CREATING CULTURE CHANGE: AN ETHNOGRAPHIC APPROACH TO THE TRANSFORMATION OF ENGINEERING EDUCATION

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Abstract —— *Anthropological support for Greenfield Coalition engineering education culture change utilizes a model of U.S. engineering education culture to explain how culture change occurs in an industrial, academic, and human rights coalition. Research design supports course transferability, encouraging culture change in other engineering education contexts. First, an anthropology team uses action research design to document existing culture, later documenting change in new courses. Qualitative ethnographic assessment enhances culture change by giving critical feedback to staff designing experienced-based courses usable by other educators. Next, anthropologists examine Greenfield as an engineering education field experiment with significant implications to recruit and retain under-represented minorities in North American and European engineering schools. The research explores how to enhance change as Greenfield enculturates new minority engineers into their profession, fully prepared to work in a twenty-first century global industrial marketplace.*

Index Terms ¾ Action Research, culture change, engineering education, anthropology of education.

INTRODUCTION

The Greenfield Coalition for New Manufacturing Engineering proposes changing teaching and learning culture and practice for undergraduate engineers, and in so doing to create a new model of engineering education that, at the baccalaureate level, integrates theoretical and practical knowledge.

This paper discusses anthropologists' role in the Greenfield Coalition, a U.S. consortium of automotive industrial manufacturing firms, traditional universities, and a 30-year old innovative human rights organization, Focus:HOPE. Focus:HOPE operates an engineering education program for inner city minority youth who complete remedial courses in reading and mathematics before taking advanced and experiential coursework in a unique teaching factory that resembles a medical school teaching hospital.

Anthropological participation in this project has two facets. The primary dimension is to conduct an anthropological action research project to understand, document, and support the academic culture transformation now underway in the Coalition. A secondary dimension is a more fundamental inquiry into this program, its processes and consequences as a unique engineering education experiment.

In this action research project, an anthropological team will work with GC staff to push the envelope of educational practice beyond traditional engineering education to help produce professional "Renaissance Engineers" equipped to successfully compete in the twenty-first century global economy. Thus, anthropological involvement in this goal, or mission-oriented project is to help Greenfield achieve its mission, by stretching the traditional concept of "program assessment" (a requirement of National Science Foundation support) to incorporate a participatory form of ethnographic research. The research will be planned and guided by a leadership team representing Greenfield faculty and staff, students, administrators and other stakeholders, working with anthropologists.

The primary mission-oriented goal of this qualitative ethnographic assessment project involves research supporting, enhancing, and documenting teaching and learning culture changes by asking these questions: How is academic culture being changed? What are key components of this cultural change? How effective are these changes in supporting education of a predominantly under represented urban minority population? What enhances or facilitates the change process?

Briefly, ethnography is anthropology's hallmark, holistic research methodology. Ethnography generates qualitative data such as narrative descriptions and interpretations of a group's life way. Ethnography discovers and articulates an insider point of view, asking how students, faculty, and staff perceive, interpret, and act upon educational process change.

Ethnography utilizes naturalistic research methodologies. Validity and reliability of naturalistic research methods come from researchers' prolonged engagement with and observations of the group under study, and from triangulating data sources such as observational, interview, and archival or written material. Descriptions of the context in which the research took place allow for generalization of study findings. During an ethnographic study, researchers generate detailed audit trails of all research process and products to allow others to track origins and underpinnings

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of all inferences. A unique characteristic of ethnography is that findings are validated in discussion with program participants.

Secondly, Greenfield and its efforts to change engineering education culture represent an ongoing, original field experiment with significant implications for recruiting and retaining under represented minorities in engineering schools and universities across the United States and internationally. Greenfield's approach responds directly to calls for engineering cultural change from educators, scientists, and engineers both in the U.S. and at international levels, from NSF leadership, and from all major professional engineering societies concerned with educating engineers.

Of necessity, this is an Action Research project. Initially, culture change involves understanding and documenting existing culture in Coalition member institutions. As data emerges and new curricula are developed, the research will document change as it occurs, and help plan the transfer of these results to other settings. Transfer can occur spontaneously or it can be facilitated through a process making cultural knowledge explicit through detailed description and analysis. To do this, the anthropology team feeds back cultural knowledge in the form of research results to Coalition program participants and stakeholders for reflection and further change in action, policy and behavior. This process of understanding, documenting, making explicit and then communicating feedback to Greenfield in the form of research results encourages and allows program participants and stakeholders to engage in in-depth reflection that can and will guide participants and stakeholders' future plans and actions.

