Collaborative Inquiry as a Lifelong Learning Methodology to Address a Diverse and Distributed Global Workforce in Engineering

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ABSTRACT
Beyond addressing its intended research questions, a recent study on the career self-efficacy of underrepresented racial minorities in the U.S. engineering workplace and career self-efficacy’s relationship to interracial work friendships revealed significant correlation between career self-efficacy and relationships with coworkers overall. Additionally, the mining of data from open-ended survey responses suggested issues associated with communication, trust, and isolation. Given that underrepresented minorities continue to be less likely to achieve their desired career attainments in the engineering workplace, a method of exploration for improving engineering workplace relationships in a diverse and distributed global workplace is warranted. This paper explores Bray, Lee, Smith, and Yorks’s description of collaborative inquiry as a method of continuing education and lifelong learning in the engineering workplace to address not only issues of racial underrepresentation as U.S. and global racial demographics change, but also to address gender, generational, geographical, and occupational cultural differences.

INTRODUCTION
A recent study (Hofacker, 2014) extended the research on career self-efficacy (Hackett & Betz, 1981) from college students to the workplace. Career self-efficacy is one’s belief in one’s capability to plan, implement, and execute one’s career path (Betz, Klein, & Taylor, 1996). The study assessed the construct of career self-efficacy as a means of understanding the gap between career attainment and opportunity among black engineers in the U.S. government workplace. Data from the study of 131 black engineers in a large Department of Defense (DoD) engineering organization suggested that career self-efficacy assessment provides data that complement other existing human resource information and assist in understanding the gap between attainment and opportunity for underrepresented minorities in the workplace using the social cognitive career theory model (Lent, Brown, & Hackett, 1994). The data also showed that the total career self-efficacy of the black engineer in the surveyed organization was high, as

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were career self-efficacy subscale scores for self-appraisal, occupational information gathering, goal setting, planning, and problem solving.

However, more important to purposes of this conference paper was the finding that while increased depth of interracial workplace *friendships* was positively linked to career self-efficacy, the data also showed that workplace *relationships* with one’s immediate supervisor and with one’s coworkers were even more important, and that a black engineer being able to say to a white friend in the workplace what he or she *really* thought was strongly linked to career self-efficacy. The results also showed that a quarter of the respondents had no white friends in the workplace at all—a workplace where the majority outnumbers black engineers 12 to one. Based on the results of that study, the workplace environmental context for underrepresented workers, and the U.S. Census Bureau’s projection of the changing US racial demographic over the next 30-45 years, the researcher provided specific recommendations (Hofacker, 2014, p. 200):

- “While the study focused on black engineers, the overall focus should remain on all underrepresented minority engineers with respect to race and gender.
- Career self-efficacy and the tools to measure it should be more strongly updated for workplace use.
- Attention should continue to be paid to inclusion in the workplace, not merely diversity.
- Retention of black engineers in the workplace should be an organizational and individual priority.
- Workplace group dialogue should be generated around the problem of 2060 and how many of the various components of that problem can be addressed.
- The majority should be intentional of and about the career self-efficacy and workplace relationships of black engineers.”

It is the recommendation on workplace group dialogue that is the launching point for this conference paper, suggesting that collaborative inquiry (CI), and specifically the CI process suggested by Bray, Lee, Smith, and Yorks (2000), is an appropriate lifelong learning method for understanding the gap between attainment and opportunity for underrepresented minorities in the changing engineering workplace. This conference paper describes a research plan to be implemented in a large U.S. DoD engineering organization. It is hoped that the resulting product of this proposed research will provide insight into the needs of a diverse and globally distributed engineering workforce.

**CONTEXT**

Engineering has been a key component of the U.S.’s global technological superiority (Rogers & Houston, 2006; Tsui, 2007). Today’s U.S. engineering workforce continues to be predominantly white; along with Asians, whites are overrepresented in engineering when compared to their proportion of the general U.S. population (Falkenheim & Burrelli, 2012; National Science Foundation [NSF], 2013). Blacks and non-white Hispanics are underrepresented (Falkenheim & Burrelli, 2012; Frehill, DiFabio, & Hill, 2008; Lewis, Menzies, Najera, & Page, 2009; NSF, 2012), and their progress towards appropriate representation in the engineering field—that is, equal to their percentage in the general population—has been largely unchanged over the last 30 years (NSF, 2012).

The racial demographic of the U.S. is changing. According to a U.S. Census Bureau (2012) report, the U.S. will be majority-minority by 2043, with a majority-minority workplace by 2060. As part of this
change in the U.S. racial demographic, both the number of white engineers currently in the workforce and the number of white engineers entering the workforce will also decrease based on current matriculation rates (Freeman, 2005; Lichter, 2013). Given college and university graduation rates by race, the number of underrepresented minority engineers is not on a path to provide adequate representation and meet the expected shortfall (NSF, 2012).

Despite the attention given to science, technology, engineering, and math in high school and college, the underrepresented minority engineer enters the engineering workforce where career attainment is less likely than for the white majority (Falkenheim & Burrelli, 2012; NSF, 2013; Tang, 2000; Thomas, 2005; Thomas & Gabarro, 1999). Underrepresented minority engineers do not advance in their desired career paths, including management ranks, at the same rate as whites; estimates range from 40% to 13 times less likely depending on the metric (Falkenheim & Burrelli, 2012; Tang, 2000; Thomas, 2005; Thomas & Gabarro, 1999). Tang notes that while minority “engineers may have overcome barriers in the education system, results...show that they have not achieved a comparable rate of success in the occupational system” (2000, p. 201). In their desk reference on diversity, Gardenswartz and Rowe (2010) note that there is an overall perception that things have gotten better—that underrepresented minorities attain at the same levels as whites—although this is not the case (Falkenheim & Burrelli, 2012; NSF, 2013).

