Crossed Wires:
Challenges to Traditional Apprenticeship in the Electrical Trade

by

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ABSTRACT

This work investigates the reproduction of communities of practice. Focusing on apprenticeship into the electrical trade in British Columbia, the work reports findings of three years of ethnographic fieldwork. The work documents challenges to traditional apprenticeship — the historical learning model of transmission of domain knowledge and domain practices in the trade. Discontinuities between the acquisition of domain knowledge and domain practices, in light of the evolution of electricity from work energy to information energy, are the principal challenges faced by the apprenticeship model currently in place in British Columbia. The present study also documents the emergence of a form of cognitive apprenticeship in workplaces where non-traditional practices of the electrical trade are enacted. The nature and merits of cognitive apprenticeship as an alternative to traditional apprenticeship are discussed, and implications of the findings for educational programs are offered.

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Acknowledgments

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Dedication

To Stella, Sophia, and Olivia, who help me see this world with child-like wonder, and to Morgana, who helps me make sense of what I see.

Chapter 1

Introduction

Communities of practice are groups of individuals who share in a common set of domain knowledge and domain practices. According to Lave and Wenger (1991) communities of practice may be viewed as being made up of a core — populated by established members of the community of practice — and of a periphery — the site where novices begin their apprenticeship. Apprenticeship, then, may be viewed as the journey from the periphery towards the core, and from the state of novice towards the achievement of full membership into the community of practice (Lave and Wenger, 1991). Historically, communities of practice renew themselves through the education of novices, non-members of the community of practice. Novices become full-fledged members of communities of practice through progressive acquisition of domain knowledge and domain practices. Whether the community of practice consists of high steel workers (Haas, 1989), nurses (Cope et al., 2000), or research scientists (Gooding, 1990), novices access it through some form of apprenticeship. Key terms pertaining to apprenticeship are defined in table 1.1. In spite of apprenticeship's many facets, its overall goal "has been the same throughout the centuries": it is to provide "a training, a learning of a trade, with responsibility on the part of the master to teach and of the pupil to learn" (Strange, 1982, p. 10).

Apprenticeship into the construction trades strongly reflects this unchanging aim of apprenticeship (Applebaum, 1981). Over the centuries, building materials and techniques slowly evolve, and working conditions become better regulated, but the pedagogical methods of trade apprenticeship remain rooted in the traditional apprenticeship model (Collins et al., 1989). Within the past fifty years, however, some of the construction trades witnessed the emergence of niches in which domain knowledge and domain

Table 1.1 Definition of key terms utilized in this study.

Apprenticeship: a learning trajectory that allows a non-member of a community of practice to progressively move from the periphery to the core of a community of practice through the acquisition of the domain knowledge and domain practices characteristic of an established member of the community of practice in question.
Traditional apprenticeship: a form of apprenticeship in which the acquisition of long-established, slow-evolving domain knowledge and domain practices occurs in the workplace through the use of modeling, coaching, and fading (fully defined on pages 20 – 21).
Non-traditional apprenticeship: a form of apprenticeship in which the acquisition of complex and fast-evolving domain knowledge and domain practices occurs in the workplace through the use of modeling, coaching, fading, articulation, exploration of ideas, and reflection (fully defined on pages 20 – 21 and 30 – 31).
Community of practice: a group of individual who share in a common set of domain knowledge and domain practices, spread over the gradient of integration into the community of practice itself, from its periphery to its core.
Apprentice: an individual who has entered an indenture agreement in order to access and advance through the learning trajectory of apprenticeship.
Indenture: a contractual agreement between an apprentice, an employer, and a regulatory body (provincial government) that ratifies the parties' intention to jointly ensure the apprentice's progress through an apprenticeship.
Journeyman: a member of a community of practice in the building trades who has completed an apprenticeship, has passed an Inter Provincial Trade Accreditation Exam (IP) and has acquired the Red Seal certification that is warranted to full members of the community of practice in question.
Traditional areas of the electrical trade: areas of practice in the electrical trade centred on the use of electricity as work energy.
Non-traditional areas of the electrical trade: areas of practice in the electrical trade centred on the use of electricity as information energy.

practices evolve at an atypically rapid rate. The electrical trade — a subset of the construction trades — best exemplifies this trend: since the second World War, the use of electricity as a means of storage and processing of data gave rise to rapidly evolving, non-traditional areas of practice. These are the areas where the limitations of long unchallenged pedagogical methods are felt most strongly (Canadian Electrical Contractors Association, 1997), and where new emergent models of apprenticeship may be found. This ethnographic study aims to document 'from the inside' the current state of apprenticeship in the electrical trade, paying particular attention to the limitation of existing pedagogical models, and to the emergence of new ones.

Coy (1989) dwells on the universality of apprenticeship, "bound by neither history or culture," as "the means of imparting specialized knowledge to a new generation of practitioners" (p. xi). Early records of apprenticeship agreements date back to the Babylonian Code of Hammurabai, 2100 years before Christ (Douglas, 1921). The work of Strange (1982), documenting the life of chimney sweeps' apprentices in London between 1773 and 1875, and that of Woodward (1995), investigating apprenticeship among building craftsmen in northern England between 1450 and 1750, exemplify historical overviews of apprenticeship in England. Douglas (1921) offers a similar overview of the early history of apprenticeship in the United States. The work of Cooper (1980) exemplifies contemporary ethnographic studies of traditional apprenticeship. Cooper worked as an apprentice among Hong Kong furniture carvers, studying the impact of automation on their trade. Similarly, Jordan (1989) served an apprenticeship as a means for studying Mayan women entering the midwives' community of practice. Lastly, Coy (1989) apprenticed under a Kalenjin blacksmith in the Rift Valley of Kenya. Closer at hand, Gamst (1986) documented the training and enculturation of American and Canadian railway personnel, while Terkel (1971), Cherry (1974), Applebaum (1981), and

Haas (1989), investigated apprenticeship into the construction trades.

Educational researchers have adopted the language of apprenticeship to describe, metaphorically, the acquisition of domain knowledge and domain practices in communities of practice that do not make use of a recognizable apprenticeship. With regard to these communities, Collins et al. (1989) coined the term cognitive apprenticeship to describe the learning that occurs through a synchronous combination of academic training, observation, and experience. Cognitive apprenticeship is based on the metaphorical view of learning environments as sites of apprenticeships: in cognitive apprenticeship, the learning situation is cast as a community of practice, teachers are cast as mentors rather than dispensers of knowledge, and learners are cast as active participants rather than passive vessels (Berryman et al., 1993). Cognitive apprenticeship has been applied successfully in both academic and vocational domains (Berryman et al., 1993; Cash et al., 1996; Collins et al, 1989). Orr (1998, 1990) documented the use of cognitive apprenticeship among photocopier technicians. Collins (1982), Brown and Duguid (1991), and Gooding (1990) investigated its use among scientists and in the technological workplace. Lastly, Collins et al. (1989), and Lee (2001) reported on the successful application of cognitive apprenticeship in cultural modeling environments.

Communities of practice in the construction trades, of which the electrical trade is a subset, historically have reproduced themselves through apprenticeship (Applebaum, 1981). Historical studies of traditional apprenticeship (Douglas, 1921; Strange, 1982; Woodward, 1995) point to three potential limitations of this educational model. First, traditional apprenticeship is characterized by an easily abused disparity of status and power between apprentice and mentor; second, it does not ensure the apprentice access to the more desirable sectors of a trade; third, it appears ill suited to educate apprentices working in fast-evolving technological settings. Apprenticeship into the electrical trade is not immune to these limitations. Furthermore, a comparison of the current status of trade apprenticeship in England, Germany, Australia, and Canada (Young, 1992; Steedman et al., 1998; Ray, 2001) points to the lack of concerted updating and reform of apprenticeship outside of Australia and German-speaking countries.

Within Canada, British Columbia (BC) has been a pioneer in its attempts to develop a model of apprenticeship that ensures the highest degree of technical training for apprentices (Crisford, 1936). Beginning in the mid 1930's, the BC government has taken the responsibility for educating apprentices in the domain knowledge of a trade out of the hands of employers, separating the sites of acquisition of domain practices and of domain knowledge. Initially, apprentices in BC acquired domain practices on jobsites during the day, and acquired domain knowledge in night school after work. Although this model no longer corresponded to that of traditional apprenticeship — in which both domain practices and domain knowledge are acquired in the workplace — the acquisition of domain knowledge and of domain practices remained synchronous. The number of learners embarking in trade apprenticeships, however, kept decreasing steadily through the 1960's and 1970's (Jeffcoatt, 2002). In the late 1970's, in an attempt to market trade apprenticeships as academic peers to a college education, the BC government introduced formal full-time, off-site college training periods for apprentices (Jeffcoatt, 2002), causing further distancing between the sites of acquisition of domain knowledge and of domain practices. The workplace and the college thus became separated both geographically and temporally: the apprentice become a "worker" on the jobsite, and a "learner" while in college — a common fallacy in training programs (Brown and Duguid, 1991).

Under the current model of apprenticeship in BC, entry into the electricians' community of practice follows one of the trajectories summarized in Table 1.2. As the table indicates, apprentices may come to the trade 'off the street' or through a pre-apprenticeship training programme. In either case, apprentices then alternate between periods of acquisition of domain practices through long-term observation and experience in the workplace (Coy, 1989), and periods of acquisition of domain knowledge while attending yearly training sessions at an accredited college. The current apprenticeship model performs relatively well in preparing apprentices to work in the trade's slow-evolving, traditional areas of practice. However, the overall effectiveness of BC's current apprenticeship model in preparing sufficient numbers of adequately trained workers is challenged by the ongoing shortage of skilled trade workers in this province (Finlayson, 2002). Furthermore, the effectiveness of the current apprenticeship model in addressing the needs of employers and apprentices working in the fast-evolving, non-traditional areas of the electrical trade has come under review in recent years (Canadian Electrical Contractors Association, 1997).

This study explores the relationship between the current model of apprenticeship into the electrical trade, and the evolving needs of apprentices and employers in the electrical industry in British Columbia. This study investigates three factors: the nature of incentives and disincentives of serving an electrical apprenticeship, the pertinence and effectiveness of the current apprenticeship model in targeting the needs of traditional and

Table 1.2. Apprenticeship routes into the electrical trade in British Columbia.

Off-the-street route		Pre-apprenticeship programme route	
Newcomer secures a job with an electrical firm, is indentured and works in the field	9 months		
Apprentice attends college for first year training	3 months	Newcomer attends college for pre-apprenticeship programme	6 months
Apprentice works in the field	9 months	Programme graduate secures a job with an electrical firm, is indentured and works in the field	9 months
Apprentice attends college for second year training	3 months	Apprentice attends college for second year training	3 months
Apprentice works in the field	9 months	Apprentice works in the field	9 months
Apprentice attends college for third year training	3 months	Apprentice attends college for third year training	3 months
Apprentice works in the field	9 months	Apprentice works in the field	9 months
Apprentice attends college for fourth year training	3 months	Apprentice attends college for fourth year training	3 months
Journeyman status		Apprentice works in the field, is awarded 6-month equivalency for pre-apprenticeship training	3 months
		Journeyman status	

non-traditional areas of practice, and the potential emergence of new models of apprenticeship in non-traditional areas of the electrical trade. Stemming from the factors monitored, the following research questions emerge that guide this study:

- Do the disincentives of the current model of apprenticeship into the electrical trade outweigh its incentives?
- Do apprentices and employers rely on the traditional apprenticeship model to prepare workers in traditional and non-traditional areas of the electrical trade?
- Are there new models of electrical apprenticeship emerging in non-traditional areas of the electrical trade?

The first of this study's working hypotheses is that obstacles and disincentives to the learner characterize the current model of apprenticeship, and are partly responsible for the province-wide shortage of skilled workers. One of the key obstacles in the current model of apprenticeship is the discontinuity between the apprentice's acquisition of domain practices while on jobsites, and of domain knowledge while at an accredited college. The second of this study's working hypotheses is that apprentices and employers rely less on the current apprenticeship model as they move along a continuum between traditional and non-traditional areas of the trade. Apprentices and employers in non-traditional areas of the trade actually re-embrace many aspects of the traditional apprenticeship model, creating workplace-based sites of acquisition of both domain knowledge and domain practices. The third working hypothesis is that the shortcomings of the current apprenticeship model in addressing the needs of non-traditional areas of the electrical trade results in the development of alternative pedagogical models. New models of apprenticeship are emergent in non-traditional areas of the trade. These models reintegrate the site of acquisition of domain knowledge and domain practices into the workplace, and utilize the structure of the traditional apprenticeship model, expanding on it in order to accommodate for the greater complexity of the domain knowledge and domain practices involved. The emergent models amount to a workplace-based version of the cognitive apprenticeship model described by Collins et al. (1989).

The inadequacy of the current trade apprenticeship system in BC is reflected in the chronic shortage of skilled trade workers faced by our province. The shortage has been addressed in a number of governmental and private-sector studies (see for example Conference Board of Canada, 2000; Advisory Council on Science and Technology, 2000). These studies, while valuable, limit themselves to looking at the apprenticeship experience in terms of enrolment statistics, program completion rates, and placement opportunities, and to making broad recommendations, such as calling for adjustments in the marketplace, and for appropriate changes in immigration, retirement, and post-secondary funding policies (Finlayson, 2002). The present study, by contrast, investigates the day-to-day reality of serving an electrical apprenticeship. This is a qualitative study utilizing descriptive ethnography to explore its research questions.

This study is based on records of the researcher's own experience while serving an electrical apprenticeship, outlined in Table 1.3. Concurrent with completing graduate coursework, the researcher entered a typical apprenticeship program into the electrical trade. He worked and studied as an apprentice for three years, in order to attain an insider's position — available only to individuals serving an apprenticeship — from which to describe and evaluate qualitatively the effectiveness of the apprenticeship process. The researcher recorded ethnographic field notes to document his experiences while working on a variety of jobsites, and while attending an accredited trade college. The researcher also kept field notes to document apprenticeship as it unfolded in venues other than workplace and college, venues such as union meetings, company functions,

Table 1.3. Summary of the researcher's time in the electrical trade

Labourer and electrician's helper (non-union) Cement work, framing carpentry, residential wiring in wood frame homes	4 months
Accredited College Pre-apprenticeship training program	6 months
Job search	1 month
Company A (non-union) Electric metallic conduit installation, lighting installation, and sound system installation in a new movie theatre	5 months
Company B (non-union) Electric metallic conduit and cable tray installation; lighting, data, and fibre optic installation in factories and offices	4 months
Accredited College Second-year electrical apprentice training	3 months
Company C (non-union) Electric metallic conduit installation; fire alarm wiring and detection device installation in a new cancer clinic	3 months
Company D (union) Electric metallic conduit and cable tray installation; high voltage distribution systems installation; data and fibre optic installation and testing; installation and programming of computerized building automation systems	12 months

and after-hours training seminars. The researcher also used materials readily available to apprentices, such as union newsletters and government publications, to locate his field notes in the context of the current model of apprenticeship in BC. The use of interviews and of instruments for the quantitative evaluation of apprenticeship programs fall outside of the scope of this study.

The use of apprenticeship as an ethnographic method is well established (Coy, 1989). Serving an apprenticeship, and keeping records of one's learning experiences in the process, is used extensively to create ethnographies of apprenticeship in a variety of trades, both in developing and developed countries (for an instance of each, see Coy, 1989, and Gamst, 1986). This study uses apprenticeship as ethnographic method to investigate specific research questions about the current model of electrical apprenticeship in BC. Grounded in established ethnographic methods, this study is in a unique position to uncover aspects of a traditional electrical apprenticeship that can only be detected from within the apprenticeship process itself. The study contributes an insider's view of apprenticeship to the body of literature on the process of generating skilled workers in our province. Current studies about apprenticeship in BC tend to focus on the dynamics around the 'black box' of apprenticeship (eg. enrolment statistics, graduation rates, and placement rates), while implicitly trusting that the self-regulating nature of the construction industry will *de facto* maximize the efficiency of the 'black box' itself. By entering the 'black box' and serving an apprenticeship the researcher gained insights into the internal dynamics of apprenticeship, insights that are inaccessible to the outsider. The observation offered in this study can be used to inform policy decisions about apprenticeship in BC.

In conclusion, apprenticeship is an educational method that dates back thousands of years. The serving of an apprenticeship is an established ethnographic method used to gain insight into the renewal of a community of practice (Coy, 1989). Traditional apprenticeship (as described by Collins et al., 1989) is the oldest, but not the only, form of apprenticeship. Cognitive apprenticeship (as described by Collins et al., 1989) is an educational method that applies the language of apprenticeship metaphorically to domains that do not utilize apprenticeship in the traditional sense for the education of newcomers (see Berryman et al., 1993). Through the use of apprenticeship as ethnographic method, this study documents the incentives and disincentives of the current model of electrical apprenticeship in BC. The study also documents the progressive shift away from the current model of apprenticeship that occurs along the continuum between traditional and non-traditional areas of the electrical trade. Finally, in the non-traditional areas of the electrical trade, this study documents the emergence of new models of apprenticeship, similar in concept to cognitive apprenticeship, but applied in a non-metaphorical manner to the reality of the non-traditional workplace in the electrical trade.

This study unfolds over the next five chapters by providing a review of current literature on apprenticeship in chapter 2, followed by a discussion of research methods in chapter 3. Chapter 4 presents the study's findings, and is followed by an interpretation of the findings in chapter 5. Lastly, chapter 6 offers recommendations for integrating the findings into the design of future apprenticeship programs.

Chapter 2

Literature Review

This chapter offers a review of current literature on apprenticeship by opening with a discussion of the serving of an apprenticeship as a research tool for the investigation of the renewal of communities of practice. The next two sections discuss two dominant forms of apprenticeship: traditional apprenticeship and cognitive apprenticeship. Traditional apprenticeship is used primarily in communities of practice characterized by long-established, slow-evolving domain knowledge and domain practices, while cognitive apprenticeship is encountered in settings where complex and often fast-evolving domain knowledge and domain practices are exchanged in the context of a metaphorical view of learning situations as sites of apprenticeship. The fourth section of the chapter contrasts the current structure of apprenticeship in England, Germany, Australia, and Canada. The fifth section offers a detailed discussion of the development of apprenticeship in British Columbia, focusing in particular on the current state of electrical apprenticeship in the province. The last section discusses the role of this study in filling existent gaps in apprenticeship literature.

2.1 Apprenticeship as ethnographic method

Researchers have successfully used ethnography to investigate the renewal of communities of practice through the education of newcomers. Ethnography is an established research method used in anthropology, sociology, and educational research to learn about the social and cultural life of communities, institutions, and other settings (Burgess, 1985; Gay, 1992; LeCompte and Schensul, 1999). LeCompte and Schensul (1999) define ethnography as a scientific, investigative method that uses the researcher as the primary tool of data collection. Ethnography "emphasizes and builds on the perspectives of the people in the research setting" to inductively build local theories, with the aim of "testing and adapting them for use both locally and elsewhere" (LeCompte and Schensul, 1999, pp 1-14). Ethnography is based on rigorous research methods and data collection techniques designed to avoid bias and assure the accuracy of the data collected. Emerson, Fretz, and Shaw (1995) offer technical guidance in the collection of field notes — the ethnographer's records of experiences encountered in the field — while Amit (2000) offers insights into the constructing of field notes into ethnographic narrative. Guba and Lincoln (1989) describe a number of strategies that can be adopted in ethnographic research to establish credibility, a measure of the isomorphism between the constructed realities of respondents and the reconstructions attributed to them by the investigator. Lastly, Barrett (1996) advocates conducting ethnographic research on close-at-hand communities, with which the researcher already shares "information that would have taken an outsider years to accumulate," as the best means to avoid constructing misleading stereotypes of the community studied (p. 189).

