Work-in-Progress:
Investigating the experiences that develop competence for newly hired engineers in an electric power company

Introduction

This study is a work-in-progress investigating the experiences most salient to newly hired engineers in an electric power utility as they began new jobs. The study is based on an inductive, qualitative design using semi-structured interviews with 12 newly hired engineers.

A major milestone in the professional formation of engineers is the transition from student to practitioner—typically via employment into commercial/industrial organizations or other forms of employment [1]. Transitioning into a new job from school is an experience akin to crossing a distinct cultural boundary requiring one to transfer and/or translate one's current knowledge and skills and learn new knowledge and skills [2]. For engineers transitioning from one engineering job to another the experience requires learning new cultural, social, political, and practical norms which vary more or less based on the degree of similarity and difference between organizations. For new graduates from school, the experience also requires learning, although the boundary is greater between different institutional cultures having different ways of thinking and doing.

One of the goals of engineering programs in higher education is preparing students to transition into professional careers. Yet, the outcomes of these efforts have been regularly criticized by employers for shortcomings in the competencies commonly referred to as the professional or 'soft' skills [3] needed to perform effectively in professional practice [4], [5].

The idea of what one needs to have to perform effectively on a job is often called competence and is made up of a loosely defined bundle of competencies that variously include much more than skills. Competencies are also referred to as KSAs (*Knowledge, Skills, Abilities*), although recent conceptualizations have expanded this description to include the additional elements of motivations, beliefs, values, interests and behaviors that contribute to performance in a particular occupation, role, or job [4], [6], [7]. A broader view of competencies describes, not only what someone can do, but also what they will do, what they know, and who they are. This broader view also aligns with a shift to a broader view of aspirations and competencies for engineers and engineering practice [8].

The aim of the work-in-progress reported in this paper is to better describe and explain the experiences of practicing engineers and to better articulate the nature of the broader set of competencies that are important to accomplishing the work of engineers. In the next section we briefly review the idea of competencies. This is followed by a brief overview of the socialization process by which newly hired engineers learn to do their new jobs competently and effectively in the workplace. Then we present the design of this study followed by an overview of the findings. Finally, we conclude with a discussion and conclusions, including the plans for continuing work on this study, and initial implications for engineering education.

Brief review of competence and organizational socialization

There is little consensus about the definition of competence or competency [9]; however, one view considers competence to be the overall disposition of a person made up of particular abilities, or competencies [10]. In addition, there is *internal competence*, which views the abilities of the individual to perform, and *external competence*, which views performance as interdependent, including the relational and cultural influences of the situation [9], [10]. Recent conceptualizations of competencies and competency models have expanded to include not only individual behaviors, but also group/team and organizational behaviors, as well as the requirements of a job, occupation, or profession [6], [7].

Setting aside the semantic debates, collectively these views describe the position of the authors of this paper who use the term competence and competencies as heuristics for what a person can do and will do. There are two kinds of competence referred to in this study. One is *academic competence*, which strives for mostly a cognitive mastery of a discipline (e.g., engineering), and the other is *operational competence*, which strives to fulfill occupational and economic performance goals [11]. This paper focuses on the latter.

Even within a particular situation or context, valued competencies might vary among different stakeholders [12]. Elkin [11] proposed differentiating between micro-competencies (those closely linked to doing specific tasks) and macro-competencies (the more generic and deeper personal qualities that enable one to do higher-level tasks). The competencies needed also differ over time. Initial competencies are the basic requirements needed to effectively enter a workplace as a newly hired employee prior to learning the competencies for doing specific job tasks. Beyond that there are developmental competencies that become important for growth and promotion in a job [11]. For example, initial competencies for new graduates beginning a new job typically focus on the competence to build effective working relationships with others in the organization, learn organizational procedures, and the competence to learn job tasks [13]. Initial competencies for experienced hires would add a focus on the competence to solve problems and manage projects.