A number of workplace environmental conditions have also been identified as contributing to the gap between opportunity and attainment. These include homosocial reproduction (Kanter, 1977, 1993); nepotism and cronyism (Gibbs, 2008); structural, social, and occupational segregation; and subtle forms of racism (Feldman & Huddy, 2005; Thomas, 2005); and homophilic relationships (McPherson, Smith-Lovin, & Cook, 2001). Minorities suffer from stereotype threat (Perna et al., 2007), segregation (Vallas, 2003), and bias (Taylor, 1982; Tversky & Kahneman, 1982).

**Correlation Between Career Self-efficacy and Workplace Relationships**

Among other things, the recent dissertation asked, “In general, how would you characterize your working relationship with your immediate supervisor?” and “In general, how would you characterize your working relationship with your coworkers?” All career self-efficacy subscale scores, as well as the total career self-efficacy score, were positively correlated at the .01 level of significance with the responses to these questions. The higher the score on these questions, the higher the career self-efficacy score. Workplace relationships, specifically networking and mentoring, have been linked to the success of minority employees. Successful minority employees, specifically successful minority engineers, are needed to address the demographic changes of 2060.

**Having Someone to Whom You Can Say What You Really Think.** The data suggest that within the statistically significant relationship between interracial friendships in the workplace and career self-efficacy, one of the questions may have uncovered an important aspect of interracial friendships in the workplace. One question, concerning whether or not respondents had a coworker with whom they could say what they really thought, was strongly correlated with overall career self-efficacy (α = .01), as well as the self-appraisal (α = .05), occupational information gathering (α = .01), goal setting (α = .01), and problem-solving subscales (α = .01). None of the other friendship questions in that study showed a statistical correlation with more than one of the subscale scores.

**Having No White Friends or No Friends at All.** Twenty-five percent of black engineer respondents to the study questionnaire had no white friends in the workplace at all. This lack of
friendships with the majority at any level can lead to isolation in the workplace, which then leads to inequality in attainment (Kalev, Dobbin, & Kelley, 2006). It must be acknowledged that there were no data to identify how many of the white majority engineers in the surveyed organization had no friends.

**SUGGESTED ISSUES OF COMMUNICATION, TRUST, ISOLATION**

The recent study also allowed for an open-ended response to a question about workplace relationships, specifically friendships. While not the focus of the study, approximately 40% of the open-ended responses were categorized as positive in nature, 40% neutral, and 20% negative. Some of the negative responses are cross-walked to communication, trust, and isolation as shown in Table 1.

Table 1

*Examples from Open-Ended Responses of Workplace Environmental Conditions*

<table>
<thead>
<tr>
<th>Area</th>
<th>Selected open-ended question responses</th>
</tr>
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<tbody>
<tr>
<td>Communication</td>
<td>“[majority] never talk with me.”</td>
</tr>
<tr>
<td></td>
<td>“I am a very friendly person and I make my own way in the communication process whether it is openly received or not.”</td>
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<tr>
<td></td>
<td>“Their network is alive and well.”</td>
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<td></td>
<td>“Supervisor either unwilling or unable to provide effective communication on individual career development.”</td>
</tr>
<tr>
<td>Trust</td>
<td>“There is definitely a feeling of uncomfortableness when interacting.”</td>
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<tr>
<td></td>
<td>“Guarded. It is a very competitive environment.”</td>
</tr>
<tr>
<td></td>
<td>“Can't be trusted.”</td>
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<tr>
<td></td>
<td>“I'm mostly careful when talking to white co-workers because I'm getting the sense they constantly judging and ready to fault me at what I do.”</td>
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<tr>
<td></td>
<td>“There is still disrespect as far as the black engineers’ or scientists’ ability to do technical work.”</td>
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<tr>
<td></td>
<td>“It is as though leadership is aware of your talents and capabilities, and wants to utilize them for their benefits, but deny you the opportunity for upward mobility at the same time.”</td>
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<tr>
<td>Isolation</td>
<td>“Sometimes I get the feeling like my white coworkers only want to associate with members of their own race.”</td>
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<td></td>
<td>“The white group exclusively socializes together. The intergroup dynamic ranges from polite coldness to outright hostility.”</td>
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<tr>
<td></td>
<td>“There is an abstract racial line that divides coworkers. . . . opportunities and awards are given to the Caucasians regardless of how hard African Americans work or if African Americans are the most qualified.”</td>
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<tr>
<td></td>
<td>“There is a feeling out period and interracial relationships, especially in the workplace, take much longer.”</td>
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<tr>
<td></td>
<td>“I have very friendly dealings with the minority engineers. . . . to some extent we are drawn together by our shared alienation.”</td>
</tr>
<tr>
<td></td>
<td>“Friendship categories are segregated.”</td>
</tr>
</tbody>
</table>

The conclusion of the researcher was that the environmental conditions described in the literature still exist and are contributing to the gap, as “most interracial contact is still superficial in nature” (Smith, Dijksterhuis, & Chaiken, 2008, p. 50). This is not to suggest that things are not getting better as generations pass (Lichter, 2013), but based on the open-ended comments, the “racial tax” (Hughes &
Thomas, 1998, p. 793) still exists and is contributing to the gap. Can we use dialogue, specifically collaborative inquiry, and even more specifically Bray et al.’s (2000) description of collaborative inquiry as way to better understand this changing demographic of 2060 and the impact it will have on the engineering workplace in the face of this context?

