organizational activity, the paper addresses both the challenges and opportunities of designing environmentally sound organizations and begins to answer some of the recent calls (Stern and Barley, 1996; Hinings and Greenwood, 2002; Margolis and Walsh, 2003) for greater attention to the interaction between organizations and the broader society.

Notes

[1] Chipco is a pseudonym. Group and personal names have also been disguised to protect the identity of the company and employees.
[2] The pollution prevention hierarchy is a commonly used tool that establishes most and least favorable alternatives to treating chemical waste. It typically is stated as (from most to least environmentally favorable): reduce, reuse, recycle, abate.
[3] It was impossible to gain access to Chipco without becoming a participant, and as a student internship was a common type of participation, it afforded me the opportunity to be regarded as a member, albeit somewhat temporary, and to be socialized as such, giving me a much more in-depth view of the organization than I would have had as a non-participant. A student intern is also relatively low status, so my contributions to the various projects I describe here were minimal, hence my stance as a participant observer and not an action researcher.
[4] For an earlier study I had already coded all of my field notes, interview notes, and many of the related documents using emergent themes (Glaser and Strauss, 1967; Miles and Huberman, 1994) to identify cultural characteristics of Chipco in general, and subcultural differences between Tech and EnviroTech. These were used to develop an ethnographic account of how Chipco incorporates environmental considerations into process development work, which provides an underpinning for the current study.
[5] Seven of the selected projects involved traditional process development activities because I felt that these were most likely to show how knowledge had to gain currency and simultaneously be integrated across boundaries. In contrast, many of the less traditional projects (e.g., strategic plans, models) were being pursued by EnviroTech but had had minimal impact within Tech or other groups so far. I did select one less traditional project for further study, a new EnviroTech decision tool, because it was used surprisingly quickly after its development in two of the more traditional projects studied in detail and I wanted to understand whether and how this procedural improvement was related to the other projects.
[6] AWN stands for Acid Waste Neutralization system, POTW for Publicly Owned Treatment Works, and TDS for Total Dissolved Solids. All are technical terms relevant to wastewater treatment, but unfamiliar to those engaged in manufacturing work at Chipco.
[7] Of course, the relatively high use of mobilizing resources in the earlier projects may be explained as necessary precisely because the formal roles and procedures were not in place. Certainly, some of the early failures informed the creation of these formal roles and procedures. But some of the failed projects, notably the Greenhouse and Capturer projects either continued well past or were initiated after the formal changes and still relied heavily on the practice of mobilizing resources. Further, the shift to increased framing is not necessarily explained by any interaction between the formal changes to roles and procedures and the use of the mobilizing resources practice.

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