THE ENACTMENT-EXTERNALIZATION DIALECTIC:
RATIONALIZATION AND THE PERSISTENCE OF COUNTERPRODUCTIVE TECHNOLOGY DESIGN PRACTICES IN STUDENT ENGINEERING

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This article explores why engineering students are committed to counterproductive practices. Student informants’ work practices appeared to coincide with lay stereotypes about what “good engineers” do, and they sought to justify those practices as rational. This externalization encouraged them to perform these practices more frequently. We characterize the relationship between the enactment of norms and the externalization of work practices as a dialectical process that helps explain why the students could not conceive of changing their practices. We draw implications for theory on occupational socialization and for the management of engineering work from our findings.

Socialization processes are normally aimed at helping newcomers to learn the norms of a particular culture. For this reason, most research on organizational and occupational socialization discusses those tactics that managers, leaders, colleagues, teachers, and others use to teach newcomers what sorts of practices are “natural” (Van Maanen & Schein, 1979: 210), “normal” (Jablin, 2001: 756), and “proper” (Van Maanen & Barley, 1984: 238) for that social context. In many cases, socialization is needed because people are unfamiliar with the norms of a professional community (Ashforth & Saks, 1996; Brown, 1985; Cable, Aiman-Smith, Mulvey, & Edwards, 2000; Jones, 1986; Kim, Cable, & Kim, 2005; Morrison, 2002; Van Maanen, 1978). In other cases, socialization is necessary because people come to an occupation or organization with strong, inaccurate ideas about what it means to be a member. In superb ethnographic detail, Becker and his colleagues (Becker, Geer, Hughes, & Strauss, 1961) demonstrated that students often began medical school with strong beliefs about what made a “good doctor.” The researchers pointed out that in many cases, students’ notions about natural, normal, and proper medical practice were out of line with the norms strongly upheld by most physicians. Thus, the goal of educators in the medical school and of clinical residency programs was to disabuse newcomers of false impressions about what practices characterized a good doctor and to properly socialize them into occupational membership.

Becker and his colleagues’ findings are striking, given that their studies were conducted in the 1950s, before TV shows, news reports, cartoon strips, and pervasive advertising began to bring images of professional membership into every household. In today’s ubiquitous communication environment, idealized depictions of doctors, surgeons, police officers, lawyers, chefs, pilots, teachers, engineers, and many other professionals are abundant. As research has shown, these images of professional membership serve as resources laypeople use to construct images of what it means to be a “good” member of a given occupation and that many use to form their career aspirations (Pfau, Mullen, Deidrich, & Garrow, 1995; Turrow, 1989; Wright, Huston, Truglio, Fitch, Smith, & Piemyat, 1995). One of the consequences of having so many people who think they know what it is like to work as a member of a given profession is that educators, prominent occupation members, leaders of professional organizations, and workplace managers, among others, often find themselves having to cor-

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rect inaccurate stereotypes about what activities are really natural, normal, and proper within an occupational culture (Friedman, 1989; Holtz, 2007; Machura & Ulbrich, 2001).

This problem also presents itself for many organization managers and other would-be socializers in workplace organizations. Their jobs are doubly difficult because, rather than simply teaching eager newcomers occupational norms, they may have to actively work to correct newcomers’ inaccurate stereotypes about what it means to be a good professional. Evidence suggests that this job is quite difficult to accomplish. Within the professions of software and computer engineering, for example, many managers find that new employees hold strong stereotypes about what it means to be a good engineer and work in ways that are counterproductive to conventional organizational practices. For example, Ford, Voyer, and Gould-Wilkinson (2000) found that new engineers strongly preferred individual work and resisted attempts to collaborate with others. As these authors suggested, the ethos of individuality was counterproductive to building a “learning organization,” as managers sought to do. A study by Dryburgh (1999) showed that new engineers often intentionally excluded from their workgroups others who they believed did not have high technical skills. These exclusionary tactics were counterproductive to creating an apprenticeship model, another managerial aspiration.

Professional engineering organizations have also begun to report a mismatch between students’ stereotypical understandings of how engineers should work and the types of practices organizations are looking for in new employees. The Accreditation Board for Engineering and Technology (2007), the National Society for Professional Engineers (2004), and the IEEE/ACM Joint Task Force on Computing Curricula (2004) all report that workplace managers are normally satisfied with the technical preparation of undergraduates from U.S. engineering schools, but they are unsatisfied with their communication and teamwork skills. Scholars have suggested that many engineering graduates continue to work and the types of practices organizations are acting appropriately (Brown, 1985; Morrison, 2002; Wanberg & Kammeyer-Mueller, 2000). If a new person receives reinforcement, his/her identity as a member of that group becomes stronger, and if no reinforcement is received, the person’s identity as an outsider begins to form (Chreim, Williams, & Hinings, 2007; Nkomo & Cox, 1996). Additionally, during the socialization period newcomers establish an identity as members of a culture by learning to attach meanings to the same practices that everyone else does and by making sense of why they are attaching those meanings to those practices in ways similar to those of other members. As Reichers suggested, “The primary tasks that newcomers accomplish during the encounter stage of the socialization process are (a) establishing a situational identity and, (b) making sense of (attaching meaning to) organizational events, practices, and procedures” (1987: 279).

Although newcomers may begin their professional socialization with perceptions (accurate or otherwise) about the identity of a typical occupation member and whether or not their own identities are congruent, educators, managers, and others work purposefully to instill in them the real norms of occupational membership (Adkins, 1995; Feldman, 1976; Ondrack, 1975; Wanberg & Kammeyer-Mueller, 2000). In engineering in particular, many educators work hard to teach productive occupational practices such as communication skills and teamwork skills to students and to encourage them to view collaboration, teaching, and sharing as important occupational norms (Hilburn & Humphrey, 2002; Lovgren & Racer, 2000). Despite these attempts, during their tenure in engineering schools students often grow more committed to practices that reflect lay stereotypes about engineering identity than they were when they entered and have an increasingly difficult time accepting practices that educators, managers, and others suggest are fundamental to success in most modern workplaces (Beerson, Slaten, Williamson, & Ho, 2004; Chris-
tiansen, 2002; Waite, Jackson, Diwan, & Leonardi, 2004).

In this inductive research study, we ask, Why do engineering students often remain committed to practices that are counterproductive for the engineering occupation and disavowed by many practicing engineers? We believe this question is important because the issues of identity, resistance, change, and effectiveness that are bound up with it are essential for good theory about socialization and occupational change. Through an analysis of qualitative data, we illustrate how software and computer engineering students carry out a number of work practices that “enact” norms they believe to be acceptable within their new culture. Informants draw on their lay understandings of what sorts of requirements particular tasks impose upon them and on popular occupational stereotypes to justify their continued performance of these actions to themselves and others. By rationalizing justifications for their practices over time, students come to “externalize” their work practices. In other words, they view the work practices they perform as natural, normal, and proper responses to engineering problems. As the legitimacy of norms becomes stronger to a newcomer and the work practices whereby those norms are enacted appear more immutable, newcomers begin to perform those work practices more frequently. Thus, we propose that newcomers to an occupation engage in a dialectic between enactment and externalization processes (Barley & Tolbert, 1997; Berger & Luckmann, 1967). Through this enactment-externalization dialectic, they come to believe not only that some ways of working are more acceptable than others, but also that they must continue to engage in those practices despite urgings from others to abandon them. We conclude by discussing the implications of this emerging framework for theory and practice.