**CONVERSATION AND DIALOGUE AS A CONTINUING EDUCATION METHOD**

Given the topic of career self-efficacy and relationships, and their importance to the future engineering workplace, dialogue is required. Exploring tensions, rather than suppressing them, opens opportunities for understanding (Lewis, 2000; Luscher & Lewis, 2008; Okech & Champe, 2008). With discomfort and avoidance behavior often evident in majority-minority interactions (Plant & Devine, 2003), a behaviorally scripted approach is suggested (Avery, Richeson, Hebl, & Ambady, 2009). Diving into the career development of underrepresented engineers requires a better understanding by the majority of cultural variables and their mechanisms (Byars-Winston, 2010), but meaningful dialogue is possible (Okech & Champe, 2008). Dialogue groups create a closeness of relationships (Thomas & Gabarro, 1999).

**ADULT LEARNING**

Dialogue may be best enabled through concepts in adult learning. Several methodologies are available to create structured dialogue and conversation in the engineering workplace around the topics of the changing demographics of 2060, as well as workplace relationships and their effect on attainment. These adult learning concepts include action learning (Marquardt, Leonard, Freedman, & Hill, 2009), collaborative inquiry (Bray et al., 2000), the organizational learning systems model (Schwandt & Marquardt, 2000), communities of practice (Wenger, 2009), transformative collaborative learning (Mezirow, 2009), Dewey’s process of inquiry (Elkjaer, 2009), and expansive learning (Engestrom, 2001), among others.

**COLLABORATIVE INQUIRY**

The researcher recommends that organizations implement small groups of workers, to include the majority and underrepresented minorities, in one of these types of adult learning methods or other equivalents. For this paper, collaborative inquiry (CI) will be used as described by Bray et al. (2000). Collaborative inquiry “is a powerful method for facilitating adult learning” (Yorks & Kasl, 2002, p. 93) and can point to a number of different methods (Bray et al., 2000; Brooks & Watkins, 1994; Zech, Gause-Vega, Bray, Secules, & Goldman, 2000).

Bray et al.’s method of collaborative inquiry is based on the work of Reason (1988) and Heron (1996) and their writings on cooperative inquiry. According to Kasl and Yorks (2002), the term collaborative was chosen rather than cooperative because it was seen as a more general concept. CI is based on understanding how we know what we know—epistemology—through experiential, presentational, propositional, and practical ways of knowing (Kasl & Yorks, 2002; 2010).

The overarching theme of CI is its emphasis on “researching with people, rather than conducting research on them or about them” (Kasl & Yorks, 2002, p. 5). There are two principles of collaborative inquiry: first, each participant takes an active part in the experience; and second, each participant participates fully as an equal (Kasl & Yorks, 2002; 2010). CI must be voluntary and open to all (Bray, 2002; Goodnough, 2005).
Unlike action research, which focuses its learning goals on the system, the participants or members in a CI group change themselves (Kasl & Yorks, 2002; 2010). There is a strong role between personal development and action: “Inquiries that involve intense issues of personal identity invariably result in changes in how participants show up in various settings in the world” (Yorks & Kasl, 2002, p. 96). Kasl and Yorks warn of three “corrupting influences” (2010, p. 315) within collaborative inquiry: financial support, power inequities, and reporting requirements. They examine these as part of workplace professional development. Their desire is to protect the integrity of inquiry and warn that these three influences can compromise the values of CI.

**PREVIOUS CI EFFORTS**

CI can be used to explore research questions in a professional setting. CI has predominately been used with teachers in educational settings (Bray, 2002) specifically with community women, managing change, holistic relationships, nurturing intuition, improving teacher practices, fostering teacher technology comfortability, and improving student learning (Kasl & Yorks, 2010). Goodnough (2005) conducted a study specific to problem-based learning. Cruz-Ramos and Cruz-Valdivieso (2011) also reported on CI use in poor communities in Mexico. Bray (2002) suggested that collaborative inquiry be applied in other sectors. There is nothing that prohibits CI from being applied in the engineering workplace.

Kakabadse, Kakabdse, and Kalu (2007) prove a detailed chronology of CI’s history and development. One study that they discuss is relevant, due to its use in a government workplace, to the proposed research plan being described in this conference. The government of the United Kingdom wanted to reform the civil service through inclusiveness and integration, creating a culture of change. Many governmental departments were having difficulty implementing this plan. One cabinet office successfully adopted CI as a means of improving inclusiveness and integration. Kakabadse et al. concluded from the UK study that “CI is a powerful transformational interventionist vehicle that can substantially impact on the direction and process of change in complex organizations” (2007, p. 247).