Organizational socialization (socialization) is "the process through which individuals acquire the knowledge, skills, attitudes, and behaviors [*i.e., competencies*] required to adapt to a new work role" [14, p. 3]. Transitioning into a new job brings the newcomer into contact with organizational social systems including organizational expertise, preferred practices, identities, and social norms [15], [13]. For newly hired engineers, socialization experiences include learning new cultural routines, social norms, interactional protocols, and job-related procedures. The experiences also include learning the socio-cultural practices of different occupational communities that make up the organization, such as management, finance, marketing, production, and technician communities [1]. Previous studies of organizational socialization found that it was the quality of the relationships in the newcomers' work group that was a primary driver of socialization success—typically reported as job satisfaction, work group assimilation, and commitment to the organization [16].

The socialization process is a critical stage in the professional development of engineers. It is the quality of socialization experiences that influence the newcomers' perceptions of their work and of their professions, as well as the formation of their identities and competence as practicing

engineers [16], [17]. It is also a developmental process unfolding over time—especially the first couple of years of employment [18], [19]. The newcomers' development of professional competence includes both the technical, personal, and the interpersonal domains of expertise. This development is facilitated and/or hampered by various experiences encountered during the course of the person's employment—especially by the early experiences on the job.

The aim of this study was to collect and analyze the experiences of newly hired engineers developing their professional competence through the socialization process at new jobs in the energy industry. The following describes the details of the research methodology and design.

Research Methodology and Design

The purpose of this study is to investigate the experiences reported by newly hired engineers beginning new jobs in a subsidiary organization of a large electric power holding company in the U.S. The subsidiary focuses on the development, ownership, and operation of a variety of renewable electric power generation facilities.

The overall research question guiding this exploratory study was focused on two aspects of newcomers' experience: *What do newly hired engineers learn about their work as they begin their new jobs in an energy company—and **how** do they learn what they learn?* This compound question addresses two closely related aspects of learning as conceptualized in the literature: content (*what* we learn) and process (*how* we learn). The content focus identifies specific things newcomers learn and need to learn, while the process focus identifies myriad ways of learning.

The participants in this study were all newly hired engineers in subsidiary of an electric power company. Four participants were *new graduates* (beginning their first engineering jobs after graduation), and their time with this company ranged from one month to eighteen months. Eight participants were *experienced hires*, (engineers coming from previous jobs with other organizations), and their time with this company ranged from seven months to three years. Ten participants were male, two female; seven were educated as Electrical Engineers, two as Mechanical Engineers, one in Civil Engineering, one in Physics, and one Technician. All were considered engineers and they worked in various engineering groups of the organization.

Data to answer the research question were collected from the newly hired engineers via in-depth, semi-structured interviews that inquired about what the newcomers' learned and their experiences learning how to do their jobs, including learning about the company and its business and learning how to work within the social systems that included coworkers, managers, technicians at various field sites, and other stakeholders. The interview protocol was designed based on existing research, theories, and literature on socialization, workplace learning, and work practices. The aim was to collect participants' experiences learning to do their jobs and integrating into the company. Interviews ranged from approximately 45 minutes to an hour and followed Institutional Review Board (IRB) requirements for informed consent and voluntary participation in research on human subjects. Interviews were conducted and recorded by the first author. Interviews were transcribed verbatim in confidence by a professional transcriptionist yielding 491 pages of transcripts. Participant, project, and company identifiers were removed to protect privacy per IRB requirements.

Interview data collected from the new hires were analyzed following the methods recommended for qualitative data analysis [20], [21], [22]. This analysis is still ongoing. Objectives of the analysis were to identify the variety of newcomers' experiences via the coding, identify clusters of similar experiences, and map out the general progression of learning during socialization. A set of 30 pre-determined codes was developed identifying key concepts of the socialization experience based on reviews of existing literature on socialization, workplace learning, and work practices (e.g., technical knowledge, job roles, interpersonal skills, problem solving, KSAs, mentoring).