METHODS

Research Setting

The research setting for this study was the school of engineering at a large research university in the United States. Professional training for engineers is conducted in undergraduate degree programs at colleges and universities. Given that over 80 percent of all U.S. practicing engineers are trained in engineering schools (Yurtseven, 2002), these are locales for a major occupational “boundary passage” (Van Maanen & Schein, 1979). As McIlwee and Robinson observed, “An engineering school is not just any social organization . . . . It serves as a ‘gatekeeper’ to the profession of engineering” (1992: 76). Particularly important to this study, managers at many organizations have suggested that the students they hire out of engineering schools come to their new jobs with strong beliefs about what are natural, normal, and proper ways for an engineer to work.

The present study was part of a larger action research project designed to evaluate and revise a series of courses in the curricula of software, computer, and electrical engineering. Although students in each of these departments learned tasks specific to their engineering specializations, we were interested in the work practices common to these specialties. We were interested in data that could suggest what practices newcomers engaged in or thought they should engage in to become good engineers and the justifications they gave for why they engaged in those practices.

Data Collection

Over three academic years, members of the research team interviewed and observed students enrolled in four undergraduate courses, each of which was offered twice during the course of this study, for a total of eight classes. Three of the courses were lectures with labs, required of all three majors, with an average enrollment of approximately 115 students. The fourth course was an advanced seminar for fourth- or fifth-year students that enrolled equal numbers of students from each major both times it was taught. Students in all of the courses were informed during the first week of classes that they would be observed working on projects throughout the semester and that they would be asked to participate in an interview about their experience in engineering courses. To solicit participation for both the interview and observation portions of data collection, we researchers verbally announced the project to all students in each of the eight classes included in this study. In addition to the general call, students were selected randomly from class rosters and invited to participate in the interviews and observations. Finally, informants referred us to

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1 This multiyear action research project combined qualitative and design methods to develop interventions grounded in empirical data concerning student work practices, to assess them, and to develop a next generation of intervention. These interventions were begun after the data presented in this paper were collected. The results showed considerable success (Diwan, Waite, Jackson, & Dickerson, 2004).

2 Henceforth we use “specialization” to refer to the three different courses of study of our informants: software, computer, and electrical engineering.
classmates; thus, several informants were recruited by the snowball method. Instructors were not told who was interviewed or how many people had participated, and participation in the study did not affect students’ grades. Informants’ education levels ranged from one through five years of university study. All informants had completed at least two introductory courses in software and computer engineering, and the average number of engineering courses completed was five.

The primary data collection procedure used in this study was the semistructured interview. Semistructured interviews are an effective way to understand “behaviors that derive from the cultural and ideological identities of the speaker” (Lindlof, 1995: 165–166). Thus, following the symbolic interactionist framework, we used interviewing procedures to obtain informants’ “vocabularies of motive” (Mills, 1940). Adopting the view that motivation for action does not reside solely in individuals, but is constructed in the situations in which people find themselves, we sought to uncover the ways in which informants perceived their own actions and the reasons they gave for their continued performance of such actions.

Interviews were conducted in the final third of each 15-week semester. All interviews used a semistructured protocol; the Appendix presents an abridged version of this protocol. We asked informants a series of open-ended questions within four general areas: (1) education and work experience, (2) experience working in groups in engineering courses, (3) studying and preparation practices for engineering courses, and (4) opinions about the assignments and teaching style of the course in which an informant was currently enrolled. Informants were also asked to estimate the grade they expected to receive in the course. All interviews, which averaged approximately 50 minutes, were recorded and transcribed. Over the course of this study, 643 students were enrolled in the eight classes included in our data. Every one of these students received an invitation to participate in the study. In total, we conducted in-depth interviews with 128 engineering students (104 men and 24 women), achieving an overall participation rate of 20 percent.

We collected additional data by observing students completing engineering homework and extra-curricular assignments. We asked each of the 128 students we interviewed if he/she would also be willing to allow one of the researchers to “shadow” his or her normal work for a two- to three-hour period so we could observe how informants conducted tasks. Fifty-four students (42 percent of the interviewees) were observed working alone and with others in class, in labs, and in groups on days before large assignments were due. In total, we observed over 140 hours of activity.

Throughout the period of data collection, members of the research team from the Department of Communication, the Department of Computer Science, and the Department of Electrical and Computer Engineering met weekly to discuss data collection procedures and emerging themes. Periodic analysis throughout data collection helps to sharpen questions, focus interviews and observations, and ground evolving theory (Miles & Huberman, 1994). The interdisciplinary nature of the research team proved helpful in providing etic (outsiders’) and emic (insiders’) perspectives on the data as we discussed, debated, and agreed upon what we saw.

Data Analysis

We analyzed our interview and observational data by following the processes of open and axial coding outlined by Strauss and Corbin (1998). Open coding refers to the process of breaking down, comparing, conceptualizing, and categorizing data. In this step, we read through all the transcripts, flagging all instances of informants talking about (1) the kinds of work they normally performed and (2) how they completed that work. We then read through all of the field notes taken from observations with informants and flagged these same two categories. Next, we compared the codes made in the interview transcripts with the codes made in the field notes to discover similarities and differences. When we found evidence from the field notes that supported informants’ talk about numbers 1 and 2 above, we knew we had uncovered a robust activity. We excluded those codes that did not appear in both the interview transcripts and field notes from further analysis. Following Glaser and Strauss’s (1967) constant comparative method, we sorted and resorted activities into clusters of like concepts that evinced some coherent work practice. In total, we identified eight work practices, which we describe in some detail in the Findings section.

Our next step was axial coding. Axial coding involves putting coded data back together in new
ways by grouping conceptually similar codes. To do this, we sorted our list of work practices on the basis of similarity. To make the determination about what practices were similar and what practices were different, we asked ourselves, What kind of norm does this practice suggest? This question is based on the ontological assumption put forth by symbolic interactionist researchers that one’s continued performance of particular work practices enacts cultural norms (Blumer, 1969; Hughes, 1958; Reichers, 1987). With this assumption as our guide, the goal of this axial coding process was to help us to explain the types of practices informants engaged in or believed they should engage in to be considered good engineers. Several informants who expressed interest in our study agreed to be contacted again if we had any further questions, and by comparing our findings with those of other studies of engineering students, we modified our categorization scheme to reflect two main categories that best represented informants’ perceptions of their occupational cultures’ norms (see the Findings section).

Next, we returned to the raw interview and observational data and used open coding to find instances in which informants referenced either or both of the norms we identified. Within each of these coded segments, we looked for explicit justifications informants gave for those norms. After identifying these justifications, we again used axial coding to group similar reasons into a common set of justifications. We refer to these collective justifications as “rationalization practices.” Two rationalization practices surfaced: justifying from occupational expectations and justifying from perceived task demands. These rationalization practices represented an aggregate of all the justifications informants made about why they performed work as they did.

Through our qualitative analysis procedures, we noticed that a greater number of each of the eight work practices appeared in the interviews and observations of long-tenured informants (upperclassmen) than those of the relative newcomers (underclassmen). To determine whether this observation could be empirically verified, we used chi-square tests to measure the differences between these two groups in the number of each of the eight work practices that appeared in their respective interview transcripts and field notes. We also combined the frequencies for each work practice into one continuous variable and submitted the data to an analysis of variance test. Similar methods were used to determine if any difference existed between the frequency with which upperclassmen and underclassmen performed the two rationalization practices we uncovered in our qualitative analysis. Finally, our qualitative coding suggested that the practice of justifying from perceived task demands externalized work practices that enacted one occupational norm and the practice of justifying from occupational expectations externalized work practices that enacted another. To verify this interpretation, we regressed the frequency with which each of these two norms was enacted against the frequency of the two externalization practices. Each of these tests was used to corroborate our qualitative findings and to verify whether our interpretations of the patterns in the data could be substantiated by different analysis techniques.