**CONTINUING EDUCATION CREDIT**

In many organizations, including the organization targeted as the setting for the proposed CI effort, a minimum number of continuing education points are necessary during a defined time cycle—e.g., 80 hours over a two-year period. The argument is made that CI can be an effective adult learning method in an organizational environment such that the time spent in group dialogue can count towards continuing education requirements. In addition to course work, for example, continuing education credit is often given for awareness training, self-directed study, teaching and mentoring (Defense Acquisition University, 2014). Workshop participation is another activity that is often given continuing education sanction. One can argue that CI is a more intensive, focused and intimate form of conversation and dialogue than a workshop, and provides learning benefits equal to or better than other credit opportunities.

**COLLABORATIVE INQUIRY**

The following sections describe the steps of Bray et al.’s (2000) CI process as it would apply to the proposed research effort. Collaborative inquiry is defined by Bray et al. as a “process consisting of repeated episodes of reflection and action in which a group of peers strives to answer a question of importance to them” (2000, p. 20). While the steps in this specific CI process are well defined, Bray et al. are quite clear that they are not meant to be a constraint. Any CI group is free to adjust the process as
necessary to promote and accommodate their specific learning needs. This is in line with many of the seminal thinkers in adult learning such as Lindeman (1924).

**PHASE I: FORMING A COLLABORATIVE INQUIRY GROUP**

The steps for Phase I are initiating/co-initiating a group, obtaining institutional consent, establishing a physical context, ensuring diversity, orienting the group, developing the inquiry project, framing the inquiry question, designing the inquiry project, transitioning to collective leadership, and reflecting on the group process (Bray et al., 2000).

**INITIATING/CO-INITIATING A GROUP.** The first step in the CI process is forming the group. The CI group initiator must find others with an interest in addressing a similar dilemma or discomfort (Kasl & Yorks, 2002) associated with workplace difficulties (Bray, 2002). The discomfort that was the genesis of the proposed CI effort was the findings from the author’s recent study. This, in combination with the recommendation for dialogue to further understand the gap between opportunity and attainment for underrepresented minority engineers, form the basis of the proposed effort. Some of the participants from the previous research study (Hofacker, 2014) have volunteered to participate in future research. These participants may form the core of the CI group and serve as co-initiators. Participants must be volunteers (Goodnough, 2005), otherwise they may block the progress of the CI group if they do not take ownership of the inquiry question and the process (Kakabadse et al., 2007).

For the proposed research effort, the desire is to have eight to 12 engineers from within the organization with two or three persons at each of three to five different geographic work locations. The number of participants is similar to past CI efforts. Bray et al., (2000) recommended five to 12 participants, Goodnough (2005) recommended up to 10.

It is not required that the initiator or co-initiators be experienced in CI. Groups can be managed by following a guide such as Bray et al.’s (2000) *Collaborative Inquiry in Practice*. Yorks and Kasl conducted their initial CI efforts using Reason’s 1988 book. In the case of the proposed study, the initiator has some experience with the CI process, and the Bray et al. (2000) text will be made available to the group members.

Finding co-collaborators beyond the initiator and co-initiators should not be assumed to be an easy task. As noted, it is important to develop the CI group around common interest. A short summary of the topic will be developed for distribution to potential participants. The initiator and co-initiator will each seek to find additional diverse participants at each person’s geographic location. The initiator and co-initiator must be careful not to oversell the CI project. This may result in recruiting participants who do not share the CI question.

Although there is typically a single initiator or a few co-initiators, it is important that all participants share interest in initial inquiry topic. If this is not the case, the initiator is just as well off conducting an individually-lead research study. However, the loss in that approach is the collaborative bond between the initiator and his or her collaborative co-inquirers and the shared learning that emerges from the CI effort. CI is an example of eliminating the distinction between the researcher and the researched. Together, the CI group develops a question of mutual interest than can be addressed by examining their personal experiences (Kasl & Yorks, 2002). Given the mutual interest in the topic, participation in previous effort has been high (Bray, 2002). In those efforts, all were part of the inquiry (Bray et al., 2000).
Early in the process, basic demographic information will be collected from the group members. It is also possible that a pre-participating survey may be taken to be compared later to post-participation survey data. Thus, the impact of the CI effort on the participants can be assessed. The survey may also include open-ended questions. The decision on whether or not to use real or fictitious names in any final documentation will be deferred until Phase IV.

**Obtaining Institutional Consent.** For the proposed study, the plan is to conduct the CI in the same organization originally surveyed as part of the author’s previous study. Obtaining organizational consent will be conducted through an institutional review board (IRB) process within the organization. This will be undertaken according to the appropriate IRB documentation and DoD regulations. CI personnel may need to obtain approval for their participation from their local chain of command if their participation will take them away from their work during normal work hours. Individuals will also be required to sign a consent form. Bray et al. recommended that this be signed after the group has agreed to an inquiry question. This differs from most research efforts where the consent form is signed at the beginning. In either case, the organization will require a consent form.

There is certainly no intention by the researcher to harm any of the people surveyed; all care will be taken to minimize any potential of this occurrence. No physical, psychological, social, legal, or other side effects are anticipated. In the case of the proposed research, anonymity of the group’s participants within the organization will not be guaranteed. Participation will be known through individual’s claim of continuing education points, as well as through presentations to management. For publications outside the participant’s organization, fictitious names can be used when attributed to actions, learning or quotations within the published document.

There will be no outside consultants or collaborators on the proposed effort, no contractual agreements associated with this research, and no cost to the subjects to participate. Conversely, subjects will receive no compensation for participation in this research. At organizational level, the granting of continuous learning and education points will be requested on a one to one ratio for group contact hours. All group members will request and receive the same number of points.