The analysis was iterative going back and forth among the transcripts, codes, clusters, and memos in a constant-comparative process that included the following steps (see Fig. 1):
1) **Reading transcripts:** Each interview transcript was read carefully by the first author.
2) **Coding:** A two-step coding process was used. First, specific passages in the transcripts were coded drawing from the set of 30 pre-determined codes that described the main topic of the passage. Second, an open-code was added to the passage, or relevant parts of the passage, following the methods of Strauss and Corbin, [22]. Open codes describe the content of a passage with an abbreviated phrase that stays close to the language of the newcomer [22] (e.g., a lot of the learning is trial and error; learned that the money side is crucial here, it's got to be economically viable; learned that everyone has their own view of the problem and solution).
3) **Sorting codes into categories:** After all transcripts were coded, 734 unique open codes were sorted into major categories based on similarity (affinity), such as learning, culture, work tasks, interactions with others.
4) **Cluster analysis:** Further analysis of these clusters of open-codes revealed the scope and range of the clusters (axial codes, [22]), as well as patterns of experiences.
5) **Develop memos:** Memos describe emergent themes and explain the patterns of experiences and activities representing what newcomers learned about their jobs, as well as how they learned what they learned.—thus, beginning to address the research question [20].
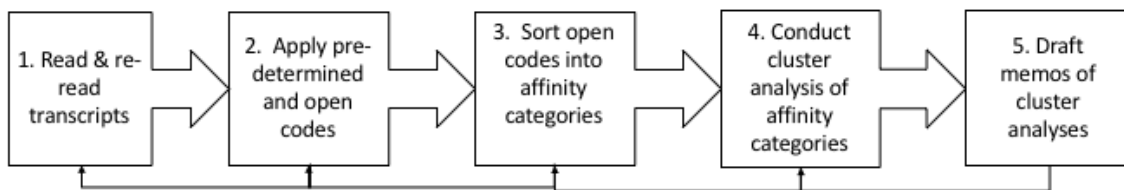

Figure 1: Constant-comparative data analysis process for analyzing interview data

The analysis is still underway with the objective to identify patterns, categories, and generalized themes of newcomer experiences learning to work for and integrate into the organization. Identifying these patterns, categories, and themes will inform the development of competency models for the education of future engineering students and help with the improvement of the socialization process in organizations.

Initial findings

From the analysis process above, we began to answer the research question to understand *what* newly hired engineers learned, and *how* they learned as they began new jobs? At a general level, learning how to do a new job and integrate into a new company (organizational socialization) has

been studied in a variety of different organizations for different occupations. The general progression from newcomer to experienced member of the organization is highly transferable among a variety of organizations; however, we are looking for the nuanced experiences and occupational details of this process that can inform engineering students, newly hired engineers, and the managers of newly hired engineers in the workplace. This detailed information likely will help engineering students preparing for jobs in engineering more generally.

The themes found in the cluster analyses illuminated four stages of experiences and learning for newcomers. This model displays a synthesis of the experiences newcomers reported as they worked to develop their competence to perform as engineers in this company (see Figure 2).
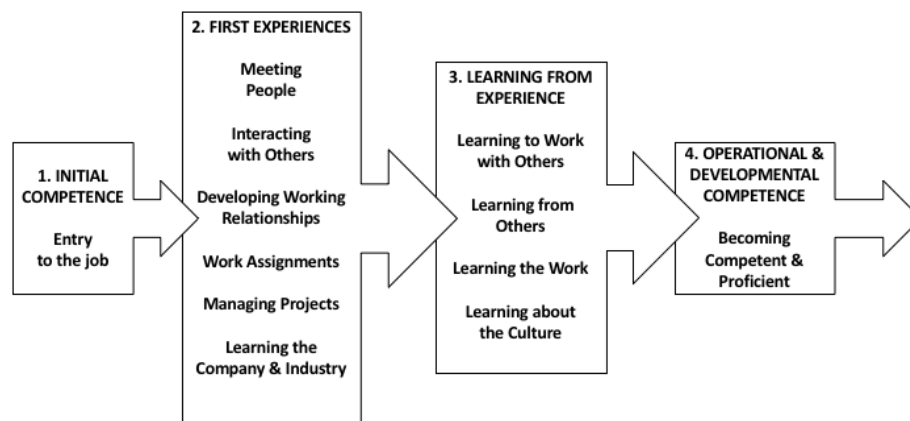

Figure 2: Four Stages of Newcomers' Socialization for Developing Competence

What these newcomers learned and how they learned what they learned developed over time starting with: **Stage 1)** *Initial Competence* that includes pre-entry knowledge and skills learned from their education in school, experiences in internships, and experiences in previous jobs.