**FINDINGS**

Our presentation of the findings is divided into three sections. First, we provide illustrations of eight work practices informants routinely engaged in as they were learning to become software and computer engineers. The performance of these work practices enacted two occupational norms that informants believed were characteristic of engineering culture. Next, we discuss the two rationalization practices informants used to justify those norms. Finally, we present our quantitative analyses, which suggest that by rationalizing their norms over time, informants eventually began to externalize their work practices—that is, they began to view them as natural, normal, and proper and to perform them more frequently.

**Occupational Work Practices**

Informants carried out eight distinct work practices. Each work practice certainly affected how students engaged tasks and assignments, but when performed with other similar practices, they also enacted occupational norms. Informants’ performance of these eight work practices enacted two distinct occupational norms. In this section, we first describe the eight work practices and then present the norms those practices enact.

**Work practice 1: Delaying the start of a task.** A common work practice was to delay starting a project. Although waiting until the last possible moment to begin a project might be seen as a sign of laziness or of lack of good judgment, informants in this study framed this practice as a sign of technical competence and expertise. Informants described intentionally calculating backward from the deadline to determine the last feasible moment to begin work. For example, one informant described his time management as follows:
I don't. I'm bad at it, I admit it. I procrastinate. I watch TV, I surf the internet. I’ll go to my computer and sit down, start reading over the assignment, and just be like, well, I have three more days until it’s due, so I figure I can surf the internet or play a couple of video games or something. Then I eventually get down to the due day and, like, damn. And that's—it’s a big time crunch sometimes. I just put together half-ass work and send it in or, you know, really try hard and nail it. I end up doing it all in one big block. I try to, and end up having it in the last eight hours of possible time. (2nd-year male, anticipated course grade, B)

Another informant not only shared this strategy, but also described how he gauged the difficulty of a task on the basis of his expectations that other students would procrastinate as well:

So basically what I do is I would wait until Monday night [for an assignment due on Tuesday] and I would go into the lab and I would see how many people were there. If there was no one there, then I knew that it was easy. If there were a lot of people there, then I knew that I’m going to stay up all night. So basically Monday night I would plan on staying up, you know, until five the next day working on this thing, if I could. Which means, you know, skipping his [the instructor's] class and all sorts of stuff. (5th-year male, anticipated grade, A)

Note in both of these examples the acceptance of engaging in a practice that effectively increased the difficulty of completing the assignment. One informant recounted an experience with a group project in which she wanted to complete and test pieces of the assigned program and other students wanted to wait until the end and write the program all at once. To reconcile their differences of opinion, the students took a vote. The informant who proposed the “outrageous” idea of starting early was outvoted, because the others felt that not waiting to delay the start of the project would be a sign that they hadn’t mastered the concepts and that they needed extra time to work on the project. Thus, the entire group stayed up the night before the assignment was due to debug the program.

Certainly, students in disciplines outside of engineering procrastinate when it comes to completing routine assignments. The important point here is that for the informants in this study, waiting until the last minute to begin a project was not a sign of laziness or disinterest in the subject matter. Rather, beginning an assignment late made the successful completion of the task more difficult and, thus, was a sign of their expertise and mastery of technical skill. In the laboratories on days before large projects were due, informants regularly discussed the status of their projects with one another, comparing how much they had completed. Similarly, on days projects were due, student engineers typically asked one another, When did you start? and When did you finish? Higher status was awarded to those who waited the longest and still completed the project successfully. As one informant exclaimed after hearing that another started had his project only four hours before it was due: “Geez, you must really know your shit. There’s no way I could write that in FORTRAN in such a short time. That’s impressive” (1st-year male, anticipated course grade, B).

**Work practice 2: Ignoring instructions.** Those performing professional engineering work typically follow some structured procedure to arrive at desired solutions (Brooks, 1982; Bucciarrelli, 2003). These structured procedures, instructions, or “best practices” are taught from one generation of engineers to the next because they have proven their ability to direct engineers toward the “right answers” (Vincenti, 1990). Oftentimes, student engineers are taught to first conceptualize the problem and then draw on their training to select and follow one such best practice to reach the correct answer. However, because assignments are commonly graded solely on output (e.g., Does the solution function as it is supposed to?), it may not be necessary for students to follow best practices to receive high marks on assignments. This situation introduces an opportunity for students to increase the challenge of an assignment by ignoring the practices that they have been told will make the task easier. When asked how they generally approached assignments for an engineering course, informants normally responded that while they were supposed to follow certain known procedures, they often did not. As one informant commented after he was asked this question:

The proper procedure idea is that you actually identify all your problems before you start fixing anything. That way you know what this is going to cause and what that’s going to cause. The idea of figuring out your solution and making sure that your solution works for all the cases, making sure your solution fits the proper model and produces the proper results, and that is more on the lines of what you’re supposed to do as far as how to design, rather than the way I usually do it: Just start designing and, when I run into problems, design around them or patch them more. Or, design through them and just have something else that handles the problems. (2nd-year male, anticipated grade, B)

Informants also recognized that completing the task would be more difficult if they did not follow instructions:
I don’t do it right. I know I don’t do it right. I come up with an idea and I start coding . . . And, sometimes it ends up real, real again, sometimes it ends up really, really, messy, nasty, but it usually works eventually. (3rd-year male, anticipated grade, B)

We found no place in the data where informants suggested that ignoring instructions would help them arrive at a better solution. Rather, they admitted readily that following prespecified instructions made the task easier. But ignoring instructions increased the challenge and introduced a higher level of risk. As one engineer observed, “If you can do it by figuring it out yourself instead of following some cookie-cutter process then you’re on your way to becoming an expert” (2nd-year male, anticipated grade, A). Success under such conditions demonstrated expertise and technical competence.

Work practice 3: Working without a plan. Despite being taught structured task hierarchies for completing projects, informants often followed a rather arbitrary or capricious approach to engineering work, starting projects without first exploring and understanding relevant concepts and without a strategy for successful completion. Many informants described their approach to difficult projects as figuring them out as they went along:

We just like to jump in and do it. I mean we don’t really sit around and analyze the problem until we run out of time for the assignment. We usually just like to go in and take a headfirst approach into it which, again, isn’t always the best way to do things. (2nd year male, anticipated grade: C)

Informants frequently used clichés indicating they approached tasks without strategic planning or detailed thought:

I would continue to plug away at it and try to get something working. (4th year female, anticipated grade: A)

I just learn by trial and error. (4th year male, anticipated grade: C)

I take a bottom-up approach. (3rd year male, anticipated grade: B)

Throughout our data, there were few images of the technically savvy engineer as someone who planned things out in advance before beginning to work.

Although they are related, “working without a plan” is distinct from “ignoring instructions” (work practice 2), in that the former explicitly relies on finding the solution in the unpredictable interaction with the materials. This unpredictability adds the dimension of challenge and difficulty. For example, many informants observed that “real” engineering work involved getting one’s hands dirty. In the engineering laboratories, we regularly observed student engineers at their work stations with unopened reference manuals stacked neatly on the corner of their desks. Even when encountering problems, they relied on tinkering to lead them toward the right answer. When talking with each other about difficulties in a project, informants normally prefaced their questions or queries with “I was playing around with this and . . . ” instead of “I was reading about how to do this and . . . ”

A good engineer, as perceived by informants, was one who did not need to plan but who could enter boldly into a problem and be confident of success as a result of technical skill. As one informant commented, “Engineering is all about tinkering. To be a good tinkerer you have to know your stuff. You have to master your concepts then it’s like you’re an artist making your own plan” (1st year male, anticipated grade: A). The underlying assumption was that the engineer is well prepared and trained and open to taking risks.