Supporting organizational structures are needed (Yorks & Kasl, 2002) when workplace resources are to be used, regardless of the magnitude. These may include meeting rooms, telephones, internet access, video teleconferencing (VTC) facilities, and even travel funding if permitted and available. Bray (2002, p. 84) noted that teachers’ administrators expressed the following concerns about CI: how much time would be required and what expenses would be incurred, what would be the benefits to the organization, would there be any risk, and where would the groups meet? These types of questions appear to be applicable to an engineering organization as well. Given that the initial inquiry topic deals with race, the organization may have concerns about the implications of deep dialogue. To be recognized by the organization is that change in the participants that will ultimately lead to changes in the organization. According to Bray, CI is “an intervention into a social system and culture” (2002, p. 85).

In general, the organization’s support is important, but it is equally or more important that the research effort continue to belong to the participants, avoiding the corrupting influences identified by Yorks and Kasl (2002). The potential paradox for the group is that they may want to stay away from institutional constraints while still using institutional resources. Add to this that the institution has some interest in the outcome of the study (Kasl & Yorks, 2010). The organization may have specific results, or even answers
that it would like to see from the CI effort. It may also be threatened by what it sees as a result that questions its effectiveness.

**ESTABLISHING A PHYSICAL CONTEXT.** Given the geographic diversity of the participants of the organization planned for the research, the physical context will likely be provided by phone conference, VTC, and online screen and file sharing (Defense Connect Online [DCO]). If funding becomes available, face-to-face CI sessions will be proposed at either one of the participant’s sites or at a neutral location, but this is unlikely. It is also possible that the telephone conversations could be recorded, but only given the agreement of all participants in the CI group.

Bray et al. (2000) emphasizes a single physical setting in which the CI group will meet. However, an important component of this proposed CI effort is assessing the impact of geographic diversity while using Bray et al.’s process. The participants will be encouraged to group at their respective locations if at all possible, but it is inevitable that there will be instances where the geography-in-common participants will not be able to meet together to participate in the telephone call or VTC.

**ENSURING DIVERSITY.** Diversity of many types—race, gender, age, thought—is key to any group, and in the proposed CI effort, diversity of race is strategically important to the inquiry topic. The desire is to have the eight to 12 engineers constitute a mix of whites, blacks, Hispanics, and Asians from within the organization with racially diverse participant pairs or trios at each location. Although aware of their behavior, majority individuals may initially distance themselves from such an approach due to stereotype threat (Goff, Steele, & Davies, 2008). Gender diversity will not be a requirement for this study but is encouraged. Occupational diversity will only exist in so much as an electrical engineer is a different occupation than a mechanical engineer. Diversity of thought, while still focused on the inquiry topic, is highly desirable. Having diverse sets of perspectives gives better coverage to the solution set (Page, 2008, 2010).

**ORIENTING THE GROUP.** CI groups form around a common discomfort or dilemma (Goodnough, 2005). This dilemma is summarized for the group in the introduction of this paper and expounded in previous works by the author. Volunteers for the inquiry will, by agreeing to participate, declare their interest in the subject area. This commonality is essential for the CI group to function efficiently.

Goodnough (2005) noted that the groups must move through the CI cycle together. Bray et al. (2000) note that group members in academic settings often want to have some idea of how the process is going to work. This will likely be true for those in a predominately engineering organization also. An orientation-type discussion will be held to describe the CI process and the initiator or co-initiator’s interest in the inquiry topic, and to allow for discussion around the earliest forming of an inquiry question. This provides the participants with the opportunity to make a final decision about participation. After this commitment has been made, the CI effort can begin.

It is important at this point to differentiate collaborative inquiry from just another series of meetings. This may be especially appropriate for engineers in a large DoD organization. Unlike a meeting with a set agenda and distinct objectives, the CI process will follow a more flexible learning path.

**DEVELOPING THE INQUIRY PROJECT.** From the introductory information presented, the team will begin to coalesce around the inquiry topic and specifically the inquiry question. For this particular setting

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2 Note that race is used as defined by the National Science Foundation (2012). The discussion of various terms for race, and the discussion of the concept of race versus ethnicity, are left for other forums.
the overarching topic is provided—that is, the changing demographic in the engineering workplace, and the continuing gap between opportunity and attainment for underrepresented minority engineers. However, the specific topic within this broad area and the inquiry question must be developed, as well as a path forward to addressing the question.

**FRAMING THE INQUIRY QUESTION.** The key to CI is the inquiry question itself. Through an iterative process of candidate question presentation, discussion, and modification, the team will develop and finalize the inquiry question. The question must be important to everyone in the group and it must allow the group to take action to facilitate learning. A question that is too broad will not be answerable by the group.

Clearly, the answer to the question should not be known beforehand (Bray, 2002). The knowledge is produced by and for the group (Kasl & Yorks, 2010). The CI group should expect much wordsmithing during this framing step with the understanding that the question may still change further along in the process. The group will begin to own the question here as it moves from this rough assemblage of individual questions to a shared group question.

**DESIGNING THE INQUIRY PROJECT.** Once the question is defined, the CI team will design the inquiry project. This step is heavily dependent on the form of the question. The resulting plan will use methods of inquiry that reflect this form. Bray (2002) noted that teachers are often troubled by the slow pace in reaching consensus or the pace of the inquiry, the number of side conversations and their direction, apparent lack of clarity, uneven levels of participation, and clashes within the group. These types of characteristics may also be experienced by engineers.

