Research Summary

Putting It Together…Bit by Bit:
A Relational Theory of Interpersonal Collaboration in Software Development
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The goal of this study was to better understand close collaboration, specifically interpersonal collaboration in a creative, knowledge-intensive field. Interpersonal collaboration is a joint, interdependent effort to accomplish tasks that are larger than any one person has the resources or knowledge to do. Effective collaboration requires that everyone contributes their unique expertise or perspective to the task. Existing research on the topic of collaboration between individuals (as opposed to between organizations or departments) is quite scarce, focusing mainly on technological tools that support collaboration across distances of time or space. There is little to explain how people working side by side can support each other to become more involved in their joint task. To investigate this topic, pair programming offered an ideal opportunity to study people who work together on a constant basis.

The design of the study relied on observations and interviews. I assumed that the participants in the study were knowledgeable, experienced collaborators, with varying levels of expertise and exposure to pair programming. Over the course of 11 months, I closely observed pairs and interviewed approximately 30 software developers and XP coaches, amassing hundreds of pages of fieldnotes and interview transcripts. (The average transcript length was 25 single-spaced pages.) I also collected and read company documents and other publications about XP and pairing. Prior to and throughout the study, I attended local meetings of the Michigan Extreme Programming Enthusiasts group to provide additional context for the practices of pairing. These materials were analyzed using a variety of methods traditionally used with this kind of data, focusing on cross-cutting themes and identifying activities and behaviors common to the collaborative process. Because I was interested in understanding how collaborators encourage their partners to contribute to their joint work, I called these sets of activities and behaviors "encouraging moves."

I divided the encouraging moves that I identified into six broad categories based on the functions they served. See Table 1 for a list of these moves. This list is probably not exhaustive and may not apply to contexts that are different from this study.

An example of an encouraging move in the category of supplying moves is "thinking out loud." This move, in fact, was the most pervasive encouraging move that I observed and that participants in this study described. This term refers to saying one's thought process out loud while doing a task or working through a problem. As one participant described:

> I'd say first and foremost is to give a clue as to what my immediate and short-term goals are when I'm driving at what I'm trying to accomplish. I usually try to do that by sort of a play-by-play with color commentary that explains that. And even to the point of just saying what I'm doing, you know, "I'm deleting this. And I'm pasting this and now I'm going to do this."

A less common encouraging move is welcoming debate. Welcoming debate is an equalizing move that encourages both members of a pair to contribute because it communicates that it is important for both partners to share their ideas. In the process of developing any piece of

Table 1: Encouraging Moves by Category

Categories and Moves	Definition
Supplying	*Furnishing another with what is needed or wanted*
"Thinking out loud"	Articulating or narrating one's thought process while typing or thinking through a problem
Offering opinions or ideas	Suggesting out loud an opinion or idea that provides material to use with the task at hand
Providing knowledge	Sharing knowledge or information with or teaching one's partner
Gathering	*Collecting whatever another has to offer*
Asking questions	Using questions to prompt a partner to clarify something or to move toward a solution
Accepting suggestions	Being willing to try an experiment or alternate approach suggested by a partner
Complying	*Adhering to others' ways of working*
Honoring agreed practices	Observing and supporting standard, agreed-upon procedures and rules
Considering future issues	Anticipating the long-term effects of current decisions and precedents
Optimizing	*Making the most of another's capacity*
Keeping focused and on-task	Ensuring that the pair puts their time toward working on the most important or necessary parts of the task at hand
Paying attention to pace and timing	Recognizing and accommodating a partner's abilities by adjusting the speed of working or making remarks
Maintaining light, positive atmosphere	Using humor, playfulness, and casual conversation to reduce stress, tension, or conflict and to make work more pleasant
Equalizing	*Treating another as an equal*
Sharing the keyboard	Making sure both partners have an opportunity to drive so that they can both have control of and learn about the task
Welcoming debate	Being open to negotiate and develop a mutually satisfactory idea when faced with conflicting opinions
Refraining	*Curbing an urge that negatively affects another*
Knowing not to distract	Recognizing when silence (or another courtesy) is needed for one's partner to be able to concentrate
Giving the benefit of the doubt	Assuming that another's remark or action is well intentioned

code, it is inevitable that people will have different opinions about the best way to accomplish their goal. After debating these options, the final idea that is pursued should take into account both partners' perspectives. Here's one person's description of this move:

> It's just a matter of throwing out suggestions and being willing to negotiate between different alternatives. And, as always, the willingness to realize the other person's is better. I tossed something out, and [my partner] said, "Mmm, I was thinking this." And I thought, "Yeah, that's better." And then I thought, "Well, what if we did it this way?" …. So you go back and forth, and you pick one that's better than the other, and then you keep thinking on that and modify that, and in the end, everyone's right.