Work practice 4: Monitoring task difficulty. This practice did not itself increase the level of challenge for a task. Rather, it set an expectation that true experts find easy what others perceive to be hard. Informants monitored the difficulty of needed work and reflected on not only their own ability to complete the work, but also on the ability of others.

Vocabulary that framed engineering work as “difficult” or “challenging” was common throughout the interviews. The word “difficult” was used to describe tasks in 82 percent of the interviews. Similar words, such as “frustrating,” “arduous,” and “hard” occurred frequently. However, informants often used this vocabulary to describe other engineers’ experiences with engineering work—not their own. One informant, for example, used words such as “overwhelm” and “daunting” to describe how others felt about an assignment:

I got an 80 on that first assignment. I have programmed professionally in Java before, so that wasn’t a problem for me. I wouldn’t say that the first project was too difficult. I think that a lot of people were overwhelmed by the learning of Java. It can be, you know, a daunting task . . . You know, with the average of a 39 or whatever it was. Yeah, I don’t know, I thought it was a good project. (2nd year male, anticipated grade: A)

Similarly, another informant used “difficult” to describe how his peers react to assignments and “bored” to describe his reaction.

When informants described their own difficulties with the material, they typically framed them as difficulties felt by everyone. For example, one student engineer said:
This was the last assignment we worked on, a type analysis and nobody finished type analysis. It was just too big and too difficult. The problem was the poor documentation. Nobody could understand what we were supposed to do or how to make it work. (4th year male, anticipated grade: A)

Even those students who were not performing very well expressed their situation in terms of differentiating themselves from other, better-performing students. One informant described how she couldn’t engage with a lecture: “Like maybe for the smarter people and the people who already know everything or the people who are spending more than 20 hours a week on this class can find this interesting and engaging.” (4th year female, anticipated grade: D)

**Work practice 5: Completing work alone.** Nearly every informant in this study commented that to learn fundamental engineering concepts and skills, engineers must be able to work alone. This is not to say that student engineers felt that working with others could not help them to understand ideas and pick up new skills; in fact, many believed that working with others was quite beneficial in this sense. Rather, informants generally acknowledged that to be an engineer meant that one had to know how to do certain things alone and therefore one had to learn those things by working alone and without relying on others. As one informant commented,

> It’s good to be able to have the colleague that you can go to to talk about something but I think part of the engineering degree is really also being able to come up with things on your own—to be able to solve problems on your own. (3rd year male, anticipated grade: B)

Informants expressed concern that when working in groups they would fall victim to the temptation to rely on their peers and not do the work themselves, thus not learning as much as they were supposed to.

Learning something on one’s own also provided more satisfaction with the completed work. As one informant indicated,

> I think it’s really satisfying work to complete an assignment, so I’m trying to be more self-sufficient. When you go from start to finish on an assignment and you haven’t asked for help, it feels pretty good. I want to know it all on my own and I learn it better on my own. (1st year male, anticipated grade: D)

Others described their feelings similarly: “I actually like working by myself more [than in groups] because it gives me more self-worth where I can say, I did this, not, I sat there while someone else did it for me.” (2nd year male, anticipated grade: A)

**Work practice 6: Ensuring one’s contribution stands out.** A variety of stories recounted the importance of ensuring that individuals received credit for their own ideas and work. The common protagonist in these stories was the maverick, the engineer who could do it all by him-/herself. The general plot focused on a situation in which others tried to usurp the maverick’s claim to his/her accomplishments. Underlying these stories was a desire for recognition.

For example, working in groups was not perceived to be satisfying because the work of each member could not be differentiated; no one could “stand out.” As one informant commented,

> I guess I’m real cutthroat in the workplace. Honestly, I want to move up as quickly as possible, and, whatever it takes for me to do that, I want to do it to the best of my ability and everybody knows and sees that I can do that, and that it will be good. Whereas, in a group, you’re responsible for all these other people and everybody gets the same. Nobody stands out because it’s a group. You turn something in as a group, and so, you never get to stand outside of that and be seen for the talent that you have or the talent that you don’t have. So, if you get assigned to a group where one guy is real lazy and stupid, you’re kind of screwed. (3rd year male, anticipated grade: B)

Informants also regarded individuation as protection against risks associated with the interdependence of group work. This interchange between a researcher (R) and an informant (I) provides an example:

R: Would you choose to work in a group in other job situations?
I: No.
R: Why not?
I: I’d just rather do my own thing.
R: Okay, why? Can you explain that?
I: Why? Because, then I’m responsible for myself and not responsible for anyone else’s work so that anything that came out with my name on it would be mine, me, myself and I. Then I wouldn’t have to worry about that. I could do all my own design. Yeah, I’d much rather work by myself.
R: What about in classes?
I: Oh, I hate group projects. I hate ’em, I hate ’em, I hate ’em, I hate ’em. (5th year male, anticipated grade: C)

Because it is unclear which member of a group has ownership over which part of an assignment, some
engineers noted that it was difficult to assign responsibility to a group member. 

**Work practice 7: Ranking oneself against others.** Informants in this study understood “expertise” to be a quality located in individuals, and they constantly measured their own expertise by comparing grades and perceptions of intelligence. In this way, they linked intelligence with expertise. The word “expert” was present in a mere 6 percent of the interviews. Instead, engineers used vocabulary normally enlisted to describe intelligence to comment about when someone was an expert. As one student mentioned to one of the researchers, “It’s hard for someone to be an expert when they are in school just because they haven’t been able to make a name for themself [sic] yet. But you know if someone really knows something by how smart they are.” (*3rd year male, anticipated grade: C*)

Informants measured expertise in themselves and others by comparing how well they did in engineering courses. One of the words most frequently used by engineers in this study was “grades.” In fact, in 91 percent of the interviews, informants referred either to their own grades or to the grades of their classmates without any prompting from the researcher.* Most of these references compared the speaker with the rest of the class. The word “rank” also appeared often, and many interviewees would share their rank with the researcher, even though this was not a specific question in the study. The students knew their ranks in courses because professors would post the grades for each exam, and many used their rank to gauge their performance:

R: How confident are you in your ability to do well in this course?

I: Very. So far, I’ve gotten the second highest grade in all the exams. I’m glad he puts that stuff on the web so I that I know the strategy is working. I don’t need to adjust. (*2nd year male, anticipated grade: A*)

Another example:

Right now I’m ranked fifth in the class. That dropped two places after the last test because I got a 40 instead of a 42. (*3rd year male, anticipated grade: A*)

The single most common descriptor in the interviews was “smart,” which was used in 92 percent of the interviews. Most engineers drew comparisons with and among other students by categoriz-

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*Note that at the very end of the interview, we did ask the informants what grade he or she expected in the course. Our analysis of the frequency of the use of the word “grades” excluded the response to this question.*

---

ing them according to perceived intelligence. The three most common terms the student engineers used to categorize themselves and other students were “genius,” “smart,” and “stupid.”

**Work practice 8: Excluding technical inferiority.** When working on projects with other students, informants often formally or informally excluded peers they felt did not have strong technical skills. Numerous studies have documented the high value engineers place on ability to perform the technical components of the work well (Dryburgh, 1999; McIlwee & Robinson, 1992). Consistently with this theme, informants in this study repeatedly acknowledged that the best engineers were those with superior technical skills.