Another project goal is to push the engineering education knowledge envelope in general by using anthropological research design and methodology to learn about and to document this case of culture change, thus furthering culture change in other engineering education contexts. For example, the anthropological team is interested in information technology's role in active learning processes, and what changes must occur in Greenfield's program to enable successful transfer to other contexts. Thus this study also focuses on advancing the state of engineering education knowledge.

The project described here is being conducted by Marietta L. Baba and Diane Pawlowski, both affiliated with the Wayne State University Anthropology Department's Institute for Culture and Technology. This study is one of several ongoing projects designed to understand interactions between new and emerging information technologies and social, organizational, and cultural contexts of their use.

CULTURE AND CULTURE CHANGE

National and international engineering education leaders, including the NSF, repeatedly call for broad engineering

education change that involves more than merely sprinkling new courses here and there, or stiffening program requirements. Instead, entire curriculum transformation is needed, encompassing not only new course structure and content, but refreshing educational goals and fundamentally reformulating roles that engineering faculty and students take on during the teaching and learning process. Industrial and academic leaders, professional associations, and the NSF by funding conferences and studies all recognize that such educational transformation represents academic culture change.

Culture here is defined as shared systems of meaning and practice emerging from collective learning and taught to a group's newcomers as the correct way to think and behave. Examples of such knowledge transfer are mandatory orientation programs offered to an organization's new employees or to incoming university freshmen or transfer students. The engineering profession has a recognized culture, with its own linguistic patterns, artifacts, and behaviors. Because education is where engineering culture is passed on, this is the key place to affect culture change, as John Prados, Accreditation Board for Engineering and Technology (ABET) past president, former Senior Education Associate in the NSF Engineering Directorate, and editor of the Journal of Engineering Education, noted when he was speaking at an NSF sponsored conference on excellence in Engineering Education and leadership held at the Massachusetts Institute for Technology in Cambridge, Massachusetts:

"what is needed is a new culture of engineering education characterized by active learning, project-based learning; integrated development of mathematical and scientific concepts in the context of application; close interaction with industry; a faculty devoted to developing emerging professionals as mentors and coaches, rather than as all-knowing dispensers of information; and effective and broad use of information technology." [1]

While engineering education scholars and industry leaders agree that cultural transformation is called for, there is neither widespread understanding nor agreement about how to change academic culture. Some worry that this mission is truly impossible. Certainly, it is difficult to change any academic culture, since one of academia's characteristics is conservatism and a generally high level of resistance to change.

In the past, limited or deficient understanding of culture hampered earlier efforts to modify or influence academic or organizational culture. But recent advances in psychoanalytic theory, cognitive anthropology, linguistics and artificial intelligence have generated new understandings of culture that support understanding and enabling Greenfield's attempts at cultural change.

Earlier paradigms saw culture as a bounded, static set of properties residing either in people's heads or manifested in their behavior. In other words a "culture as mind" or "culture as body" outlook. Such views prompted either development and implementation of training-based efforts to either change what was inside people's heads, or to increase commands and controls designed to force behavioral change. Neither approach, in combination or alone, succeeded in corporate or government settings.

Recent scholarship now views culture as a dynamic process responding to both environmental stimuli and to an actor's efforts to achieve significant goals. Culture, therefore, resides not simply in people's heads, nor just in their observable behaviors, but in a complex interaction between mind, body, and external forces. This contemporary culture theory suggests new approaches to culture modification that the anthropology team will employ in the Greenfield project.
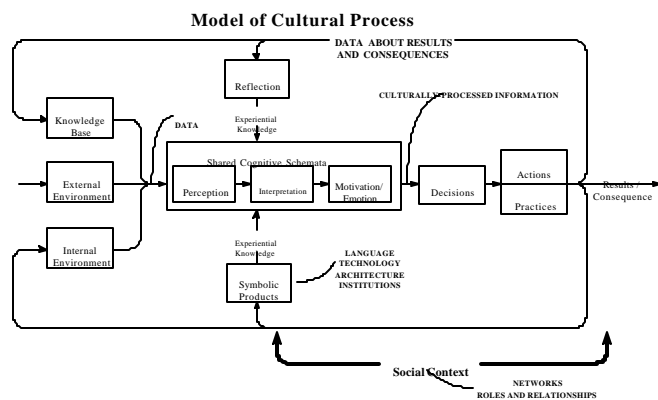