The Chicago School of sociology in the 1920's and 1930's recognized the importance of personal life-records as a source of insight into social phenomena, and proceeded to lay the groundwork of ethnographic research (Hammersley, 1989). In the words of William Thomas and Florian Znaniecki (1927), authors of an extensive ethnography on Polish peasants in Europe and America, "even when we are searching for abstract laws life-records of concrete personalities have a marked superiority over any other kind of materials. We are safe in saying that personal life-records, as complete as possible, constitute the perfect type of sociological material" (Thomas and Znaniecki, 1927, vol. 2, pp. 1832-1833). Over the years, ethnographic records have come to include field notes, autobiographies, newspaper articles, personal and published letters, and government publications — expanding researchers' data sources beyond academic books and articles about the community under investigation (Hammersley, 1989).

Researchers conducting ethnographic studies of the renewal of communities of practice have relied on serving an apprenticeship as a method of enquiry. Coy (1989) observes that while serving an apprenticeship, the apprentice-researcher has an opportunity to learn cultural and technical practices in the manner typical of the community of practice studied, while having minimal impact on the community of practice itself. While apprenticing, the apprentice-researcher fits unobtrusively in an established niche within the community of practice studied. The apprentice-researcher enters a community of practice from a position of acceptable ignorance, and while progressing through the apprenticeship experiences firsthand a learning trajectory typical of member of the community of practice studied (Coy, 1989). Furthermore, Lave and Wenger (1991) observe that apprentices engage in legitimate peripheral participation as they move through an apprenticeship. In their journey from the periphery to the core of a community of practice, apprentices participate in activities that are legitimately part of the range of activities characteristic of a given community of practice. The activities are also peripheral in that they are not part of the activities characteristic of the core of the community of practice: they are activities that, if performed incorrectly, will not have an irreversible effect on the overall activity and function of the community of practice (Lave and Wenger, 1991). In short, the apprentice-researcher occupies a unique position — unavailable to the outside observer — from which to document the renewal of a community of practice.

The use of apprenticeship as ethnographic research method is well established in literature. Cooper (1980) served an apprenticeship among Hong Kong furniture carvers to document firsthand the impact of automation on their trade. Cooper (1980) speaks of his difficulty in securing an apprenticeship in the first place, furniture carving masters deflecting his requests on grounds of his being too old (Cooper was an adult, while most apprentices in Hong Kong are 12 years old when they start their apprenticeship), not having enough time to apprentice (Cooper had one year of field time to offer, while on average apprenticeships lasted over three years), and being used to a different lifestyle (Cooper, 1980). In fact, much of the resistance experienced by Cooper stemmed from his being a foreigner (Cooper, 1980).

Jordan (1989) served an apprenticeship among Mayan midwives to evaluate the role of traditional learning and of Western medical training in their education. Jordan observes that lectures offered by government nurses who came to 'educate' the Mayan midwives often focused on concepts that, while scientifically valid, were not framed within the target audience's daily context. Ultimately, failure by the government nurses to frame information in a context familiar to the rural midwives undermined the effectiveness of their lectures. For instance, following a lecture on the process of fertilization, where drawings of highly magnified spermatozoa were shown to the midwives, one of them took Jordan aside and commented that perhaps what the nurses described came out of men in the city, but that their men did not produce *palitos* (little sticks) when they made babies (Jordan, 1989).

Coy (1989) apprenticed under a Kalenjin blacksmith in the Rift Valley of Kenya, documenting the social reality of apprenticeship into a trade in which practitioners — apprentices and mentors alike — are treated as second-class citizens by the local farming population. Coy (1989) advocates the importance of occupying as specific a role as possible while utilizing apprenticeship as ethnographic method. He notes that individuals around the apprentice-researcher will inevitably assign a particular role or status to the apprentice-researcher. However, he encourages ethnographers to use this to their advantage, as it enables them to collect information that is "richly detailed and contextually accurate" (Coy, 1989, p. 116).

Closer at hand, Gamst (1986) conducted an ethnographic study of apprenticeship into Canadian and American railway work, to document newcomers' enculturation into unwritten codes of ethical conduct in the trade. Gamst (1986) provides numerous examples of situations in which domain knowledge and domain practices do not necessarily dovetail. For instance, according to one of the federal rules governing trains crossing roads, the on-board engine bell must be rung when doing so. In practice, however, the bell is only rung when a train is crossing a road at low speed, given that the noise of a train moving at high speed deafens the sound of the bell itself (Gamst, 1986).

The use of serving an apprenticeship as an ethnographic research method is well established in current literature. Serving an apprenticeship offers researchers rich insight into the domain practices and domain knowledge of the community of practice investigated. It also affords researchers the ability to address specific questions about social and educational aspects of the methods of renewal of a community of practice.

2.2 Traditional apprenticeship

2.2.1 Structure of traditional apprenticeship

The term apprenticeship defines a learning trajectory, primarily workplace centred, by which an individual gains access to a community of practice (Collins et al., 1989). The journey from newcomer to full member of the community entails the progressive acquisition of the domain knowledge and domain practices characteristic of the community (Coy, 1989). Apprenticeship also entails the progressive enculturation of the apprentice into a community of practice — in other words, the acquisition by the apprentice of journeyman-like identity. This encompasses, among other competencies, the apprentice's ability to think and behave as a full-fledged member of the community of practice (Gamst, 1986).

Collins et al. (1989) identify traditional apprenticeship as the learning trajectory by which an individual gains access to a community of practice whose domain knowledge and domain practices have essentially gone unchanged over tens or hundreds of years. Historically, traditional apprenticeship has been characterized by a one-on-one relationship between a mentor journeyman and an apprentice. The relationship unfolds over months or years, during which the apprentice works at the elbow of the mentor. Collins et al. (1989) identify three phases of traditional apprenticeship: modeling, coaching, and fading.

Modeling consists of the mentor enacting domain practices while the apprentice observes, at the same time offering domain knowledge to the apprentice (Collins et al., 1989). In traditional apprenticeship, domain knowledge is often offered through the exploration of the outcomes to various domain practices. For example, if a mentor blacksmith does not run the bellows when heating the iron, the coals in the forge do not get hot enough for the iron to become pliable. Domain knowledge about exothermic reactions in the presence of excess oxygen is developed through exploring the effects of not providing excess oxygen. Hence, mentors may model practices that do not accomplish the desired outcome, in order to illustrate the domain knowledge that lies behind more effective practices. Thorough modeling is necessary for the apprentice to acquire not only domain practices, but also the domain knowledge that is to guide them.

Coaching consists of the mentor assisting the apprentice in the enactment of a domain practice. If the apprentice is unable to enact a given domain practice, the mentor offers coaching through physical help, through the verbal description of the practice, or through a combination of both (Collins et al., 1989). Initially, coaching unfolds in a 'co-operative' manner, as mentor and apprentice work together on a task. As the apprentice's competence increases, coaching unfolds in a 'parallel' manner, where the apprentice and mentor work on their individual tasks, and the apprentice seeks assistance as needed.

Fading — sometimes referred to as scaffolding — consists of the mentor gradually removing support to the apprentice until the apprentice can enact domain practices independently (Collins et al., 1989). Through fading the apprentice undertakes increasingly more complex tasks with less and less assistance from the mentor. Thus, the apprentice learns to draw on domain knowledge and to enact domain practices without modeling or coaching, and in the absence of the infrastructure the mentor offers — such as provision of materials or securing of work.

2.2.2 History of traditional apprenticeship

The works of Strange (1982), Woodward (1995), and Douglas (1921) exemplify historical studies of traditional apprenticeship. Strange (1982) offers an overview of traditional apprenticeship into the chimney sweeps' community in London between 1773 and 1875. According to Strange, apprenticeship into the chimney sweep's trade was a disguise for the use of enslaved child labour, rather than a didactic tool to offer children a trade. Critically, a master sweep's workplace instruction of an apprentice was a physical impossibility: the adult mentor was too large to fit inside the nine inch by nine inch lumen of a coal-burning flue. Sweep's apprentices, known as climbing boys, were simply sent up a flue, to crawl their way up and out the chimney, while acting as a human brush. Master sweeps would often light a small fire under their apprentices as an incentive, especially if the apprentice became stuck in the flue. Sweep's apprentices were malnourished, stunted, and deformed; they often died of suffocation — smothered by soot inside the flues. They frequently suffered from tuberculosis and from cancer of the scrotum — the latter contracted from living in soot-impregnated clothes, with little chance for washing and for personal hygiene. According to Strange (1982), apprenticeship into the chimney sweep's trade was the last bastion of legalized slavery in England: child welfare and social reform took almost one hundred years to free the climbing boys. Even the passing of the Chimney Sweep Act in 1834, on the heels of the abolition of the slave trade in the British Empire in 1833, seemed to have no impact on sweep's apprentices, the majority of whom asserted that they were willing and desirous apprentices, thus meeting the criteria of the Act. Strange (1982) points out that technology — more than philanthropy — led to the freeing of climbing boys. Sweeping-machines were perfected as early as 1828, and fire insurance companies approved their use. Also, a building code introduced in 1840 demanded that all new construction be equipped with chimneys that could be cleaned by sweeping-machine. Ultimately, it was the city planners' and insurance companies' demand for chimneys that could be maintained mechanically that led to the end of the use of climbing boys.

Woodward (1995) provides a historical study of apprenticeship into the building trades in northern England between 1450 and 1750. Woodward focuses on the failure of traditional apprenticeship to generate more than wage-earning proletarians. Despite achieving journeyman status through serving an apprenticeship, journeyman builders resided only two rungs above "the very bottom stratum of urban society which included the poor widows subsisting with difficulty in cheerless parish rooms" (Woodward, 1995, p. 249). Journeyman builders fared better than unskilled labourers, but depended wholly on their own earning potential for survival. Injury on the worksite often spelled disaster for an entire family. Woodward (1995) observes that traditional apprenticeship did not give its graduates access to the position of master craftsman, which involved less reliance on personal wage labour and more on profit from supplying materials and the labour of others. To become a master craftsman, journeyman builders had to access a layer of education not included in an apprenticeship. However, master craftsmen tightly controlled access to this layer of education by demanding that apprentices buy freedom from their mentors, pay a guild admission fee, and pass a skill test set by guild members. In most master craftsmen guilds, admission fees almost doubled "for one that is not a brother's son," while they dropped to almost half their normal amount for a master craftsman's own offspring (Woodward, 1995, p. 74).

The study by Douglas (1921) offers a snapshot of the state of traditional apprenticeship in the United States in the early twentieth century. The study poses questions about traditional apprenticeship that are no less valuable today as they were in the 1920's. Douglas (1921) looks at the failure of traditional apprenticeship to address the needs of a technologically evolving workplace. He observes that demand for skilled workers in factories dropped substantially with the advent of the machine age: "A large number of highly-trained and competent engineers are needed in the drafting room. For the other workmen, however, muscle and endurance rather than skill and dexterity are required" (Douglas, 1921, p. 111). Conversely, while machines produce other machines and "steel gives birth to steel" (p. 111), Douglas (1921) also observes that "to repair one part of a machine requires a knowledge of the whole mechanism. Modern industry has made repair work a trade in itself" (p. 117). And when "the man who runs the machine does not know how to put it into working order," (Douglas, 1921, p. 117) a separate work force emerges: maintenance technicians, of whom he observes, "these men must be thoroughly competent, for a variety of problems faces them every day. They must have more all-round skill than the old craftsman ever dreamed of" (p. 117). Douglas (1921) states that the divide between unskilled workers and maintenance technicians should not be allowed to widen, or it would harm both groups' employability. Thus, he suggests a new form of apprenticeship be made available to all workers in industry. In a recommendation that appears ahead of its time, even to this day, Douglas suggests that all workers be educated into "a general knowledge of machine methods and management, the care of machinery … together with a working knowledge of mathematics and mechanics … and thorough instruction in safety methods" (Douglas, 1921, p. 125). The advantages resulting from the new model of apprenticeship proposed by Douglas (1921) includes the reduction of physical injury and of mental monotony in the workplace, and the increased employability and transferability of workers.

This brief historical review of traditional apprenticeship points to three potential limitations of the traditional apprenticeship model. First, as illustrated by Strange (1982), traditional apprenticeship is rooted in the disparity of status and power between apprentice and mentor, thus harbouring the possibility of abuse. Second, as discussed by Woodward (1995), traditional apprenticeship may fail to facilitate access by apprentices to the inner sanctum of a trade — be it a position of independent contractor, or simply a job in the more desirable and lucrative areas of a trade. Third, as observed by Douglas (1921), traditional apprenticeship appears ill suited to educate apprentices working in fast-evolving technological settings.

2.2.3 Contemporary literature on traditional apprenticeship

Many ethnographic studies of traditional apprenticeship have focused on the learning of traditional trades in foreign countries. Samples of this work, discussed earlier in this chapter, are offered by the studies of Cooper (1980), documenting apprenticeship among traditional Hong Kong furniture makers; of Jordan (1989), describing apprenticeship among Mayan midwives; and of Coy (1989), investigating apprenticeship among Kalenjin blacksmiths in the Rift Valley of Kenya. Similarly, Lave and Wenger (1991) document the role of apprentices among the Vai tailors of Liberia. The initial role of the apprentice as described by Lave and Wenger (1991) is to observe the mentor working, and to fetch for the mentor necessities such as water, buttons, and the like. Later in the apprenticeship the mentor entrusts the apprentice with tasks characteristic of the periphery of the community of practice. These tasks are legitimately part of the repertoire of practices of the given community of practice, yet are peripheral in their being near-foolproof tasks, like sewing on buttons or trimming threads — tasks that, even if performed incorrectly, will not irremediably damage a garment. Lave and Wenger (1991) observe that is only in the later stages of an apprenticeship that the apprentice is entrusted with practices characteristic of the core of the community of practice. These are more consequential tasks, such as cutting the fabric for a garment. Through their field investigation, Lave and Wenger (1991) developed the concept of legitimate peripheral participation, discussed earlier in this chapter.

A smaller body of work focuses on traditional apprenticeship in the industrial and construction trades in North America. As introduced in the previous section, Gamst (1986) describes apprenticeship into the railway industry in Canada and the United States. Terkel (1971), Cherry (1974), and Haas (1989) focus on traditional apprenticeship into high steel work in the American skyscraper building industry. Terkel (1971) explores the interdependence among workers that characterizes lethally dangerous workplaces. Apprentices and journeymen alike face the task of walking on steel beams as narrow as eight inches, dozens of stories up in the air, just to get to the site of their work. Interdependence develops to ensure mutual safety, not only among the high steel workers, but also across trades. For instance, Terkel (1971) points to the interdependence between high steel workers and crane operators, responsible for setting iron. This task consists of lifting, by up to 240 feet, steel beams that weigh tens of tonnes, and positioning them with half-inch precision for the high steel workers to bolt into place — without ever endangering the lives of the workers. If inconsistency of performance is demonstrated, a crane operator will fail to gain the trust of the high steel workers: they will refuse to work with the given operator, who will be fired from the jobsite (Terkel, 1971).

Cherry (1974) explores fear management among high steel workers — a skill he argues is partly innate and partly acquired through apprenticing. The apprentice high steel worker observes and adopts the manner in which established workers behave: high steel workers see fear as contagious, and as having to be stemmed first within the individual. Also, through apprenticeship, the high steel worker acquires the use of 'fear monitoring' to gage the overall danger of a task. If workers, individually or collectively, experience a level of fear that exceeds their inner acceptable norm, they refuse to undertake a task until the employer improves safety (Cherry, 1974).

Haas (1989) returns to the notion of interdependence as he discusses binging, the ongoing mutual evaluation that occurs among high steel workers. Binging is an interactional process through which established workers test both the apprentices and each other: "The group can never be too sure of others, and thus it continues to take readings on old and new alike. The only way members can be taken for granted with the more serious problems of their work is by repeated indication that they are trustworthy" (Haas, 1989, p. 93). Binging consists of a combination of mutual observation on the job, and of verbal exchanges, often aggressive, while on breaks. This behaviour, alternatively known as sounding or ranking, also emerges in other environments where mutual reliance is critical to individual safety (Haas, 1989).

Lastly, Applebaum (1981) offers an analysis of traditional apprenticeship into the American construction industry from both the cultural and the structural-functional viewpoint. Applebaum observes that apprentices in the construction trades come to accept that job insecurity is a way of life — a reality that stems from the high variability of the construction industry. Methods of mass production — which often lead to secure work conditions — are inapplicable in construction. Apprentices in the construction trade are enculturated, instead, into reliance on hand methods and craftsmanship. Bolstered by the high wages associated with construction work, this leads to "independence and self-respect among construction workers," while quelling the "hostility towards employers as a class or towards capitalists as a social group" often observed in sites of mass production (Applebaum, 1981, p. 124).

This brief review of current literature on traditional apprenticeship highlights some of the findings that inform the present study. Most critical are the documented need for legitimate peripheral participation (Lave and Wenger, 1991), and for the integration of formal education with the needs and values of the workplace (Jordan, 1989). Also, awareness of mechanisms for mutual evaluation (Haas, 1989) and for the enhancement of safety (Terkel, 1971) informs this investigation of apprenticeship into the electrical trade.

2.3 Cognitive apprenticeship

2.3.1 Emergence and application of cognitive apprenticeship

As early as the 1920's, Douglas (1921) had recognized the need for upgrading traditional apprenticeship through the integration of non-traditional domain knowledge and domain practices. Later ethnographic research on the renewal of communities of practice that do not rely on traditional apprenticeship laid the groundwork for the development of the cognitive apprenticeship model. Orr (1998, 1990) documents emergent forms of cognitive apprenticeship among photocopier technicians, who use an ever-updated collection of stories to share among themselves domain knowledge and domain practices not encompassed in their official training. Similarly, Collins (1982) and Gooding (1990) investigate the role of human interaction and of the transmission of tacit knowledge — knowledge that falls outside of the domain knowledge formally taught to community members — in shaping scientists' understanding the phenomena they investigate.

Educational researchers have used the language of traditional apprenticeship metaphorically to describe the renewal of communities of practice that, historically, do not make use of traditional apprenticeship. A model of learning has emerged from this research that views learning environments as sites of apprenticeships. From this perspective, Berryman et al. (1993) describe the learning situation as a community of expert practice, where knowing and doing are integrated, where instruction is problem-centred rather than didactic, and where individuals can learn naturally and effectively. As a learning model, cognitive apprenticeship transforms the role of the teacher from that of dispenser of knowledge to that of mentor: a facilitator, coach, and guide. It also transforms the role of learners from that of receivers of knowledge to that of active participants who take responsibility for their own learning (Berryman et al., 1993).

The creation of the type of learning environments recommended by Berryman et al (1993) has led to the successful application of cognitive apprenticeship in both academic and non-academic communities of practice. Collins et al. (1989) and Lee (2001) describe applications of cognitive apprenticeship in cultural modeling environments. Learners are cognitively apprenticed into activities that fall outside the ones into which they would be traditionally apprenticed — such as literary analysis being carried out by marginalized inner city students (Lee, 2001). Cash et al. (1996) report on the successful application of cognitive apprenticeship in automotive vocational training, particularly with respect to highly technical domain knowledge and domain practices. Lastly, Cope et al. (2000) report on the successful use of cognitive apprenticeship strategies in practice placement programs for nurses in Scotland. Practice placements in which mentors utilized cognitive apprenticeship strategies, including situated learning, are reported to facilitate graduates of traditional nursing programs into becoming socially and professionally accepted members of the medical community of practice.