When project groups were discussed, the importance of technical skills surfaced in expressions of frustration with skill-level differences among group members. When asked if he would choose to work in a group in the future, one informant said:

That depends on who I have the opportunity to work with. I would want someone who would be at my same level. It’s easier to split things that way and to get things done. Otherwise, one person is going to end up doing all the work and either it’s going to be not you, and you don’t learn anything or it’s going to be you, and you’re dragging all these other people behind you. (*4th year male, anticipated grade: B*)

Informants framed their own options for action as either not joining a group, or as excluding nonperforming group members, as in this example:

We had scheduled labs we had to meet in and I guess sometimes we had to write code outside of the lab but usually just me and [one other member] would go. Well, we would invite the other people to come except for they wouldn’t contribute anything so we [stopped inviting them]. We figured . . . they wouldn’t really mind if they didn’t have to come. They get that extra time and we do the work and they get the grade and we figured they wouldn’t care. And, we didn’t really want them there because then we’d probably have to explain everything to them. It just wouldn’t have been fun. (*3rd year female, anticipated grade: B*)

On numerous occasions we observed that teams who regularly met in the engineering labs to work on a large project purposefully excluded “slacking” or “incompetent” members. In one example, a team of four computer engineering students had a standing weekly meeting to work on a compiler construction project. By the fifth meeting, one member had been missing for three consecutive weeks. The
researcher asked another member what had happened to the missing individual and was told that the team stopped inviting him because “he didn’t get the concepts.”

Work Practices Enact Norms

Our analysis suggested that informants’ performance of these eight work practices enacted two norms that guided their continued activities. We illustrate the relationship among work practices and occupational norms in Figure 1. Specifically, we found that by engaging in the work practices of delaying the start of a task, ignoring instructions, working without a plan, and monitoring the difficulty of tasks, informants began to enact a norm “stating” that one’s expertise can be measured by the difficulty of the tasks accomplished (arrow A1). Similarly, by engaging in the work practices of completing work alone, ensuring one’s contribution stands out, ranking oneself against others, and excluding technical inferiority, informants enacted a norm stating that one’s success should be measured by personal as opposed to team accomplishments (arrow A2). We discuss each of these norms below.

**Norm 1: Expertise is measured by doing difficult tasks.** A norm whereby expertise is measured by doing difficult tasks implies that engineers should place value on overcoming challenge and “beating the odds.” The work practices enacting this norm artificially and purposefully increased the difficulty of a given task, such as a homework assignment. Taken together, these practices introduced a sense of “sport” to engineering work by providing handicaps that ultimately decreased an informant’s chances of success. Informants perceived that completing a task with a handicap was a mark of an expert engineer.

**Norm 2: Success is measured by individual (rather than team) accomplishment.** The second norm indicated that newcomers should cultivate an environment of competition among their peers. Because students perceived the successful engineer as one who worked autonomously, the work practices enacting this norm emphasized the importance of individuation and the desire for individual accomplishment. Specifically, these work practices led individuals to value solo over team-based work and to believe that people who worked in teams could
never be considered expert engineers because they relied too heavily on others for support.

Norms Are Justified by Rationalization Practices

Informants performed a second set of practices to rationalize their ongoing actions as members of a student engineering culture and to justify their emerging identities as engineers. Informants recognized that the occupational culture in which they were slowly gaining membership held several strong norms for how engineers should behave. They also recognized that to continue enacting these norms, they had to justify to themselves and to others why they needed to work in such ways. To make these justifications, informants looked outside themselves to explain their own behaviors. As arrows B1 and B2 in Figure 1 indicate, our analysis revealed that informants rationalized the norm of measuring expertise by perceived task difficulty by claiming that the tasks they performed forced them to work in some ways and not others. Likewise, informants rationalized the norm of measuring success by personal accomplishment by claiming that all engineers learned to be effective by performing individual work.

Rationalization practice 1: Justifying from perceived task demands. It is no surprise that the informants in this study perceived that their work practices as induced by the nature of the tasks they were assigned. Informants consistently framed their actions as simply following what the task inherently and objectively called for, thus justifying their practices in terms of an external force. With regard to a strong norm emphasizing the value of task difficulty, informants invoked intrinsic (and therefore unchangeable) characteristics of the tasks themselves to rationalize their continued performance of work practices that constituted that norm. For example, one informant commented that the task of programming a compiler itself exerts certain pressures on an engineer:

With programming, realistically, there’s usually only one or two ways to approach the problem. There’s only do it this way or do it this way. There’s rarely even three. There’s usually just two different ways you can go about doing it. And, if we disagree on how to do it, it’s usually because one of us doesn’t understand the bigger picture fully, and, with that misunderstanding of the bigger picture, their idea of a solution wouldn’t work; one of us has got something wrong. Like for example, there’s no way you can plan it out in advance because you don’t know what bugs you’ll find, so you just have to sort of rely on the knowledge you have and tinker with it. So if the other guy thinks you can plan it, and you know you can’t then there’s a problem because how do you tell him he’s wrong? (4th year male, anticipated grade: C)

Thus, a particularly difficult programming task was only solvable by working without a plan (work practice 3). Because the nature of the task itself was seen to determine the type of work practices the student engineer could adopt to confront it, it seemed natural to adopt certain work practices over others. Further, attempts to follow instructions (work practice 2) could appear as a “misunderstanding” of the situation or as simply “getting something wrong.” As the same informant later commented:

I: Basically, either you know the one or two possible approaches to the problems because you’ve been paying attention in class and following along or you don’t know them. So if I’m working with someone who doesn’t know them, it actually is a disadvantage to me and it is better for me to try and get the person not to work with me because it will just kind of slow me down and wreck the progress.

R: So how do you get them not to work with you?

I: I just stop inviting them to come, or I tell them me and someone else will just take care of the problem because we know that you just have to ignore those guidelines they give you if you really want to do this specific task. Like I said, if you don’t know the right approach to take you won’t be able to get it.

To rationalize their various work practices, informants adopted the belief that one must work in certain ways to complete tasks. Asked why he delayed the start of a project (work practice 1), an informant said:

I don’t know why people are always trying to change how engineers work. It’s that way in school, and it’s even more that way in industry. I mean, what’s wrong with how we work? It’s not like there are a lot of options for how we can work. I mean, some tasks are supposed to be done by one person alone. Get over it. That’s just the way it is. (3rd year male, anticipated grade: A)

Thus, tasks were seen to necessitate certain work practices, closing off the possibility that the informant had options and reinforcing these work practices as natural, efficacious, and necessary.

Rationalization practice 2: Justifying from occupational expectations. A second way in which informants rationalized their actions was to call on what they perceived to be the nature of engineers. For example, one student engineer accepted the stereotype of the engineer as a “lone gunman,” because “that’s the kind of person attracted to engineering”: 
People that I find that are very good at what they do in engineering are stereotyped for a reason. They usually have a problem communicating. Working with a boss is one thing, but I’ve found that it’s even harder for them to work as a team as equals, because then your roles as to who makes decisions, who has bottom line, is up in the air, and that’s usually even harder for them. Engineers are supposed to do difficult work, and the good ones do do difficult work. They really do their best work on things alone. I think that’s part of the reason why I came to engineering and why lots of people are in classes like this . . . because good [engineers] are lone gunmen and they don’t like working with people. (5th year male, anticipated grade: B)

This portrait of the professional engineer completing his or her work alone (work practice 5) and standing out from others (work practice 6) justified these work practices, making them seem natural and resistant to critique or to the perception of alternatives. Norms were fortified as student engineers began to internalize them into their own preferences and their identities as engineers.