FIGURE 1

This diagram represents a theoretical model of culture capturing much of this new thought on culture as a dynamic process. It also incorporates the notion that professional communities share certain practices and associated systems of meanings that are commonly understood as "culture." This model could represent faculty culture in a particular academic discipline such as engineering or anthropology, or it could represent a particular student population and their culture. All model elements are at least partially shared at the group level across the population in question. Thus the anthropology team is interested in group members' thoughts and actions, not what is idiosyncratic to any individual, just as anthropologists are interested in how group members teach, learn and share their knowledge, their ways of thinking and rules for conduct.

The model does not identify any one single locus of culture, suggesting instead that culture is created through operation of an open, non-linear, complex and dynamic system dedicated to learning about the actor's world and

involving several interacting elements. Each element leads to a set of salient questions addressed in this study. Critical elements of this theoretical framework to explain culture are:

1. Partially shared or overlapping cognitive schemata that process environmental data through neural pathways of memory and association established by regular past interactions with structured environmental or ecological features [2]. These pathways shape perception and interpretation, and are linked to emotion and motivation;
2. Social structures and networks that shape information and knowledge flow among community members and that position members differently with respect to environmental interaction, thereby creating differences across the schemata of individuals and subgroups;
3. Patterns of action and practice, including behavioral routines, that are guided by meanings and motivations flowing from shared and unshared cognitive schemata. Examples include how classroom practices shift, leading us to ask what effect such shifts have on teachers' and students' roles. Think, for example, how repeated interactions shape how students think about faculty - and faculty think about students.
4. Symbolic products and artifacts, including language and technology, that are created through patterned practices, and that embed meanings in symbolic form. The symbolic forms act as a type of feedback, reinforcing shared and unshared schemata or nudging them to change, prompting the anthropological team to ask how new technology supports new understandings and practices; and
5. Data about results or consequences of action and practice that, after reflection, validate existing schemata, or contribute to modification over time.

Culture changes when new environmental stimuli challenge or conflict with existing perceptions and interpretations, requiring a search for new actions and practices and prompting results that modify cognitive schemata, or when new stimuli trigger old actions and practices that reflection fails to validate. Such shifts occur continuously, usually without any conscious direction, often in response to a certain agent's efforts. In combination with creative imagination, these changes result in innovation. For example, widespread bans on smoking in public places and growing resistance to cigarette smoke by the U.S. public, represents culture change in middle class adults. Americans no longer perceive cigarette smoke as harmless - a culture change ultimately affecting even architecture of public buildings.

The Coalition currently works with industry, scholars and academic leaders, and expert applied engineers to change both academic engineering faculty and Greenfield student culture. Furthermore, Greenfield Coalition's long-term goal is to influence academic cultures of other university based engineering programs. The anthropology team's mission-oriented assessment goal is to use

ethnographic research methods to understand the nature and extent of this change process, and because this is action research, to use its data to support and enable change. Such research compliments curriculum assessment of student reaction, learning gains, and learning transfer.

KEY RESEARCH QUESTIONS

The anthropology team, working with Greenfield, will do this by investigating faculty and students' shared cognitive schemata and actions/practices. How do they perceive and interpret GC goals? How do students and faculty view their roles and relationships in the educational process? How do their schemata, practices, and symbols change? What do they think about the program's effectiveness in meeting its goals? What works well? What needs improvement? Do changes meet program goals? Do students view the program as effective in retaining and academically preparing under represented minority students? How is students' emergent identity as engineering professionals fostered by the Greenfield educational experience? In terms of practice, has there been fundamental change in roles and relationships? What does active learning look like in real time? What different learning styles and strategies emerge in response to changes in roles, relationships, and technology? In short, do faculty and student schemata and practices change to meet expectations or in ways that were not anticipated, and are these changes effective in terms of achieving program goals? In general, the anthropology team will work with Greenfield staff to ask how cultural knowledge can guide future actions.

These questions can be addressed through in-depth discussions with faculty and students, and by directly observing learning activities. In this effort, the anthropology team will work the qualitative side of the assessment process, which should give us access to information that cannot be accessed by using quantitative approaches.