2.3.2 Structure of cognitive apprenticeship

Collins et al. (1989) describe cognitive apprenticeship as composed of six phases. The first three phases — modelling, coaching, fading, which were discussed in the previous section — are common to both traditional and cognitive apprenticeship. As cognitive companions to these three phases, Collins at al. (1989) introduce articulation, exploration of ideas, and reflection as the further components of cognitive apprenticeship.

Articulation is the cognitive companion of modeling. Contrary to modeling, which is the prerogative of the mentor, both mentor and learner engage in articulation. Articulation renders visible not only one's actions, as in modeling, but also one's thoughts. Articulation consists of the mentor and the learner verbalizing what domain knowledge they are using while performing a task. It makes the mental processes of both learner and of mentor available to the other for learning and evaluation.

Exploration of ideas is the cognitive companion of coaching. Contrary to coaching, which is conducted by the mentor, both mentor and learner embark in exploration of ideas. In exploration of ideas mentor and learner engage in a discussion to select the domain knowledge and domain practices to be used in accomplishing a given task. Mentor and learner also use exploration of ideas in evaluating the performance of the accomplished task, debriefing the manner in which the task was completed, and identifying ways in which it could be better accomplished in the future. Exploration of ideas capitalizes on the domain knowledge and domain practices the learner may already possess that are relevant to a given task.

Reflection is the cognitive companion of fading. Contrary to fading, in which only mentors engage, both mentor and learner engage in reflection. Through reflection mentors and learners integrate their newly acquired domain knowledge and domain practices, becoming progressively independent of each other. Furthermore, reflection allows learners to benchmark their own learning against the mentor's knowledge, thus informing learners of their own possible need to 'fade' from their present mentor, and seek further learning with a new mentor.

According Collins et al. (1989) and Berryman et al. (1993), designers of learning environments where cognitive apprenticeship is enacted must pay attention to four parameters: contents, methods, sequencing, and sociology. The content of cognitive apprenticeship encompasses not only domain knowledge, but also the means to manage such knowledge. Heuristic strategies — also known as tricks of the trade — come into play when dealing with content, in that the mere possession of domain knowledge may be insufficient if not strengthened by the possession of ways to adapt such knowledge to changing situations. Cognitive management strategies are also part of the content of cognitive apprenticeship: they consist of ways of contextualizing and cross-referencing domain knowledge from one area of practice with that of other areas of practice. Lastly, learning strategies are part of content: the learner must acquire the tools to independently access information in the future (Cash et al., 1996)

The methods of cognitive apprenticeship consist of the three components of traditional apprenticeship — modeling, coaching, and fading — and their three cognitive companions — articulation, exploration of ideas, and reflection. The methods of cognitive apprenticeship must aim to give the learner an opportunity to observe, engage in, discuss, and evaluate domain knowledge and domain practices (Collins et al., 1989).

Sequencing in cognitive apprenticeship aims to challenge the learner with domain knowledge and domain practices of increasing complexity and increasing diversity. Ultimately, the goal of sequencing is to bring the learner to expert status in a wide range of competencies. This is achieved first through increasing the complexity of the domain knowledge and domain practices explored within a competency, and then through introducing additional competencies. Cognitive management strategies, discussed earlier, play a role in the achievement of expert status across competencies (Cash et al, 1996).

Finally, the sociology of cognitive apprenticeship aims to create authentic learning environments, ones that closely mimic the technological, social, temporal, and motivational characteristics of the real world (Berryman et al., 1993). Sociological considerations in cognitive apprenticeship, for example, call for the use of practitioner instructors — individuals that hold the dual role of real life protagonists in a given field, and of mentors to learners wanting to enter that field (Cash et al., 1996).

In summary, cognitive apprenticeship was first proposed as a learning model for communities of practice that did not make use of an actual apprenticeship for their renewal. Initially, cognitive apprenticeship used the language of apprenticeship only in a metaphorical sense: it looked at the three phases of traditional apprenticeship — modeling, coaching, and fading — and matched them with their three cognitive companions — articulation, exploration of ideas, and reflection (Collins et al, 1989). Later, educators in both academic fields (see for example Lee, 2001) and non-academic fields (see for example Cash et al., 1996) successfully utilized cognitive apprenticeship to convey often complex and fast-evolving domain knowledge and domain practices.

2.4 The state of apprenticeship in England, Germany, Australia, and Canada

2.4.1 England and Germany

Steedman et al. (1998) review the current state of apprenticeship in England, contrasting it with its German counterpart. They observe that there is a wide gap in the number of skilled individuals in the two countries. In 1985, the percentage of 25 to 28 year-olds with "vital skilled craft, technician and junior professional skill levels" was 44% in England, and 82% in Germany. By 1996 the gap had narrowed slightly, the percentage being 54% in England, and 87% in Germany. Conversely, no equivalent gap is reported in the number of university graduates in the two countries (Steedman et al., 1998, p. 14).

Steedman et al. (1998) look at the historical development of apprenticeship in the two countries to explain the current gap. Although apprenticeship enjoys a lengthy history in both Germany and England, harking back to the guilds of the Middle Ages and beyond, the development of apprenticeship in the post-industrial revolution era followed radically different paths in the two countries. England focused on increased production through automation, thus reducing emphasis on worker education. In contrast, Germany remained rooted in its tradition of apprenticeship, even for factory workers. Furthermore, while apprenticeship in England survived primarily as a source of skilled labour in traditional occupations, such as the construction trades, the German apprenticeship system consistently broadened its range of disciplines, both in industry and in commerce. Lastly, Germany undertook an extensive reform of its apprenticeship system between 1960 and 1990, leading to increased employer control over apprenticeship, and to the formation of a specific contractual niche for apprentices outside of the ranks of employees. Apprentice wage were set at one-third of the wage of skilled workers. Upon completing the apprenticeship, graduates joined the ranks of employees, and drew a wage higher than that of untrained entry-level employees. Over the same period of time, England moved altogether away from apprenticeship, experimenting instead with government schemes aimed at generating employment, rather than skills (Steedman et al., 1998).

In the early 1990's England reworked its apprenticeship system, in response to three rounds of precipitous fall in apprentice ratios in the late 1970's, the mid 1980's, and the early 1990's. In 1993 the British government launched Modern Apprenticeship, which moved away from employment schemes to refocus on skill development. Steedman et al. (1998) report on the qualities of Modern Apprenticeship: it provides broad skills as well as a broad educational base; it also promotes transferability of skills, and enhances progression through to further education for those who want it. Modern Apprenticeship delivers compulsory key skills, including numeracy, communication, IT, problem solving, and personal skills such as teamworking. Lastly, Modern Apprenticeship covers disciplines in the majority of British industry and commerce, thus becoming comparable with the broad-ranging German system (Steedman et al., 1998).

Following the introduction of Modern Apprenticeship, apprenticeship in England and Germany now share a number of features, such as the age range, qualifications, and most frequently chosen occupations of entrants. In England, however, Modern Apprenticeship still suffers from a 20% drop out rate, from the lack of experienced trainers, and from variability in quality assurance. Most critically, Modern Apprenticeship suffers from lack of enrolment, especially among young people. In 1997, 10% of 18 year-olds in England were apprenticing, compared to 66% in Germany. To circumvent these problems, Steedman et al. (1998) recommend that apprentice wages be reduced, thus making it possible for employers to offer apprenticeship opportunities to a greater number of learners: “We see no reason why an adequate number of young people should not come forward even at lower pay rates – if the training offered is of genuinely high quality” (Steedman et al., 1998, p. 33).

2.4.2 Australia

Ray (2001) discusses the state of apprenticeship in Australia. Historically, expansion of the British Empire depended on individual colonies’ ability to develop their own skilled workforce. The British apprenticeship model was thus introduced to Australia, where it thrived in a manner unparalleled in other colonies. Contrary to places like Canada and pre-independence United States, Australia offered a limited inhabitable landmass. This reduced the geographical mobility of workers, making it possible for employers to enforce apprenticeship rules. It also limited the number of trained apprentices walking out on their mentors to take their trade to frontier areas (Ray, 2001).

In the twentieth century, apprenticeship in most western countries gave way to technical schools and private training. In contrast, apprenticeship in Australia expanded its role, becoming “the main way of training for both the traditional crafts and more contemporary trade occupations” (Ray, 2001, p. 2). Worldwide, the extensiveness of the Australian apprenticeship system is second only to that in Germany. Although the Australian system did not expand outside of trade occupations, it surpassed the German system in the ability to meet the needs of the labour market, without producing a surplus of tradespersons (Ray, 2001).

Apprenticeship legislation in Australia began differing from British law as early as

1894. By 1901, the New South Wales Apprenticeship Act stipulated terms far ahead of its time: apprentices had to be over the age of 14, could not be indentured for more than 7 years or beyond 21 years of age, and were "bound to serve their master" no more than 48 hours a week. Furthermore, masters could not dismiss apprentices without first resorting to the dispute resolution mechanism set by the Act (Roy, 2001, p. 7). Reform has been continual in the history of Australian apprenticeship. In the late 1950's, for instance, industry lobby groups requested the introduction of shorter apprenticeships, apprenticeship for adults, and assessment mechanisms based on competence testing, rather than on time spent apprenticing. These measures were integrated into the Apprenticeship Act in 1962. Currently, Australian apprentices are guaranteed employment for the duration of their apprenticeship, and receive away-from-home allowances if relocating from rural areas. Their success in completing apprenticeship has made Australia over 95% independent of immigration for its supply of skilled workers (Roy, 2001).

2.4.3 Canada

Young (1992) discusses the history of apprenticeship in Canada. As early as 1650, master craftsmen from France were brought to the colony of Quebec to train settlers in practical skills and construction trades. The beginnings of apprenticeship in Canada are closely linked with the Catholic Church, which took it upon itself to oversee both the spiritual and earthly development of young apprentices. In 1668, Bishop Laval brought skilled artisans to St. Joachim and to Quebec City to train male apprentices in carpentry, masonry, roofing, shoemaking, and tailoring. By the late seventeenth century, Jesuit priests provided their charges in Quebec and Montreal with training as ship's captains and surveyors (Young, 1992).

Following the British victory over the French at the Plains of Abraham, educational efforts in Canada — including apprenticeship — slid into almost a century of disorganization because of the ensuing ethnic and religious conflict. Through this time the Catholic Church lessened its control over the training of apprentices: by the early 1800's, apprenticeship in Canada was the responsibility of individual artisans and lay associations of craftsmen. From this point, the history of apprenticeship in Canada followed diverse paths, depending on the province in question. In the future province of Quebec, for instance, apprentice training became linked to an expanding number of formal institutions. Artisans' Institutes opened in Montreal and in Quebec City in 1828 for training apprentices into traditional crafts. Trade and industrial schools trained apprentices in building and manufacturing trades, while Ecoles Politechniques were set up in the 1830s to train apprentice engineers, surveyors, and hydrologists (Young, 1992).

Through the nineteenth century, New Brunswick retained the English model of apprenticeship, while Newfoundland, with a large population of unskilled immigrants, educated workers through publicly and privately funded Charity Schools. Nova Scotia focused largely on preparing mariners and miners, while Ontario attempted a liberal approach to apprenticeship and vocational training based on cooperative education. For instance, the Ontario Society of Artists' School opened in Toronto in 1876, with strong financial backing from the Ontario government. A requirement of funding, however, was that professional training be supplemented with workplace training provided by industry and trade associations. In the Northwest Territories (NWT), which in the 1800s included Saskatchewan and Alberta, missionaries ran industrial schools for the Native population.

Beyond that, however, the NWT government saw apprenticeship as a self-regulating system best left in the hands of individual craftsmen (Young, 1992).

From the outset, what became the provinces of Canada took diverse paths in the fields of apprenticeship, and education in general. In the Constitution Act, 1867, the right to legislate with respect to education was allotted to the provinces rather than the federal government, allowing divergent approaches to continue (Young, 1992). The current state of apprenticeship in Canada reflects the history of difference and often disparity among provincial apprenticeship systems. A brief comparison of current apprenticeship models in Quebec, Ontario, and Alberta illustrates this point.

Quebec's legislation is notably interventionist. There, the provincial government will allow an employer to retain an apprentice only if the employer guarantees a minimum number of hours of employment. Although the number of required hours has decreased from 500 in 1992 (Young, 1992) to 150 in 2002 (Emploi Quebec, 2002 a), other government interventions have been introduced. For example, mentors must attend a mandatory training seminar, and can access further distance education to improve their mentoring skills (Emploi Quebec, 2002 b). Furthermore, Quebec employers with a payroll of $250,000 or more must invest 1% of that amount into training apprentices or upgrading employee skills (Emploi Quebec, 2002 c).

The view of apprenticeship as co-operative education continues in Ontario, where apprenticeship falls under the jurisdiction of the Ministry of Education. Ontario apprentices can complete large portions of their theoretical training in high school, while spending summers working in their chosen trade, garnering workplace hours that count towards their graduation as journeymen (Ontario Ministry of Education, 2003 a).

Apprentices in Ontario qualify for government loans to purchase the tools for the trade in which they intend to apprentice (Ontario Ministry of Education, 2003 a). Furthermore, Ontario is investing in the development and implementation of exemption tests to evaluate the existing domain knowledge and domain practices of apprentices, potentially reducing the length of their apprenticeships (Ontario Ministry of Education, 2003 b).

The apprenticeship system in Alberta has developed in keeping with its early history, in which regulation was left to the private sector. The provincial government plays a purely administrative role in Alberta's apprenticeship system, focusing on credentialing and uniformity of curriculum delivery. The private sector determines the contents and structure of apprenticeship. Incremental progress is being made in the use of Prior Learning Assessment. However, an apprentice's pre-existing knowledge and skill affect the amount of technical training, but not the wages, that he or she will receive. Furthermore, the cost of college training for apprentices in Alberta is to almost double over the next three years — from $400 in 2003-2004 to $900 in 2006-2007 for an 8-week course — regardless of varying remuneration across the apprenticed trades. Finally, apprentices in Alberta are responsible for purchasing their textbooks and tools, while they can offset to some extent the cost of attending college training through student loans and grants made available by the provincial government (Alberta Apprenticeship and Industry Training, 2003).

2.5 The state of apprenticeship in British Columbia

Apprenticeship in British Columbia (BC) initially followed the English model. From the 1830s until the 1930s, apprenticeship was largely free of government regulation. Instead, individual craftsmen and trade associations managed it. During that time, apprenticeship in BC was primarily workplace based and was linked to a very limited educational infrastructure compared to that in Quebec. By the 1850s, the Anglican Church sponsored trade schools in Fort Hope and Barkerville, while a non-sectarian Mechanics' Institute opened in Victoria in 1864 (Young, 1992).

By the early 1930s, the BC government began to play a greater role in apprenticeship. Identifying a need for tradespeople to have appropriate technical education, the BC government selected accredited institutions — rather than employers — to impart technical and scientific learning to apprentices (Crisford, 1936). Since then, the structure of apprenticeship in BC has situated acquisition of domain practices in the workplace, segregated from the site of acquisition of domain knowledge, the accredited institution. Initially, acquisition of domain practices and domain knowledge were simultaneous, although geographically separate, in that apprentices attended night school while working during the day. Starting in the late 1970s a system of yearly block release for full time college training was introduced (Jeffcoatt, 2002). Currently, in BC, the apprentice operates as a 'worker' while in the workplace, and as a 'learner' while attending yearly full-time training periods at a trade college.

Pedagogically, the decision to separate the site of acquisition of domain practices from the site of acquisition of domain knowledge holds both merit and liabilities. Taking responsibility for teaching domain knowledge out of the hands of employers has merit, according to Stasz et al. (1990), and Tan (1989). They indicate that training programs that rely on employers to educate learners in the workplace are limited in their effectiveness by the employers' primary interest in making a profit. According to these studies, it is in the employers' interest to only provide apprentices with sufficient domain practices to make them into profitable workers (Stasz et al, 1990; Tan, 1989). Furthermore, few — if any — employers work in all practice areas of a given trade. The risk then would be producing journeymen who acquire a fraction of the domain knowledge and domain practices of a trade in the workplace. Instead, the BC government opted to offer apprentices a broad range of domain knowledge through college training —trusting that the acquisition of domain practices would take care of itself.

Brown and Duguid (1991) see this implicit trust as a liability. They observe that, "In a society that attaches particular value to "abstract knowledge," the details of practice have come to be seen as nonessential, unimportant, and easily developed once the relevant abstractions have been grasped" (Brown and Duguid, 1991, p. 40). Furthermore, Brown and Duguid (1991) note that separating the sites of acquisition of domain knowledge and domain practices leads to a second, more problematic dichotomy: "Much conventional learning theory, including that implicit in most training courses, tends to endorse the valuation of abstract knowledge over actual practice and, as a result, to separate learning from working, and, more significantly, learners from workers" (Brown and Duguid, 1991, p. 40). Currently, an apprentice in BC alternates between an identity of 'learner' at college and of 'worker' on jobsites.

BC offers pre-apprenticeship programs at trade colleges to prepare learners to secure apprenticed work in a trade. Participation is not a pre-requisite for employment as an apprentice, although employers may give preference to pre-apprenticeship graduates over off-the-street applicants. These programs simultaneously offer learners both domain knowledge and domain practices. In these self-paced, competency-based programs, future apprentices acquire and internalize the domain knowledge guiding domain practices in the context of enacting the practices in question. Moreover, these programs capitalize on domain knowledge and domain practices that learners may already possess, affording them credit through Prior Learning Assessment and Recognition (PLAR) strategies (Centre for Curriculum Transfer and Technology, 2000). Overall, pre-apprenticeship programs fit the learning-centred instructional paradigm recommended by Barr (1998).

Once past the pre-apprenticeship program, BC apprentices acquire the bulk of their trade's domain knowledge during college-based yearly training periods (Industry, Trade, and Apprenticeship Commission, 2001). For electrical apprentices, college training uses a modularized curriculum, source texts such as the *Electricians guide to conduit bending* (Cox, 1982), and the *Canadian electrical code* (Canadian Standards Association, 1998). The rate of change of the curriculum mirrors the rate of technological evolution of traditional and non-traditional areas of the electrical trade. For example, the domain knowledge about lighting — a traditional area of the trade — contained in the 1947 edition of *Audel's new electrical library* (Graham, 1947) appears almost unchanged in current training modules about lighting (Electrical Sector, 1999). Conversely, the modularized curriculum pertaining to non-traditional areas of the trade is often outdated by the time college training manuals are printed (Canadian Electrical Contractors Association, 1997).

The flexibility, PLAR-friendliness, and integrated acquisition of domain knowledge and domain practices that characterize pre-apprenticeship programs are absent in the yearly training periods. There, apprentices are lock-stepped into ten weeks of learning domain knowledge that is not tied to domain practices. There are no prescribed laboratory activities, nor is discussion of the apprentices' workplace experiences integrated into curriculum delivery. Yearly training periods for electrical apprentices exemplify the teaching-centred instructional paradigm criticized in the work of Barr and Tagg (1995) and Boggs (1996). Instruction is lock step, leaving no room for different rates of learning. Evaluation is by multiple-choice tests, which do not test the practical application of the subject matter. Attendance is mandatory, lest the apprentices become ineligible for Employment Insurance benefits while attending college. Overall, there is little incentive in these training periods for apprentices to develop the intrinsic motivation to acquire domain knowledge.