When new work practices introduced by instructors undermined or challenged norms, informants rationalized their behaviors on the basis of what was expected of them as engineers, critiquing or confronting the new practices and reasserting the old established practices. In one of the courses we tracked, for example, the instructor initiated a series of exercises in which each student was required to sit with another and write code collaboratively. This was an innovative pedagogical technique in the department intended to increase student understanding of programming through explicit talk about the process. The instructor spent a great deal of time discussing the principles of pair programming and detailing how students should play the roles of “driver” and “navigator.” At the end of the semester, informants were asked how they felt this process worked. The following interchange conveys one informant’s strongly critical view:

R: Would you say that you two were collaborating when you worked together?
I: It sounds so sinister.
R: What do you mean sinister?
I: Collaborating, like we’re doing something wrong or bad.
R: I never thought of it like that.

The key here is that, regardless of the technical merits of the practice, the students saw it as contradicting the norm measuring success as individual accomplishment. As a consequence, a collaborative project seemed unnatural and even “sinister,” “wrong,” and “bad,” even though the instructor endorsed and promoted it.

Informants also subverted the goals of the new practice, pair programming, by reverting to existing work practices, as in this account:

We actually didn’t work together all that much even though we were supposed to. We sort of figured out who did what best and then we each took on that part and sort of tried to do it on our own so we would know it really well. Then at the end we just told each other what we did and put it together. (2nd year female, anticipated grade: A)

The justification for work practices was not simply resistance to change. By justifying their actions with external support, informants were able to rationalize working in certain ways because they could not perceive of themselves changing those actions that were said to “make an engineer an engineer.” As one informant put it, “Even my grandma knows what engineers are like.”

Rationalization Practices Externalize Work

The findings presented up to this point suggest that informants performed eight specific work practices that enacted two norms. They perceived these norms to be characteristic of the occupational culture into which they were seeking entry. Informants rationalized the existence of these norms, and the work practices that enacted them, by providing external justifications for their actions. To uncover whether the enactment of norms and their rationalization by informants could externalize the work practices they performed, we examined whether informants increased the frequency with which they performed each of these eight work practices as they moved more deeply into the socialization process. Specifically, we attempted to explore the extent to which the processes of enactment and externalization were dialectical, so that participation in one might permit and affect participation in the other. We followed Berger and Luckman’s use of the term “dialectic” to suggest that the “product acts back on the producer” (1967: 61). In other words, we suspected that informants could only externalize their work if they performed work practices that enacted occupational norms, and then used rationalization practices to justify the existence of those norms. If the relationship

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5 For a complete explanation of the pair programming methodology and the collaboration practices it promotes, see Williams and Kessler (2000).
between enactment and externalization was dialectical, we expected to find that informants who had spent significant time externalizing work practices (e.g., upperclassmen) would see those practices as more natural, normal, and proper than would those who were just beginning to participate in the enactment-externalization dialectic (e.g., underclassmen), and we expected to find that the first group (long-term participants in the dialectic) would perform these practices more frequently than those just beginning to participate.

We began by examining whether frequencies of work practices differed by tenure in the program. Table 1 displays the number of informants who performed each of the eight work practices. Chi-square tests indicate significant differences in each frequency based on tenure. As a whole, upperclassmen (juniors and seniors) engaged in each of the eight considerably more than underclassmen (freshman and sophomores).

To better investigate whether other factors unrelated to tenure (and, therefore, less likely to be related to socialization) could also explain the relationship, we next combined the frequencies for each work practice into one continuous variable (as all eight work practices were highly correlated), and submitted the data to an analysis of variance. The ANOVA results, which are reported in Table 1, confirm that when specialization (type of engineering degree) and expected course grade were controlled for, students with longer tenure in the program performed the eight work practices more frequently than those with shorter tenures.6 Thus, the more time informants spent in the program, the more likely they were to orient toward tasks in ways that produced occupational norms.

6 To see whether there were any differences in the practices of high-performing and low-performing students, we asked interviewees what grade they expected to receive in the particular course under study. Expected grades were converted into a 4-point scale with an “A” valued at 4. A handful of informants did not provide a letter grade, but merely described their performance. In these cases the researcher estimated a grade on the basis of their description and scaled this estimate. The mean letter grade for all informants was “C,” and the mode was “B.” There were no significant differences in the distributions of the letter grades that the informants expected to receive between freshmen, sophomores, juniors, and seniors.

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**Table 1**

**Work Practices Uncovered in Data**

(1a) Frequency by Program Tenurea

<table>
<thead>
<tr>
<th>Work Practice</th>
<th>Underclassmen</th>
<th>Upperclassmen</th>
<th>Chi-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Percentage</td>
<td>n</td>
</tr>
<tr>
<td>1. Delaying start of task</td>
<td>42</td>
<td>40%</td>
<td>56</td>
</tr>
<tr>
<td>2. Ignoring instructions</td>
<td>28</td>
<td>27</td>
<td>62</td>
</tr>
<tr>
<td>3. Working without a plan</td>
<td>39</td>
<td>37</td>
<td>64</td>
</tr>
<tr>
<td>4. Monitoring difficulty of tasks</td>
<td>41</td>
<td>40</td>
<td>58</td>
</tr>
</tbody>
</table>

Norm 1: Expertise is measured by doing difficult tasks

Norm 2: Success is measured by individual accomplishment

(1b) Analysis of Variance of All Work Practices

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>$\eta^2$ b</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenure</td>
<td>1</td>
<td>319.24</td>
<td>319.24</td>
<td>.46</td>
<td>155.87***</td>
</tr>
<tr>
<td>Specialization</td>
<td>2</td>
<td>2.19</td>
<td>1.09</td>
<td>.00</td>
<td>0.29</td>
</tr>
<tr>
<td>Grades</td>
<td>3</td>
<td>22.54</td>
<td>7.40</td>
<td>.03</td>
<td>2.01</td>
</tr>
</tbody>
</table>

a Frequencies are for both interview and observation data and were coded as categorical variables.

b $\eta^2 = SS_{effect}/SS_{effect} + SS_{error}$.

*p < .05

**p < .01
Next we examined whether the appearance of work practices and rationalization practices appeared at similar levels, in such a way that new members would exhibit low levels of both practices, which would then increase equally over time. Table 2 displays, for underclassmen and upperclassmen, the frequencies with which rationalization practices appeared in the data. As the mean percentages indicate, the rates at which underclassmen and upperclassmen engaged in rationalization practices were nearly identical. The chi-square tests and the analysis of variance in Table 2 confirm that no significant differences in the frequency of rationalization practices were associated with tenure, nor were there distinctions based on specialization or expected course grade.

This result suggests that the relationship between work practices and rationalization practices is not directly proportional. In other words, if there is a dialectical relationship, it is not necessarily characterized by relative frequency. A possible explanation for this finding is that there are likely other sources of rationalizations in addition to the performance of work practices. For example, previous research has shown that when students first become members of an engineering program, they are inundated with norms instructing them as to how they should act as engineers (Bucciarelli & Kuhn, 1997; Dryburgh, 1999; Ingram & Parker, 2002; Margolis & Fisher, 2001). We would therefore expect that externalization, which consists of rationalizing work from perceived task demands and occupational expectations, begins as soon as a student begins the socialization period and continues at a stable rate throughout socialization.