ETHICAL CONSIDERATIONS

In doing this work, the anthropology team will carefully follow guidelines of informed consent and confidentiality adopted by the American Anthropological Association as standard procedure in ethnographic research. All interviews and observations are voluntary and conducted only after participants give informed consent. Anthropologists protect individual and group identities. All data is reported only in aggregate fashion. It is not our goal to spy on anyone nor to give performance grades to teachers or students or anyone involved in the project. This would be unethical. Our first rule of conduct as anthropologists is to do no harm, while simultaneously protecting those with whom and for whom we work.

The anthropological objective is to understand a situation from the participants' point of view, and then to

report - to reflect - back what we learn to program participants as a whole so that they can replicate success, while addressing problematic issues quickly, with targeted improvements. The anthropologists' role is to make implicit cultural perceptions and practices explicit, raising these practices to a level of conscious attention. Then, the anthropology team will work with program participants to pro-actively use these explicit recognitions as a guide for future actions to enable reflection and to facilitate sharing and dialogue among Coalition members and participants.

FUNDAMENTAL ASSESSMENT QUESTIONS

The anthropological research effort extends farther, examining information technology's role in engineering educational and especially in active learning processes. We investigate the role of computer-based educational resources in establishing new roles and relationships in classrooms and on the teaching factory's shop floor. We ask what strategies students and faculty develop to use technology as a means of active learning and how effective are these strategies? How does technology access outside the classroom (i.e., at home or work) affect what occurs inside (i.e., the digital divide issue).

MISSION-ORIENTED ASSESSMENT GOALS

Basically, our long-range mission-oriented goals encompass four categories that are related to this new cultural model. These categories ask questions relevant to 1) perception; 2) practice; 3) symbols; and 4) the knowledge loop. Questions addressing perception include: How do faculty view their students? What liminal processes are at work here? Traditional engineering programs' first two years include a hazing gauntlet and other trials to weed out "unfit" or "unworthy" neophytes. But what are the selection mechanisms in a program attempting to support success and the entrance of as many novices as possible into professional ranks.

Questions regarding Practice include: How are classroom and shop floor experience integrated? Deep chasms often exist between theory and application. What strategies do academic engineers and their industrial partners use to bridge this gulf?

Symbols are of great concern to anthropologists because they are evidence and products of a culture. Technology is an example of a symbolic product. How is technology appropriated? Is there faithful or ironic utilization? In regards to the Knowledge Loop, how do we understand this study's results? What are the program's hidden results? What is the students' world like?

Certain aspects of Greenfield's program are intriguing from the standpoint of professional culture change. One example is the way in which ethnic diversity influences the incorporation of new members into the community.

Communities of practice are sustained over time by recruiting new members who begin their careers as legitimate peripheral participants [3]. Gradually, novices are permitted to undertake more central roles as their knowledge, skills, and abilities grow and become similar to those of the larger community. During this process, newcomers take on the identity of a community member, a status with profound implications for their lives as a whole. A salient issue concerns the gradual transformation of young adult minority under or unemployed persons into students, and later their subsequent entrance into the academic community, followed by their identification with, and eventual emergence from, academe as professional engineers. While GC and other engineering students start out as members of a culture that is separate from faculty, students should enter into engineering culture and become accepted as novice members. Student identities should expand to encompass the new identity of professional engineer. This assumes relationships between faculty as veteran members of the engineering culture, and students as novice members, in which faculty mentor students and guide or sponsor their emergence into the culture. There is evidence that this process influences student retention [4,5]. Other studies of emerging identity among engineering students focused on predominantly Anglo-American students in places where ethnic identity of faculty and students was shared (more or less). At Greenfield, the reverse is true. Students are under or unemployed members of an ethnic group different from classroom faculty. A key question is whether and how these differences effect engineering identity development among students, and whether identity effects retention, success in the program and future employment.

The anthropology team is also interested in transferring this technology, including parts or all of Greenfield's program, to academic institutions within the Coalition. Faculty and students of member universities have characteristics that differ from their Greenfield counterparts. Part of the ethnographic research design includes observations to document those differences. For instance,

the study asks if these differences require adaptations in the program, and if so, what kinds of adaptations? How does the GC program affect the campus academic cultures versus that in the Focus Hope context? Thus, research will help transfer GC's model beyond Detroit-area institutions and coalitions to elsewhere in the U.S. and to international engineering education community.

It is our intention to discuss our findings with the Greenfield Coalition community, to involve all participants in thinking about what is happening and how to make it better, and then to broadly disseminate our findings so that others can learn from this experience of culture change in engineering education.

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