Technology in Society 40 (2015) 53–63

Contents lists available at ScienceDirect

Technology in Society

journal homepage: www.elsevier.com/locate/techsoc

Transdisciplinary technological futures: An ethnographic research dialogue between social scientists and engineers

Gerardo del Cerro Santamaría

The Cooper Union for the Advancement of Science and Art, 30 Cooper Square, New York, NY 10003, United States

ARTICLE INFO

Article history:
Available online 4 December 2014

Keywords:
Technological futures
Transdisciplinarity
Ethnography
Engineers
Social scientists

ABSTRACT

This paper suggests that transdisciplinarity is rising as a powerful epistemic strategy for research in technology-related fields such as engineering. Though this topic has been approached from a philosophical perspective, we know little about the actual shape that transdisciplinarity might take in research and action. How is transdisciplinarity operationalized in research and professional practice? As a case study, we report an assessment study of communication modes and content used by engineering students in a special project-course, Robotics for Theater, focused on the planning and construction of a robot from scratch, to support theatric production as actor and prop. Our assessment tools were based on ethnographic research and included questionnaires, journals, and students' expressions of their views on the communication and learning processes. Analysis of the case study of the Robotics for Theater project revealed that: 1. Resource mobilization was fostered by the role of the advisor as information facilitator and "weak tie" in the network, and also by the frequent informal contacts among the students in the team. 2. Innovation was fostered by intra-team trust. The strong friendship and teaming experience of the group were critical for effective team dynamics. 3. Probably due to time constraints, the field of theater did not become a fundamental reference of the project, contrary to plans. 4. Time constraints and technical difficulties in implementation inhibited progress. 5. Informal meetings were crucial in the progression of design and implementation.

1. Introduction

This paper suggests that transdisciplinarity is rising as a powerful epistemic strategy for research in technology-related fields such as engineering. Though this topic has been approached from a philosophical perspective, we know little about the actual shape that transdisciplinarity might take in research and action. How is transdisciplinarity operationalized in research and professional practice? During the last decade, transdisciplinarity has become the focus of important theoretical contributions. More recently, innovative research strategies and methods tackling complex objects and contexts have been presented at academic conferences and seminars. One aim of this paper is to present a case study of transdisciplinarity, which will not only improve our understanding of this approach but also illustrate how it can be operationalized in concrete ventures as it fleshes out our next technological futures. While architecture and planning seem to be fertile domains for transdisciplinary contributions (because of their very nature as multidisciplinary disciplines involving both the natural and social sciences, and action-oriented practices aimed at transforming the built and natural environment), little is known about the shaping of technological futures involving collaborations between engineers and social scientists. This paper outlines a framework for transdisciplinary collaboration which is applied to the Robotics-for-Theater project, a transdisciplinary project made possible with NSF funding and developed at The Cooper

E-mail address: gdelcerro@gmail.com.

http://dx.doi.org/10.1016/j.techsoc.2014.10.005
0160-791X/

Union for the Advancement of Science and Art in New York City.

This paper presents the development and results of an assessment conducted on the Robotics-for-Theatre project, an educational initiative developed at the Cooper Union School of Engineering under the auspices of the Gateway Engineering Education Coalition of the National Science Foundation.

The purpose of the assessment was *summative*: we wanted to gather information about a team of students who developed a robot for theatrical performance in order to develop a protocol for assessment of similar future projects. In order to gather the information, a number of assessment instruments were designed and implemented. Students were asked to track ideas that were successfully applied to the robot, and ideas that were not. They were asked about the means of communication used during the development of the project. They were also asked to express their views on the learning process on a number of issues ranging from communication skills, to teamwork, to interdisciplinarity. The analysis of students'responses has allowed us to design a new assessment protocol.

Unlike the summative assessment performed, the proposed protocol is fundamentally *formative*: it has been designed to be a part of the overall design of engineering projects from the outset, and it specifies feedback loops for continuous improvement that should be implemented during the development of the projects. If successfully implemented, we believe the protocol can be an effective way to track *and* improve the learning by engineering students at Cooper Union in a number of dimensions or learning outcomes. A successful implementation will require full collaboration among all parties involved in each project, especially faculty and students, the main players and beneficiaries of assessment practices.

This paper is divided into six sections. Section 1 provides an overall background of the relevant literature and the research problem addressed here. Section 2 presents our case study, the Robotics-for-Theatre Project, in the context of the engineering curriculum at Cooper Union. Section 3, entitled “A Summative Assessment for the Robotics-for-Theatre Project” discusses the assumptions underlying the assessment plan designed and implemented. Section 4 is devoted to presenting the main results of our research, including a section on validity and reliability. Section 5 devoted to future work, presents our proposed assessment protocol for innovative, open-ended engineering projects. Section 6 summarizes the value of transdisciplinary collaboration.

2. Background

The explosion of information technologies during the past decade has revolutionized the practice of engineering, which, quite naturally, drives requirements for changes in engineering education [1,2,24]. Two key areas for change identified at the national level by industry, government and schools are 1) Teaming and 2) Design. The information technologies provide new tools for communication in the former and development in the latter. That is, distance learning, video conferencing, e-mail, and intranets provide a new medium for shrinking space and time in cooperative teams. Databases and CAD systems provide error-free archives and design baselines instantly accessible for the product.

The information technologies also provide a useful window into the team and design process for analysis and tuning of the teaching process. Educators can tap in to the stream of messages and designs, measuring the kinds of activities in progress, and find and correct problems in the curriculum. Larry Leifer pioneered such techniques, among others at Stanford University. Leifer electronically instrumented the communications streams between team members, analyzing their activities to assess the educational process and disseminate the results [17]. The original intent of his study was to develop methods to bridge the gap between professional practice and education with joint industry-academic product focused projects. An important discovery from this and other studies was that *team engineering is a critically social activity.* While any team effort of course requires social interaction, awareness and training of this aspect had been largely ignored in engineering education, which instead emphasized technical content.

The discovery of the importance of the social element led to deeper examinations of its nature via protocol analysis. Atman, Bursic, and Lozito [3] applied this technique to the verbalization of a student in a design project, coding sentences into categories which included Problem Definition, Information Gathering, Generate Ideas, Analysis etc. Button and Dourish [9] discuss formally on the methods and application of protocol analysis in terms of *ethnomethodogy*, i.e. treating engineering communication as utterances by an alien culture to be objectively analyzed by the anthropologist for the purpose of improving the culture (increasing engineering design productivity).

In an interesting study which focused entirely on the social interactions devoid of technical content, Bereton, Cannon, Mabogunje and Leifer [6] analyze the protocols of videotaped conversation in a design team, coding the results in terms of focus and transition. The former is a locking in of a design decision, which often requires assertion of authority based either on merit or power. For smooth teaming, this must be accompanied by persuasion, smoothing the feelings of the loser, and formal registration of the decision. Transition, on the other hand, requires cooperation, exposure of self to risk, and requests for help. The authors note that students are rarely trained in the use of such group dynamic techniques and manners. The authors of the paper at hand observe from their professional experience that the most successful team leaders in industry are superb at these social skills.

The work cited above describes studies which examine the communication associated with teaming and design. The purpose of the studies was to understand and improve skills in these two areas which industry deems of central importance, and hitherto neglected in engineering education. Our purpose is to learn from these examples, and apply communications assessment tools to the improvement of undergraduate engineering education. Every institution has unique characteristics, rendering universal methodologies inapplicable. Thus, we have selected and adapted some of the tools described above, and applied