If the dialectical relationship between enactment and externalization does indeed have a cumulative effect, the more time a student spends performing a rationalization practice, the more “natural,” “normal,” and “proper” their work practice should seem. Therefore, if members of an occupation have been rationalizing for some time, they should begin to act in ways that support and perpetuate the prevalent occupational norms—that is, they should increase the frequency with which they perform their work practices. The qualitative coding of the data presented above suggested that the practice of justifying from perceived task demands externalized work practices 1–4 and that the practice of justifying from occupational expectations externalized practices 5–8. To test whether this categorization was accurate, we regressed the frequency of each of the two sets of work practices (1–4 and 5–8) against the frequency of the two externalization practices. The results, summarized in Table 3, show that only the equations along the diagonal were accurate in predicting a dialectical relationship between enactment and externalization. In other words, the more frequently people performed rationalization practice 1, the more likely they were to perform work practices 1–4, but not work practices 5–8. Conversely, the more frequently they performed rationalization practice 2, the more likely they were to perform work practices 5–8, but not work practices 1–4. Taken together, then, these findings suggest that

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**TABLE 2**

**Rationalization Practices Uncovered in Data**

<table>
<thead>
<tr>
<th>Rationalization Practice</th>
<th>Underclassmen</th>
<th>Upperclassmen</th>
<th>Chi-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Percentage</td>
<td>n</td>
</tr>
<tr>
<td>1. Justifying from perceived task demands</td>
<td>55</td>
<td>52</td>
<td>47</td>
</tr>
<tr>
<td>2. Justifying from occupational expectations</td>
<td>52</td>
<td>50</td>
<td>45</td>
</tr>
</tbody>
</table>

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**(1b) Analysis of Variance of all Rationalization Practices**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>( \eta^2 ) ( b )</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenure</td>
<td>1</td>
<td>1.93</td>
<td>1.93</td>
<td>.02</td>
<td>3.36</td>
</tr>
<tr>
<td>Specialization</td>
<td>2</td>
<td>0.94</td>
<td>0.47</td>
<td>.00</td>
<td>0.80</td>
</tr>
<tr>
<td>Grades</td>
<td>3</td>
<td>0.45</td>
<td>0.15</td>
<td>.00</td>
<td>0.25</td>
</tr>
</tbody>
</table>

\( a \) Frequencies are for both interview and observation data and were coded as categorical variables.

\( b \) \( \eta^2 = \frac{SS_{effect}}{SS_{effect} + SS_{error}}. \)
the more frequently one externalizes work practices, the more likely one is to engage in those work practices in subsequent tasks, in turn enacting and strengthening the norms that made their externalization possible in the first place (arrows C1 and C2 in Figure 1). Overall, these quantitative analyses provide support for viewing enactment and externalization as a dialectic that is necessary for self-socialization to occur.

**DISCUSSION**

Our data indicated that student engineers performed eight key work practices. When performed in tandem with one another, these work practices enacted norms that informants used as guidelines for how they should work if they wished to one day become full-fledged practicing engineers. Informants began to seek justifications with which to rationalize to themselves and others why these norms existed. Thus, informants believed that the norms depicted how they, as prospective engineers, should work if they were to succeed in the profession. We found, however, that although underclassmen engaged in these eight work practices frequently, they used them less frequently than their upperclass counterparts. The continued rationalization over time of practices that externalize the work accounts for this difference. In other words, the more work practices are externalized and made to seem independent of the norms they produced, the more acceptable they became for our informants.

Importantly, the recognition that their work practices actually enacted the norms of student engineering culture was obscured by the performance of rationalization practices. Because rationalization practices tie the work of student engineers to phenomena they view as outside their control, informants believed that they had little choice but to continue performing the work practices of their culture. Thus, our informants claimed that they “had to” work in such ways because certain engineering tasks “required” them to do so or because that was the “nature” of being an engineer. The outcome of this dialectical relationship between the processes of enactment and externalization was that informants in this study not only ignored or discounted the validity of other ways of working, but also increased the frequency with which they engaged in the work practices that they now saw as natural, normal, and proper responses to occupational demands. Intuitively this makes sense: individuals who view a certain action as natural tend not to actively question whether they should perform it, but rather passively accept its validity and perform it with increasing frequency (Louis & Sutton, 1991). We discuss several ways in which these findings can contribute to theory and practice.

**Contributions to Theory**

Our findings point toward a rudimentary vocabulary for describing the process by which newcomers to an occupation come to engage in practices that more seasoned occupation members find counterproductive and why the newcomers resist others’ attempts to change those practices. This vocabulary may help to build theory about socialization by specifying a number of mechanisms by which counterproductive practices are perpetuated. For example, our findings demonstrate the following: (1) Newcomers perform work practices in response to perceived occupational stereotypes. (2) Work practices enact occupational norms. (3) Newcomers perform rationalization practices that link norms to phenomena that appear out of their control. (4) Rationalization practices externalize work. (5) Over time, the dialectic of enactment and externalization makes certain ways of working appear natural, normal, and proper. Together, these five mechanisms help to explain the dialectical relationship between the processes of enactment and externalization. When individuals personally employ work practices that enact occupational norms, they become invested in their own actions. Tying their identity to their work makes it important to them to find justifications that support ongoing membership in a group (Hogg & Terry, 2000; Mumby & Stohl, 1991; Tretha-
way, 1997). Studies have shown that those who do not actively participate in a culture’s social practices, but rather watch them from a distance, are less invested than those who perform them daily, and thus do not often become full-fledged members of the culture (Bormann, 1996; Taylor, 1999). Therefore, personally engaging in the enactment of occupational norms seems to be essential for externalization to occur. Rationalizing justifications for one’s work externalizes the continued performance of work practices, making it seem as though one has no choice but to continue performing them.

These findings, and the enactment-externalization dialectic toward which they point, may help to explain why managers often have a difficult time disabusing employees who came from undergraduate professional training programs about norms that are counterproductive to organizational work (Fiorito, 1981; Griffin, Colella, & Goparaju, 2000). Van Maanen and Schein (1979) suggested that newly socialized individuals adopt either custodial or innovative responses to tasks. In other words, newcomers either act as custodians of existing practices and maintain the status quo or attempt to change these practices. Much research has suggested that the tactics used to socialize an individual into a culture can explain his/her likelihood of adopting either a custodial or innovative stance (Ashforth & Saks, 1996; Griffin et al., 2000; Jones, 1986; Kim, Cable, & Kim, 2005). The findings of this study show, however, that much of the socialization that occurs in educational contexts is self-activated as opposed to managed by tactical actors. Prospective members of an occupation come to see certain practices as appropriate ways to work as they personally take part in the perpetuation of the enactment-externalization dialectic.

On this score, the enactment-externalization dialectic may help to explain why it is often much more difficult to foster innovative responses toward occupational practices than custodial ones. As Jablin (2001) observed, socialization projects that attempt to encourage newcomers to challenge institutionalized competencies and role structures often meet difficulty as individuals slip back into custodianship. Through participation in the enactment-externalization dialectic, newcomers begin to view work practices as required by the tasks they routinely perform. As a result, a competitive tension arises between a task-oriented focus and a process-oriented focus toward work. In our study, informants entered their training already attuned to well-established stereotypes about what it meant to work as good engineers (Margolis & Fiher, 2003; Yurtseven, 2002). Thus, there were already ample external justifications for seemingly unorthodox practices. Reflecting on these stereotypes, informants perceived working alone as the purest way to focus on a task. In addition, one’s relationship to others was of value primarily with respect to improving one’s own ability to succeed. Because the perception of an expert engineer was so tightly bound up with work practices that promoted individual work, a spirit of collaboration was oftentimes subverted by reasserting the importance of the task itself. Thus, the enactment-externalization dialectic not only places heavy normative pressure on newcomers to maintain what they perceive to be the status quo, but also obscures the recognition that change is possible precisely because the mechanisms for change appear to be derivatives of cultural norms rather than producers of them.