Apprenticeship in BC is coming under scrutiny as large numbers of workers in BC's traditional trades are due to retire in the near future. According to the Ministry of Advanced Education, 700,000 jobs will become available in BC by the year 2008: of these, 60% will be in trade and technical occupations (British Columbia Ministry of Advanced Education, 2001). A Canadian Federation of Independent Business survey found that 40% of businesses in BC face difficulties in finding qualified labour: internal migration is not a viable answer to the problem, since 44% of businesses nationwide face the same shortage (Canadian Federation of Independent Business, 2001). A number of agencies have undertaken studies of the problem (see for example Conference Board of Canada, 2000; Advisory Council on Science and Technology, 2000). These studies have analyzed enrolment statistics, learner demographics, program completion rates, and placement opportunities. The studies, however, have only offered broad recommendations, such as calling for adjustments in the marketplace, and for appropriate changes in immigration, retirement and post-secondary funding policies (Finlayson, 2002).

The BC government is attempting to address the skills shortage proactively by giving the private sector greater decisional power over apprenticeship. The government has announced plans to relinquish responsibility for designing curriculum and determining the structure and length of apprenticeships, though it intends to retain a role in credentialing workers. Also, the BC government has effectively de-regulated tuitions for the college component of apprenticeship, leaving it up to colleges to set the cost of training and to apprentices to shop around for the best educational value for their tuition dollar (British Columbia Ministry of Advanced Education, 2003 a). Apprentices cannot offset tuition costs with federal student loans because of the insufficient length of the yearly courses, and, contrary to the situation in Alberta, the provincial government has not set in place loans or bursaries of its own.

In a further attempt to streamline apprenticeship, the BC government has disbanded ITAC, the Industry, Training and Apprenticeship Commission, an administrative body that maintained apprentices' records, scheduled their training, and mediated difficulties between employers and apprentices. The BC government claims that ITAC was not the most efficient catalyst for apprenticeship in British Columbia (BC Ministry of Advanced Education, 2003 a). However, ITAC's Apprenticeship Counsellors did play a role in safeguarding the rights of apprentices — including their right to be trained in more than just a set of skills profitable to the employer.

The BC government has circulated a discussion paper among apprenticeship stakeholders to solicit feedback for a new model of apprenticeship (BC Ministry of Advanced Education, 2003 b). Among its many features, the new model is intended to fast-track workers already possessing certain skills. Also, the new model is intended to offer intermediate levels of credentialing — milestones that can be recognized by subsequent employers as apprentices make their way through an apprenticeship. Both of these processes, while desirable in principle, will be largely in the hands of the private sector, a less-than-invested partner when it comes to remunerating its workers for skills possessed rather than for time spent apprenticing (Stasz et al., 1990; Tan, 1989). As the last of the field offices of the Industry, Training and Apprenticeship Commission close in March 2003, and Apprenticeship Counsellors are replaced by a toll-free help-line, the new model of apprenticeship remains but a discussion paper. Meanwhile, 16,500 apprentices in British Columbia continue their apprenticeships in a problematic void.

2.6 Role of the current study

Investigators of apprenticeship have powerful ethnographic research tools at their disposal. Current literature on the shortage of skilled workers in British Columbia, however, focuses on broad social trends affecting apprentice training, while shying away from attaining insight into the incentives and disincentives that characterize serving an apprenticeship. By using apprenticeship as ethnographic method, this study sets off to contribute to three areas of apprenticeship research: first, this study expands on the existing body of literature on traditional apprenticeship; second, it contributes a new instance of emergent cognitive apprenticeship to the body of literature on that subject; and third, it fills gaps in the current research on the state of apprenticeship in British Columbia. This study documents 'from the inside' electrical apprenticeship in BC between 1999 and 2002, before the disbanding of ITAC and the de-regulation of tuition. The study looks at the incentives and disincentives of serving an apprenticeship, explores the range of reliance on existing pedagogical methods across different areas of the electrical trade, and describes emergent pedagogical methods in non-traditional areas of the electrical trade. This study provides an insider's view into factors that contribute to the shortage of skilled workers in our province, offering a perspective lacking in published research on the subject to date.

Chapter 3

Method

This study is based on the use of apprenticeship as ethnographic method (Coy, 1989). Participant observation was conducted by the researcher while serving an apprenticeship into the electrical trade in British Columbia.

3.1 Setting

Apprenticeship into the electrical trade in British Columbia is not an exact science: apprentices entering the trade do not know from the outset which jobs they will hold down or what domain practices they will acquire. The timeline of an apprenticeship is dictated by local availability of work, which also determines whether the learner will apprentice in traditional areas of trade practice (e.g. residential wiring), in non-traditional areas of practice (e.g. fibre optic cabling), or in both. The researcher did not know *a priori* the specific setting of this study, as job finding skills and availability of work were ultimately determinative. Over the duration of the study, however, the researcher was able to investigate a broad and multifaceted setting. This study documents the researcher's experience apprenticing in both traditional and non-traditional areas of the electrical trade, working for various firms under the guidance of a number of journeymen.

Table 3.1 offers a summary of the venues of apprenticeship investigated in this study. The setting of the study is representative of that of an electrical apprenticeship in BC. Conversely, the setting of the study is also unique: the sequence of employers and the nature of the workplaces documented are specific to the researcher's own apprenticeship trajectory. The breadth of the study's setting, however, maximizes the strength of the findings. The data collected documents apprenticeship in both traditional and non-traditional areas of the electrical trade, in both the union and the non-union sector, and

Table 3.1 Setting: venues of apprenticeship documented in the study.

- Setting
  - Trade college
    - Pre-apprenticeship program
    - Yearly training periods
  - Workplace
    - Union
      - Traditional
        - Supervised work
        - Independent work
      - Non-traditional
        - Supervised work
        - Independent work
    - Non-union
      - Traditional
        - Supervised work
        - Independent work
      - Non-traditional
        - Supervised work
        - Independent work
  - Others
    - Company socials (golf tournaments, Christmas parties)
    - Training seminars
    - Union meetings

while working both independently and under the direct supervision of a mentor. Furthermore, the setting of the study was extended to include other venues in which apprenticeship unfolds, such as union meetings, company functions, and training seminars. In summary, while the setting of this study is arguably unique, it is also broad and multifaceted, making it a powerful instrument in establishing the study's credibility.

3.2 Subjects

When utilizing apprenticeship as ethnographic method (Coy, 1989), the subject of the study is the researcher. This study is founded on the collection of the researcher's experiences while apprenticing, observation being guided by the study's research questions. In carrying out this study, the researcher worked, studied, and played alongside a variety of individuals, to whom the researcher is indebted. The researcher, however, remains the sole subject of the study.

3.3 Research apparatus

The researcher's continued presence in the setting of the study hinged on his ability to find and retain work as an apprentice. This demanded that the researcher attend, first and foremost, to his duties as an apprentice. In order conduct ethnographic research in a competitive and dangerous workplace, the researcher relied on a pocket-sized notebook and a pencil as his research apparatus. These items are accepted tools in the electricians' community: they are routinely used by electricians to keep notes about their work, and can be used without jeopardizing safety in the workplace. Where possible, the researcher used a standard-sized 35 mm camera to take photographs of his work.

3.4 Procedure

In conducting this three-year study, the researcher first worked in construction for four months as a labourer and electrician's helper, then attended a six-month electrical pre-apprenticeship program at a trade college. The researcher subsequently secured a position as apprentice with an electrical firm, and became indentured into the provincial apprenticeship program. Over the ensuing two years the researcher worked for three more electrical firms, and attended a ten-week apprentice training period at a trade college (see Table 1.3).

The keeping of notes is an integral part of being an electrical apprentice. Apprentices are expected to use a pocket-sized notepad and a pencil to keep notes about their work, about their studies, and about workplace conversations with their journeymen and peers. In the electrical trade, to keep notes is perceived by mentors as an indicator of an apprentice's learning, interest, and respect. Notepad entries were reviewed daily by the researcher, and were progressively transcribed and expanded into ethnographic field notes.

Preliminary work for this study involved establishing a baseline understanding of apprenticeship in traditional areas of practice of the electrical trade. For sixteen months the researcher documented his experiences as he encountered "the beliefs, behaviors, norms, attitudes, social arrangements, and forms of expression" (LeCompte and Schensul, 1999, p. 21) held by electricians in the context of apprenticeship in traditional areas of the electrical trade. This preliminary stage of the study used a broad-lens approach to ethnographic observation, producing a thick description of an apprentice's experience working in long-established areas of the electrical trade. During this time, the researcher became familiar with beliefs and norms about apprenticeship as he experienced them in the workplace and at the trade college. Once the researcher gained a baseline understanding with regard to apprenticeship in the traditional areas of the electrical trade, he was able to pursue employment with firms that worked in both traditional and non-traditional areas of the trade. At this time, the researcher undertook a focused documentation of the differences in the apprenticeship experience between traditional and non-traditional areas of trade practice. From this point onwards, data collection was closely guided by the research questions behind this study:

Throughout the study, the researcher applied a number of strategies aimed at establishing credibility — a measure of the isomorphism between the constructed realities of respondents and the reconstructions attributed to them by the investigator — in qualitative research (Guba and Lincoln, 1989). The research strategies applied were prolonged engagement, persistent observation, negative case analysis, member check, peer debriefing, and progressive subjectivity monitoring (Guba and Lincoln, 1989). The researcher utilized prolonged engagement into the community studied in order to reduce misinformation and misinterpretation. The researcher worked as an electrical apprentice for three years, becoming an established member of the electricians' community and coming to share in their culture. The researcher also documented apprenticeship in a variety of settings (see Table 3.1) in order to confirm the credibility of findings through their persistent observation in multiple venues. In order to enhance the credibility of the study's findings, the researcher also utilized negative case analysis (Guba and Lincoln, 1989), testing observations that failed to be explained by a working hypothesis against divergent hypotheses, and against the study's expanding findings, before drawing a conclusion.

The researcher used progressive subjectivity monitoring (Guba and Lincoln, 1989) to ensure the credibility of his interpretation of apprenticeship experiences. Progressive subjectivity was monitored in this study through the use of member checks and peer debriefing. The researcher used member checks to test his interpretations of unfolding events against the interpretation held by established members of the electrician's community. Operating within the context of the apprentice-mentor relationship, the researcher would present his interpretation of unfolding events to a journeyman electrician, and would compare his interpretation of events to that offered by the mentor. Similarly, the researcher tested the credibility of his findings by opening them to peer scrutiny and debriefing at international conferences in education research. Member checks and peer debriefing allowed the researcher to monitor progressive subjectivity, while also providing him with insights and guidance for the progress of the study.

In conclusion, this is a naturalistic study where the research foci flow from the data in a proactive fashion. The study was designed to provide an insider's view of the apprenticeship experience; the researcher utilized established research methods, and employed specific research strategies to ensure the credibility of the findings. Critically, the credibility of this study is enhanced by the length of the observation period, and by the variety of venues of apprenticeship documented. This study is well positioned to address the following research questions:

- Do the disincentives of the current apprenticeship model of entry into the electrical trade outweigh its incentives?
- Do employers and apprentices in traditional and non-traditional areas of the electrical trade make use of the traditional apprenticeship model?
- Are emergent new models of apprenticeship to be found in non-traditional areas of the electrical trade?

Chapter 4

Findings

This chapter contains the findings of the ethnography of apprenticeship that was conducted by the researcher. The chapter unfolds over four sections; each of the first three sections offers findings that address one of the research questions that guide this study. The research question addressed is stated at the beginning of each section. The last section summarizes the chapter.

4.1 *"Do the disincentives of the current apprenticeship model of entry into the electrical trade outweigh its incentives?"* Findings.

4.1.1 Incentives

Access to a desirable, lucrative trade

The primary incentive to serving an electrical apprenticeship is the access to a desirable, lucrative trade that is afforded to apprenticeship graduates. Although often seasonal in nature, and dictated by local availability of work, the electrical trade is seen among construction workers as a well remunerated and overall 'clean' trade, as indicated in the field note entry below.

> *I'm quickly finding out that electricians, or sparkies, are seen on jobsites as working one of the more desirable trades. For one thing, we often get a better wage than, say, a drywaller or a mudder. Our work is, for the most part, not as physically taxing as theirs: no shouldering four-by-eights of sheetrock all day, or slinging 20-litre buckets of drywall mud. We have a certain mystique, too, and we're seen as "smart" since we deal with electricity and go to (trade) college four times. Most of all, we are seen coming onto a jobsite when the roof is up and the windows in, and for the most part we stay clean all day.*
>
> *Field notes, Company A*

Traditionally, then, construction workers perceive electrical work as unfolding under more desirable conditions than other trades. Although this is often not the case in new commercial and industrial workplaces — where electricians are out braving the elements and the physical dangers of a jobsite as they lay in electrical conduits to be encased in poured concrete structures — the image of electrical work as a well remunerated and relatively safe and comfortable activity persists among construction workers (see also Applebaum, 1981).

"Learn and Earn"

A second incentive, shared with other apprenticed trades, is the "learn and earn" model of entering a trade (Industry Training and Apprenticeship Commission, 2001). Electrical apprentices start their careers as 'first term' apprentices, earning 55% of the hourly wage of a journeyed electrician. Employers are to increase apprentice wages in 5% increments after every 'term' of four to six months the apprentice serves in the workplace. Before graduating as a journeyman, 'eighth term' apprentices will earn 90% of a journeyman's hourly wage (Industry Training and Apprenticeship Commission, 2001). The field note entry below reflects some of the advantages of the "learn and earn" scheme.

> *Despite being relatively new at this, and definitely not journeyed yet, I am clearing one hundred bucks a day while doing mostly pleasant work, and learning a trade. I've had to be sharp to stay desirable to the employer, and well connected to stay ahead of the axe on a given project — either switching employers or angling to switch projects within a company — but I'm making it. It's no free lunch, but I'm paying all the bills and then some.*
>
> *Field notes, Company D*

4.1.2 Disincentives

Non-linear learning trajectory

One of the greatest disincentives to serving an electrical apprenticeship is the non-linearity of the learning trajectory encountered by the apprentice. Recruitment materials

(Industry Training and Apprenticeship Commission, 2001) routinely present trade apprenticeships as linear learning trajectories, unfolding on a firm schedule of workplace and college terms, accompanied by regular wage increases. The researcher's experiences indicate that the reality of an electrical apprenticeship is very different. Electrical work, when available, is mostly seasonal, and tied to one individual project, as reflected in the field note entry below.

> *I owe my Italian buddy another six of Moretti* [a fine Italian beer]. *I was getting too few hours with Company B after I came back from college — work had slowed down while I was away — so I gave him a call, and he made another call, and now he's got me working on the big project he'd been hired on. He's got the best contacts, and the best feel for a project I've ever seen. He knows when a project will be booming, and when things will start to slow down nearer the end. He knows how many guys will be hired, and later how many will be laid off, when, and most often who (he can "read" the employer, and what they think of each of the guys). He's forever telling me that, in this work, you're always working yourself out of a job — but if you do good work, you get called back for the next project. And when between projects, you make it look like you meant to do that, and you go on holidays.*
>
> *Field notes, Company C*

As with all construction trades, then, electricians are almost always "working themselves out of a job." The more effort is put into a project — often entailing massive amounts of hours, including night shifts and weekend work — the closer the workers come to being laid off as the project is completed. In order to remain in work, apprentices are seldom at liberty to turn down extra work. The researcher was often forced to make last-minute changes to family commitments in order to meet the needs of an employer (Field notes, Company A).

Layoffs

A second disincentive stemming from the non-linear nature of the apprenticeship trajectory is the reality of being laid off. While working as an electrical apprentice, the researcher quickly learned to accept the unavoidable reality of lay offs. Of the firms for which the researcher worked, Company A and Company C proved to be very project-specific firms, which would dwindle down to owners and managers when between projects, and would swell up to crews of tens of workers at the height of a project. While the researcher initially brought to the electrical trade the notion that good work leads to continued employment, he soon had to accept that, in construction, being laid off needs to be seen as an indicator of one's own success at completing an assigned task. As the following field note entry indicates, however, being laid off still brings on its own share of anguish and uncertainty.

> *I think I'd developed a bit of an invincibility complex: between my Italian connection, and a certain amount of jobsite savvy, I have stayed ahead of the axe for the best part of three years. Layoffs — although the unavoidable result of working yourself out of a job — only ever happened to other guys. Today hit me out of the blue, and it came from so far out of my peripheral vision that I couldn't see it coming. We were doing good work on the pier upgrade, and had lots more work ahead of ourselves, when the client revised the "need-by" date on the project to about four weeks later. Suddenly we have more time — and just as suddenly the crew's too big: the project is still there, but fewer guys are needed to complete it over a longer time. Three o'clock, and I'm handed a paycheque: I'm laid off. All I know for sure right now is that I have one paid hour to get to the union hall to put my name back on the call list.*
>
> *Field notes, Company D*

Demotions

Having readjusted his views about being laid off, the researcher then encountered a further disincentive linked to moving between employers in order to retain work. When transitioning between employers — as well as when transitioning between workplaces under a given employer — the researcher found himself demoted to working on the most basic 'fetch and carry' tasks, ones usually assigned to a first-year apprentice. This happened regardless of the researcher's formal standing in the apprenticeship trajectory, and without reference to the researcher's skill and achievement levels, as illustrated in the following field note entry.

> *I have been transferred between jobsites within the same company, but for the new foreman it's as if I'd never existed. My first marching orders were to carry ten-foot "sticks" of four-inch EMT* [a type of metal conduit into which electrical wires are pulled to reach between locations] *from our trailer to the mezzanine floor of the mall renovation. Sort of an obstacle course with two flights of steep stairs while carrying unwieldy metal tubes on my shoulders. It took me the best part of a day to master carrying two of them at a time, as they weigh a ton, and tend to scissor from side to side and pinch your head in the middle. I've been trained to do data, fibre, and building controls — all of which are being installed here — but no one asked. I cost more than a first-year apprentice — one of whom joined the crew at the same time as me — but no one seems to care what I cost when I 'fetch and carry.' Had this not already happened to me before, I'd be worried.*
>
> *Field notes, Company D*

Comparing his experiences with those of other apprentices, the researcher came to appreciate the lack of mechanisms for having one's standing along the apprenticeship trajectory acknowledged when transitioning between, or even within, companies. Independently of the apprentice's attempts to be noticed, the 'demotion' usually lasted about two weeks, and ended with a journeyman asking the apprentice for assistance with a task. This led to the apprentice being reintegrated into the learning trajectory, as the following field note entry indicates.