To my surprise, however, I found that these moves were sometimes described as unhelpful. Though they were more often encouraging than not, almost every move was described in a negative way by one or more participants in the study. These moves tended to be problematic in three main ways: they were insulting, they made someone uncomfortable, or they were perceived as counterproductive.

For example, some people felt uncomfortable when their partners wanted to debate with them. Though debates can be civil and respectful discussions of opposite points of view, they also can be experienced as more threatening and argumentative. Each person has a different threshold for when bearable differences of opinion transform into something that is not pleasant. One person said:

> I can't say that I like it much myself personally. Like if I felt that pairing with someone all day was a constant tension... I would quickly feel that there was a winner/loser situation going on, and I don't like that.

These contradictions raised an interesting question. I had assumed that the participants in the study would generally agree on what helped them to contribute their expertise or effort, producing a straightforward catalogue of these moves. Instead, the more significant question became, "What determines whether a move is encouraging or not, and why?" I returned to the interviews to see what clues they offered, and I developed the following theory for why a particular move succeeds or fails between two people.

Essentially, the effort made by each member of the pair to interpret the meaning of (or intention behind) a move is what determined the move's success at encouraging a partner to contribute. To a greater or lesser extent, a collaborator would gather and make use of what I have called "situational resources." These resources are bits and pieces of understanding about the pair members' relationship to each other and about the organizational culture. Situational resources are developed over time through day-to-day interaction and time spent at work. The kinds of understanding that a person might have about his or her relationship with another collaborator concern their preferences, habits, aptitudes, and experiences. People tend to understand those features in terms of what they have in common, what is different between them, and the general "vibe" they get while working together. In terms of organizational culture, a person grows to understand the values and behavioral norms that dominate the work environment, and how these values and norms affect the ways that they collaborate.

Continuing with the examples used above, a person might more readily interpret a partner's attempts to debate potential solutions as positive or encouraging when that person understands that debating is the way that this partner works through ideas. People might also interpret a move to debate differently when they understand that the apparent conflict is simply produced by different experiences with the portion of code that they are developing together. These are both situational resources that are specific to the pair and how the pair's members interact. Cultural norms also serve as situational resources that can help to explain why someone might make a certain move. For instance, Menlo's persistent interest in "eliminating towers of knowledge" by switching partners provides some context for moves that teach a partner a new technique or concept. Rather than appearing condescending or insulting, moves such as thinking out loud or debating one's options may be interpreted as ways of achieving this teaching goal.

Essentially, the collaborative process is shaped by the meanings that people anticipate or see in their interactions. Making an effort to understand a partner goes a long way toward creating a productive and mutually supportive working relationship because that understanding helps a person recognize what meaning the other person would give to a move. An effective collaborator also tends to be more self aware, noting his or her own feelings or observations as useful information for collaborating. Through the process of trying to understand another person, and in acting on that understanding, a collaborator communicates meanings that may resonate on both an intellectual and an emotional level.

Surveying the range of encouraging moves, I identified two underlying meanings that moves might convey. One is that a partner cares about the pair's work and working relationship. Caring is an authentic interest in, regard for, or liking of someone or something. Second, moves reinforce the links that are essential to collaboration. Links refer to the interdependence and connectedness inherent in a pair's work process. Thus, in using moves that fit with the needs and desires of their partners, people communicate that they are making an effort to understand those partners and the culture in which the pair works because that partner is vital to the work that they are doing together. Though the underlying meaning may not be particularly conscious or deliberate on the part of the person making the move, the move can still encourage a partner to contribute. Ultimately, effective moves convey "I want you to be a part of our work" or "I need your input on this work" in a manner that is sensitive to that partner's feelings and preferences.

This research has several implications for practitioners. The participants in this study revealed just how demanding and complicated it is to collaborate well. The members of a pair must observe many signals just to sustain the work relationship, and they must be careful with what and how they communicate to their partners so that what they intended is what is comprehended. These interpersonal demands suggest that it is important for organizations to hire people not just for technical skills but for social skills as well. Even so, when people are less socially adept, organizations can reinforce cultural norms that may compensate for those weaknesses. Organizations can also manage their members in ways that make the effort to understand each other more feasible and desirable. For example, collaborators need time to develop awareness of their partners' preferences, habits, aptitudes, and experience, so by providing some degree of continuity within collaborating teams, managers might help people feel that the investment of getting to know each other is worthwhile. Likewise, by allowing communities of practice to grow, organizations can rely

on these communities to help teach novices the values and norms of their profession. Curiously, this model of interaction between employees is different from traditional notions of workplace professionalism, which tend to focus on technical skill and domain knowledge. However, any professionals who collaborate can benefit from learning about their colleagues as unique individuals rather than simply focusing on the development of their personal task-related expertise. Ultimately, effective collaboration that enables everyone to contribute reflects the shared history of a pair within a larger context and the blend of interactions, communications, and feelings that happen between them.