Contributions to Practice

The results of this study speak to a number of concerns discussed by engineering management and professional associations. Engineering organizations expect university programs to adequately prepare individuals to behave as professionals. They expect a fit between engineering education and engineering practice (Bucciarelli & Kuhn, 1997). The IEEE/ACM Joint Task Force on Engineering Education (2004) reports that employers consider the acquisition of technical skills to be only a small part of this preparation. Similarly, both the National Academy of Engineering (2004) and the Accreditation Board of Engineering and Technology (2007) have emphasized work practices generally unlike those found in our study, including communication and teamwork skills.

Research on engineering students consistently supports our finding of work practices and norms that are out of step with the modern engineering profession (Bucciarelli, 2003; Margolis & Fisher, 2001; McIlwee & Robinson, 1992). The potentially damaging effects of current work practices are particularly acute, given the current drastic shortage of young people interested in engineering in the United States (Engineering Trends, 2006). One implication of this study, then, is to encourage practicing engineering professionals to more greatly influence engineering education by taking actions that can alter the enactment-externalization dialectic. Organizations might increase the number of internships they offer, providing students a repertoire of norms that more accurately reflect engineering and organizational demands. Also, managers could join advisory boards of university departments, encouraging an emphasis on more effective work practices.

More generally, because rationalizations exter-
nalize the perceived nature of work practices, managers may need to provide newcomers with new rationalizations for the practices they are asked to adopt. The established norms new members transfer with them from their time in professional training schools or previous organizations may unintentionally subvert the desired new behaviors. For example, new engineers may find working in teams in organizations difficult because the work practices they learned to perform in school are systematically opposed to the practices of effective teamwork encouraged in the organizations at which they become employed. Instead, they perform work practices that enact norms promoting values of individualism, thus acquiring the identity of someone who does not work well in teams. And as research has shown, when individuals adopt the stance that they cannot or should not work well in teams, they act in accordance with their own prescriptions and become poorly functioning team members (Levine & Moreland, 1998).

Limitations and Directions for Future Research

As with any empirical study, these findings have several limitations, which suggest possibilities for future research. First, the content of the eight work practices identified in this study are endemic to the occupational context of student engineering, though not exclusive to it. Members of all organizations or occupations carry out a set of practices that respond to the particular demands of their cultural membership, and often these practices overlap between organizations or occupations. Identifying these work practices is one step in uncovering how individuals learn to accept and perpetuate occupational norms. Further, the rationalization practices uncovered in this study might function outside of the context of student engineering. Research into a number of occupations, including architecture (Henderson, 1998), subway operating (Heath & Luff, 2000), and medicine (Engeström, Engeström, & Saarelma, 1988), has demonstrated that behaviors are often shaped by the perceived demands of a task. Similarly, all occupations have certain expectations, if not blatant stereotypes, about how a good member acts. Studies have documented this statement to be true for nursing (Fagerskiöld & Ek, 2003), child care (Tuominen, 2003), and teaching (Little, 1993). Thus, members of other organizational or occupational cultures may well use the two rationalization practices identified in this study as they participate in self-socialization.

Second, in this study we focused only on the work of software and computer engineering students. Thus, the findings may be more representative of this particular subculture than of engineers in general. Future research should examine the relationship between enactment and externalization in occupations other than engineering to determine the extent to which the processes identified here are generalizable. The questions raised in this study call for research that tracks informants as they move out of educational contexts and into full-time professional contexts. Such research should identify those practices that are most lasting and those that are more easily altered. Ideally, researchers would follow specific individuals over time, perhaps during the first several years of organization membership. Interestingly, our findings showed that newcomers worked to socialize themselves into a culture that they believed was a typical engineering culture. However, many practicing engineers claim that working in ways that exclude others and adding complexity to tasks is not how engineering work is performed in most modern workplaces. Thus, it appears that the students we studied acted on their perceptions of what they believed engineering culture to be, yet those perceptions may be incorrect. Much research is needed on the ways in which people follow and uphold occupational stereotypes, even when those stereotypes are out of touch with the way occupations actually function.

Third, the informants in this study were learning to be engineers in the United States. Because occupational and national culture are, to a large extent, mutually influencing (Hofstede, 1991), it is possible that many of the work practices and norms identified in this study would be different for those studying engineering in other countries. Cross-cultural comparisons would thus help to establish which work practices and norms have the most global implications for the work of engineers.

Conclusion

Researchers have long suggested that changing occupations and organizations requires, at some point, an understanding of how and why norms—especially those that are believed to be counterproductive to occupational work—are produced and continually reproduced. In Perrow’s words, when norms are strongly supported, it is often difficult for managers to “wrest control and change practices” (1986: 25). We propose that the dialectical relationship between processes of enactment and externalization is a useful frame for understanding how newcomers begin to see practices as natural, normal, and proper and resist attempts to change them. Our
findings suggest that certain ways of working often appear unchangeable because individuals routinely partake in actions through which they divest themselves of agency to change them. Understanding how the members of an occupation engage in a dialectic between enactment and externalization seems to be an important step in understanding why it is often hard to change the way people work.

REFERENCES


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APPENDIX

Abridged Interview Protocola

I. Education and Work Experience

1. What is your major? Has it always been that? How far along are you in your program?

2. How many computer science classes have you taken, including this semester? What were they? Who taught them?

3. Have you worked professionally as a programmer or an engineer? For how long? What kind of work did you do?
   a. [If not yet answered] What responsibilities did you have? What kinds of decisions did you have to make? How did you make them? [prompt for example]

4. Did you work with others in that job? If yes, then ‘can you please describe this?’ Would you choose to work in a similar way in other jobs?

II. Experience Working in Groups

5. In which courses have you worked in a group with other students (not including this course)?

6. Where there any times when you were working in a group and it worked well? What happened there? Would you say that you were collaborating? Why or why not?

7. Where there any times when you were working in a group and it worked well? What happened there? Would you say that you were collaborating? Why or why not?

8. Other than this course, have you ever been given a choice to work in a group?
   i. If yes, then ‘did you choose to work in the group? Why or why not? What was that experience like?’

9. If you had a choice, would you work in a group again? In a class? In your job? (If there’s a difference, then, why?)

10. Do you think there should be more group work in computer science or engineering courses?
   ii. If yes, then like what? What is the benefit? What do people learn from being in groups?
   iii. If no, why not? Are there specific disadvantages (to learning? To the task?)

11. Did/have you use pair programming? If yes: why did you decide to try it? If no, why not?

12. Who was your partner(s)? Did you know them before hand? How would you assess their level of programming skills? [If above they said they did NOT use pair programming, skip down to general group questions]

13. Can you describe to me a typical way of how you would work together. [Listen for . . . roles, switching of roles, amount of time, negotiation of how to do the task, talking through the task. Amount of reflection on it.]

a Items are quoted verbatim from the protocol documents.
IV. Opinions about Assignment and Teaching Style in This Particular Course

29. How often do you attend lecture sessions? Where do you sit? What are your general reactions to the lecture sessions? . . . how they are presented?
30. What did you think of the instructor’s use of discussion in class?
   i. How typical is this in engineering courses?
   ii. Did you find it helpful or valuable?
   iii. Do you think it affected your ability to understand the material?
   iv. Did it change the way you learned material? How?
   v. Do you think it affected your ability to work with others? How? Or to feel connected with others? How?
31. What does the instructor do during class that you think works really well? Do you have an example? Why did you pick this?
32. What does the instructor do during class that bothers you or you think doesn’t work well? Do you have an example? Why did you pick this?
33. How was the teaching style in this course similar or different to other courses that you have taken? What do you mean?
34. Which lab are you in? How often do you attend labs? What are your general reactions to the labs? . . . generally, what do you do in lab?

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