> *This time it took just over a week. At last, after piling EMT for various journeymen at various locations on the jobsite, P.* [a journeyman] *asked me at coffee whether I knew how to bend four-inch EMT, or whether I only knew how to carry it. I've never actually bent four-inch before. I tell him that what I know about bending four-inch is that you don't want to screw up too many bends because each stick of pipe cost a fortune. He's satisfied with my 'knowledge' and tells the foreman that he will need me to work with him on the runs of pipe he's installing. I'm back on the learning curve.*
>
> *Field notes, Company D*

Unspecified wage determination

The temporary demotion when transitioning between employers or jobsites is part of a broader disincentive to completing an electrical apprenticeship. Under the current apprenticeship model, an apprentice's wage as a percentage of that of a journeyman is determined by both the hours he or she has spent in the workforce, and the level of college training he or she has attained. The expectation is that, for example, an apprentice's 'time served' and his or her college training will both mark him or her as a 'first-year,' or a 'second-year' apprentice, to be remunerated accordingly. Frequently, however, there is a disjuncture between an apprentice's time in the workforce and level of college training, deviating from the idealized four-year apprenticeship trajectory. In such a situation, the apprentice may find that he or she is effectively 'frozen in place,' unable to make further progress towards journeyed status or to receive regular wage increases.

Combined with the unpredictable availability of work, this dual mechanism can lead to frustrating and undesirable situations. Inability to find work in the job market can result in an apprentice being paid at a much lower level than would be suggested by the amount of college training that he or she has completed. For example, V., an apprentice with whom the researcher worked on a number of jobsites, completed all of her apprenticeship college training and passed the inter-provincial certification exam required for journeyed status. By then, however, V. had only accumulated about half of the hours necessary for graduation, because of lack of work locally. Employers froze V.'s wage on jobsites at the level indicated by her hours of work experience, without regard for her college training. The implications of this type of pay scale determinations are reflected in the field note entry below.

> *For once, V. was having coffee, rather than making coffee, at the donut shop where she's worked, off and on, for as long as she's been an apprentice. She was there with a friend, discussing the logistics of moving back to the East Coast. V. has now completed all of her college training, and has passed the IP* [Inter Provincial Trade Accreditation Exam], *but she is still only about half done her hours. When working electrical, she tells me, she's paid like a second-year apprentice, even though employers expect her to perform at the level of a fourth-year. V. has had enough of working more hours a month glazing donuts than apprenticing electrical, and is thinking about moving back East, where her dad is an electrician, and where either him or a buddy could see her straight through her remaining hours so she can get her Red Seal* [proof of journeyman status].
>
> *Field notes, Company D*

Because of poor availability of work and remuneration that is tied to hours worked, rather than to training attained, fully schooled apprentices may be forced to seek other sources of income alongside their electrical work. Conversely, an apprentice who defers attendance at the college may accumulate many more months or years of experience than one would expect of someone with his or her level of college training, but not be remunerated for the extra experience. This, for example, was the case for K., an apprentice and father with whom the researcher worked. Faced with stringent family responsibilities, K. continually deferred his fourth college training period because he needed to continue earning his full wage. K.'s employer froze his remuneration to correspond to his college training level. K. surpassed the number of hours required for graduation to journeyed status and acquired domain practices to the extent that his employer routinely placed him in charge of running jobs. However, K. did not receive any pay increases to recognize his experience or ability, since the employer intended to pay him as a third-year apprentice until he officially moved out of that bracket by attending college training. As the following field note entry indicates, major changes in

K's work situation became necessary for him to exit the rut in which he had become ensnared.

> *I hadn't seen K. for almost two years, and out of the blue I ran into him in the mall parking lot. He showed me his little daughter, asleep in the car seat. Talking shop, he told me that last year he'd finally quit Company B, after years of working for a wage frozen at what they deemed appropriate for his college training. He got on with a start-up firm, was right away treated and paid as a journeyman, and once he had enough hours for an EI* [Employment Insurance claim] *based on the higher wage, his boss encouraged him to go to college for his fourth year training. K. aced fourth year and the IP, and got his Red Seal!*
>
> *Field notes, Company D*

After years of working at the same wage, then, K. was able finally to attend his last college training period, and to attain his journeyman papers. Thus, although promoted as a four-year program, an electrical apprenticeship can mushroom into six or eight years of struggle. This substantial disincentive stems from the negative synergy between a volatile employment market and a poorly designed mechanism for remunerating and credentialing of apprentices.

Financial repercussions

A further disincentive to serving an electrical apprenticeship is the financial repercussions of attendance at the mandatory college training periods. First, effective March 31, 2002, the Provincial Government repealed the Access to Education Act, authorizing colleges to collect tuition fees for apprenticeship training previously offered at no charge to the student (British Columbia Ministry of Advanced Education, 2003 b). Second, no distance education version of the college training is available to date, so apprentices who live in communities without accredited colleges must relocate for the ten-week training period (British Columbia Ministry of Advanced Education, 2003 b).

Third, while in college, an apprentice's earnings are reduced to Employment Insurance benefits, representing approximately 55% of the apprentice's earnings in the weeks immediately prior to training. The volatility of job market in the electrical trade means that an apprentice attending college after a 'dry spell' of employment may receive very low benefits. Conversely, an apprentice who is 'in work' at a good hourly rate is often reluctant to step out of the work force to advance his or her training (recall K.'s situation from the previous section). The last facet of the financial disincentive of the current apprenticeship model rests with the employer's view of college training periods. In particular, if the training falls at the height of work on a busy project, employers often express resentment at losing apprentices to scheduled training, as illustrated in the following field note entry.

> *Work is under control at the multiplex, and the last floor of the school is done. Some of the guys that were hired last are beginning to sweat the unavoidable downsizing that will come soon. All in all, this is not a bad time for me to go to college for ten weeks: I have solid hours at a good wage behind me, and the EI won't be too bad. And the work here has peaked, and will end soon. All the same, today R.* [the employer] *took me aside and put on her best magnanimous air. She reminded me that, along with having provided me with lots of work, the company was now also sending me to school. All I could do was to look as grateful as possible.*
>
> *Field notes, Company A*

Furthermore, the apprentice may or may not be offered a job by the employer for whom he or she worked before the college training period. Despite assurances of being kept 'a warm spot while you're in school,' the researcher returned to an employer after a round of college training only to find his hourly wages cut, and his hours reduced (Field notes, Company B). In total, then, apprentices encounter substantial financial disincentives to the completion of their training.

Unspecified range of domain practices

A final disincentive is that graduating apprentices are not required to possess a set range of domain knowledge and domain practices. While the college training periods provide apprentices with domain knowledge pertaining to numerous areas of the electrical trade, the domain practices offered by employers are often limited to those areas of interest to the particular employer. Under the current model, an apprentice may receive journeyman credentials despite possessing domain practices in only a limited number of areas of the trade. The researcher observed this to be the case in two of the companies for which he worked, as reflected in the field note entry below.

> *Getting on with Company C has been a real eye-opener. Like Company A, all Company C does is large new construction. Contrary to Company A, which pretty much disappeared when between jobs, Company C has enough work to keep a core of employees year-round. My journeyman, I., has done almost all of his apprenticeship with them, and has stayed on once journeyed, working up and down the island on large new construction. He's wicked at what he does, but what he does is about one fifth of what electricians, at least according to college curriculum, are supposed to know how to do. Yet he's journeyed, Red Seal and all.*
>
> *Field notes, Company C*

Under the current credentialing system, then, an apprentice possessing a limited range of domain practices receives the same "journeyman" credential as would an apprentice who, like the researcher, strived to acquire a wide range of domain practices. An apprentice who wishes to gain a broad range of experience — or to learn a particular area of the trade, such as data communication — may be unable to persuade an employer to provide him or her with exposure to the desired practices. In this way, employers' responsibilities as educators within the framework of apprenticeship are only loosely defined.

4.2 "*Do employers and apprentices in traditional and non-traditional areas of the electrical trade make use of the traditional apprenticeship model?*" Findings.

4.2.1 Traditional areas of the electrical trade

Traditional areas of the electrical trade are ones centred on the use of electricity as work energy (Canadian Electrical Contractors Association, 1997). These areas encompass primarily residential, commercial, and industrial wiring. While working in traditional areas of the trade, the researcher documented three recurring traits that characterize these areas:

- Domain knowledge is embedded in blueprints
- Materials are sturdy and unaffected by rough handling
- Installations offer digital performance

Embedded domain knowledge

First, in traditional areas of the electrical trade, most of the characteristics of an installation come already defined in blueprints by off-site electrical engineers. Off-site electrical engineers have already applied the domain knowledge that guides critical decisions about the nature and size of conductors, the maximum loads for individual circuits, and the like. The outcome of their application of domain knowledge becomes embedded in the blueprints that are passed on to the electricians in the workplace. In the workplace, electricians focus primarily on the implementation of directives contained in the blueprints, rather than on the evaluation of those directives through the application of domain knowledge. This reduces the need for electricians on jobsites to possess and apply the range of domain knowledge that is taught to apprentices over their four furloughs at a trade college. In the workplace, apprentices are also expected shift their focus from the application of domain knowledge to the use of rapid ways to complete assigned tasks, according to the directives already specified in the blueprints. In the field note entry below, the researcher contrasts his college and workplace experiences around the practice of bending electric metallic tubing — EMT, or simply 'pipe,' a metal conduit into which electrical wires are pulled to reach between locations.

> *When we learned about pipe bending at the college, we got a whole load of trigonometry out of the book by Cox (1982), the Electrician's Guide to Conduit Bending. In the shop we were shown how to bend pipe using a calculator and a protractor, instead of just a bender. We could take as long as we needed, using as much pipe as we needed, until we got the piece just right to go between the two junction boxes on the wall. According to the book, in order to put an offset in a piece of pipe* [two consecutive bends set in a conduit to change the height at which it travels, while not changing its direction of travel, see figure 4.1 below], *you first calculate the hypotenuse (H, the distance between bends) based on the angle of the bend used (θ) and the height to be cleared (O), you then mark the distances calculated on the pipe, then you bend it only once, to perfection.*
>
> *Here on a jobsite, there's no protractors, no calculators, no time for trigonometry. And on the scaffold I work on I have hardly room enough to stand, let alone bend down to check the markings on the bender. Instead of trigonometry we use multipliers: you want a 6 inch offset, you mark a distance of 12 inches between bends and use 30 degree bends (the multiplier is actually the cotangent of the angle, but nobody puts it that way).*

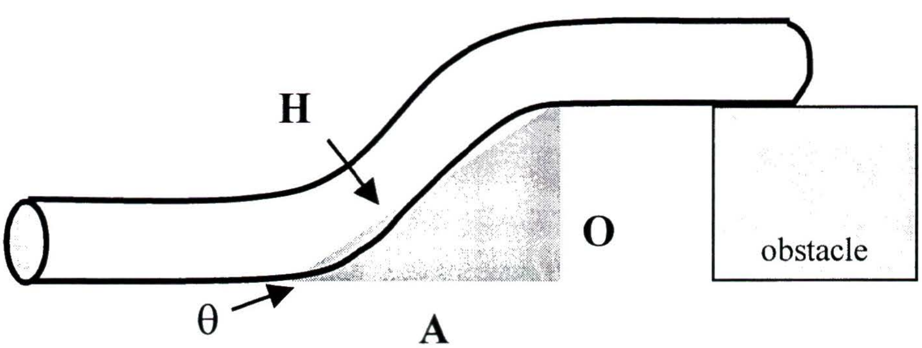

Figure 4.1. Offset bend in a conduit. **A**: adjacent side; **O**: opposite side; **H**: hypotenuse; θ: angle of the bend.

Today P., my journeyman, asked me to run a set of four half-inch pipes along the steel trusses above the theatre, starting from the screen, along the length of the theatre ceiling, then down to the projector room at ceiling height using an offset. I'm on the decking in theatre five: I'm standing on sheets of 3/4" plywood atop a three-story high scaffold. I've installed the pipe on the trusses, and before putting in the offsets I ask P. what angle he'd use. He replies that ideally you want to use 22-degree bends, 'cause they're the easiest to pull wire through. But the multiplier for those bends is hard to remember and hard to multiply by. Also, when you put in 22-degree bends, you have to look at the markings on the bender to see when you're there. When you work on scaffolding, three floors up, you don't want to be bending down to check your markings. Instead you want to put in 30-degree bends: the multiplier is 2, so you double the depth of the offset, and you have the distance to mark between the bends. And when the handle of the bender is straight up and down, the bend is 30 degrees, and you don't have to check the markings. It's fast and it works.

Field notes, Company A

As illustrated above, in the workplace where traditional practices are enacted there is little room for the application of domain knowledge. The focus in the workplace is on the rapid implementation of directives contained in blueprints through the enactment of very streamlined domain practices.

Sturdy materials

The second characteristic of traditional areas of the electrical trade is the sturdy nature of the materials used. Rough handling of these materials results in little damage to the materials themselves, and seldom affects their performance within the installation. Because of this, apprentices working in traditional areas of the trade are taught to disregard much of the domain knowledge that should guide their work, and to replace it with domain practices that take into account the sturdy and resilient nature of the materials involved. In the following field note entry, the researcher contrasts the college's concern with proper handling of materials with the workplace approach to terminating 120 Volt wires.

> *While attending the trade college, I was instructed to use a pair of needle-nose pliers to make termination loops on wires to be fitted into light switches and power outlets. I was actually tested at the college on my knowledge of the theory behind this procedure. I know by heart that, "faulty termination of the conductors can lead to increased resistance at the contact point, which results in sparking, overheating, breakdown of the insulation of the wire, a short circuit, and possibly a fire." On my first day working as an apprentice, my journeyman took me aside by the trailer. R. went through my entire tool pouch, moving the tools from the pockets they were in to the ones where he tells me they gotta be so you can find them without looking. When he came to the needle-nose pliers, he simply took them out and tossed them on the ground. He tells me I'll never need those, and to just strip the wire and use the hole on the wire stripper to put a U in it, and shove it around the screw: the contact has to be tight, not pretty.*
>
> *Field notes, Company A*

Thus, the resilient nature of materials used in traditional areas of the electrical trade permits rougher, faster ways of working with them than the ones apprentices are taught at the college. In the end, the performance of the installation is unaffected.

Digital outcome of installations

The third characteristic of traditional areas of the electrical trade is the digital nature of the outcome of an installation. Whether dealing with a high-voltage feed using conductors as thick as an arm, or dealing with wiring wall sconces, installations that use electricity as work energy produce one of two outcomes: ON or OFF. In traditional areas of the electrical trade, an installation either performs fully or fails to perform at all. Performance, then, is all-or-none: either the lights shine, the motors spin, and the baseboard heaters generate heat, or they do not. There are no gradations in the performance of a traditional electrical installation. In the following field note entry, the researcher registers some amazement at the fact that, despite the rough handling of materials, and the cost-saving deviations from the blueprints he encountered on a jobsite, the installation worked in the end.

I am sitting in Theatre 7, flanked by my wife and my oldest daughter, watching The Iron Giant at the free screening for the workers who built this place. As I look back on the work we did here, I remember the crazy stuff we did to some of the wires, like having six guys at the end of a rope pulling conductors through a pipe where, to save money, the owners had skipped installing a mid-point pull box. Or when we had to tear out half a finished wall because the drywallers had put a screw right into one of our pipes, and the wires could not go through. Or when I was connecting a light standard fast as I could because we'd forgot about it and the cement pour at the front of the theatres was going to cover it all up in a few minutes. Now that it's all done, you'd never guess that this place still looked like a battlefield two weeks ago. The house lights, now three floors up in thin air, went out when they were supposed to. The exit signs (my work) kept glowing warmly above the doors. The speakers spoke on command, the projectors rolled, and the movie came onto the screen. Amazingly, it all works.

Field notes, Company A

As seen above, the digital — either on or off — nature of installations that use electricity as work energy allows for great latitude in the quality of workmanship in an installation before the installation fails to work.

Taken together, these three characteristics of traditional areas of the electrical trade reduce the need for an electrical apprentice — and, to a large extent, for a journeyman electrician — to possess much domain knowledge in order to be a useful worker. In the current model of apprenticeship, the college component focuses primarily on domain knowledge, and becomes an odd supplement to the emphasis on domain practices that characterizes the workplace. The college provides domain knowledge that stands in contrast to the domain practices that electricians use in the workplace: it neither complements them, nor informs them with practical implications stemming from the theoretical understanding of electricity as work energy.

The current model of apprenticeship in BC, which finds its beginnings in the mid 1930's (Crisford, 1936), is characterized by the separation of the sites of acquisition of domain knowledge (college) and of domain practices (workplace). Under the current model, apprentices attending the college training periods come to possess domain knowledge about a wide range of areas of the electrical trade, but only increase they depth of knowledge by 'revisiting' individual subjects each time they return to the college. The following field note entry illustrates this fact:

> *I have run into V. today: she's fresh back from third year. I asked her what it was like, and found out that it's just like second year, but everything is three-phase. I'm puzzled by the fact that, in pre-apprenticeship or in first year, we've learned the basics of wiring—lighting, heating, motors, Code, load calculations. Then in second year we've done it all over again—lighting, heating, motors, Code, load calculations—for two-phase systems. Then in third year we do it all over again—lighting, heating, motors, Code, load calculations—for three-phase systems. In fourth year we finally get to learn about programmable logic controls, data, and the fancy stuff. But if I'm working on a jobsite with motors, and I need to learn all about them—wiring them, two-phase motors, three-phase motors, Canadian Electrical Code rules about motors, programmable logic controls for motors—there's no way of doing it other than wait four years to get the whole picture at school. This makes no sense.*
>
> *Field notes, Company D*

Moreover, once back on a jobsite, apprentices are offered no mechanism to ensure that employers will provide them workplace experience in as many areas of the trade as addressed in college. Once back from the college, apprentices are not offered ways to integrate their newly acquired domain knowledge into the domain practices they are asked to enact.

Furthermore, the current model of apprenticeship allows employers to pass on to the college their own responsibility as educators. Employers often see apprentices as competitively priced workers, rather than as learners in their charge. Both employers and other apprentices made the researcher aware that securing employment becomes increasingly difficult as one advances through an apprenticeship, becoming more expensive to the employer but still not legally able to work unsupervised.

4.2.2 Non-traditional areas of the electrical trade

Non-traditional areas of the electrical trade are centred on the use of electricity as information energy, rather than as work energy. After the Second World War researchers began using the electrical states of ON and OFF as stand-ins for the digital values of 1 and 0, creating the first electricity-based computational machines, and marking the beginning of the digital age (Canadian Electrical Contractors Association, 1997). The rapid expansion of digital technology gave rise to a number of new, non-traditional areas within the electrical trade, including data communication, programmable logic controls, and computer-based building automation. Practitioners working in non-traditional areas of the electrical trade rely heavily on specific, fast-evolving domain knowledge. However, it should be noted that, under the current apprenticeship model in BC, apprentices only receive college instruction on the domain knowledge of non-traditional areas of the electrical trade while in their fourth year of training. This raises a problematic issues for employers and apprentices working in non-traditional areas of the trade.

While working in non-traditional areas of the electrical trade — areas of practices centred on the use of electricity as information energy — the researcher documented three recurring traits that differentiate non-traditional areas of the electrical trade from their traditional counterparts. In non-traditional areas:

- Domain knowledge is dynamically engaged
- Materials are delicate and readily affected by rough handling
- Installations offer analog performance

Engaged domain knowledge

First, non-traditional areas of the electrical trade are characterized by the dynamic engagement of the domain knowledge of players involved in an installation. Contrary to traditional areas of the trade, where characteristics of an installation are decided by off-site engineers and are embedded in blueprints, much decision-making in non-traditional areas of the trade occurs as an installation is being built. In these areas, electricians share expertise with other individuals — system managers, programmers, and end users in the case of data communication. Together they create installations that best respond to the needs of their users, and that are tailored for maximal performance within the constraints of a jobsite. Electricians engage their domain knowledge in every step of an installation. For instance, in the case of data communication, they are involved in the choice of a route for data cables, in the choice and installation of supporting structures, and in the measuring and maximizing of the performance of the network. In the following field note entry, the researcher documents the active engagement of domain knowledge as electricians work together with a system manager and some end users in designing a local area network.