Many of the CI efforts discussed in the literature have required an overall number of contact hours or duration that many could perceive as considerable. Kasl and Yorks (2010) reported on an effort by nurse managers that required eight four-hour inquiry cycles held once every two weeks. In that effort, co-initiators petitioned leadership to allow the participants to conduct the CI during work hours. Kasl and Yorks (2010) noted other efforts that have required two to three years in overall duration. In Bray’s 1995 dissertation, he reported that his group’s effort required a full day each month over a period of a year. Goodnough (2005) reported on a two-year study.

The author’s personal experience with CI was completed in a three-month effort. That particular research effort was conducted with a deadline provided by the hosting organization. While the duration will be addressed by the group in the proposed research study, the initial suggested duration is approximately 40 contact hours over a six-month period.

**TRANSITIONING TO COLLECTIVE LEADERSHIP.** One of the most transformative experiences within any group is the emergence of leadership. Historically, a single leader emerges (Yukl, 2011). However, in CI this is not desired or allowed. One of the main principles of CI is that everyone is treated as an equal during the inquiry process and that each participant is a co-inquirer (Goodnough, 2005). The initiator or co-initiators must transition to group member status (Kasl & Yorks, 2010). It is also important to highlight the need to ignore any pay grade rankings or other hierarchy that may exist between participants.

Depending on the group, it may be necessary to alternate roles during various sessions. One person may take the role of facilitator, another note taker, and another time keeper. It may even be necessary for a participant to be identified as referee.
**REFLECTION ON GROUP PROCESS.** Reflection is a key underlying component of the CI process. Phase I will not be complete without a focused reflection on the process completed to this point, as well as reflection on agreement to the inquiry question and the path forward.

From this point forward, reflection will become more of an integrated ingredient of the process. At the end of every session, the participants will take a few minutes to collect their thoughts and then share them with the group. There are a number of possible methods suggested for this type of reflection. The CI group can ask questions about how well the team is working together, whether or not everyone is having an opportunity to speak, what has been going well, or what could be improved (Marquardt et al., 2009).

**PHASE II: CREATING THE CONDITIONS FOR GROUP LEARNING**

The steps for Phase II are agreeing on a constitution for collaboration, and repeating cycles of action and reflection to generate learning (Bray et al., 2000).

**AGREEING ON A CONSTITUTION FOR COLLABORATION.** Adult learning benefits from a positive and adaptive learning environment. In CI, part of this is attributable to a shared vision among the CI team. This is not to suggest that the CI group will not have difficult moments. However, an agreement on how the team will be together is important to the process.

Bray et al. takes great care to address “distress facilitation” (2000, p. 112) noting that conflict will occur at some intensity level during the process. It is better to stop the process and address the distress rather than let it build to a higher level of intensity and possibly result in a more significant event. By addressing the distress early, the process can proceed in a more effective manner.

Individual’s expectations and assumptions will need to be heard by the CI group. This may even result in a documented product, and in the case of the proposed study, may be constructed on DCO in view of the geographically-diverse participants. Bray et al. (2000) suggested that the definition of the CI process be visible during this sub-step. While not repeated here, Bray et al.’s (2000) Table 5.1 on page 74 of their book provides their expectations and assumptions for their CI effort.

**REPEATING CYCLES OF ACTION AND REFLECTION TO GENERATE LEARNING.** As was described for the end of Phase I, reflection as a scheduled step may be manageable for the CI team. During Phase II, reflection must become more integrated as a personal way of being and not as a scheduled step. This may be difficult for some participants. Goodnough noted that the process was “messy and reiterative” (2005, p. 89). Reflection is necessary to ensure both individual learning and direct a participant’s contribution to CI group development towards addressing the inquiry question.

**PHASE III: ACTING ON THE INQUIRY QUESTION**

The steps for Phase III are putting plans and designs into practice, keeping reflective records, respecting group ownership of ideas, question honestly, and practicing dialogue and reflection (Bray et al., 2000).

**PUTTING PLANS AND DESIGNS INTO PRACTICE.** Phase III begins the external experiential portion of CI. While the group discussion and effort continues during this phase, group members are also putting into action the inquiry plan that has evolved during Phases I and II. Actions develop from the group dialogue and the results of the actions inform the group’s learning. These actions support the group’s intention to address the inquiry question. According to Kakabadse et al., “dialogue is probably the most difficult, uncomfortable and sensitive form of communication since it surfaces critical insights as the source of action” (2007, p. 255).
Each participant may have the same action or assignment to pursue independently, or smaller groups of co-inquirers may take on the same or different assignments or actions. The results of these efforts and the products of these assignments are then brought back to the CI team. Inquiry into individual’s experience around the action or assignment (Bray et al., 2000) is a component of the CI process.

**Keeping reflective records.** The members of the CI team are responsible for keeping reflective records during the CI process. The term reflective records may sound more appealing to the engineer than journaling, but the concepts are similar. Reflective records include not only a telling of what has occurred, but how what occurred is interpreted by the CI member, how it relates to the inquiry question, and how it relates to the CI group’s learning. The method of maintaining individual reflective records is up to the individual participant. These can include typed or handwritten notes, journal entries, drawings, audio or video recordings, or even PowerPoint®. The important takeaway is that records are maintained. If the group has chosen to record the audio from the conversations, this will allow for returning to specific discussion points when necessary.