> . . . I don't think there was any class I took that really prepares you for the work world more than just the co-op itself, you know you've got to get in and mess up a few times to really understand the nature of working in an office versus going home and studying by yourself (*Participant 03 new graduate*).

Stage 2) *First Experiences* on the job in which newcomers meet their coworkers, mentors, and managers, as well as receiving assignments for work, projects, and information about the larger context of the company and the industry.

> . . . the biggest gift is to have somebody out there who kind of show you the ropes, to have a good mentor – and I was able to latch on to several people in the group, kind of soak in some knowledge from them, ask them questions to get a better understanding . . . (*Participant 13, new graduate*)

Stage 3) *Learning from Experience* as an ongoing process to develop competence by gaining experience with various facets of the job, such as the work, culture, coworkers, and mentors.

> . . . relationships are essential in the workplace and if you've got good relationships with your techs and your site managers and your boss and your peers it's a lot easier to get stuff done and I think a lot more enjoyable to get stuff done. (*Participant 06, experienced hire*)

The previous three stages aim toward developing into **Stage 4)** *Operational and Developmental Competence* as a practicing engineer. This complex system of interconnected experiences is a type of *socialization or learning ecosystem*. It is made up of informal, incidental, as well as formal learning experiences embedded in the social dynamics of the workplace [23], [24], [25].

Initial Discussion and Conclusions

While these four stages represent a general learning process, the details and social interdependencies of the experiences are less well understood in the literature and practice. There were four interdependent categories of Stage 3: Learning from Experience that emerged from the analyses of the interview data (see Fig. 2): two categories focused on learning to work with and learning from others, one focused on learning the work, and one focused on learning the culture of the organization. As the analysis continues the four categories will be further specified with more details of *what* newcomers learned and *how* they learned. The following discussion begins to link these categories of learning with the existing literature (transferability).

Learning to work with others and *learning from others* were commonly reported categories of learning based on social interaction. In a longitudinal study of early career engineers, nurses, and accountants, Eraut [26] found that most of the early learning reported in his study depended on the quality of the working relationships between newcomers and others in the workplace. How people learn from experiences draws upon co-participation, engagement, and guidance between learners and others in the work group [27]. Existing research indicates that the relationships with coworkers, how coworkers engage the newcomer, and the willingness of others to guide newcomers strongly affects the quality of newcomers' learning on the job [16], [27], [28].

Learning the work required specific knowledge and skills to engage competently in the practices of the job. Buch and Andersen described the practices of engineers in their studies as 'ecologies of practices' comprised of 'interconnected webs of human social activities' [29, p.38]. In this study, newcomers brought various levels of competence to the work, yet all had to learn the ways that practices were enacted within the social interactions of the work in this organization.

Learning the culture described what the newcomers perceived to be the "way things are done here" [30] and also compared what they perceived to previous organizations (for experienced hires) and to their experiences in school (for both new grads and experienced hires). For example, even in this organization, different field sites had different ways of doing things. Because engineering practice includes a high degree of collaboration with others, the prevailing organizational and social cultures embedding the work strongly influence how engineering is practiced in any particular setting [13], [31], [32].

Initial Implications for Engineering Education and Next Steps

This work-in-progress reports on the learning experiences of newly hired engineers. Collectively, four interdependent categories of learning (as described above) address the development of newcomers' competence as engineers. Further analysis and modeling of the data are forthcoming, and will provide details of the competencies developed among the newcomers and how they were developed. We anticipate that articulating the competency models of professional and technical competence developed in this learning ecology will provide a deeper understanding of what newly hired engineers learn and how they learn as they develop into their careers.

Acknowledgements

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