> *Since I got on with Company B I have been much closer to the decision-making process when it comes to an installation. I'm working with K.* [6th term apprentice] *and C.* [journeyman], *putting in cable trays and EMT delivery pipes into offices. The cable tray runs above the ceiling from the communication cabinet to the distal point of the LAN, the EMT runs from the edge of the cable tray to individual connection boxes by the desks in the offices. The cable tray looks like lengths of spinal cord with an upward-pointing ribcage protruding from it. The EMT is anchored to the office wall, does a 90 into the ceiling space, is supported from T-bar ceiling wires, and stops just off the cable tray, with a plastic bushing at the end to protect the computer cable* [see figure 4.2].
>
> *T., the system manager, gave us printouts of the desired locations of the voice/data outlets. She produced them from digital maps of the hundreds of offices in the complex. We get a map of the floor we're working on, with a line indicating the path*

of the cable tray and numbered circles indicating the location of the outlets in the offices. The first thing C. gets K. and I to do is to open up every third ceiling tile along the suggested route for the tray and poke our heads in, armed with flashlights, to make sure that we have a clear route. C. explains that the digital maps of the buildings fail to indicate the location of motors, ballasts, and transformers which generate noise that affects data transmission, and often do not indicate physical obstacles like air ducts etc. Following his instructions, we soon find out that an old ventilation bulkhead [a hollow cube of sheet metal roughly 3'x3'x3'] *sits exactly in the straight-line path we were advised to follow with the cable tray.*

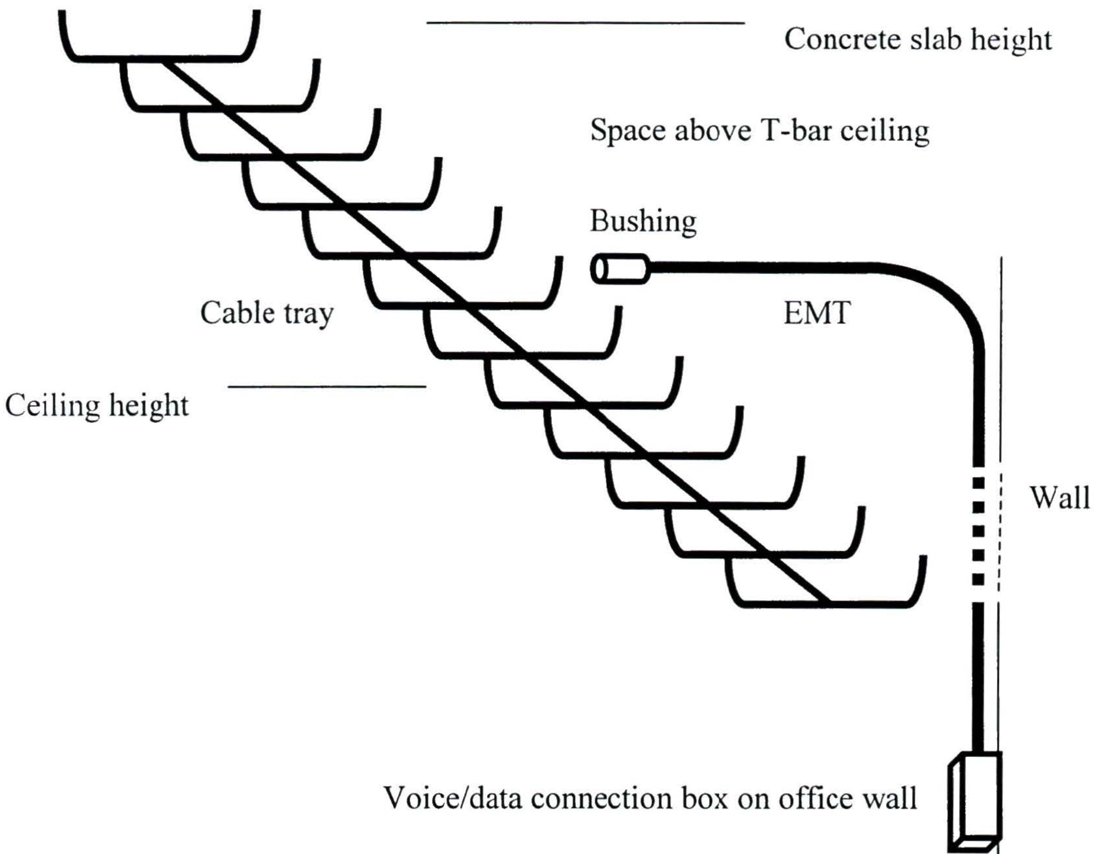

Figure 4.2. Cable tray and EMT distribution network for LANs.

We shift 3 feet to the right. The route there is clear for the length of the building, except for one wall, near the end, that comes up into the ceiling space. C. tells us to use the route 3' to the right of the suggested one, and to rise the height of the cable tray gradually so that by the time we reach the higher wall of the last office we'll be above its height. 3' to the right of the prescribed route still lands us inside the communication cabinet. We'll install a 3' piece of cable tray off the cabinet wall to *dress the cables to the router. C. tells me and K. that by doing this the cost of the installation will remain virtually the same as Company B initially priced out. We won't use any expensive curved pieces of cable tray by avoiding the bulkhead and gradually rising above the over-height wall, instead of attempting to get around them by way of curves. As K. and I work on the cable tray, C. is going office to office to discuss with the actual inhabitants their preferred location for the voice/data boxes. Blueprints do not include the layout of furniture inside the offices, so C. establishes the precise location where the data drop will work best for the occupants, and tells them when we'll need to work in their offices.*

Working on data, the accuracy of the blueprints seems far less than when I worked on the theatres, where everything was being built new, and different systems — electrical, ventilation, fire control, plumbing — mostly fit around each other. In building a LAN, blueprints are relatively useless, and a savvy electrician will scope usable routes that avoid stressing the cables or picking up interference. The electrician also discusses the installation with the system manager and the users. C. reminds me that this makes for lower costs, better performance, and happy customers.

Field notes, Company B

This entry shows how electricians working in non-traditional areas of the electrical trade actively participate in the decision-making about an installation, engaging both their domain knowledge and their domain practices.

Delicate materials

The second characteristic of non-traditional areas of the electrical trade is that the materials used are, for the most part, delicate. The performance of these materials is readily affected by rough or improper handling. In order for an apprentice to be able to work in non-traditional areas of the trade without negatively affecting the performance of an installation, the apprentice must possess an understanding of the nature and workings of the materials used. In carrying out a task as simple as installing a length of giga-speed computer cable between two communication rooms, the apprentice must be aware of the importance of not twisting or stretching the cable, of avoiding positioning the cable close to sources of interference, and of terminating the cable into its jacks without disrupting the internal structure of the cable. These precautions pertain not only to the installation of non-traditional materials, but also to the traditional domain practices that are used in preparing a site for the materials' subsequent installation. In the following field note entry, the researcher documents the impact that the use of traditional domain practices can have on the performance of non-traditional materials. On this job, his employer was contracted to install computer cables and fibre optic links onto a support structure of cable tray, which had been installed beforehand by a 'traditional' company with no data communication experience.

> *When we came onto this job, it looked like a piece of cake, as we were only here to do the cable and fibre, and none of the 'dirty work' of putting up the support structure. The fact that the other company had already installed the cable tray was supposed to be a bonus. Not so. The other guys are commercial electricians, not data people. Their idea of cable tray is that as long as it goes from A to B it's good enough. We have been fighting to keep our cables and fibre optic from being damaged by the very structure that is supposed to support and protect them. Every step of the way this job has proven a nightmare, from when S. and I inspected the cable tray all the way to now that the cables are in. On inspecting the tray, we expected to find curved segments where the tray rounds corners, and S-shaped segments where the tray changes height. No such: instead of gentle curves, the other guys did sharp 90's by cutting the tray at a 45° angle and butting it end to end, and they have left the height changes as free drops of up to two feet. They plain didn't know what this does to cables and fibre. Our end of things has been an uphill battle. We had guys gouge their arms on the sharp ends of tray. We tried using rollers to help the cable around the sharp corners, but there were just too many corners, as the other guys followed poorly scoped paths that zigzagged everywhere. This left us with no way to simply pull in the cables along the tray. In the end we had to bring in a whole bunch of guys and put one at each sharp corner or drop, and we installed the cables by helping them along by hand. Now fibre and cables are in, though it took way longer than budgeted: we've lost money already, and we haven't even begun to test the installation's performance.*
>
> *Field notes, Company D*

The above entry shows how both traditional and non-traditional domain practices can impact the delicate materials typical of non-traditional areas of the trade. The installation of cable tray — a traditional practice — conducted by the first contractor was not informed by domain knowledge about non-traditional materials. The first contractor set up cable tray in a manner suitable for supporting electrical wire — a traditional material — but unsuitable for supporting computer cables and fibre optic — non-traditional materials. The second contractor took every precaution not to damage the delicate computer cable and fibre optic during installation. However, the sharp bends and unsupported height drops that were built into the cable tray by the first contractor physically impacted the cables that rested on the tray, and ultimately affected the performance of the installation, as indicated in the next section.

Analog outcome of installations

The third characteristic of non-traditional areas of the electrical trade is the analog nature of the outcome of an installation. When dealing with electricity as information energy, rather than as work energy, a new dimension is added to the performance of an installation. In the case of data transmission through a computer cable, for instance, there still is a digital component to its performance: it either is ON if electric impulses that encode "data" are travelling through it, it is OFF if they are not. Beyond the ON or OFF component, however, there is the added issue of the performance of the cable as it transmits data — namely just how ON the cable is when it is ON. When a data cable is ON, the electric impulse "data" exiting it may nonetheless have become contaminated with other electrical signals picked up along the length of the cable. Similarly, when the cable is ON, the strength of the electric impulse "data" exiting it may have been reduced by dissipation resulting from damage to the cable's internal structure. Although a cable is ON, gauges, abrasions, torsion, tension, proximity to sources of interference, and a host of other factors influence the nature of the electric impulse "data" as it travels through it.

Non-traditional installations, then, can yield a range of performance, making the outcome of an installation analog rather than digital. Much of the domain knowledge and domain practices in non-traditional areas of the electrical trade are aimed at keeping the performance of an installation as high as possible within its spectrum. In the following field note entry, the researcher looks at the practices utilized to maximize the performance of the ill-fated installation introduced in the previous section.

> *More uphill battle. S. and I have spent the last week terminating and testing the fibre optic and the computer cables. I work the distal ends of the cable connections, while he is in the communication room downstairs. We are linked by walkie-talkie and by the cables themselves. I have with me the 'remote' end of the tester (black box), he has the 'smart' end (black box with a keyboard and a display). The smart end sends a series of data signals to my end, which sort of acts as a mirror and fires them back. The smart end assesses the performance of the cable, how much noise has been picked up, the strength of the data signal, etc. It shows all the parameters measured on its screen, and plays a happy tune when the performance of a cable is above the minimum requirements for the installation. Most of what it has played for the last week, however, is the death knell (bee-BOOOOOP) that tells us the cable is performing below acceptable levels. We have done all we could for the cables as we installed them on the damned cable tray we did not put in. All we can do now is to redo the terminations into the jacks really carefully, using up the length of extra cable that we left at each end for this purpose. This has been helping, and it has pushed many cables into just squeaking past minimum requirements. Although they pass, S. is concerned about for how long the cables will keep passing: some have squeaked through by such a small margin that any bumping or shifting of the jack, or any moving of the cables in the tray can throw the performance back below standard. S. says that, as it looks now, the cables that are failing by an big margin will have to be pulled out of the tray, and new ones put in. We're losing money, we're past the delivery date for the installation, and we're still here.*
>
> *Field notes, Company D*

As indicated in the entry above, non-traditional installations can yield an analog gradation of outcomes within the digital state of ON. The quality of the performance of a non-traditional installation is greatly affected by the domain practices enacted on the delicate materials characterizing non-traditional areas of the electrical trade.

Taken together, these three characteristics of non-traditional areas of the electrical trade increase the need for an electrical apprentice — and for a journeyman electrician — to possess a great deal of domain knowledge in order to be a useful worker. Furthermore, as illustrated in the last two entries, all players involved in a non-traditional installation must possess domain knowledge pertaining to non-traditional areas of the electrical trade — even if performing traditional domain practices such as installing cable tray. In order to ensure the successful performance of a non-traditional installation, domain knowledge about non-traditional areas of the trade must inform the enactment of both traditional and non-traditional domain practices.

For the reasons discussed above, employers working in non-traditional areas of the electrical trade cannot rely solely on the current college training system to provide apprentices with the domain knowledge they need. Critically, domain knowledge about non-traditional areas of the trade is only made available to apprentices in the last of their college training periods, four years into their apprenticeship. Instead, employers working in the non-traditional areas of the trade take it upon themselves to provide apprentices with non-traditional domain knowledge before asking them to perform non-traditional domain practices. However, the information they provide is not in the form of a list of do's and don't's — as is usually the case in the traditional areas of the trade. Instead, apprentices receive detailed information on the nature of the materials used, and on the impact that improper handling has on their internal structure. For example, before asking the researcher to help with a data cable installation, S., a journeyman with Company D, took the time to dissect a segment of cable, and to explain the function of the four colour-coded twisted pairs of wires inside it. S. first ensured that the researcher had an understanding of the structure of the cable: for example, twisted pairs are made up of a solid colour wire and a white-plus-colour wire, solid colour wires carry signal, white-plus-colour wires act as noise sinks, each twisted pair has a different frequency of twists to minimize cross-talk interference between pairs. S. then proceeded to extract rules for the proper handling of the cable by physically demonstrating on a segment of cable the impact of various forms of mishandling: disruption of the twists through torsion and stretching, separation of signal carriers from noise sinks through sharp bending, and so on. This demonstration was more akin to college training than to traditional workplace instruction, but was also directly related to workplace needs. Through it, the researcher acquired the domain knowledge that would later guide his domain practices regarding the installation of computer cables, along with the ability to derive his own list of do's and don't's as needed.

It was the researcher's experience, then, that employers working in the non-traditional areas of the electrical trade tend to provide their apprentices with a thorough understanding of the workings and internal characteristics of non-traditional materials. From this domain knowledge, apprentices can then derive the awareness that guides their enactment of domain practices. While working for Company D, the researcher attained domain knowledge not only with regard to computer cabling, but also with regard to fibre optics links, and to computerized building automation systems. Once in possession of this knowledge, the employer allowed the researcher to work in these areas of practice under very little supervision — far more so than he had experienced while working in traditional areas of the electrical trade.

In non-traditional areas of the trade, an apprentice's possession of domain knowledge and domain practices for a given area of practice can lead him or her to work in that area as if already a journeyed electrician. For instance, as the researcher developed the ability to work independently while installing computerized building automation systems (CBAS), the firm recognized his newly acquired competence in this area. After participating in the completion of a CBAS installation at the local University, the researcher was sent to work in another of his established areas of competence, namely the installation of a computer cable network at a hospital under construction. When his employer secured a contract for another CBAS installation, however, the employer transferred the researcher from the cabling crew, and made him part of a specialized three-person team for the new project. There, the researcher worked independently, almost as if journeyed, as shown in the field note entry below.

> *I must have done some good work on the CBAS at the university, and it's been noticed. After the Uni I was sent to work at the hospital: a nasty construction zone. N. was there, running a crew and being in charge of hundreds of cable runs. When the CBAS gig at the optics plant came up, the folks at the office actually remembered that S. has already taught me to do CBAS, and that I'm journeyman-good at it. They plucked me off the hospital, and set me up with S. and C.* [both journeymen] *on a three-man CBAS crack team. S. and C. are both old hands at this, and, in a way, so am I by now. They let me work off the prints, largely on my own for days at a stretch. I do my own material requisition lists, I manage my own time, and I get treated, in all manners but the pay scale, as a peer journeyman.*
>
> *Field notes, Company D*

This type of apprenticeship trajectory in non-traditional areas of the trade is not unique to the researcher's experience. For example, N., a first year apprentice, rapidly acquired domain knowledge about efficient use of spools of computer cable. By determining the length of individual runs of cable from the blueprints, and assigning specific spools to specific sequences of runs, N. minimized the amount of leftover cable that was too short to be useful, saving the company hundreds of dollars. Despite his being a first year apprentice, the employer recognized N.'s demonstrated competence, and on his next assignment put N. in charge of planning runs of computer cable for a team of workers (see field note entry above).

4.3 "*Are emergent new models of apprenticeship to be found in non-traditional areas of the electrical trade*:" **Findings.**

As indicated in the preceding section, in the non-traditional workplace, domain knowledge is dynamically engaged, the performance of materials is readily affected by their handling, and installations offer analog performance. Together, these factors create a setting in which the current model of apprenticeship fails to be applicable: when working in non-traditional areas of the electrical trade, domain knowledge needs to inform the apprentice's domain practices, both traditional and non-traditional. The view of the apprentice as a cheap set of hands to be unleashed with minimal training on virtually indestructible tasks cannot be transferred to the non-traditional areas of the trade. Likewise, the current model of apprenticeship, characterized by the temporal and geographical split between acquisition of domain knowledge and the acquisition of domain practices, does not meet the requirements of non-traditional areas of the trade.

While working in non-traditional areas of the electrical trade, the researcher documented the occurrence of workplace-based teaching and learning of both domain knowledge and domain practices. These incidents appear to fit into a broader model of non-traditional apprenticeship. Within this model, apprentices still learn through the traditional model of apprenticeship, which entails modeling, coaching, and fading. Beyond this, however, they receive closer mentoring and interaction with journeymen, and acquire domain knowledge and domain practices simultaneously. Thus three new steps in the apprenticeship model have emerged in non-traditional areas of the electrical trade: articulation, exploration of ideas, and reflection.