**Respecting group ownership of ideas.** As dialogue ensues and reflective record content is brought into the CI conversation by the members of the CI team, a group voice will begin to form. During this process, it is a near certainty that not every piece of content will be assimilated by the team. Members must let go according Bray et al. During this step of the process, individual participants may experience some frustration. It is important that respect be given by all members of the group to each other. The learning is both individual as well as collaborative, but the group’s product is truly collaborative.

**Questioning honestly.** Inquiry through questioning is foundational to action research and learning (Marquardt et al., 2009), the family of research methods to which CI belongs. The CI team is encouraged to question the process and the inputs of other group members. However, this must be performed in a respectful and helpful way as noted in the preceding discussion. The inquiry question itself may be challenged throughout the process. This is an opportune place in this paper to remind of the lessons learned from humble inquiry, described by Schein as “the fine art of drawing someone out, of asking questions to which you do not already know the answer, of building a relationship based on curiosity and interest in the other person” (2013, p.2). Group members must make asking questions of other members about their experiences a priority over simply putting forth their own stories. This is not to say that group members will not be able to share, but it should be driven by the requests of others in the group.

**Practicing dialogue and reflection.** Reflection is the final step in the prescribed Phase III process, but once again Bray et al.’s (2000) message is that dialogue and reflection are the key underlying and ongoing components of CI. The iterative process of dialogue and reflection is woven throughout the process. At the end of each session, the group will implement an agreed upon process of reflection. Bray et al., suggest rating the group’s process and discussing why the rating is what it is, allowing an individual to rate their own participation, and identifying whether there are any issues of group direction. Marquardt et al. (2009) suggest asking questions such as what did the group do right, and what could the group have done better?

**Phase IV: Making meaning by constructing group knowledge**

The steps for Phase IV are capturing the group’s experience, understanding the experience, selecting a method for interpreting experience, constructing knowledge, avoiding flawed meaning making, guarding
against groupthink, checking validity, celebrating meaningful collaboration, and communicating in the public arena (Bray et al., 2000).

**Capturing the Group’s Experience.** The first step as the group begins to complete the effort is to capture the experience. This may be the time to formally collect all the written and recorded data from the effort, and begin to organize it as a group. It is important that the participants take notes during and between sessions, including capturing their own feelings about the process and their learning. It may also be the appropriate time to organize the collected records into taxonomies and themes that shape the final products: reports, presentations, and articles.

While CI is itself qualitative, Bray et al. (2000) suggested that quantitative measures can be used to assess individual tendencies and characteristics, and assess changes in the participants during the CI effort. Entrance and exit surveys may be a way to measure the change in individual participant’s attitudes during the CI process. Entrance and exit surveys will require the appropriate level of planning on the part of the initiator or co-initiators. Part of this entrance and exit experience might also be qualitative, such as a narrative of expectations from the process prior to entering the CI effort, and reflection on those expectations at the end of the CI effort.

**Understanding the Experience.** Once the group’s experience has been captured, the group begins to coalesce around what it was that was actually learned. This can include not only the answer to the inquiry question, but how the individual reacted to the process and what they learned personally, as well as how that learning will impact her or his behavior as part of the organization.

**Selecting a Method for Interpreting Experience.** While each member may have her or his own way to understand the CI effort, it is important for the group to determine how they are going to interpret the experience collectively. This includes interpreting both the data and the experience. The knowledge brought into the inquiry by the experiences of the learners is the source of the groups’ learning. Bray et al. (2000) found this to be best captured by narrative and storytelling. Regardless of the method of interpretation selected, dialogue is used to draw out the knowledge of the inquirers. Active listening, rather than debate, is necessary to allow the inquirers to provide the information necessary to sustain the CI effort.

**Constructing Knowledge.** From these interpreted shared experiences, the overarching product—the shared knowledge that enables learning—is constructed. The final documented or physical products of the effort can be used as the focal point or as a binning taxonomy for this construction process. The mix of final products can be modified as necessary given that the group’s collaborative learning will continue during this process as the group discusses what was learned.

**Avoiding Flawed Meaning Making.** Bray et al. (2000) noted the importance of “knowing what we think we know” (2000, p.104). The author is reminded of Weick’s (1993) discussion of the Mann Gulch fire. This is not to suggest that the planned CI effort will result in loss of life, but rather that Weick reports on the impact of flawed meaning making. A team of people can enter a situation expecting a certain outcome. The situation that they actually enter may be different than what they expect, but for one reason or another they may be unable to see this. Pre-suppositions, flawed interpretations of small events, and a lack of closeness within the group are just some of the factors that can lead to flawed meaning making. It is important that the group be aware of the biases they bring with them to the effort.
**GUARDING AGAINST GROUPTHINK.** Even for this inquiry topic, racial diversity does not insure diversity of thought. It is important for the group to avoid the flawed meaning making described above. One way this flawed meaning making may manifest itself is through groupthink. Coryell (2013), while using a process similar to Bray et al.’s, noted that westerners are steeped in western values. Others may see ways of learning and knowing differently. With that said, he noted that there is a call for cross-cultural learning to overcome “ignorance, language- and ethno-centricity, and racism” (Coryell, 2013, p. 300). Reflection again plays a key role here as it requires the inquirer to look at her or his worldview, beliefs, and assumptions. Inquirers must continue to question each other as knowledge is constructed. If individual knowledge is received without question, group dynamics take over. Critical thinking is then thwarted (Bray et al., 2000).