4.3.1 Articulation

Articulation is the cognitive companion of modeling. Contrary to modeling, which is conducted by the mentor, both mentor and learner engage in articulation. Articulation renders visible not only one's actions, as in modeling, but also one's thoughts. Articulation consists of the mentor and the learner verbalizing what domain knowledge they using while performing a task. It also entails verbalizing the impact that working environment, available tools, available materials, and other factors are having on the process of accomplishing the task. Articulation makes the mental processes of both learner and of mentor available to the other for learning and evaluation. Working in non-traditional areas of the electrical trade, the researcher witnessed a degree of verbalization of one's thought processes that stands in stark contrast with the lack of articulation he experienced in traditional areas of the trade. The contrast is reflected in the following field notes entry:

> *What a relief. I was starting to think that I was the only electrician ever to talk to myself, when all of a sudden talking to myself, thinking out loud, is not only acceptable, it's expected. As he works, S. points out the Canadian Electrical Code rules that have to be obeyed in our installation, along with the manufacturer's specifications for distances between cables and noise-emitting equipment like motors, and fluorescent fixtures. He talks about the impact our work environment can have on the installation, and about the impact we can have on our environment — we don't want to accidentally take down a computer that runs half the province. After months, years of being instructed by way of nods and grunts on industrial jobsites, it amazes me to have so much of a journeyman's inner reasoning presented to me, and to see how interconnected knowledge and practices actually are.*
>
> *Field notes, Company D*

Articulation, however, is not only about making the journeyman's reasoning manifest. S. routinely called on the researcher to explain the reasoning behind his own choices in building an installation, and to explain the results he attained in testing the installation's performance — thus strengthening the apprentice's domain knowledge. This dynamic is illustrated in the following entry:

> *Working with S. is like a chess game: time is limited, yet every move is to be thought of in the context of three subsequent moves, and has to be informed with all moves previously made. And I have to talk, I have to remember, I have to explain every bit that went into every choice. Slowly, mindfulness is becoming second nature.*
>
> *Field notes, Company D*

4.3.2 Exploration of ideas.

Exploration of ideas is the cognitive companion of coaching. Contrary to coaching, which is the prerogative of the mentor, both mentor and learner engage in exploration of ideas. Exploration of ideas consists of mentor and learner engaging in a discussion to select the domain knowledge and domain practices to be used in accomplishing a given task. Mentor and learner also use exploration of ideas in evaluating the performance of the accomplished task, debriefing the manner in which the task was completed, and identifying ways in which it could be accomplished more effectively in the future. Exploration of ideas capitalizes on the domain knowledge and domain practices the learner may already possess that are relevant to a given task. When the researcher first experienced incidents of exploration of ideas in the non-traditional workplace, they felt oddly humanizing, as reflected in the field note entry below:

> *After months of being a disposable set of hands on the big industrial site* [traditional area of the trade] *working with S. just about brings on culture shock. I've shed my fifteen-pound tool belt, and walk around with a "data geek" pouch with precision cutters and termination tools. I've been introduced to, and routinely discuss my work with, the network manager, a system analyst, and a couple of programmers. I'm a player in a team not just of electricians, but of network builders.*
>
> *Field notes, Company D*

The following entry documents how exploration of ideas places domain knowledge and domain practices within the wider context of a jobsite.

> *Now, when we enter a computer room, we do a walk-through, and S. tells me how each piece of equipment —routers, hubs, switches —fits into the network. When we lift the floor tiles, or we open up a ceiling, he talks me through the existing components of the network, sensitive equipment to watch for, and connection points into which the expansions of the net we're building will tap into. All this information allows me to "see" appropriate routes for our cables and fibre optics the same way as he would. S. talks about each path in terms of what it could do to the installation: sharp bends distort the internal structure of computer cables and cause cross-talk, a cable crossing over a fluorescent fixture picks up interference from the ballast and kills the signal to noise ratio. S. walks me through his reasoning, and how the physics of data transmission end up dictating the choice of route for the installation.*
>
> *Field notes, Company D*

4.3.3 Reflection

Reflection is the cognitive companion of fading. Contrary to fading, however, both mentor and learner engage in reflection. Through reflection mentors and learners integrate their domain knowledge and domain practices, and become progressively independent of each other. Furthermore, reflection allows learners to benchmark their own learning against the mentor's knowledge, thus informing learners of their own possible need to "fade" from their present mentor, and seek further learning with a new mentor. In the non-traditional workplace, the researcher encountered examples of reflection that dealt not only with the domain knowledge and domain practices pertaining to the logistics of installations, but also with the broader issues of attaining information on new technologies, developing a work ethic, and obtaining and retaining work. The following field note entry offers an example of reflection:

> *As we sit in the service van, munching lunch or traveling to a site, S. and I sort of take turns at monologues. I reflect on how my science training impacts my ability to process information about physics and optics. S. reflects on how taking on sidejobs* [work outside the company done on evenings and weekends for cash] *has helped him*

to develop the ability to run jobs as a journeyman. He reminds me that there does not come a day, after you write your Inter-Provincial exam, when the college instructors come along, make a hole in you head, and pour in everything you need to know to be a journeyman. S. also reflects on our professional identity as unionized electricians, and often reminds me that we cost one and a half times more than the non-union guys, so we have to be one and a half times better than them if we want to keep working. This stuff is not just about work: it's about how to work.

Field notes, Company D

Apprenticeship in the non-traditional areas of the electrical trade appears to follow an emergent new model of apprenticeship that allows the simultaneous acquisition of both domain knowledge and domain practices. Employers in non-traditional areas of the trade no longer rely solely on the college to impart domain knowledge to their apprentices, as the apprentices' enactment of both traditional and non-traditional domain practices must already be informed by pertinent domain knowledge. Along with the three steps of modeling, coaching, and fading — effective means for imparting domain practices — journeymen in non-traditional areas of the trade use articulation, exploration of ideas, and reflection to offer apprentices the domain knowledge they need. Employers provide apprentices with domain knowledge within the context of its use: acquisition of domain knowledge and domain practices thus becomes re-integrated into the workplace.

4.4 Summary of findings.

The findings of this study offer answers to each of the research questions that guide the study itself. The first research question — do the disincentives of the current apprenticeship model of entry into the electrical trade outweigh its incentives? — is answered in the positive by the documented disincentives of the current apprenticeship model. The non-linear nature of the learning trajectory, the recurrent layoffs and demotions, and the lack of a specific model of wage determination are the most prominent of the disincentives.

The second research question — do employers and apprentices in traditional and non-traditional areas of the electrical trade make use of the traditional apprenticeship model? — is answered in the negative. The study documents a long-standing deviation away from the traditional apprenticeship model, and towards a model with separate sites for the acquisition of domain knowledge and of domain practices. The study also indicates that the current model of apprenticeship in BC performs relatively well in traditional areas of the electrical trade, and less well in the non-traditional areas of the trade. The study links this observation to three characteristics of traditional and non-traditional areas of the trade:

- Domain knowledge is largely embedded in blueprints in the traditional areas of the trade, while it is dynamically engaged in the non-traditional areas of the trade
- Materials are sturdy and unaffected by rough handling in the traditional areas of the trade, while they are delicate and readily affected by rough handling in the non-traditional areas of the trade
- Performance is digital for installations in the traditional areas of the trade, while it is analog for those in non-traditional areas of the trade.

The third research question — are emergent new models of apprenticeship to be found in non-traditional areas of the electrical trade? — is answered in the positive by observations documenting the use of a new model of apprenticeship in those areas. The apprenticeship model is akin to the cognitive apprenticeship model of Collins et al. (1989), although it is workplace-based rather than classroom-based. The new model makes use of the three components of traditional apprenticeship — modeling, coaching, and fading — but also utilizes these components' cognitive companions — articulation, exploration of ideas, and reflection (Collins et al., 1989). The new model facilitates the workplace-based teaching and learning of both domain knowledge and domain practices.

Chapter 5

Interpretation of findings

This chapter discusses the significance of the findings of the ethnography of apprenticeship that was conducted by the researcher. The chapter unfolds over four sections; each of the first three sections offers interpretations of the findings that address one of the research questions that guide this study. The research question addressed is stated at the beginning of each section. The last section summarizes the chapter.

5.1 *"Do the disincentives of the current apprenticeship model of entry into the electrical trade outweigh its incentives?"* Interpretation of findings.

The findings of this study answer this question in the positive. The disincentives inherent to the current apprenticeship model of entry into the electrical trade both outnumber and outweigh the model's incentives. This observation is consistent with literature on the ongoing shortage of skilled workers in our province, a problem that is seen as stemming in part from the difficulty in recruiting and retaining apprentices (Finlayson, 2002).

The traditional apprenticeship model (Collins et al., 1989) operates most successfully in situations where the mentor is solely responsible for offering the apprentice a relatively small set of domain knowledge and domain practices. This is the case in the traditional apprenticeships served by Coy (1989) under a Kalenjin blacksmith in the Rift Valley of Kenya, and by Lave and Wenger (1991) among the Vai tailors of Liberia. Under these circumstances, the apprentice follows a linear trajectory, without layoffs or demotions, and without loss of employment in order to go acquire domain knowledge away from the workplace. Also, under the circumstances, it is reasonable for the mentor to link the apprentice's wages and date of graduation to hours served, since these would be an adequate marker of the apprentice's progress.

As documented in the previous chapter, however, apprentices in the electrical trade are no longer engaged in a traditional apprenticeship as described by Collins et al. (1989). Under the current model of apprenticeship in BC the apprentice's learning trajectory and apprenticeship trajectory — the apprentice's progression from novice to journeyman — are non-linear. Findings of this study indicate that apprentices often have to work for a number of employers in order to accumulate sufficient work hours to graduate. Also, under the current model, the acquisition of domain knowledge and of domain practices in the electrical trade has become split, as the instruction of apprentices into domain knowledge has been entrusted to colleges.

The separation between the site of acquisition of domain knowledge (college) and that of acquisition of domain practices (workplace) was first introduced in the mid 1930's in order to ensure the highest degree of technical training for apprentices (Crisford, 1936). Initially, the split was only geographical, but not temporal: under the regulated apprenticeship system of the 1930's and 1940's, apprentices acquired domain knowledge at night schools, which they attended at the same time as they acquired domain practices on jobsites by day (Jeffcoatt, 2002). Although this model of apprenticeship moved away from the traditional one, it still retained the synchronous nature of the learning of domain knowledge and domain practices. Decline in apprenticeship enrolment in the 1960's and early 1970's resulted in a dramatic shortage of skilled labour in the late 1970's, which prompted the government of British Columbia to strive to market apprenticeship as being equally important to industrial excellence and productivity as formal schooling and education (Jeffcoatt, 2002). In an attempt to make trade apprenticeships more akin to formal schooling, the government introduced full-time college training periods, giving rise to the current model of apprenticeship.

The introduction of full-time, off-site college training periods resulted in the further distancing between the sites of acquisition of domain knowledge and of domain practices, the workplace and the college becoming separated both geographically and temporally. Furthermore, particularly in the traditional areas of the electrical trade, the introduction of full-time off-site college training resulted in the polarization of what is valued in the workplace and at the college. For apprentices and employers in the traditional areas of the trade, the workplace has become the site where "things get done", while the college has become the site where "things get learned." This study's findings point to a broad underlying assumption at work in the current model of apprenticeship in BC. In the eyes of employers, educators, government, and — to some extent — the apprentices themselves, the identity of an apprentice is one of "worker" while on a jobsite, and "learner" only while in college. While it is true that learning does take place on the job, the players in the current apprenticeship model perceive learning to be only the acquisition of domain knowledge at the college, and not the acquisition of domain practices in the workplace. Thus, the apprentice's identity and needs as a learner are not prioritized in the workplace.

There are some unquestionable advantages to the shift in educational responsibility: as indicated in the previous chapter, most employers in the electrical trade specialize in one or two of its many areas (Companies A and C, for instance, specialized in large industrial installations only). In this respect, colleges are better equipped than most employers to convey domain knowledge about a broad spectrum of areas of the electrical trade. Furthermore, deferring to the college the conveying of domain knowledge partly addresses the concerns expressed by Stasz et al. (1990), and Tan (1989) about employer-centred educational programs, found to be limited in their effectiveness by the employers' primary interest in making a profit.

One of the processes that did not accompany this shift, however, was a review of the mechanism by which an apprentice's wages and credentials are determined. Currently, an employer may choose to link an apprentice's wage and date of graduation to hours worked, in a manner consistent with the traditional apprenticeship model. As reported, this was the case with V., who had completed all her college training, but was still drawing the wages of a fifth-term apprentice. Conversely, an employer may choose to link an apprentice's wage and date of graduation to the apprentice's level of college training. This was the case with K., who worked for years at a frozen wage because he could not afford to step out of the work force to attend college. As these two examples indicate, the current remuneration and credentialing mechanism fails to recognize the existence of different trajectories to an apprentice's mastery of domain knowledge and domain practices. It also gives employers an opportunity to further their own interests over those of apprentices, as employers can pick either hours worked or college standing achieved as the marker to which to link an apprentice's advancement through an apprenticeship. In both of the examples provided, employers chose the marker that allowed them to cap the apprentice's wages.

The other disincentives documented in this study — summarized in Table 5.1 below — largely flow from the separation of the sites of acquisition of domain knowledge and of domain practices. Critically, within the current model of apprenticeship, apprentices face layoffs and financial hardship in order to attend college training periods. They also.

Table 5.1. Summary of incentives and disincentives of the current apprenticeship model of entry into the electrical trade.

INCENTIVES of current apprenticeship model	**DISINCENTIVES** of current apprenticeship model
Entry into a clean, well remunerated trade	Apprentice's learning trajectory includes layoffs and demotions, often takes more than four years to complete
Ability to earn a wage while learning	Apprentice's wages and date of graduation are linked either to hours worked or to college training completed, to the employer's advantage
	Apprentice has to leave employment, travel to a college, and pay tuition in order to attain domain knowledge
	Apprentice often has limited exposure to the many areas of the electrical trade, no mechanism to ensure acquisition of an established set of domain knowledge and domain practices

Because of the disincentives discussed, an apprentice currently working in traditional areas of the electrical trade will typically experience a non-linear apprenticeship trajectory such as that illustrated in figure 5.1 below.

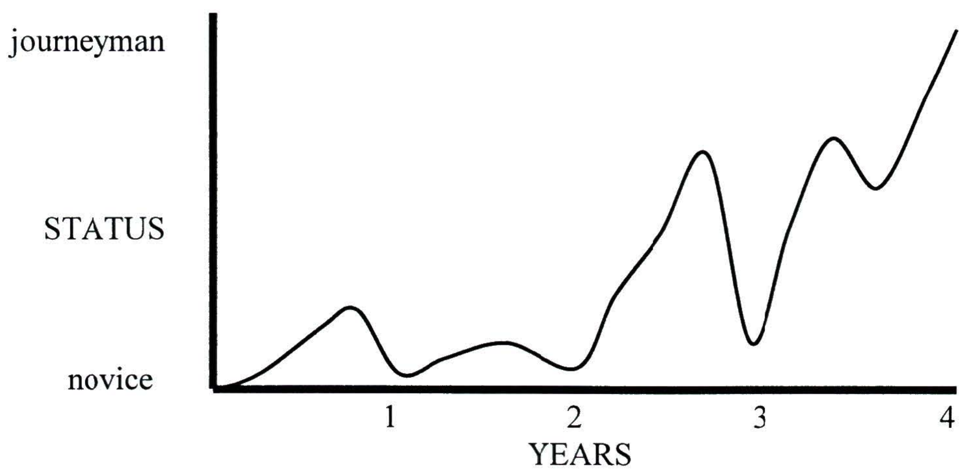

Figure 5.1. Typical apprenticeship trajectory in traditional areas of the electrical trade.

The findings of this study with regard to the first research question indicate that the contend with demotions on rejoining the workforce. Last, the current apprenticeship model does not prioritize the apprentices' identity and needs as learners in the workplace incentives of an apprenticeship into the electrical trade are outweighed by the disincentives. The documented disincentives stem from the temporal and geographical split between the acquisition of domain knowledge and of domain practices — and compound the already problematic non-linear availability of work in the electrical trade. The split has changed the nature of an electrical apprenticeship, creating two streams of learning, one college-based, the other workplace-based. Each stream has its own markers of an apprentice's progress, respectively completion of college training levels, and hours worked (British Columbia Ministry of Advanced Education, 2003 b). The ensuing lack of a clear mechanism by which to determine an apprentice's wages and credentials has left employers free to choose the marker that best allows them to minimize the apprentice's wages. Disincentives stemming from having to attend college training, then, have become compounded in the workplace by low wages and extended timelines to graduation.

5.2 *"Do employers and apprentices in traditional and non-traditional areas of the electrical trade make use of the traditional apprenticeship model?"*

Interpretation of findings.

The findings of this study answer this question in the negative. Collins et al. (1989) identify traditional apprenticeship as the learning trajectory by which an individual gains access to a community of practice through modeling, coaching, and fading. Two factors are central to the effectiveness of traditional apprenticeship: the slow evolution of materials and of practices, and the long one-on-one relationship between a mentor and an apprentice (Coy, 1989). To varying extents, as discussed below, neither traditional nor non-traditional areas of the electrical trade meet these criteria. Furthermore, the current apprenticeship model in BC features a separation between the sites of acquisition of domain knowledge and of domain practices. Together, these factors render the current model of apprenticeship into the electrical trade different from traditional apprenticeship.

5.2.1 Traditional areas of the electrical trade

Findings in this study indicate that, within the traditional areas of the electrical trade, employers and apprentices are no longer engaged in a traditional apprenticeship. Currently, they are concerned primarily with the rapid implementation of directives contained in blueprints. Employers appear less concerned with conveying to apprentices the domain knowledge necessary to independently design an installation because of two factors. First, off-site electrical engineers, already in possession of the necessary domain knowledge, design the installations. Second, apprentices are "sent to school" to acquire domain knowledge. Together, these two factors reinforce the employers' role as teachers of domain practices, rather than teachers of both domain practices and domain knowledge.

Furthermore, as the findings indicate, apprentices often have to set aside the domain knowledge they acquired at the college once they return to the workplace. As illustrated in the field note entry about bending conduit while on a scaffold, there is literally no room once on a jobsite for the use of protractors and calculators. In the traditional areas of the electrical trade, emphasis shifts not only away from the teaching and applying of domain knowledge, but also away from the enactment of domain practices *as taught at the college*. These last are viewed as being too imbued with domain knowledge —

requiring too many measurements and calculations — and, ultimately, as being too slow. This observation is consistent with the findings of Cash et al. (1996) on the emphasis on heuristics that characterizes the workplace.

In this respect, apprentices and employers in traditional areas of the electrical trade find themselves not once, but twice removed from the mentor-learner dynamic that characterizes traditional apprenticeship. Not only do employers surrender their responsibility as teachers of domain knowledge: apprentices must also set aside the domain-knowledge-imbued practices they have learned at the college. The primary role of the employer, then, has become teacher of heuristics, the 'tricks of the trade' that allow for fast — and therefore profitable — implementation of directives. This observation is consistent with the theorizing of Stasz et al. (1990), and Tan (1989) about shortcomings of employer-based training.

With regard to the second research question, then, this study's findings indicate that the traditional areas of the electrical trade could, in theory, be an apt locale for the use of the traditional apprenticeship model. The domain knowledge and domain practices pertaining to electricity as work energy have changed little since their inception, and the materials used are slow evolving, sturdy, and unaffected by rough handling. What has changed in the traditional areas of the trade, however, is the relationship between the worker — be it an apprentice or a journeyman — and the pertinent domain knowledge. Off-site 'experts' (electrical engineers) are now responsible for designing installations through the application of domain knowledge, and more off-site 'experts' (trade college instructors) teach what domain knowledge is still to be possessed by the worker. Domain knowledge, then, becomes the currency of a society of off-site 'experts,' further deepening the divide between what is valued at the college and what is valued by electricians in the workplace. These observations are consistent with the findings of Brown and Duguid (1991), who report that, "Much conventional learning theory, including that implicit in most training courses, tends to endorse the valuation of abstract knowledge over actual practice and, as a result, to separate learning from working, and, more significantly, learners from workers" (Brown and Duguid, 1991, p. 40). Orr (1998, 1990) reports similar findings with regard to the training of reprographic technicians. There, once again, a rift arises between the engineers that design diagnostic manuals, and the technicians in the field. These last often rely on an assortment of heuristics, rather than on the diagnostic manuals, to successfully troubleshoot and repair photocopiers.

The relocation of domain knowledge off-site, and into the hands of 'experts,' has resulted in employers and apprentices in the traditional areas of the electrical trade being cut away from the integration of domain knowledge and domain practices characteristic of the traditional model of apprenticeship. What is left in the workplace is but a ghost of traditional apprenticeship's former self. The three phases of the model — modeling, coaching, fading — are still being utilized, but the subject matter that is being passed on is no longer an integrated blend of domain knowledge and domain practices; rather, it is almost purely heuristics.

5.2.2 Non-traditional areas of the electrical trade

Findings of this study indicate that, in the non-traditional areas of the electrical trade, employers and apprentices utilize a model of apprenticeship that is akin to the traditional one, but also possesses a number of additional features. In non-traditional areas of the trade, domain knowledge is dynamically engaged, materials are delicate and readily affected by rough handling, and installations offer analog performance (NORDX/CDT, 1999). Also, employers and apprentices working in non-traditional areas need to possess and apply domain knowledge in order to effectively perform both traditional and non-traditional practices, and do not rely on the off-site, asynchronous learning of domain knowledge offered by college training periods. Findings of this study indicate that in non-traditional areas of the trade, the learning of domain knowledge becomes re-integrated with the learning of domain practices, and that the site of acquisition of domain knowledge shifts back to the workplace.

Non-traditional areas of the electrical trade are characterized by rapidly evolving materials and practices. In this respect they differ a great deal from the slow-evolving sites of traditional apprenticeship, such as a Kalenjin blacksmith's workshop (see Coy, 1989). However, contrary to the current apprenticeship model in the traditional areas of the electrical trade — in which the split between domain knowledge and domain practices/heuristics is felt most strongly — non-traditional areas of the electrical trade are the milieu for a model of apprenticeship that shares a great deal with the traditional apprenticeship model described by Collins et al. (1989). Along with re-integrating the sites of acquisition of domain knowledge and domain practices into the workplace, employers and apprentices in the non-traditional areas of the electrical trade aim to rapidly maximize the competency of apprentices to journeyman level — yielding an apprenticeship trajectory such as that illustrated in figure 5.2 below.

In non-traditional areas of the electrical trade, then, employers take it upon themselves to offer their apprentices the domain knowledge needed to inform domain practices — rather than relying on the college training periods to do so. This allows

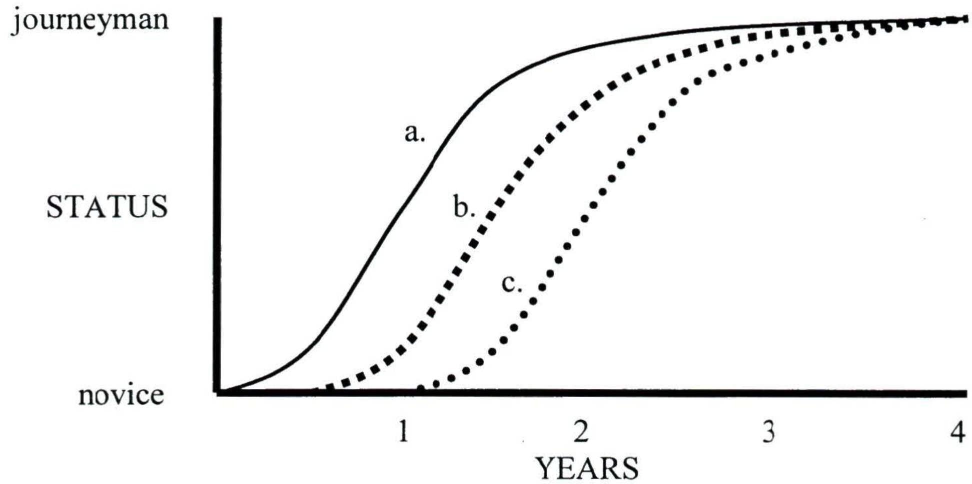

Figure 5.2 Typical apprenticeship trajectory in non-traditional areas of the electrical trade: a. Computerized Building Automation System (CBAS) installation, b. computer cable installation, c. fibre optic installation.

apprentices to quickly perform like journeyed electricians in a given area of practice. Over the course an apprenticeship in non-traditional areas of the trade, employers educate apprentices in as many areas of practice as possible, and bring them to a journeyman-like qualification in each area. As an apprentice acquires journeyman level competency in a given area, the employer recognizes the accomplishment, and offers the apprentice a commensurate level of responsibility and independence. This is also in keeping with the observations of Collins et al. (1989) about the traditional apprenticeship model, in which mentors "fade" as apprentices become established in their competencies.

What differentiates the model of apprenticeship documented in non-traditional areas of the trade from the traditional apprenticeship model (Collins et al., 1989) is the complexity of the domain knowledge needed by workers to inform their domain practices — both traditional and non-traditional. The traditional apprenticeship model relies on the integration of domain knowledge and domain practices through observation and enactment of practices. Conversely, findings of this study indicate that the model of apprenticeship used in non-traditional areas of the electrical trade relies on the externalizing of reasoning to bring domain knowledge to bear on domain practices. These observations are consistent with the findings of Collins et al. (1989) with regard to an alternative model of apprenticeship — one specific to areas of practice that are characterized by complex tasks with multiple potential outcomes.

The findings of this study indicate that employers and apprentices working in non-traditional areas of the electrical trade rely on the traditional model of apprenticeship to a greater degree than those working in traditional areas of the trade. In non-traditional areas of the trade, the site of acquisition of domain knowledge and of domain practices is re-integrated into the workplace. Also, employers and apprentices in non-traditional areas of the trade strive for the apprentice's rapid acquisition of journeyman level competency in a series of areas of practice. The findings, however, still answer the second research question in the negative, in that employers and apprentices in non-traditional areas of the electrical trade do not simply make use of the traditional apprenticeship model. The traditional apprenticeship model would falls short of the needs of apprentices and employers in non-traditional areas of the trade when it comes to the complexity of the domain knowledge and domain practices of those areas — a shortfall of the traditional apprenticeship model recognized by Collins et al. (1989) and by Cash et al. (1996). Instead, employers and apprentices in non-traditional areas of the electrical trade use an expanded version of the traditional apprenticeship model, one that closely matches the cognitive apprenticeship model first described by Collins et al. (1989).

5.3 *"Are emergent new models of apprenticeship to be found in non-traditional areas of the electrical trade?"* Interpretation of findings.

The findings of this study answer this research question in the positive. The findings indicate that, in the non-traditional areas of the electrical trade, employers and apprentices engage in an emergent new model of apprenticeship. The new model, non-traditional apprenticeship, differs from both the current model of apprenticeship and the traditional model of apprenticeship. The non-traditional apprenticeship model differs from the current apprenticeship model in that it re-integrates into the workplace the sites of acquisition of domain practices and of domain knowledge — a feature it shares with the traditional apprenticeship model. The non-traditional apprenticeship model, however, also differs from the traditional apprenticeship model in that it makes use of externalization of reasoning, rather than observation, to facilitate the learning of domain knowledge and domain practices (Collins et al., 1989; Cash et al., 1996).

The findings of this study indicate that employers and apprentices working in the non-traditional areas of the electrical trade need to possess and apply domain knowledge when performing domain practices — both traditional and non-traditional. Non-traditional areas of the electrical trade are characterized by complex domain knowledge, by delicate and fast-evolving materials used, and by the analog performance of the materials once installed. These characteristics place unique demands on apprentices and employers, and on the apprenticeship model in which they engage. At the core of the non-traditional model of apprenticeship documented in this study is the externalization of the thought processes of both apprentice and employer. Findings of this study offer instances of apprentices and employers engaging in exploration of ideas, articulation, and reflection. These steps were observed to act as a corollary to modeling, coaching, and fading, which underlie both traditional and non-traditional apprenticeship models. The findings are consistent with those of Collins at al. (1989), and of Cash et al. (1996), who view modeling, coaching, and fading as necessary for the acquisition of domain practices, and articulation, exploration of ideas, and reflection as necessary for the acquisition and integration of domain knowledge. In this respect, the non-traditional apprenticeship model documented in this study can be seen as an instance of the cognitive apprenticeship model described by Collins et al. (1989).

While the examples of cognitive apprenticeship discussed in current literature rely on a classroom component to the learning environment, the emergent new model of apprenticeship documented in this study actually moves away from reliance on full-time, off-site college training. The non-traditional apprenticeship model documented makes use of the workplace as the site of learning of both domain knowledge and domain practices. Some of the concerns of researchers of cognitive apprenticeship deal with the content, methods, sequencing, and sociology of learning (see for example Cash et al, 1996). In dealing with cognitive apprenticeship applied to the automotive trade, Cash et al. (1996) strive to create learning environments within the college classroom that are reflective of the needs of the workplace. They share in this concern with Berryman et al. (1993), Cope at al (2000), and Lee (2001) about the creation of effective learning environments that are reflective of the 'outside world' where the subject matter learned is to be applied.

The non-traditional apprenticeship model documented in this study addresses the above concerns head-on by integrating into the workplace the learning and enacting of domain knowledge and domain practices. Specifically, with regard to content, the non-traditional apprenticeship documented in this study addresses the four areas deemed necessary by Cash et al. (1996):

- domain knowledge;
- domain practices, including — but not limited to — heuristics;
- cognitive management, such as the ability developed by the apprentice to plan and execute independently one or more days' worth of work, as shown by the researcher's experience installing computerized building automation systems for Company D; and,
- learning strategies, such as the ability developed by the apprentice to associate with each other competencies attained in different areas, as shown by the researcher's experience installing computer cable and fibre optic networks for Companies B and D.

With regard to method, the non-traditional apprenticeship model observed utilizes the six components of cognitive apprenticeship described by Cash et al. (1996), namely modeling, coaching, fading, articulation, exploration of ideas, and reflection. Furthermore, the researcher's findings while working for Company D indicate that the sequencing of the non-traditional apprenticeship model utilizes the increasing complexity and increasing diversity discussed by Cash et al (1996). In this manner, the non-traditional apprenticeship model provides the apprentice with journeyman-level competency in a progressively broader series of areas of practice (recall figure 5.2). Lastly, with respect to the sociology of apprenticeship, the non-traditional apprenticeship model documented meets the requirement by Cash et al. (1996) for the use of situated learning and of practitioner instructors. As illustrated by the researcher's experiences working for Companies B and D, learning in non-traditional electrical apprenticeship occurs in the site of its application — the workplace — under the mentoring of practitioner instructors — namely a journeyed electrician, system managers, technicians, and end users.

The findings of this study indicate that emergent new models of apprenticeship are to be found in non-traditional areas of the electrical trade, thus answering the third research question in the positive. The non-traditional model of apprenticeship documented in this study, an example of such new models, can also be considered to be an emergent form of the cognitive apprenticeship model first described by Collins et al. (1989).

5.4 Summary of interpretations.

In summary, the findings of this study provide answers to each of the research questions that guided the study. The first research question — do the disincentives of the current model of entry into the electrical trade outweigh its incentives? — was answered in the positive by evidence that points to far more consequential disincentives than incentives. The disincentives appear to stem from the current separation of the sites of acquisition of domain practices (workplace) and of domain knowledge (college). The separation requires apprentices to leave their jobs to attend college, causing apprentices to face layoffs, demotions, increased costs, and reduced earnings. The separation also induces employers, especially in the traditional areas of the electrical trade, to defer the role of educators to the instructors at the college. It also allows employer to use to their advantage the current variable standards for establishing the remuneration for apprentices. Overall, the disincentives cause the learning trajectory of apprentices to become highly non-linear (recall figure 5.1), and often to stretch over more than the theoretical four-year length of an electrical apprenticeship.

The second research question — do employers and apprentices in traditional and non-traditional areas of the electrical trade make use of the traditional apprenticeship model? — was answered in the negative. The findings of this study indicate that apprenticeship in all areas of the electrical trade utilizes a model — current apprenticeship — that differs from traditional apprenticeship in that the sites of acquisition of domain practices and domain knowledge are separate. In the traditional areas of the electrical trade, employers and apprentices still utilize modeling, coaching, and fading for the workplace acquisition of domain practices. However, they rely largely on yearly training periods at a college for the acquisition of domain knowledge. In the non-traditional areas of the electrical trade, employers and apprentices further modify the current apprenticeship model, as they strive to re-integrate into the workplace the sites of acquisition of domain practices and of domain knowledge. Also, employers in non-traditional areas of the trade rapidly train apprentices to journeyman-like competence in a sequence of areas of practice (recall figure 5.2). In this respect, apprenticeship in the non-traditional areas of the electrical trade is somewhat akin to the traditional apprenticeship model. However, it does differ from the traditional apprenticeship model in that employers and apprentices utilize novel ways of exchanging the complex and often fast evolving domain knowledge characteristic of these areas.

The third research question — are emergent new models of apprenticeship to be found in non-traditional areas of the electrical trade? — was answered in the positive. This study presents evidence of a new model of apprenticeship — non-traditional apprenticeship — being used by employers and apprentices working in non-traditional areas of the electrical trade. Non-traditional apprenticeship re-integrates into the workplace the acquisition of both domain knowledge and domain practices, and strives to sequentially bring apprentices up to journeyman-like competence in an expanding number of areas of practice. Also, non-traditional apprenticeship uses modeling, coaching, and fading in conjunction with their cognitive companions, namely articulation, exploration of ideas, and reflection. The non-traditional apprenticeship model documented by the researcher while working in non-traditional areas of the electrical trade can be considered to be an emergent form of cognitive apprenticeship, as described by Collins et al. (1989).

The findings of this study, then, provide answers to each of the research questions that guided the study itself. The next chapter draws on these findings to formulate recommendations for the design of a trade apprenticeship model that reduces the disincentives and minimizes the non-linearity of the current model of apprenticeship.

Chapter 6

Recommendations and conclusions

This study offers an insider's view of apprenticeship into the electrical trade in British Columbia. The data garnered by the researcher show that learners serving a trade apprenticeship encounter disincentives that outweigh the incentives potentially offered by a "learn and earn" scheme (see Industry, Training and Apprenticeship Commission, 2001). The data also point to a reduced reliance on the current model of apprenticeship in the non-traditional areas of the electrical trade. Last, the data indicate that in non-traditional areas of the electrical trade, learners and their mentors engage in a model of apprenticeship that unfolds simultaneously in the practice-based and the cognition-based realms of apprenticeship.

The emergent cognitive apprenticeship model documented by the researcher in non-traditional areas of the electrical trade succeeds in reducing the disincentives and the non-linearity currently associated with serving a trade apprenticeship. At this time, the success of the model is limited by the fact that the emergent cognitive apprenticeship still operates within the context of the current regulatory model of apprenticeship in British Columbia. As the current regulatory model of apprenticeship in BC comes under review, however, the emergent cognitive apprenticeship model documented in this study offers valuable lessons for the reshaping of trade apprenticeship in this province. Specifically, the core of the success of the emergent apprenticeship model rests in the relationship established between employer and apprentice. Apprenticeship in British Columbia is currently in the midst of transition, with an emphasis on increasing the private sector's ability to shape the training process to meet industry needs (British Columbia Ministry of Advanced Education, 2003 b). Thus, the employer-driven apprenticeship model documented in this study has the potential to serve as a template for apprenticeships across the province.

Future models of apprenticeship in BC would benefit from re-integrating the site and time of acquisition of domain practices and domain knowledge — effectively doing away with the current college-based training periods, and with the need for apprentices to leave employment and attend college in order to acquire domain knowledge. This would be achieved through employers taking on a greater role in educating apprentices, as is the case in the non-traditional areas of the electrical trade. Employers and apprentices would then use modeling, coaching, and fading to exchange knowledge of domain practices. They would also use articulation, exploration of ideas, and reflection — cognitive companions to the three components of traditional apprenticeship — to exchange domain knowledge, and to integrate it into domain practices in the workplace.

Future models of apprenticeship would benefit from enhancing the apprentice's acquisition of domain knowledge through the use of computer-based training. This would replace the spiral learning of domain knowledge that apprentices currently experience in college with workplace access to on-line reference materials. The materials would make available to the apprentice all the domain knowledge pertinent to individual areas of practice — when and where the domain knowledge is needed to inform the enactment of a domain practice. For example, an apprentice and an employer could sit down at a computer the day before engaging in a domain practice new to the apprentice, and obtain the relevant domain knowledge. The apprentice could again access the information via a laptop computer while enacting the domain practice, and could revisit it afterwards to debrief the relationship between domain knowledge and domain practice.

Future models of apprenticeship would also benefit from maximizing the apprentices' ability to sequentially achieve journeyman-like competence in each area of practice of a given trade. In a manner similar to that documented in this study, apprentices and employers would work together at ensuring that apprentices come to possess all the domain knowledge and domain practices necessary to work at a journeyman-like level in a progressively expanding number of areas of practice (recall figure 5.2). The domain knowledge made available on-line would contain, in one site, all the material necessary for an apprentice to acquire journeyman-like competence. Concurrently, employers would ensure that apprentices receive experience in all aspects of the domain practices of a given trade. This would ensure that future models of apprenticeship rapidly create apprentices possessing journeyman-like ability in an expanding range of areas of practice — a notion that contrasts with the current spiral learning model of acquisition of domain knowledge, and the current hit-and-miss, unregulated exposure to domain practices.

In summary, this study makes three recommendations for the design of future models of workplace-based apprenticeship in British Columbia:

1. Re-integrate into the workplace the acquisition of both domain knowledge and domain practices;
2. Enhance workplace delivery of domain knowledge through comprehensive on-line reference materials; and,
3. Offer apprentices rapid and sequential acquisition of journeyman-like competence in each area of practice of a given trade.

If implemented responsibly, workplace-based models of apprenticeship could not only address the non-linearity of the current apprenticeship model — as discussed above — but could also reduce the disincentives currently associated with apprenticeship in

British Columbia. Primarily, unifying into the workplace the sites of acquisition of domain practices and domain knowledge would do away with the loss of income and the reduced job security that apprentices experience when they leave paid work to attend college. Also, in a workplace-based model of apprenticeship, apprentice wages could be linked directly to competence rather than to hours served or to college training completed — neither of which is a measure of what the apprentice can actually do. When working in areas where the apprentice has acquired journeyman-like competence, the apprentice would draw journeyman wages. In areas where the apprentice is still in training, the apprentice would draw a lower wage. Both apprentice and employer would be motivated to rapidly expand the areas of practice in which the apprentice holds journeyman-like competence. An apprentice would strive for journeyman-like competence, since it would merit a higher wage. An employer would be motivated to provide an apprentice with journeyman-like competence as the apprentice could then work under greatly reduced supervision — whereas currently a journeyman must be present to supervise the apprentice, regardless of the apprentice's competence in any particular area. Lastly, phasing out periods of college training would contribute to a seamless relationship between employer and apprentice This type of relationship would increase the apprentice's job security, as it would not be necessary to leave work to attend college. In addition, it would improve the employer's ability to retain the apprentice during and after the apprenticeship — securing a return on the educational investment they have made.

In conclusion, this study offers insights into the current model of apprenticeship in British Columbia that are only available to the participant observer. The study documents first-hand the incentives and disincentives of the current model of apprenticeship in BC.

It also illustrates the different degrees to which employers and apprentices in traditional and non-traditional areas of the electrical trade rely on the traditional apprenticeship model. Lastly, the study provides evidence of the emergence of a new model of apprenticeship in the non-traditional areas of the electrical trade. The emergent model is recognizable as an example of cognitive apprenticeship, as described by Collins et al. (1989). The emergent model can provide a guide for the design of future apprenticeship models for British Columbia that alleviate some of the problems encountered at this time by learners and employers engaged in a trade apprenticeship. Also, through generalization, the emergent model may find beneficial applications in other areas of the construction trades, and in professional fields including — but not limited to — education, nursing, and jurisprudence. These possibilities merit further investigation.

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