**CHECKING VALIDITY.** One of the aspects of CI that the engineers may question is its qualitative, rather than quantitative, nature. CI does not inherently provide a quantitative set of data for which most engineers have been taught to seek. According to Kasl and Yorks (2002), coherence is the primary way in which the validity of the effort is judged. Yet coherence must not be the result of groupthink. Sharing the ongoing process and the findings of CI with others is one way to check validity. Changes in group members professional lives are a validation of the inquiry effort (Bray, 2002).

**CELEBRATING MEANINGFUL COLLABORATION.** The group will be geographically distributed. Funding and schedule availability permitting, it is desired for the CI group to meet at one of the organization’s locations or at a neutral organizational-mission related site at the conclusion of the effort. Bray et al. (2000) stressed the importance of the group forming a cohesive, empathetic team. Deliberate measures should be taken to ensure that this happens. Bray, et al. (2000) suggested that groups take the time to check-in at the beginning of group discussions to understand where each member stands with respect to the process and the progress, to take occasional time-outs to make sure that each group member is where they need to be in the process, and solicit thoughtful reflections from each member at the end of meetings. Socialization activities are also beneficial, but this may not be possible in a traditional sense given the geographic distribution of the CI group.

**COMMUNICATING IN THE PUBLIC ARENA.** CI is about the CI group itself, and their learning. One of the most powerful aspects of CI is that while the group is learning collaboratively, the individual members change. The members take this change back to their organizations. This creates the opportunity to quite visibly demonstrate this learning and these changes within the overarching organization through presentations, paper publication, policy and procedure, and implementation of change goals. In previous CI efforts, teachers and administrators created events to share knowledge (Kasl & Yorks, 2010). Not sharing the results of the CI effort reduces the opportunity to assure validity, keeps the newly created knowledge within the learning of a few, and inhibits meaning making that is created during the documentation preparation process (Bray et al., 2000). Kasl and Yorks (2010) note that some groups produce formal papers for publication. Conference presentations are another way to broadcast new knowledge. Other opportunities include special presentations to fellow employees in the workplace, presentations to management, and publication on internal organizational websites and in organizational magazines. Some may wish to participate to a greater extent than others. This is not a problem and should be acknowledged and understood by the group; it should not be a product of hierarchy domination, physical trait characteristics, or some other manifestation of power of some over others.
While the participants in the CI effort may have spent time with non-group members as part of the external portion of the process, the institution as an entity may have its first exposure to the CI products and group learning at this point. The group should be aware that this visibility may cause some discomfort for the organization given the topic, inquiry question, and answer.

**ENGINEERING WORKPLACE IMPLICATIONS BEYOND UNDERREPRESENTED MINORITIES**

While the proposed study will focus mainly on race and geographic distribution of the group within the US, it will naturally venture into other areas such as gender and age/generation. Given the organization, there will be little chance of wandering into global workplace diversity during this study. Also, since the proposed CI team will include only engineers, occupational diversity within the group will not be realized. Yorks and Kasl are clear on the importance of these diverse areas: “From our perspective, the influence of gender, education, race, and cultural background on participants’ experience of CI is a topic that needs to be explored” (2002, p. 102).

**GENDER**

The engineering workplace is predominately male. Only 15% of US government engineers were female as of 2009 (NSF, 2012). This has been well documented and programs have been put in place in high school and college to increase these numbers. Interestingly, engineering is one of the few fields where pay is on equal par between men and women (Anonymous, 2011). Yet, women often face barriers in the workplace where, like the racially underrepresented engineer, they are not the majority. CI may also be a method to address associated discomforts or dilemmas.

**AGE/GENERATION**

The engineering workforce, like the US population at large, is aging (U.S. Census Bureau, 2010). With this change in the age curve, there are notable changes in the constituency of the workforce (Gratton, 2011). Pension provisions differ between the older workers and those that are younger, the shaping experiences in their lives are different, and work habit perceptions differ. According to Gratton, these affect individual and organizational performance.

**GLOBAL DISTRIBUTION**

Global geographic diversity is multi-layered. Not only is there an impact of not working in the same physical location, but scheduling is often impacted by time zone differences. To add to this, international geographic diversity often amplifies the time zone differences into day and night differences, as well as adding in the much larger issue of culture.

**OCCUPATION**

The study proposed by this paper deals only with engineers. While the targeted organization is predominately made up of this occupational classification, the majority of workplaces are not. Even in a workplace such as this engineer-dominated target, other occupations exist and are affected by the changing demographic. CI may be one way to draw in other important contributors to organizational success into the dialogue about the changing workplace.

**FINAL THOUGHTS**

Dialogue, and specifically collaborative inquiry, is necessary to better understand and intend (McIntyre & Smith, 1989; Siewert, 2011) positive outcomes associated with the changing racial demographic of the
U.S. engineering workplace. CI also allows for further learning in related areas of diversity such as gender, age, and global geographic distribution. Organizations will benefit from incorporating CI as an adult learning and research tool that can provide meaning to continuing education and lifelong learning opportunities for their workforce.

In organizations, CI must produce meaningful results. Dialogue for dialogue’s sake will not impress management. While CI will certainly change the participants, there must be a demonstratable benefit to the organization. This will manifest itself in how the participants disseminate their learning and ultimately change their workplace through practice.

REFERENCES


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